A Study of

the Computerisation of

Primary Health Care

by

Steven Mark Di Ponio

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SUMMARY

THE COMPUTERISATION OF PRIMARY HEALTH CARE

Steven Mark Di Ponio

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Primary health care consists of independent health professionals, who are contracted to provide general medical, pharmaceutical, dental and ophthalmic services. Patients have substantially more contact with primary health care than with secondary care.

The benefits of collecting information across the health services have long been apparent. All contacts with patients in secondary care are routinely recorded, while little data are recorded from primary health care despite the greater number of contacts.

Data in primary health care are potentially more comprehensive than that of secondary care, allow individual patient information to be linked and provide a health profile of the whole population.

The main barrier to the exploitation of data in primary health care is the absence of computers in many practices. Other barriers are the absence of standards for data and classification systems, the accuracy of computer captured data, concern over the confidentiality of data beyond practice and interprofessional barriers.

There is a need to coordinate and manage the computerisation of health care. To this end a Steering Group comprising representatives from health professionals, service managers, computer system suppliers and patients should be appointed. Its terms of reference would be to define minimum data that should be collected in each profession and to lay down specifications for computer systems in primary health care.

In addition, Family Health Services Authorities should provide advice and training to assist practitioners installing computers. Pilot trials are needed to explore different mechanisms of sharing data between the health professions. Representatives from the four professions should meet to decide which items of data need to be shared among practitioners.

The collection of information across the whole health service will greatly increase the efficiency of the service and the sharing of data among practitioners would enable the patient to be treated more effectively by all the health professions.

Key words

Primary health care, Information, Computers, Family Health Services Authorities, Networking.

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DEDICATION

To my parents,
for my education.

THE COMPUTERISATION OF PRIMARY HEALTH CARE

LIST OF CONTENTS

PAGE

SUMMARY 2

ACKNOWLEDGEMENTS 3

DEDICATION 4

LIST OF CONTENTS 5

LIST OF FIGURES 11

LIST OF TABLES 12

LIST OF APPENDICES 13

LIST OF ABBREVIATIONS USED IN THE TEXT 14

Chapter 1. PRIMARY HEALTH CARE: DEFINITIONS 15

1.1 Overview: primary health care computing worldwide 17
1.1.1 Computers in America and Australia 17
1.1.2 Computers in Scandinavia 18
1.1.3 Computers in the developing world 21
1.1.4 Primary health care computing in Great Britain 22
1.1.4.1 Computers in general medical practice 23
1.1.4.2 Computers in community pharmacy 25
1.1.4.3 Computers in general practice dentistry 26
1.1.4.4 Computers in optometry 29
1.2 Background to the Project 31
1.3 Information from primary health care 34
1.3.1 General medical practice 34
1.3.2 Community pharmacy 35
1.3.3 General dental practice 36
1.3.4 Optometrists and ophthalmic opticians 36

Chapter 2. PRIMARY HEALTH CARE NETWORKING IN GREAT BRITAIN 38

2.1 Prescription Pricing Authority linkage: pilot trial 40
2.2 Family Health Services Authorities Linkage: pilot trial 41
2.3 Dental Practice Board linkage: pilot trial 42
2.4 Electronic communication and optometry 43
2.4.1 Electronic ordering 43
2.4.1.1 Optometry 44
2.4.1.2 Community pharmacy 45
2.5 Vertical and horizontal data flows 45
2.5.1 Existing records 46
2.6 Smart cards 48
2.6.1 Smart cards and patient medication records 49
2.6.2 Smart cards beyond primary health care 50
2.6.3 Administrative verses clinical data 52

2.6.4 Evaluation of smart card trials 53
2.7 Patient registration 53
2.8 Population registers 54
2.9 Information systems in primary health care 56
2.9.1 G PASS 56

Chapter 3. CONFIDENTIALITY, SECURITY AND DATA PROTECTION 59

3.1 Security of computer data 59
3.2 Confidentiality 61
3.2.1 Confidentiality of data beyond practice 64
3.3 The Data Protection Act 66
3.3.1 Accuracy of data in the Family Health Services 68
3.4 Data ownership in general practice 72

Chapter 4. STANDARDS IN PRIMARY HEALTH CARE 75

4.1 Classification and coding of disease 75
4.2 International Classification of Diseases 77
4.2.1 International Classification of Primary Care 77
4.2.2 Royal College of General Practitioners Classification Scheme 78
4.2.3 Prescription Pricing Authority Classification Scheme 78
4.2.4 The Read Classification Scheme 79
4.3 Standards in primary health care 81
4.3.1 Communication and Open Systems Interconnection 82
4.3.2 Standards for data 83
4.3.3 Information systems 84

Chapter 5. COST BENEFIT AND COST EFFECTIVENESS 86

5.1 Cost Benefit analysis in America 88
5.2 Viewpoints in cost effectiveness 89
5.3 Cost benefit analysis of computers in Britain 90
5.3.1 Medical practice 90
5.3.2 Cost Benefit of computers in pharmacy 91
5.3.3 Prescribing 92
5.4 Effects of remuneration 93
5.4.1 General practice 93
5.4.2 Community pharmacy 94
5.4.3 Single user and multi-user computer systems 95
5.4.4 Funding general practice computers 96
5.4.5 The internal market and general practice computing 97
5.4.6 Cost benefit of computers in optometry and dentistry 98
5.4.7 Conclusion 98

Chapter 6. RESEARCH METHODOLOGY 100

6.1 Introduction 100
6.2 Published literature 100
6.3 Questionnaires 101
6.3.1 Sampling the population 105
6.3.2 Data analysis 105

Chapter 7. RESEARCH INTRODUCTION 106

7.1 General practice 106
7.2 Community pharmacy 108
7.3 General practice dentistry 110
7.4 Optometry 113
7.5 The Family Health Services Authorities 114

Chapter 8. COMPUTERS IN GENERAL MEDICAL PRACTICE 116

8.1 Method 116
8.2.1 Objectives 116
8.2.2 Hypotheses 107
8.3 Results 117
8.3.1 Response to the Pilot 117
8.3.2 Computer use and non use in general practice 118
8.3.3 Data entry 119
8.3.4 Response to the PHCSG survey 120
8.3.4.1 The practices 120
8.3.5 Information for GPs 121
8.3.6 Regional advisors 122
8.3.7 Computer systems 123
8.3.8 Morbidity coding 125
8.3.9 Support and help available 126
8.3.10 Staff impact 126
8.3.11 Training courses 127
8.3.12 Practice research 129
8.3.13 Security and confidentiality 129
8.3.14 Electronic communication and data sharing 131
8.4 Discussion 137
8.5 Conclusions 144

Chapter 9. COMPUTERS IN COMMUNITY PHARMACY 145

9.1 Method 145
9.1.1 Objectives 145
9.1.2 Hypotheses 146
9.2 Results 146
9.2.1 The pharmacies 146
9.2.2 Computer systems 147
9.2.3 System installation 149
9.2.4 Computer applications 149
9.2.4.1 Labelling 150
9.2.4.2 Stock control and ordering 151
9.2.4.3 Drug interactions 152
9.2.4.4 Patient medication records 153
9.2.4.5 Other applications 154
9.2.5 Pharmacists' expectations of computer systems 154
9.2.6 Pharmacists' attitudes to information technology 156
9.2.7 Smart Cards 163
9.3 Discussion 167
9.3.1 Computers in pharmacy 167
9.3.2 Electronic communication and pharmacy 169
9.3.3 Card based solutions 170

9.3.4 Cluster based approach 171
9.3.5 Coding systems 173
9.4 Conclusions 173

Chapter 10. COMPUTERS IN GENERAL PRACTICE DENTISTRY 175

10.1 Method 175
10.1.1 Research objectives 175
10.1.2 Hypothesis 176
10.2 Results 177
10.2.1 Respondents and practices 177
10.2.2 Computer systems 177
10.2.3 Computer applications 180
10.2.4 Barriers to computer use 182
10.2.5 Information for dental practitioners 183
10.2.6 Information needs 185
10.2.7 Meeting information needs 185
10.2.8 Sources of information 187
10.2.9 Electronic data exchange 188
10.3 Discussion 189
10.4 Conclusions 196

Chapter 11. COMPUTERS IN OPTOMETRY 197

11.1 Method 197
11.1.1 Objectives 197
11.1.2 Hypothesis 198
11.2 Results 198
11.2.1 Practices 198
11.2.2 Computer systems 199
11.2.3 Computer applications 202
11.2.4 Electronic communication 205
11.3 Discussion 208
11.4 Conclusions 212

Chapter 12.

COMPUTERS IN THE FAMILY HEALTH SERVICES AUTHORITIES 214

12.1 Method 214
12.1.1 Objectives 214
12.1.2 Hypothesis 215
12.2 Results 215
12.2.1 Computer systems 215
12.2.2 Family Health Services Authorities services 216
12.2.3 Computer Records in general practice 219
12.2.4 Electronic communication 219
12.2.5 Management information 222
12.2.6 Community index 224
12.2.7 Smart cards 225
12.2.8 The Family Health Services Authorities network 227
12.3 Discussion 231
12.3.1 Management information 233
12.3.2 Screening 234

12.3.3 The network 234
12.4 Conclusions 236

Chapter 13. COST-BENEFIT OF COMPUTERS IN PHARMACY 237

13.1 Method 237
13.1.1 Objectives 237
13.1.2 Hypotheses 238
13.2 Results 238
13.3 Discussion 242
13.4 Time Series analysis of prescription data 245
13.4.1 Method 245
13.4.2 Results 248
13.4.3 Criticisms of the model 254
13.4.4 Improvements to the model 255
13.5 Conclusions 256

Chapter 14. DISCUSSION 257

14.1 PRIMARY HEALTH CARE IN THE NATIONAL HEALTH SERVICE 257

14.1.1 Payment for services 259
14.2 CORPORATE INFORMATION 263
14.3 INFORMATION COLLECTION IN THE NATIONAL HEALTH SERVICE 265
14.3.1 Information at different levels 266
14.4 DATA IN PRIMARY HEALTH CARE 268
14.4.1 Medication data 268
14.4.2 Morbidity data 268
14.4.3 Administrative data 269
14.4.4 Information exchange in primary health care 271
14.5 THE GENERAL APPLICATION OF COMPUTERS 272
14.5.1 Linking files 273
14.5.2 Microcomputers 274
14.5.3 Computer usage in primary health care 275
14.5.4 Computer networks 276
14.5.5 Standards 277
14.6 NETWORKING OF THE FAMILY HEALTH SERVICES 279
14.6.1 The Family Health Services Authorities 279
14.6.2 The Dental Practice Board 279
14.6.3 The Prescription Pricing Authority 280
14.6.5 Exploiting Prescription Pricing Authority data 280
14.7 BARRIERS TO EFFECTIVE COMPUTERISATION IN PRIMARY HEALTH CARE 282
14.7.1 LOW NUMBERS OF COMPUTERS 283
14.7.1.1 Reasons for low usage 283
14.7.1.2 Consequences of low usage 284
14.7.1.3 Promoting computer use 284
14.7.1.4 The benefits of a common system 285
14.7.1.6 The benefits of a range of systems 285
14.7.2 DATA ITEMS CAPTURED BY COMPUTER SYSTEMS 288
14.7.2.1 A Steering Group for primary health care 289
14.7.3 CLASSIFICATION SYSTEMS 291
14.7.3.1 Classification systems in primary health care 291

14.7.3.2 Extending Read classification schedules 292
14.7.4 DATA OWNERSHIP 294
14.7.5 DATA ACCURACY 296
14.7.5.1 Improving the accuracy of data 296
14.7.6 THE DATA PROTECTION ACT 298
14.7.6.1 Complying with the Data Protection Act 299
14.7.7 CONSTRAINTS OF EXISTING COMPUTER SYSTEMS 301
14.7.7.1 Improving computer systems 301
14.7.8 TRAINING FOR PRIMARY HEALTH CARE 303
14.7.8.1 Computer system suppliers 303
14.7.8.2 Academic institutions 304
14.7.8.3 The Family Health Services Authorities as a manager of training 303
14.7.8.4 Professional organisations 305
14.7.8.5 The benefits of training 306
14.7.9 CONFIDENTIALITY 307
14.7.10 INTERPROFESSIONAL BARRIERS 308
14.8. INFORMATION EXCHANGE AND PRIMARY HEALTH CARE 309
14.8.1 Smart cards 309
14.8.2 Centrally held indexes 311
14.8.3 Computer to computer communication 313
14.8.4 Universal patient registration in primary health care 314
14.8.5 Using more than one approach 315
14.8.6 Investigating the alternatives 316

15. CONCLUSIONS 318

16. RECOMMENDATIONS 321

17. LIST OF REFERENCES 323

18. APPENDICES 337

LIST OF FIGURES

Figure 1. Primary health care.	16
Figure 2. Data flows in primary health care.	37
Figure 3. Pharmacists' expectations of computer systems.	155
Figure 4. Time series analysis output. PMR pharmacy.	249
Figure 5. Time series analysis output. PMR pharmacy.	250
Figure 6. Time series analysis output. Non PMR pharmacy.	251
Figure 7. Time series analysis output. Non PMR pharmacy.	252
Figure 8. The Hierarchy of the NHS.	258
Figure 9. The Health Service by Patient Contacts	260
Figure 10. Data flows for remuneration.	261
Figure 11. Horizontal and vertical flows in PHC.	262

LIST OF TABLES.

Table 1.	Non acquisition of computer by GPs.	118
Table 2.	Computer systems in general practice.	123
Table 3.	Training needs in general practice.	128
Table 4.	Electronic links and general practice.	132
Table 5.	Computer systems in community pharmacy.	147
Table 6.	Date of installation of computer systems.	149
Table 7.	Applications in community pharmacy.	150
Table 8.	Computer systems in dental practice	178
Table 9.	Computer applications.	181
Table 10.	Reasons for non-acquisition of a computer.	182
Table 11.	Subject evaluation.	185
Table 12.	Methods of information dissemination.	186
Table 13.	Evaluation of printed information.	187
Table 14.	Computer systems in optometry.	201
Table 15.	Data from general practice.	222
Table 16.	Electronic communication and the FHSA network.	227
Table 17.	PMRs and patient loyalty.	240
Table 18.	Residual variation.	253
Table 19.	Barriers to computerisation.	282
Table 20.	Increasing Computer Usage.	284

LIST OF APPENDICES

APPENDIX 1.1 PHCSG Questionnaire. 337
APPENDIX 1.2 PHCSG Covering letter. 342
APPENDIX 2.1 Community pharmacy Questionnaire. 343
APPENDIX 2.2 Community pharmacy Covering letter. 347
APPENDIX 3.1 Dental practice Questionnaire. 348
APPENDIX 3.2 Dental practice Covering letter. 353
APPENDIX 4.1 Optometrist Questionnaire. 354
APPENDIX 4.2 Optometrist Covering letter. 356
APPENDIX 5.1 FHSA Questionnaire. 357
APPENDIX 5.2 FHSA Covering letter. 361
APPENDIX 6.1 Cost-effectiveness Questionnaire. 362
APPENDIX 6.2 Cost-effectiveness Covering letter. 366
APPENDIX 6.3 Time series analysis model code. 367
APPENDIX 6.3.1 Seasonal component values. 372
APPENDIX 6.3.2 Morbidity component values. 373
APPENDIX 6.3.3 Model data. 374

LIST OF ABBREVIATIONS

BCS - British Computer Society.
BDA - British Dental Association.
BMA - British Medical Association.
RCGP - Royal College of General Practitioners.
DEB - Dental Estimates Board.
DHA - District Health Authority.
DHSS - Department of Health and Social Security.
DoH - Department of Health.
DPB - Dental Practice Board.
FHSA - Family Health Services Authorities.
FHS - Family Health Services.
FPC - Family Practitioner Committee.
G PASS - General Practice Administrative System for Scotland.
GP - General Practitioner.
GPFH - General Practice Fund Holder.
ISO - International Standards Organisation.
IT - Information Technology.
MSC - Manpower Services Commission.
OSI - Open Systems Interconnection.
OTC - Over the Counter.
PHC - Primary Health Care.
PHCSG - Primary Health Care Specialist Group.
PMR - Patient Medication Records.
PPA - Prescription Pricing Authority.
RHA - Regional Health Authority.
UK - United Kingdom.
VAMP - Value Added Medical Products.
WONCA - World Health Organisation and the World Association of National Colleges, Academies and Academic Associations of General Practitioners and Family Physicians.

Chapter 1. PRIMARY HEALTH CARE: DEFINITIONS

There is no universally agreed definition of primary health care (PHC). Some consider that PHC can be defined as "the first level of contact of individuals, the family, and the community with the national health service, bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process" [1].

The World Health Organisation (WHO) see primary health care as bringing together primary, secondary, and tertiary levels of care, including prevention, health promotion, and diagnostic and curative services, rehabilitation and after care [2]. This is because the patient makes contact initially with primary health care practitioners, who may then either treat the patient or refer to a practitioner of secondary care. After treatment by a specialist in secondary or tertiary care, the patient is discharged and his well being is the responsibility of the primary health care practitioner.

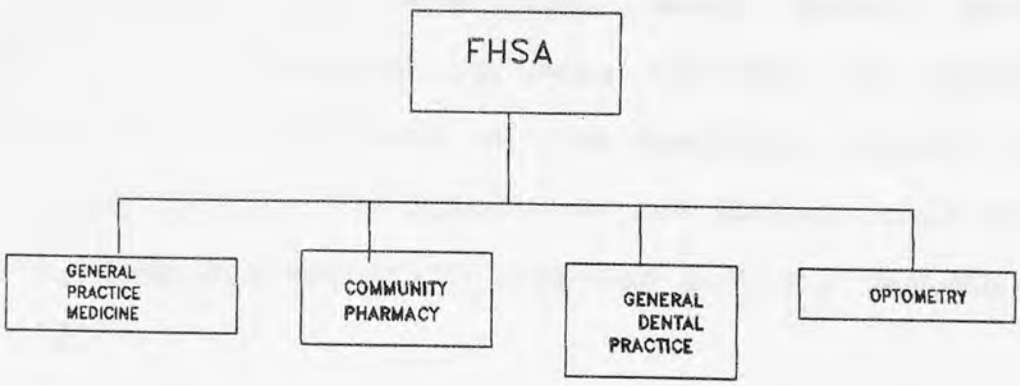
In Britain, the services described above are provided either by practitioners, who are members of health care professions and normally enter into contracts with Family Health Services Authorities (FHSAs) or Health Boards in Scotland, or by professional staff employed directly by Health Authorities [3].

For the purposes of this project a distinction is drawn between primary health care and what can be termed community health care, which includes nursing and paramedical staff [4].

It is recognised that the distinction between primary health and community health care can sometimes be so fine as to be virtually indistinguishable [5]. This is because para medical professionals such as practice nurses often form a part of general medical practice and consequently primary health care.

For practical purposes this project considers primary health care to be care provided by independent practitioners under the Family Health Services Authorities (FHSAs) i.e. general medical practitioners (GPs), general dental practitioners (GDPs), community pharmacists and ophthalmic opticians (optometrists). All of these practitioners have to balance both business and care aspects of their practices. **Figure 1** illustrates the structure of primary health care in Britain as defined in this research.

Figure 1. Primary health care.



1.1 Overview: primary health care computing worldwide

The design of computer systems in primary health care reflects the environment in which they operate. Systems vary considerably between countries where health care is paid for by the state and those where the cost of health services is met predominantly by the patient or private insurance.

1.1.1 Computers in America and Australia

As a consequence of the commercial nature of health care in America, practice management applications such as billing are more likely to be computerised than clinical applications such as medical records [6]. Pressure on practitioners in the USA to automate has largely come from insurance companies, as electronic billing cuts their costs by reducing the amount of work the insurance company handles [7]. Most computerised medical offices in America therefore do billing only or tasks directly related to billing [8].
A similar situation exists in Australia, where software for various billing and management functions has been available commercially for more than seven years. Although the majority of computer software suitable for primary health care has concentrated on the business aspects of private medical care at the expense of the patient care applications [9], some systems which comprise medical records also exist [10].

1.1.2 Computers in Scandinavia

In a marked contrast to the situation in America and Australia are the Scandinavian countries, where the patient does not pay for any services and the state has an active involvement in health care. The systems which operate here have been developed by the state and place greater emphasis upon patient records and improved care, rather than the commercial aspects of medical practice.

Norway, Finland, Denmark and Iceland have all developed their own computerised systems which are described by Hasvold [11], Hosia [12], Krogh-Jensen [13] and Sigurdsson [14] respectively. A common aim behind all these systems is the improvement of patient care and the provision of a state information system, which is achieved through a standardized patient record.

Sigurdsson [14] describes the Icelandic medical record system and lists the benefits as -

1) a valuable aid in the treatment of patients, which improves the quality of treatment.

2) a useful source of information of the health of the population, which among other things makes possible the identification of those at special risk e.g. hypertensive patients.

3) a good instrument for research and teaching.

4) a useful source of statistics on the primary care services.

An Icelandic health centre using this system has been successful in recording a basic set of data on all contacts taking place since 1976 and linking these data to the national register data for the population in the district. This is important because it is possible that information from hospitals can also be related to this register data. Thus data from primary and secondary care can be linked and all the events in a patients life brought together. An evaluation of secondary care treatments is then possible, as is looking for associations between any two events for epidemiological purposes.

Hasvold [11] gives details of a Norwegian system developed at the University of Tromso in cooperation with the District primary health care physicians of Balsfjord. Although the main aim is to create a medical record system adjusted to general practice, two statistical systems are included in the program. One is based on data from the encounters, and the other is a search and statistical system based on the individual record as a unit.

Krogh-Jensen [13] describes a system which is set to be the future standard record system for Danish general practitioners. The system consists of nineteen modules with a medical record at its heart containing information on allergies and interactions, a review of the life history, current medication, the full text of the medical record for the last three encounters as well as recent recordings of key figures such as blood pressure or weight. Other modules

include prescribing, appointments, a register of complaints, diagnosis and therapy with classifications, accounting and billing, statistics and a text editor as well as the facility for online searching.
Hosia [12] describes a system which is operational in Finland, having been developed in cooperation between Kuopio University and the health centre at Varkaus. The system is based on the American system COSTAR (COmputer STored Ambulatory Records) and was named Finstar as it is the Finish derivative of the American system. The medical record can be displayed as an overall summary of patients problems, medications, laboratory results, etc. A pre-defined follow up report of a certain problem is possible and the information can be looked at on a visit by visit basis. Registration information held on the system is obtained annually from the National Population Register Office in Helsinki. Only registration information about patients who have moved intc the area or the newborn are entered manually. For these categories data can be entered in either of three ways: by filling in an encounter form or dictating onto tape and forwarding to the typist or directly from the physicians own terminal. The system has been accepted well by different professional groups and little time (2-8 hrs.) is needed to teach the newcomer the systems basic functions. The system has improved the transport of information to different parts of the health service as regards speed and reliability.

The potential for improving communication facilities has not been taken up in Norway [11], where, due to confidentiality considerations,the system is limited to the health centre only, without any links to outside data centres. Thus there are different approaches to the issue of confidentiality of data within the Scandinavian countries.

1.1.3 Computers in the developing world

The application of microcomputers in PHC in the developing world has also been recognised [15], in that they can support more reliable information systems which allows better analysis and can lead to more cost efficient management. Given the ever increasing power of microcomputers at relatively low cost many African and Asian countries including Uganda and Kenya, Burma, Thailand, Pakistan, Bangladesh, are now utilizing technology to assist the management of primary health care. This is achieved by health workers in the community collecting data manually on forms, which are then entered into the computer by trained computer operators.

The main areas of application are in area census, primary health care databases, health surveillance, supply inventories, word processing and supporting special studies e.g. surveys. The main problems encountered were difficulties in obtaining hardware and replacement parts in a reasonable time, training computer operators to a high enough standard and problems in giving feedback to the health workers on the ground. This resulted in less enthusiasm for the system and a consequent reduced quality of data collection.

1.1.4 Primary health care computing in Great Britain

The British system of primary health care lies somewhere between those of America and Scandinavia and the computer systems which have developed have facilities for both business administration and clinical records. As a result of the different structure of health care provision in Britain, the professions have different needs in terms of computer systems. Despite this, many of the problems and issues revealed in primary health care computing internationally are also apparent in Britain. These include -

* The relative benefits of a centrally planned approach to computing, compared with a market-led approach.
* The need to balance care with commercial aspects of practice in a system.
* The need to link data gathered in primary health care with data from secondary health care.
* The problem of ensuring that the data collected is accurate.
* The need to balance the benefits of electronic communication with the risk to patient confidentiality inherent in networked systems.

1.1.4.1 Computers in general medical practice

Reports of computers in general medical practice go back to the late sixties [16] and a research project which sought to make the GP the focus of an integrated medical record, accessible by hospital and nursing staff during inpatient and outpatient treatments was supported by the then Department of Health and Social Security (DHSS) in 1969. In 1980 reports commissioned by the Royal College of General Practitioners (RCGP) [17] and the British Medical Association (BMA) [18] were published, both of which urged a cautious take up of computers in general practices and gave some advice to GPs who were considering the acquisition of a computer. Progress was relatively slow, until further impetus came in 1982, which was designated Information Technology Year, when the Government launched the Micros for GPs scheme [19]. Under this scheme, which cost the Government £2.5m, 150 general practices were able to claim back half the cost of a computer system, provided that the practices purchased either the CAP (UK) Limited or British Medical Data Systems (BMDS) system. In the event 140 practices were involved in the scheme. Some withdrew due to financial reasons, others because the computer systems available failed to meet their needs. A scheme such as this was recommended by the Scicon Report, in order to generate interest in general practice computing [18]. The results of the scheme were published in 1986. Unfortunately, neither

CAP nor BMDS are now active in the primary care market and practitioners who purchased these systems will be unable to update their existing systems. The acquisition of a more modern system from another supplier will require that the practice enters large amounts of patient data manually for the second time.

The number of computers in general practice received a boost with the introduction of two schemes by AAH Meditel and Value Added Medical Products (VAMP) Health in May 1987 [20]. GP's were provided with multi-user practice management systems, where the cost of the system was compensated by the GP providing prescribing and morbidity data to the system supplier. This data can then be sold to the pharmaceutical industry for market research, post marketing surveillance and monitoring adverse drug reactions. The data can also be used for epidemiological studies, and will be commercially available to the pharmaceutical industry, the Department of Health and researchers based in institutions of higher education.

The most recent incentive for GPs to computerise is the 50% reimbursement of the cost of a computer as part of the new contract for GPs, which is subsidised to the extent of £ 19m in the financial year 1991 to 1992 [21].

1.1.4.2 Computers in community pharmacy

More computer systems are used in pharmacies than in any other sector of primary health care. This is due primarily to the recommendation in 1984 that labels on medicines be machine-produced [22]. Pharmacists soon found it more convenient to use a word-processing facility rather than typewriters. Early pharmacy systems were mostly incapable of functions other than labelling, but from these basic systems have evolved packages that offer some administrative functions such as stock control and ordering, and later for drug interaction alerts [23], [24].

Most systems now also offer the facility to hold patient medication records (PMRs). These systems have been encouraged since 1987 by "Promoting Better Health" [25], when the Government indicated that modest additional remuneration would be made available to community pharmacists who were maintaining PMRs. This remuneration was set at £165 if the records are installed before April 1991 and £110 for every year that they are maintained thereafter [26]. This amount is to be reviewed annually. One PMR computer system, Mawdsley Brook's Chemiserve, is available to pharmacists at no cost, in return for placing orders for medicines with one wholesaler. A similar situation exists with Vestric's Link, where a PMR computer system is available at low cost in exchange for placing orders for stock with the AAH Group. The PMR computer system, from

Hadley Hutt Computing, utilizes two printers to allow extensive additional patient information leaflets to be produced at the same time as the label for the medication.
An additional point in favour of having such systems in the pharmacy is that some are able to record the use of Over The Counter drugs, which can potentially interact with prescribed medicines. Furthermore, it has been shown that 80% of patients use one pharmacy only for all their medication [27].
However, the fact that patients are free to go to any pharmacy of their choice can reduce the usefulness of PMR systems, as no one pharmacy may have a complete record of a patients medication. This means that it cannot provide a fully comprehensive alerting system for potential drug interactions.

1.1.4.3 Computers in general practice dentistry

In 1981 the British Dental Association (BDA) commissioned a report entitled "Computing in General Dental Practice" [27] from Scicon Consultancy, with the objective of assessing the feasibility of computers in General Dental Practice in both the short and longer term. The BDA were particularly interested in the electronic transmission of claims for remuneration. The report made a number of recommendations to assist the general dental practice to computerise. These are summarised below -

* Data storage and processing tasks in dental computing could be carried out more efficiently by computer.
* Before computerising a dentist should have clear expectations of the system.
* A step by step approach to computing should be adopted to ensure a smooth transition from a manual system.
* Dentists should ensure that the system can be maintained reliably, regardless of geographic location.
* That copies of data should be easy to make.
* That the computer system should be capable of expansion.

However, the numbers of computer systems are comparatively low in general dental practice, despite their potential to improve efficiency and accuracy of information [65].

Accuracy, with regard to the finances of a practice, could be improved as the computer would enable a dentist to have accurate information on the amounts of money owed by the Dental Practice Board (DPB) and individual patients at any one time. Improvements in efficiency would come from knowledge about the value of materials held, and improvements in handling practice accounts, such as salaries, wages, practice rents etc.

A survey of dental computer use in Scotland in 1987 revealed that at least 6% of practices currently used a computer and a further 25% were interested in computerising. [29] The response rate to the postal questionnaire was 55%. It may be that more systems have been installed in England where more companies are based.

The main areas of application for computers in dentistry are reported as being in practice management, such as appointment diaries, fee accounts, and materials control and clinical reports, for example recording patients' details and tooth charting [30]. However, in practice it is invariably easier to record appointments manually. Appointment diaries can only be justified for retrospective use, that is to find out when the practice is most busy and orient work accordingly. Specific activities which can be successfully computerised include patient recall, patient registers, fee calculation, accounts and payroll following up debtors and the analysis of treatment [31].

Different causes are attributed to the low use of computers in dentistry by different commentators. Some [32] suggest a lack of funding and difficulties over arriving at a consensus view over any one system. Others have called for the BDA to take the initiative and adopt one system as a standard [30]. However, such a call is unrealistic as the computer systems used will result from success in the market. Some consider that the large capital investment required for most systems acts as a disincentive [28], or that the lack of systems is due to a combination of disappointing systems and that the profession as a whole has "not bothered to meet the challenge" [33]. However, none of these writers comment on the perceived need for systems by the profession or any rising expectations on behalf of the public. Both of these factors have played a role in other professions. As with general medical practice, the importance of independent reference sites, that is dentists who already have the system in use is stressed. This would allow prospective purchasers to test the claims of the suppliers that they have a suitable system. Also of importance is the need for equipment and program maintenance contracts to ensure adequate support for the system when it malfunctions or needs upgrading [30], [27]. Although this is needed none of the writers have pointed out the practical advantages of having one company being ultimately responsible for any malfunction. Separate maintenance contracts for hardware and software can lead to both companies denying that a malfunction is their problem.

A significant factor in whether computers are useful in a dental setting is the size of the practice. One writer considers that, for the solo practitioner where the number of patients is limited, the computer has not shown itself to be cost effective [34]. However, it must be stressed that this is the opinion of the author, rather than a conclusion from any research.

1.1.4.4 Computers in optometry

Interest in computers in optometry mainly dates back to 1985, when it was realised that practice efficiency could be enhanced and business improved [35]. These benefits would be realised through improved information about cash flow, amounts owed and stock held. Papers were published with the intention of giving optometrists a general introduction to the basics of computers and computer communication [36] [37] [38]. Other papers [39] [40] described the application of the computer in practice management and patient treatment, such as the investigation of oculo-motor treatment and stereopsis. At this stage, the advice of a computer consultant prior to system acquisition was considered imperative [41].

Recent papers continue to give optometrists an overview of how computers can assist their practices, through patient recall, monitoring levels of stock, maintaining payroll records, calculating VAT and providing interim balances [42].

Other papers provide information about systems currently available and caveats about the dangers of automation without careful planning [43].

Computer systems in optometry today offer facilities to automate patient records, spectacle dispensing, word processing, recall and reminders, stock control and ordering as well as clinical and marketing analysis [44],[45]. However, for some of these applications, for example spectacle dispensing, it is claimed can be done more quickly manually [45]. The computer is not a panacea for all aspects of practice management [46] and some opticians have restricted the role of the computer to a patient reminder and recall system [47].

Dollond and Aicheson, the largest optometric group in Britain have computerised all of their branches, using a system designed by ICL [48]. This allows branches to electronically transfer orders to factories, and statistics to head office. In return, head office electronically updates prices and an electronic mail facility exists in both directions. The computers also utilises electronic point of sale (EPoS) information. This allows popular spectacle frames to be identified and the company to respond accordingly. It also provides a source of marketing information.

1.2 Background to the Project

At the instigation of the U.K. Secretary of State for Health and Social Services, the Government commissioned a series of reports into aspects of the UK National Health Service [49] - [54]. These reports were produced by a Steering Group, which was chaired by Mrs. E. Korner and advocated a programme of information collection across the hospital and community care services in order to assist management decisions and improve patient care. The use of information technology (IT) would greatly facilitate the collection of information as well as its processing into a format which would assist both managers' planning and those engaged in research.

Criticisms of previous NHS information systems include inaccuracy, lack of timeliness and some inherent defects due to the disjointed nature of the data systems.

The information system suggested by the Korner Reports is based on three sources of data -

a) a population register

b) a record of activity of a clinic

c) a record of activity of a particular member of staff.

Data about coverage within a district cannot be based simply on services delivered within a district due to population movement. The population register is intended to overcome this by relating data on a service to data on an individual. The Steering Group which Mrs Korner chaired did not however address itself to primary health care, that is those services managed by the Family Health Services, and what information could be collected from this source. The Steering Group only went as far as to recommend that "district health authorities explore with local general practitioners ways of obtaining, in accordance with agreed safeguards, data about the general practice contribution to programmes comparable to the minimum data sets." [53]

The minimum data sets collected from hospital and community care, concerning an individual patient consist of:

a. data that allow the merging and linking of information about an individual patient,

b. data about the personal details of patients admitted,

c. data about referral for admission to hospital,

d. data about the use of hospital resources and facilities,

e. data about discharge from hospital care , and

f. data that allow patients to be classified by speciality, clinical or diagnostic groups.

It was anticipated that these data would be collected at different times, e.g. admission, during consultations and at discharge.

Additional information was stipulated for the purposes of planning, budget setting and monitoring as well as management and financial audit and accounting. This information was to be collected from hospital and community health services, as well as ambulance, blood transfusion and District and Regional administration.

Absent from this list are the general medical practitioners, general dental practitioners, pharmacists and opticians who collectively cost 24.5% of the total national health service budget [55]. Without similar data being collected from these groups it is not possible to budget, plan and monitor these services in a similar way to that envisaged for the hospital and community health services by Korner.

Fundamental to any data gathering activities suggested by Korner is that collection should be a by-product of existing procedures. Consequently, IT could assist such data gathering by remitting information already held in files on a routine basis.

As a consequence of the Korner Reports, much attention was given to computerising the hospital services. Community care, which is the range of services provided by district health authorities, including family planning clinics, vaccination and immunisation as well as health education and clinics for mothers and children were also considered [5]. However, the need for and benefits of the use of computers in primary health care have not been investigated and reported upon in the same way as the hospital sector. Similarly there has been no investigation of what data could usefully be collected from primary health care.

1.3 Information from primary health care

Examples of information that could routinely be collected from primary health care are shown in the following sections.

1.3.1 General medical practice

The FHSAs collect information about the number of patients registered, as well as their age, sex and address. The FHSA also collects data about how many patients have vaccinations and cervical smears. Other information collected from general practice includes notifiable diseases, as well as the voluntary reporting of suspected adverse drug reactions to the Committee for the Safety of Medicines (CSM).

However, other information which could usefully be collected includes the numbers and types of prescriptions issued in general practice, as well the numbers of investigations ordered, referrals and the amount of minor surgery carried out.

Collection of this data would allow general medical practitioners to compare their own performance with their partners, as well as other GPs on a District, Regional and National basis.

This would facilitate improved planning of both primary and secondary health care, as it would be possible to estimate from previous experience how many people are likely to suffer from any particular illness at any given time. As a result of this information it would be possible to plan how many beds are needed in any ward at any time.

1.3.2 Community pharmacy

Information on the number of prescriptions dispensed is collected by the Prescription Pricing Authority (PPA). However, this is not the same as the number of prescriptions issued, i.e. some patients do not present their prescriptions at a pharmacy.

Information about over the counter (OTC) medication could be collected, as are prescriptions presented in terms of both numbers and specific medicines. By comparing these data with data from general medical practice, measures of compliance could be arrived at for any medication. It would also be possible to monitor how many minor ailments are currently handled outwith general medical practice, and to collect data about blood pressure and cholesterol testing, both of which are increasingly being carried out in pharmacies.

1.3.3 General dental practice

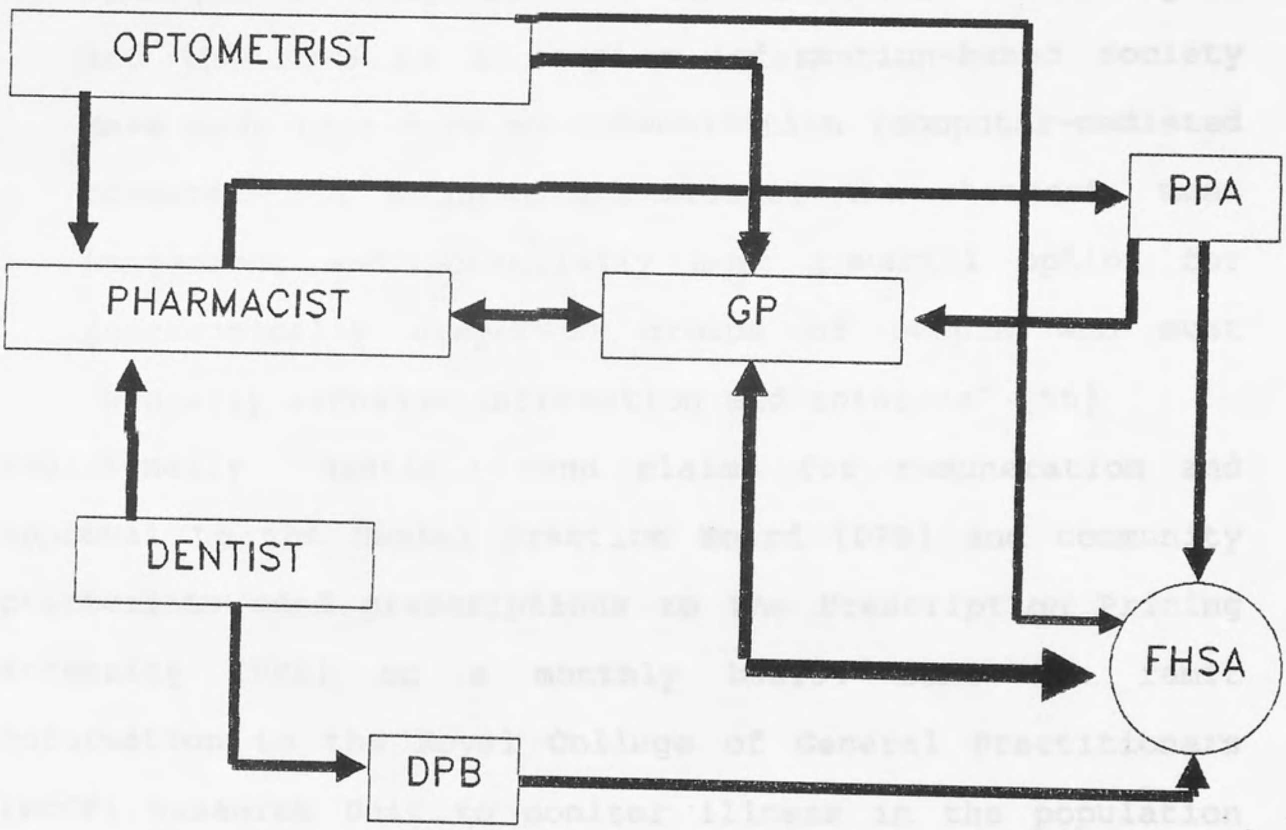
Information on dental treatments is collected manually for remuneration purposes. However, treatment data that does not involve remuneration are not collected. Examples are preventative checks and prophylactic treatments. Collection of these data would enable comparisons to be drawn between the incidence of caries in different areas and the different treatments offered to assess the relative efficacy of treatments.

1.3.4 Optometrists and ophthalmic opticians

Information for remuneration purposes is collected by FHSAs. However, information on the prescription of lenses and any disorders recognised during an inspection of the eye could make possible comparisons of optometric morbidity and treatment within different areas.

Current data flows in primary health care are illustrated in Figure 2.

Figure 2. Data flows in primary health care.



Chapter 2. PRIMARY HEALTH CARE NETWORKING IN GREAT BRITAIN

Professionals in primary health care (PHC) regularly exchange information. All four professional groups send data in varying amounts to their Family Health Services Authorities (FHSAs).

> "Changes in computer and communications technologies and the move to a complex information-based society have made this form of communication (computer-mediated communication among human beings) the cheapest, most convenient and potentially most powerful option for geographically dispersed groups of people who must regularly exchange information and opinions" [56].

Additionally dentists send claims for remuneration and approval to the Dental Practice Board (DPB) and community pharmacists send prescriptions to the Prescription Pricing Authority (PPA) on a monthly basis. Some GPs remit information to the Royal College of General Practitioners (RCGP) Research Unit to monitor illness in the population and send details of suspected adverse drug reactions to the Committee for the Safety of Medicines (CSM). Optometrists send signed orders, which are similar to prescriptions, to pharmacists to be dispensed.

The benefits of computer communication between PHC practitioners and the various associated administrative bodies were outlined by The Andersen Report [57], which looked at the use of computers in the Family Health Services

Authorities and the Nuffield Report in pharmacy [58]. The following potential benefits of IT were identified by The Andersen Report -

* the transfer of medical records when patients move could be facilitated.
* valuable data could be made accessible, thereby improving both the care of individual patients and NHS services. Examples are more information about morbidity in the population, which could be used to allocate resources more efficiently and the discrepancy between the number of prescriptions issued and dispensed.
* current duplication of effort could be avoided, for example it is possible that prescription data could be entered into three different computer systems manually, by the GP, the pharmacist and by staff at the PPA.
* claims for remuneration from practitioners could be processed more efficiently.
* greater coordination between different organisations in health care could be achieved.

Trials to link GPs, community pharmacists and dentists with bodies involved in their remuneration have all been piloted. [59] - [62]. These trials all involved the remittance of data upon which remuneration was based. Some extra information, used for administrative purposes, was also included.

2.1 Prescription Pricing Authority linkage: pilot trial

A pilot trial to link pharmacies with the PPA was the first of the Family Health Services, i.e. those services managed by the FHSAs, computer trials to be implemented. It ran from September 1986 to March 1987, with ten pharmacies transmitting prescription form data over a network, that is a communication system that supports the transfer of data between several users, to the PPA in Newcastle [60]. Despite the reported enthusiasm of the pharmacists involved, the trial was not extended on a national basis. There are several reasons for this -

* data supplied by pharmacists was not as accurate as data entered from prescriptions entered at the PPA. This is because staff at the PPA have extensive training in entering data via a keyboard, while pharmacists and dispensing technicians had comparatively little experience.
* due to the current low cost of entering data at the PPA (around 5 pence per prescription) there is limited room for any cost savings.
* some of the data that must be captured is not connected with the remuneration of pharmacists but with monitoring the prescribing costs of individual GPs and practices. An example is the data that identify the practice and the prescriber.

In general, pharmacists would probably feel reluctant to spend time entering all this data, much of which is not directly used for their remuneration.

2.2 Family Health Services Authorities Linkage: pilot trial

A standard software system was produced by the FHS Computer Unit at Exeter and software developed for the Exeter FHSA, previously Family Practitioner Committee (FPC), and GP computer systems. Six of the major GP computer system suppliers agreed to take part in a trial of the system [59]. The trial was intended to allow practices to claim item of service (IOS) remuneration and FHSA stationery electronically. Forms that practice staff would normally use were duplicated on screen where the data was entered. This enabled a replica of a paper form to appear on the VDU, which was intended to make practice staff feel more comfortable with the new system.

These data were then saved and sent to a mail box on a weekly basis, using a network provided by International Network Services (INS). The FHSA then accesses this mail box and can leave its own messages for the practices.

Direct communication between practice and FHSA was not possible for two reasons -

* the FHSA computer could not cope directly with the volume of traffic over the network, as only one

practice could have access to the computer at any one time.

* this would necessitate leaving the computer open to online access for long periods, with attendant security and confidentiality problems.

The writer did not go into the technical reasons why more than one general practice could not access the FHSA computer at any one time. Since the trial the structure of GP remuneration has changed, rendering the transmission of IOS claims in this way obsolete [63].

2.3 Dental Practice Board linkage: pilot trial

This pilot trial became operational on 29 June 1987 and aimed to evaluate the effectiveness of using electronic data transmission to send remuneration claims of dentists to the Dental Practice Board (DPB). In addition it sought to set standards for transmitting data for companies wishing to market dental computer systems [62].

Three software houses were originally involved in the trial: Apollonia Computer Research Ltd., Status Point Ltd. and Sentinel computers. Sixteen dentists from eight practices initially participated, using three different systems.

An interim evaluation concluded that the basic technical feasibility had been established but that both technical and administrative issues have still to be addressed. The interim report has also indicated that a larger sample of

both dentists and suppliers was required to establish a business case [62]. The trial was consequently extended to include 57 practices and seven suppliers, though this was reduced to six when one went into receivership.
Following the successful extension of the trial, plans have been made to allow dentists to submit claims routinely to the DPB and to this end a software specification was published in September 1990. The regulations governing dental claims for remuneration have been amended to allow claims to submitted electronically [64].

2.4 Electronic communication and optometry

Unlike the three other sectors of primary health care there are no plans at present to link optometrists electronically with Family Health Services Authorities. This may be due to the lower volume of data which passes between optometrists and the FHSAs, as the vast majority of patients now meet the cost of optometric care themselves.

2.4.1 Electronic ordering

In pharmacy and optometry, computers are now being used to communicate directly with suppliers and wholesalers [24], [65].

2.4.1.1 Optometry

The Norville Optical Group have interfaced their own computer system with Prestel and have developed a network through which the optometrist can interrogate Norville branches to obtain a number of services [66]. These services include enabling the optometrist to place orders for prescription work, uncut lenses, single or stock frame orders into the Norville computer, resulting in savings in time for both parties. Furthermore, the optician can have instant access to information about the status of any order within the Norville group, and whether any item is temporarily out of stock.

However, the Prestel system is only used by Norville and unless Norville handles the vast majority of a practice's work there are few benefits when measured against the time and expense of installing and running the system.

Other networks exist to allow an electronic link between opticians and suppliers [65] and Kalamazoo, the manufacturers of an optical computer system, sought to develop 'Optinet', to link opticians with suppliers. The problem that prevented development was that unless a substantial number of suppliers subscribe to Optinet it will be of little interest to the optometrist and if only a small number of optometrists subscribe, the suppliers will be disinclined to become involved [66].

2.4.1.2 Community pharmacy

All of the major PMR systems intended for community pharmacy allow the pharmacist to order medicines automatically from the wholesaler. Indeed one wholesaler, Mawdsley Brooks, provides a computer system free to any community pharmacy in return for orders for medicines. However, some computer systems can only communicate with one wholesaler, while other computer systems can communicate with more than one. This is important to pharmacies which use more than one wholesaler.

2.5 Vertical and horizontal data flows

All of the trials described are concerned with vertical data flows, that is, professionals sending data to organisations which have a role in management or administration of their aspect of primary health care. However, major benefits in patient care could be realised by horizontal data flows, among practitioners in different professions. For example, pharmacists need to know patients' current medication to alert prescribers to potentially harmful interactions, and to prevent patients using certain over the counter (OTC) medicines which might interact with some prescribed drugs. Optometrists need information about a wide range of medical conditions which have a bearing on vision. Similarly, they need to communicate information about disorders of the eye to the GP. Dentists using a local anaesthetic need to know relevant aspects of a patients medical history and any current medication details.

2.5.1 Existing records

GPs hold a complete record of patient morbidity, as well as most of the information about the medication a patient uses. Pharmacists collectively hold all of the information about a patient's medication, including GP prescriptions, dental prescriptions, optometrists orders and OTC medication. Dentists hold records of dental treatment, and collect data about patient's histories and medication from the patient when necessary. Optometrists maintain records about defects in the patients vision.

Patient care could be improved if information held by one practitioner could be made available to other professionals. Examples of this are dentists accessing information about patient medication and histories, where incomplete information volunteered by patients can result in the inappropriate administration of anaesthetics, which in turn could even result in death. If GPs were fully informed of a patient's medication steps could be taken to avoid drug interactions and contraindications with prescribed drugs. Likewise, if each individual pharmacist had complete information about patient medication, drug interactions between prescribed and OTC medication could be avoided and interactions between prescribed drugs detected. If information about medication used by optometrists was available to GPs and pharmacists, it would be possible to monitor the possibility of adverse reactions, contraindications and interactions with these particular drugs.

In addition to improved care there are administrative benefits in horizontal data sharing. The Nuffield Report [58] envisaged prescriptions being sent electronically between general practice and pharmacies. This would enable pharmacists to prepare the prescription in advance of the patient arriving, and so save patients' time. However, this raises issues of both confidentiality and professional barriers. Traditionally the patient decides which pharmacy will be visited to have a prescription dispensed. The idea of the GP appearing to or possibly selecting the pharmacy to send an electronic prescription would prove unpopular with many pharmacists. In addition, certain sensitive medical conditions can be inferred from the medicines used to treat them, making the ability to protect this data from unauthorised access while in transit of paramount importance. For this reason it would be difficult to realise such a scenario and allay fears about protecting patient confidentiality. One way of achieving this is by using a smart card.

2.6 Smart cards

Smart cards are credit-sized cards which contain a microprocessor and memory. Two types of intelligent cards, i.e. containing a microprocessor, exist: microchip cards and optical cards [67].

Optical cards are cheaper than microchip cards and can hold more data. Data are stored and retrieved in a similar way to a compact disk, that is a laser scans the surface and reads data through alterations in reflected light. These alterations are caused by pits in the surface of the media. The problem with optical cards is that medical applications require the ability to both read and write to the card, and to achieve this a laser is necessary to burn pits into the card. The cost and complexity of this is prohibitive [68].

However, microchip cards offer the possibility of carrying a patient's medical and medicinal records. When a patient presents the card to a health professional, all data on the card are read into the computer's memory, and compared with the existing record. If the card contains data which are not held on the computer, the computer is updated from the card. When the health professional adds data to the patient's record during the consultation, the data are written to both the card and the record in the computer.

2.6.1 Smart cards and patient medication records

The White Paper "Promoting Better Health" [25] and Primary Health Care: An Agenda for Discussion [69] recommended that all pharmacists should keep medication records and some see the smart card as a means of overcoming the incompleteness of records which would result when patients use more than one pharmacy [26]. Another advantage of a smart card system would be that information is accessible to more than one kind of practitioner. For instance, if an adverse ocular drug reaction occurs today, then there is no way of knowing which drug or combination of drugs (possibly from different practitioners) caused the reaction [70]. Similarly, information on drug treatment by the dentist would be available to the GP and vice versa [71].

However, some suggest that a smart card system would have problems with multiple medication used by some chronic patients. It is argued that such patients should patronise a single pharmacy where complete patient medical records can be kept which incorporate self medication and pharmacist consultation records [26]. The limited space available on the card precludes the possibility of all dressings and appliances being recorded. However, the author, a pharmacist, does not point out that not all pharmacists as yet have the computing facilities necessary to maintain such detailed records.

2.6.2 Smart cards beyond primary health care

Private medicine outside the National Health Service is not subject to any comprehensive IT strategy. As such there are no plans to link computer systems for information exchange. Despite this, some patients will use both services, and consequently both services need to communicate information about common patients. The smart card could be a vehicle for such data exchange. The card could also provide a major benefit where doctors have no previous knowledge of the patient e.g. locums or casualty admissions [72].

As well as its compact size, the smart card is more robust than a patient held disk, in that it is resistant to electrostatic, X-rays and ultraviolet light, all of which can result in the loss of data [68]. These characteristics have meant that the smart card has received extensive trials in Europe and America, with over 20 million smart cards produced in Europe alone [73]. The European trials are being assessed by a management committee of AIM, (Advanced Informatics in Medicine). One trial in France, the SESAM Project, utilised 130, 000 cards [74], and is largely concerned with containing the administrative costs of the health insurance societies. Other trials exist in France which are concerned with clinical information, however, the numbers involved are much smaller, form between 500 in the Dialybre trial to 5 000 in the Transvie trial and both trials are restricted to the hospital sector.

However, the cards which are used most widely are magnetic strip cards for health administration. These are not "smart" by definition, having no microprocessor, but as 40 million have been distributed in Spain they indicate that the widespread use of cards is technically feasible [75].

In the UK, following a pilot trial near Cardiff, a trial of the smart card has been conducted at Exmouth, to evaluate the potential benefits the card can could bring to both patient care and improved communications [76], [77]. [78]. The trial involves Honeywell Bull (now Bull) and Abies System 5. The software is structured to allow hierarchical access, and the Read classification system is used to maximise space available on the card. Two general practices are involved (involving around 8 500 patients), as well as two hospitals, a dental practice and eight pharmacies. The pharmacists add markers to prescribed drugs to help monitor compliance, but do not enter data on over the counter (OTC) medication [76].

The Exmouth trial has been the largest of four smart card trials in Britain. In an other trial an optical card is being tested in an ante natal clinic in London and 300 community nurses are testing an SRAM card, i.e. Static Random Access Memory, or Random Access Memory maintained by a battery, in Southport. The other trial involved a pharmacy and a general practice in South Wales and was the forerunner of the Exmouth care card trial. This trial used a smart card to capture prescription and OTC medication, allowing patients to have a complete record of all medication.

2.6.3 Administrative verses clinical data

It is clear that trials of smart cards have not been conducted on the same scale in Great Britain, as they have in Europe. This is because the larger European trials have concentrated on administrative data, whereas the British trials have involved clinical data. This is because more memory is needed on the card to hold clinical data, which increases costs and the advantages of clinical data are less easy to measure. Trials involving clinical data and smart cards in Europe have not involved larger numbers of cards than the British trials. Part of the enthusiasm for card technology in France may stem from the prominence of Bull, a company owned in part by the French Government, in the market.

Several draft specifications of components for smart cards have been published by the International Standards Organisation (ISO), and these will eventually lead to an international standard [68]. However these standards only apply to the physical dimensions and materials of the cards. The problems of what data to hold on the card and how to encode it have still to be addressed in an international context.

2.6.4 Evaluation of smart card trials

The evaluation of the largest trial of smart cards in Britain concluded that -

* There was an insufficient number of card-carrying patients, which resulted health professionals having to cater for both card-carrying and non-carrying patients. This was a barrier to the smooth running of services.
* The health professionals found that it took an unacceptably long time to load data from the card.
* The cards themselves were prone to failure with a resulting loss of data.
* There was a highly variable card-carrying rate by patients.

However, the trial did reveal some benefits of sharing data. Both dentists and pharmacists found that they could provide a service that offered both safer and more effective as a result of the cards. The trial also found that both dentists and pharmacists desired to write prescribing details and OTC medication to the card respectively, and that there needs to be an agreement between pharmacists and GPs about the labelling instructions on any medication [76].

2.7 Patient registration

The smart card is intended to overcome the problem of prescribing data being scattered between several pharmacies.

The same effect could be achieved if patients presented all prescriptions at the same pharmacy. It would also be possible to keep a complete record of all minor dressings and appliances, as a pharmacy based record system contains more memory than a smart card.

Patients routinely register with a dentist and a GP, which enables all morbidity data to be held in one place. If patients routinely registered with a pharmacy in a similar way, then most of their medication details could be collated in a similar way. Some OTC medication, e.g. aspirin, can be purchased at outlets other than pharmacies.

For the majority of patients however, the smart card could provide for the efficient exchange of data throughout the NHS infrastructure, thereby avoiding both duplication and inaccessibility of information, to improve patient care [26].

2.8 Population registers

An alternative way to assist the passage of data in the health service is the population register or community index [79] - [82]. This allows different parties to access a central register of patients which will avoid duplication of data entry and allow both primary health care practitioners and community care to have access to clinical information about patients. Such information is likely to be name, address and postcode, sex, date of birth, NHS number as well as information about immunisations, vaccinations cervical cytology and breast screening [79].

It could form the basis of preventative programmes and be updated by any practitioners who had a treated the patient. It would be theoretically possible to mount all medical and medicinal information about a patient on such a register and allow professionals to have access to parts of the record that would allow them to provide better care [80]. However, there are two obstacles to this -

* the telephone costs of online access is likely to be prohibitive.
* the security and confidentiality of this information could not be guaranteed.

However, the use of the NHS number in the register, as well as in all other records in the health service could allow patient data in disparate databases to be related.

The problem of confidentiality exists in all electronic systems (see section 3.2). Smart card systems effectively make the patient the guardian of their own data. If the card is lost or stolen, then it is possible that the integrity of the information it contains could be compromised. However, guardianship of a community index or networked system would fall to a District Health Authority or Family Health Services Authority. With the community index, the patient no longer would have direct control over the data, and there are no readily identifiable individuals in whom patients could place their trust and confidence.

2.9 Information systems in primary health care

Vertical data flows have been seen largely as replacing paper-based systems should they prove to be more cost effective. However, there are advantages in the routine collection of morbidity and mortality data in primary health care [83]. Information from general practice in particular is invaluable because it enables an evaluation of all health service treatments. This is because GP records form a continuum throughout the patient's life, enabling the outcome of hospital treatment to be assessed years after the patient's discharge from hospital. The importance of being able to connect incidents occurring over a long period in a patient's life has been recognised for many years [84]. This is because two pieces of information may be of great significance when taken together: for example exposure to a chemical and the incidence of a type of cancer. A trial is underway which aims to use data from general practice to monitor and plan primary health care and its interface with secondary care [85] [86].

2.9.1 G PASS

The experience of G PASS (General Practice Administration System for Scotland) by between 45-50% of Scottish practices [87] has demonstrated the value of an information system. It has been shown that data can be collected by means of an electronic questionnaire on a disk sent to practices. The data were used to give practices information about their epidemiology and administration but also could be analysed in an amalgamated form to monitor and plan services [88]. For instance, if total morbidity figures were known for a given area, it would be possible to anticipate levels of morbidity in a future time and allocate resources accordingly. If these figures were available for all areas it would be possible to allocate resources pro rata on a basis of need.

The diverse number of systems in general practice place a restriction on the development of a similar information system in England and Wales. Dr. G Hayes, Chairman of the Primary Health Care Specialist Group of the British Computer society and an authoritative commentator has stated that "Computing standards decisions are probably the most important we will make in general practice in the next ten years." Any standard adopted must take into account the Common Basic Specification or CBS (the NHS standard), as well as developments in FHSA computing.

While the Open Systems Interconnection (OSI) committee of the International Standards Organisation (ISO) works towards a model for standardisation, some feel that large interested parties should seize the initiative by dictating their own standards (within the OSI model) to suppliers. Precedents for this include General Motors initiation of the Manufacturing Automation Protocol (MAP) and Boeings'

Technical Office Protocol (TOP) [89]. To achieve standards and set specifications a model of the information exchange in primary health care has been proposed [90]. Primary health care is diverse and must be viewed in relation to health care as a whole. A model has been put forward to simplify the processes involved before the "How?" of a network can be addressed. Both Aylett and Dean, GPs and authoritative commentators, suggest that general practice has avoided accountability for too long and states that FHSA links are necessary to support audit, which is required by the 1990 contract for GPs [91] [92].

Information systems in the NHS have up till now been vertical, that is data has flowed upwards from health providers to administrators [93]. However, the need for horizontal information systems (data exchange between practitioners) is now being recognised [94] [95].

Chapter 3. CONFIDENTIALITY, SECURITY AND DATA PROTECTION

3.1 Security of computer data

The security of computer data relates to preventing the loss of, or damage to data whereas the confidentiality of computer data is concerned with the restriction of access to data to the legitimate users of that data.

In discussing the problems of data corruption and computer malfunction, as well as possible preventative steps, the salient points that emerge are that while transient high voltages and computer vandals ("hackers" accessing the system via a modem links or unguarded keyboard) can cause extensive corruption, the main source of data corruption is from poorly designed software [96].

Asbury suggested that software should be purchased only after it has been available for a year or two when any errors are likely to have been detected [96]. However, this would be rather counterproductive to the development of new programs [97]. It is almost always dangerous to be a pioneer in computing equipment. This is partly because of defects, or bugs, in the program but also because of uncertainty over the future of the market. The writers cited above [96], [97] miss the point that if a product fails to find a market, its supply will be discontinued. In computing terms this means there will no longer be any software maintenance or upgrades. This will soon render the system obsolete, requiring the users to re enter data on a new system.

Defects in the circuits are rarely a problem: much more frequently data corruption results from damage to the storage medium. Gross mishandling of disks is described by one writer as the commonest cause of data corruption and operators are advised to make regular back-up copies of their data [98]. This is because if information is important enough to record, then it merits protection against loss. Copies of data should be made every day at least: in practice very few professionals in primary health care make backup copies with this frequency [99].

Strong magnetic fields are also mentioned as a source of data corruption, as is "dirty current", i.e. voltage fluctuation. However, following this form of data corruption most of the information can be recovered with the help of disk editing software [98]. Other writers [100] suggest that all programs should incorporate validity checks to prevent the user from entering data with values that must be erroneous. This advice has not been taken up by some suppliers, resulting in computerised general practices producing prescriptions that are unacceptable as they contain impractical quantities or impossible directions [101].

3.2 Confidentiality

All professions have long recognised the importance of keeping information about patients, clients or customers private. Confidentiality is concerned with preventing unauthorised access to patient data. As the Working Party of the Royal College of General Practitioners stated -

"The Working Party is satisfied that the confidentiality of patient data can be achieved in a computerized system at a higher level than that currently available on manual records." [17]

This is because the computer can make it much more difficult for an unauthorised person to gain ready access to a record when compared to the methodically arranged manual files such as patient records cards. Consequently the computer can improve security overall, despite the fact that it introduces its own particular hazards [102]. For example, when patient records are held electronically, it becomes very much easier to search for patients with a particular condition. Other possible abuses include patient address lists being sold to mail advertising companies or health data being sold to assurance companies [102].

On the whole the monetary value of medical information may not be great. The greatest danger is not so much access to the data for money, but potential embarrassment to patients through details of their private lives becoming commonly known. If this were to happen the relationship between patient and practitioner could be damaged and patients could become reluctant to impart important information to practitioners.

Computer security techniques cannot entirely prevent damage to data or its illicit use. As far as is known, no practical computer system can be completely secured. Keeping a computer in a secure place and preventing outside access can often protect a machine more effectively than more sophisticated programming techniques. Such arrangements also help prevent some "low-tech" hazards, such as fire damage and theft [103].

Methods of protection of data include -

* Passwords

These are a series of letters, numbers or a combination of both, which is unique to a user and known only to that user. Before a system can be accessed users must enter their individual passwords, thus in theory preventing access by anyone without a permit.

Passwords should be as long as permitted to minimise penetration by attack programs which are capable of trying many combinations every second. Passwords should also be changed periodically, both on a regular basis and when an individual employee leaves.

* Encryption

Here data is transformed from ordinary text to a cipher and stored as such in the computer's memory. The data is transformed back (decryption) after it is recovered from storage. Encryption is most effective when the user must supply crucial parameters or keys to encrypt or decrypt data. The advantage of encryption over password protection is that the computer does not know what the keys are, and this data is consequently not available from it. The disadvantage is that encrypted data may remain encrypted forever if the key is forgotten or misplaced.

* "Callback" Modems

Conventional modems answer the telephone and connect the remote user to the computer system which that remote user sought to access, regardless of whether the user has any authorisation. The callback modem requests the user's identity, generally by asking for a traditional password. It then breaks the connection, searches a list of users and phone numbers and then dials the phone number of the authorized user who called. The advantage of this device is that the intruder must discover a password and obtain access to the one phone line which is identified with that password [104].

While callback modems provide an additional layer of security they require more expensive equipment and could prove frustrating to inexperienced users. Encryption devices are expensive and are largely limited to synchronous communications, while most microcomputers utilize asynchronous communications. In addition, it may prove difficult to circulate new encryption keys on a regular basis [105].

The majority of systems in primary health care offer some sort of password protection. However, not all are hierarchical, nor are these facilities always utilised by the practising professionals. Further, not all passwords allow each member of the practice who enters data to be uniquely identified. This could become important in later legal proceedings e.g. one member of a practice could be held responsible for the clinical interventions of another member of the practice. It is essential that anyone who enters data in a patient's record is clearly identified. None of the computers currently available identify the source of all data entered. Without this practitioners risk being involved in cases for damages as a result of negligence or malpractice for which they were not responsible. Data collected over a network for sale to the pharmaceutical industry is currently encrypted. That is to say the data are transformed into different characters in order to hide its meaning. When the data arrives at its destination a key is used which translates encrypted data back into its original intelligible form.

3.2.1 Confidentiality of data beyond practice

Since May 1987 it has been possible for a general practice to obtain a computer at little or no cost by supplying patient data stripped of identifiers. The pharmaceutical industry then pay the companies involved to conduct searches of the data to obtain market research information. In the spring of 1991 the computer companies decided to concentrate solely of supplying computer systems, and data gathering is now done by separate companies [106] [107] [108].

Some doubt exists as to the confidentiality of these data. As far back as 1980, warnings have been given that unlabelled statistical information may not be confidential even when names have been removed [109]. Further discussion of inference from statistical data in a medical context is given by Kay and Goble [110]. The danger arises when the intersection of some sets of data is small but not zero. Individuals can be identified by a conditional Boolean AND logic. If an individuals age, sex and postcode are known, the set of individuals who meet these criteria may be one. It is then possible to add conditions to the search, one at a time. Examples of extra conditions might be drug use, mental disorders or an abortion. If the set resulting from these conditions contains one entry, it can be inferred that the known individual has had that condition or experience.

It is intended that the companies that collect data will themselves search the database on behalf of the users of the data. They will consequently be able to prevent searches whose intention is to identify individual patients. An extra safeguard would be to withhold the results of searches which resulted in a small but non zero set.

With regard to confidentiality and security, it has been said that -

"The choice of defences depends on the likelihood of the perceived threats and the magnitude of the losses that may result from these threats "[104].

Whatever the magnitude of perceived threats, the steps taken to safeguard it must comply with the principles enshrined in the Data Protection Act [111], the relevant parts of which are explained in the next section.

3.3 The Data Protection Act

The Data Protection Act and accompanying guidelines applies to all data held on computer systems [111]-[119], except where that data consists solely of an individuals name and address.

The Act contains eight general principles. These are that -

1. The information to be contained in personal data shall be obtained, and personal data processed, fairly and lawfully.
2. Personal data shall be held only for one or more specified and lawful purposes.
3. Personal data held for any purpose or purposes shall not be used or disclosed in any manner incompatible with that purpose or those purposes.
4. Personal data held for any purpose or purposes shall be adequate, relevant and not excessive in relation to that purpose or those purposes.
5. Personal data shall be accurate and, where necessary, kept up to date.

6. Personal data held for any purpose or purposes shall not be kept for longer than is necessary for that purpose or those purposes.

7. An individual shall be entitled-

a) at reasonable intervals and without undue delay or expense-

(i) to be informed by any data user whether he holds personal data of which that individual is the subject; and

(ii) to access to any such data held by a data user; and

(b) where appropriate, to have such data corrected or erased.

8. Appropriate security measures shall be taken against unauthorised access to, or alteration, disclosure or destruction of, personal data and against accidental loss or destruction of personal data.

Potential and or actual conflict with these principles and current practices in primary health care exists. The conflict is with principles 3, 4, 5, 6, and 8.

General medical practices are routinely required to give information about their patients to their FHSA. This information consists of the patient's name, age and address. The FHSA could possibly pass this information on to District Health Authorities, who may in turn disclose this data in some way not envisaged by the GPs. An example might be the sale of name and address lists to direct mail agencies.

One of the difficulties that the Act presents is knowing which data are relevant and which are not. Much data that are kept will never be used. However, there is always a very small possibility of any seemingly trivial piece of data becoming important, for example in a litigation case many years later.

3.3.1 Accuracy of data in the Family Health Services

Levels of accuracy of data held in general practice give some cause for concern. Recently the Chairman of the Primary Health Care Specialist Group (PHCSG) of the British Computer Society (BCS) compared the NHS number of patients on the practice computer with the NHS number on the manual record. In 15% of cases, the numbers recorded between the computer and the manual record were different. It is reasonable to assume that other practice computers, which do not have the benefit of a resident expert, will not be any more accurate. Different studies published after this indicated that computer records are not as accurate as paper records [120] [121].

The problem of the accuracy of databases extends beyond practitioners to the registers of the Family Health Service Authorities. A study in south east London revealed that 35% of patients in a recall programme failed to receive invitations to attend a clinic due to inaccuracies in the FHSA database [122]. Another study in inner London showed that 69% of invitations derived from a FHSA database contained an inaccuracy, either in the address or by calling in appropriate patients to a clinic [123]. While these findings are disturbing, it has been pointed out that people in London are generally more mobile than in other parts of the country and these results may not be extrapolated reliably nationally. Other work suggests a 14% address inaccuracy in urban areas and less in rural areas [124]. The low levels of accuracy are predominantly a result of patients not informing their GP of a change of address. The situation could be improved by reception staff routinely asking patients to confirm their address whenever an appointment is made.

It is impossible to say how long data should be held in a medical context. However, medical defence societies insist that archives are kept, in order to have evidence on which to base a defence and reduce the level of compensation awarded. Archiving consists of storing data that are no longer kept on the hard disk of the computer. It enables data that are no longer of direct interest to be kept, in the event that these data may one day of use. Practices should maintain two archives in separate locations. This means that any piece of data will always be available, regardless of local calamities, e.g. fire.

In addition if GPs wish to perform a clinical audit of themselves over a period of time it is necessary to look back at morbidity over a period of time. This also allows the GP to monitor changing patterns of morbidity in the population.

Many of the issues discussed above may only be capable of resolution by a test case to establish a judicial precedent. This may be unfortunate for the practitioner who becomes a participant in such a case.

With regard to principle 7, i.e. a data subject's right to have access to data, the practitioner must comply with a patient's request but is obliged only to impart information on a discretionary basis. However, the practitioner may have to justify withholding particular information later in court. This is intended both to give rights of access to patients but also to prevent the identity of third parties being compromised. A case where withholding information would be justified is when a patient tells a GP that her father drinks heavily and becomes violent. If the father then requested access to his records the GP would be able to withhold this information. At the time of writing very few patients have asked to see the data held on them.

There are some practitioners in all the primary health care professions who seem to be failing to take appropriate measures to restrict access to data. Similarly, few practitioners take backups at daily intervals and store this backup in a separate place - essential to protect backups from fire or flood.

There are still some practitioners using computers in primary health care who have not registered with the Data Protection Registrar - which is a criminal offence.

It is essential that practitioners not only comply with the Act but that they do business with suppliers who also understand their obligations under the Act. Suppliers themselves must also be registered. This is because if equipment malfunctions representatives of the supplier will have to have access to the data held on a system. Similarly, a responsible supplier will take charge of malfunctioning hardware at the practice - thus obviating the need to send equipment through a parcel or postal service.

In case of any practitioner failing to comply with the principles of the Act, the Data Protection Registrar has certain powers as follows:

When a registered person is reported for failing to meet any of the principles the Registrar may serve an enforcement notice, requiring the registered person to comply with the principles in a specified time. Failure to comply with a notice is an offence. In addition the Registrar can serve a de-registration notice, preventing a person from holding data. A de-registration notice would prevent any practitioner from maintaining records on a computer.

If convicted of an offence under the Data Protection Act practitioners are liable for substantial penalties. Non registration, operating outside the terms of the Register entry and failure to comply with enforcement notices all carry unlimited fines [125]. Any individual has the right to appeal against a decision of the Registrar to the High Court.

3.4 Data ownership in general practice

There is still some doubt as to who is the legal owner of the data in computers of GPs contracted to the NHS through the FHSAs. There are two contenders for ownership: the Secretary of State, represented by the FHSAs and the general practitioner. The patient has no claim to ownership under law but has rights of access set out in the Data Protection Act. That is to say he can obtain a printout of as much of the data stored in the computer as the practitioner sees fit. If the patient is dissatisfied with the information given, he may go to court to obtain any information that is withheld.

The ownership of data is important to the State as the routine collection of morbidity information may allow resources to be allocated more effectively and services to be monitored more closely. In addition data gathered by the State could also be used for epidemiological research and post marketing surveillance which would be used for an independent appraisal of new medicines. The data could also be sold to pharmaceutical companies, who would find it useful for the independent monitoring of the sales of their own products and that of their competitors.

Regarding data ownership, the Secretary of State for Health, currently owns all paper-based records in general practice. General practitioners could argue that while the Secretary of state owns the paper based records, data held on a computer belongs to the practice. However, the state now subsidises computers in general practice by up to 50% and may consequently lay claim to the data held on computers whose cost it has partly met.

Both doctors and the State, represented through the FHSAs could benefit financially from data held in general practice computers. FHSAs selling patient data would enable more resources to be found for the health service but would jeopardise the stability of the two largest GP computer suppliers. By entering into contracts to supply data to commercial companies in return for financial benefits GPs have presumed ownership of the data rather than custody. This is because practices involved in the schemes have entered into two contracts, one to buy the system and another to supply data in return for financial remuneration. Should ownership lie with the state, contracts made to supply data to companies may be ultra vires and consequently void. This could result in practices becoming liable to the two computer companies, AAH Meditel and VAMP Health, for the full cost of their computers.

In practice, it may not be in the interests of the State to permit FHSAs to sell data to the pharmaceutical industry if this would damage the two largest computer suppliers in general practice. Considerable amounts of time and resources have been spent promoting general practice computing and it is unlikely that progress in this area would be halted. The State already has a great deal of information about prescribing collected by the PPA. This data could, if desired be sold to the pharmaceutical industry for post marketing surveillance purposes. However, it is likely that the state will attempt to gather data from general practice for its own use, rather than to perform searches on data that has been collected privately from general practice.

Chapter 4. STANDARDS IN PRIMARY HEALTH CARE

4.1 Classification and coding of disease

> "Classifying, in its simplest terms, means putting together things or ideas that are alike, and keeping separate those that are different." [126].

Classifications usually take the form of an inverted tree, with facts or concepts on one branch being more similar to each other than to facts or concepts on other branches. There are basic principles of classification -

1) Each division must produce at least two branches.
2) One principle of division must be used to produce mutually exclusive classes.
3) The end point of a branch must be exhaustive of this class.

The use of specific codes to identify medicines, diseases and therapies is important for several reasons. Firstly, data recorded as a number rather than as free text description, such as typed clinical notes, use up less space in the memory of a computer. This allows either more data to be held or resources to be saved by spending less on storage devices. Of particular importance is the ability of classification systems to improve clinical care by facilitating the storage and retrieval of information in the patients record at the time of the consultation. This is because a specific code is independent of the vagaries of language, for example, the use of more than one term to describe a disease. In addition, it is much easier to manipulate codes than free text, allowing more meaningful information to be extracted from the data for the purposes of service planning, research and clinical audit.

It is most important that all people involved in treating patients reliably use either the same code, or coding systems that are compatible, i.e. one code in one system directly corresponds to another code in the other systems. This is important so that data can be exchanged between different computers and amalgamated data from several computers can be used to give a wider view of any area, service or disease.

Warnings have been given [127] that the classifications used by health care providers are rapidly becoming data-incompatible with each other and a call has been made [128] for a worldwide standardized coding system for general practice. WONCA and WHO's international "Family of classifications with definitions" (ICPC, ICHPPC, ICPC-PROCESS) has been recommended for primary care by some [127]. In America, of the practices that do keep clinical records of patients the most common coding system is ICD 9-CM [8]. This classification is also used some Scandinavian countries [14], while in Britain the Read classification (see section 4.2.4) has been advocated in general practice by the GMSC-RCGP Joint Computing Group Technical Working Party as it is the most detailed, [129] and is now accepted as the standard for general practice by the Royal College of General Practitioners over their own classification system [130]. Some consider that a possible solution to the problem of different coding systems may lie in standardizing the extensions of ICD-9, and work on both this and semi-automatic coding of diagnosis is underway as part of the European Community Advanced Informatics in Medicine (AIM) research initiative [13].

4.2 International Classification of Diseases

All of the above classification schemes have their merits and drawbacks. The International Classification of Diseases (ICD 9), although biased towards the hospital sector, is used widely internationally and extensively in British secondary care. In addition, it is not comprehensive to the extent that it cannot allocate a unique code to every disease entity. ICHPPC is essentially a subset of ICD, that deals with primary health care. It suffers from the limitations of ICD mentioned above.

4.2.1 International Classification of Primary Care

International Classification of Primary Care (ICPC) is a classification scheme intended for primary health care. However, it makes no attempt to classify morbidity treated by the secondary sector. It therefore fails to support the transmission of data between GPs and the hospital sector and is unsuitable in the British context as a result.

4.2.2 Royal College of General Practitioners Classification Scheme

The Royal College of General Practitioners Classification Scheme (RCGP) is designed for general practice and suitable in some ways, particularly for recording the incidence and prevalence of disease. However, the classification suffers from a rudimentary coding of patient occupation, a constrained nomenclature in the fields of morbidity and procedures and the coding does not extend to some fields of classifiable data, e.g. clinical procedures and patients' occupation.

4.2.3 Prescription Pricing Authority Classification Scheme

The Prescription Pricing Authority (PPA) classification is based around the British National Formulary (BNF) classification scheme. That is, all medicines are divided into fifteen separate groups, depending upon the way in which they act upon the human body. These chapters are then subdivided into different sections, which may be subdivided again into a distinct category of drugs. The PPA classification, although based around the BNF, contains a greater number of preparations as well as their strengths and different pack sizes, and so has extended schedules. Although capable of classifying any drug, the classification is unsuitable for primary health care as it does not attempt to classify disease.

4.2.4 The Read Classification Scheme

The Read classification mentioned above is hierarchical, with codes consisting of a five character mixture of letters and numbers. The use of both upper and lower case letters increases the number of codes available. This arrangement creates a theoretical maximum of over 650 million codes - ample room for any necessary expansion. "Redundancy", i.e. unused codes, are essential in any classification to enable advances and refinements in knowledge to be classified. That is, the amount of known diseases and therapies will always increase and a classification system must be able to record these new conditions and treatments.

An example of the Read coding has been given by its author [127] -

Code	Rubric
A	Infectious/parasitic diseases
A5	Viral diseases with exanthem
A56	Rubella
A560	Rubella + Neurological complic
A5601	Rubella encephalomyelytis

The codes in existence are cross-referenced to existing coding systems, i.e. for any code in an existing classification there is also a Read code. The NHS centre for Coding and Classification has been formed in Loughborough with Dr. Read, the author of the Read classification system, as its director to continue the development of these codes. The Department of Health has envisaged a future for Read codes not only in primary health care but also in secondary health care and community care.

The advantage of the Read classification is that it has greater depth than any other classification. It is this comprehensiveness that enables it to provide codes which correspond to any entry in any other major medical classification, i.e. RCGP, OPCS-4, ICD and its subsets, ICPC, OXMIS, BNF etc. This means that it can act as a standard classification system as all entries in other classification can be translated into a Read code without any data being lost. The converse is obviously not true, to translate Read codes into another classification would only be possible to a certain extent as data would be lost because medical conditions and treatments could not be defined with the same specificity.

Although Read codes are now accepted as a standard in general medical practice, they are not as yet in international use. The PPA continues to use its own classification system as Read codes are not yet specific enough to identify different pack sizes and drug strength. Another problem with the Read classification system lies in the amount of text on the computer that explains the use of an individual code. This is limited to 30 characters, which results in abbreviations which are sometimes incomprehensible to users.

Classification systems are continually expanding and changing to be able to encode advances in knowledge and therapy. There is a danger that in the future this compatibility will be lost through classification systems developing either greater levels of detail or by adopting different conceptual approaches. To prevent this happening it is vital that the use of Read codes extends beyond the UK and becomes recognised worldwide. While other countries may not adopt Read, greater awareness of the system should prompt more appropriate revisions and extensions to other classification systems.

4.3 Standards in primary health care

The problem of standards extends beyond the classification and coding system to include issues specific to primary health care and to computer standards generally.

Such issues in primary health care include the data held, its coding and the structure of practice reports, as well as communications protocols and hardware specifications. However, it is impossible to consider these issues purely within a health care framework, without reference to the international movements towards standards.

4.3.1 Communication and Open Systems Interconnection

It is possible to connect any two computers together and exchange data between them by writing new software, but in practice it is inefficient to do this whenever a problem arises. It is more efficient to set out a standard method of communication to which all computer system suppliers could adhere.

The International Standards Organisation (ISO) is a body responsible for setting a range of advisory and compulsory standards worldwide in many different product areas. In 1977 ISO started to set out terms of reference for Open Systems Interconnection (OSI), to enable different computer systems to interwork and so provide users with a variety of communication based services [132]. Open Systems Interconnection attempts to do this by defining ways of communicating, both in terms of conceptual approaches and protocols and definitions. As a result of these approaches and models OSI provides a variety of products, which enable computer suppliers to write software interfaces to internationally agreed standards, resulting in different systems being able to communicate with each other to allow:

* the exchange of files,
* the exchange of electronic messages,
* logging on to each others systems,
* submitting jobs to each other's systems [133].

In the longer term these OSI standards will make it easier for computer suppliers in primary health care to enable their systems to communicate with all parts of the National Health Service. However, it is important that the data held in different computers in primary health care is consistent.

4.3.2 Standards for data

The Primary Health Care Specialist Group has set up a working party to develop standards in primary health care. The working party has initially concentrated attention on defining a set of patient registration data which could be accepted universally. Registration was chosen because it was one of the first aspects of general practice to be computerised but also because it is essential to transmit this data to the FHSAs. This is because FHSA databases are used to remunerate practices for both registered patients and meeting targets of immunisation programmes. GPs are entitled to remuneration if seventy or ninety percent of their patients have been vaccinated. The remuneration is greater if the larger percentage is reached. If the FHSA believed that a practice has more patients than it actually has through an inaccurate database, it may consider that the practice failed to meet its targets and withhold money accordingly.

There are several widely known models which correspond closely to essential registration data. These are -

* Medix, a draft standard which grew out of secondary care in the USA.

* Korner data sets.

* The data set of the Exeter care card, as well as the data set used by the FHSAs, i.e. the FP1.

The PHCSG proposed standard is a subset of care card set. It intersects all the other sets, that is it contains some but not all items of data common to other sets and has data items of its own that are absent in other sets.

It is vital that a standard data set for patient registration contains only data for that purpose. Should this not be the case it would be in breach of the Data Protection Act, by keeping data other than for the stated purpose. Examples of such data that are superfluous for registration purposes, include marital status, ethnic group and religion. These items are all specified by Medix but could not be legally held for the purpose of patient registration in the UK.

4.3.3 Information systems

Without the developments of standards the potential benefits of information systems cannot be realized fully. Where the state has played a more active role in the development of computer programs, for example in Scotland and in the Scandinavian countries, a standard system is in place and the framework for an information system exists. This means that there is the potential to collect data from every practice, amalgamate these data and analyse it to provide information about services, morbidity and clinical practice. Where systems are standardised, both horizontal and vertical data flows are possible, enabling improved patient care and more efficiently manage services. This is because data can both be collected and amalgamated for service management but also different practitioners can have access to the parts of the record that they need to improve the treatment of patients.

In addition to the need for standards, a prerequisite of an information system is that there is widespread use of microcomputers among primary health care practitioners. This is not yet the case. Even in community pharmacy, where the use of microcomputers is more common than in any of the other health care professions, many of the systems currently in use in pharmacy could not support such information systems. This is because they were designed solely for labelling and cannot store and remit all the necessary data. An estimate in 1990 indicated that around 40% had a labelling system only, although this figure is likely to decrease [133].

Chapter 5. COST-BENEFIT AND COST-EFFECTIVENESS

In all systems of health care provision there is a finite amount of resources available to treat patients. The acquisition of information technology (IT) reduces the amount of resources that is available to treat patients. Close attention must therefore be paid to the costs of IT as well as advantages that it can bring, in order to ensure that scarce resources are used to optimal effect. It is possible to monitor the use of health resources spent on IT through cost-benefit and cost-effectiveness studies.

Cost-benefit analysis measures the economic rather than the health benefits of a treatment or programme. The cost of treatment is measured in monetary terms, as are the results. Health benefits do not enter into the calculation, but are usually listed as qualitative factors.

Cost-effectiveness measures the results of health programmes in both monetary and non monetary units [134]. Health programmes rarely result in financial benefits but different programmes can yield varying amounts of improvement in health. Cost-effectiveness allows the researcher to measure and compare different programmes in terms of overall efficiency.

Many of the costs of computer systems are readily quantified, e.g. hardware and software, maintenance contracts, stationery and training costs of staff. Other costs are less easy to quantify, e.g. the cost of both initial and ongoing data entry that can result in the practitioner seeing fewer patients. Although no research had looked at systems in primary health care from a comprehensive cost effectiveness standpoint, some research has attempted to measure the costs and monetary benefits of systems in general practice from the GPs viewpoint [19].

Some of the benefits of computers in health care can be quantified, while others are highly qualitative. Examples of quantitative benefits are possible time savings in printing repeat prescriptions or the detection of more interactions or contraindications. Less tangible benefits include more legible and better organised information about patients during the consultation, more legible prescriptions, enhanced clinical audit and the ability to search for information electronically and communicate electronically via e-mail and bulletin boards.

No comprehensive cost-benefit or cost-effectiveness studies have been carried out for any computer systems in primary health care in the UK, although some studies have been conducted on computer systems in the USA. It is also important to consider cost-effectiveness from several viewpoints: that of the practitioner, the National Health Service as a whole and the patient.

5.1 Cost-Benefit analysis in America

The experience of cost-benefit analysis work done in America [135], [136], [137] has found that the computer was cost-beneficial. That is to say that the revenue gained by the computer was greater than the costs of acquisition. The benefits of a computer are not restricted to larger practices: Lloyd [136] found that even in a comparatively low volume solo practice the computer was a cost effective management tool. In this case the practice increased its revenue by 24%, in spite of some dramatic increases in cost, including a 50% increase in personnel. While this suggests that computers are cost-beneficial in Britain, these studies cannot be considered as definitive. This is because both the administrative tasks and method of remuneration are different in Britain and America.

Lloyd adds a caveat that the use of a clinical subsystem requires a fundamental change in the methods of practice. That is to say the computer imposes disciplines of record keeping and entering data in a predefined format [136]. This is as applicable in Britain as America. The computer compels primary health care practitioners to alter the way that they record data.

Saxena et al [135], working with a computerised record system, also found the computer to be cost-beneficial. Direct savings in time were not statistically significant,

but after estimating monetary values for qualitative care, it was concluded that the computer was cost beneficial.
A major conclusion by Lloyd was that although the computer can result in an increase in the average cost of care per patient, compensation can result from each averted hospitalization due to improved screening [136].

5.2 Viewpoints in cost effectiveness

There are three components of health care in Britain, that is the practitioners, the National Health Service as a whole and the patients. In a British situation the NHS would benefit financially from avoiding hospitalization through enhanced opportunistic screening, but the practice, who bear the cost of the computer system, do not receive the savings from any averted hospitalisation. The computer makes possible more opportunistic screening, that is performing a screening procedure when a patient consults about another matter, by automatically alerting the GP when the patient is overdue for a vaccination or examination.
In other areas the NHS benefits overall from the use of the computers in primary health care at the expense of the practitioners. Examples of this is the potential for practitioners to claim remuneration electronically and data about service provision being collected routinely. The NHS could cut costs if some groups of practitioners made claims for remuneration electronically, by reducing the clerical

effort needed to type in these claims. Similarly information about the morbidity of patients from computers in primary health care following encounters could be used to manage services more efficiently.

5.3 Cost-benefit analysis of computers in Britain

5.3.1 Medical practice

While research in America found computers to be cost-beneficial, this is contradicted by research into the financial viability of computer systems in British primary health care. The Micros for GPs Scheme [19] found that

> "although some extra income may be generated from improved item of service fees, experience shows that installing, maintaining and running a computer is a financial liability to the practice".

However, the Scheme looked only at purely financial considerations from the practices viewpoint and did not consider health benefits accruing to patients or the overall benefits to the NHS.

Other studies in Britain [138] also indicate that extra and more skilled staff are likely to be required if a practice automates. In the UK as well as the USA, studies have found that time was lost by using a computer system [139].

Although the majority of doctors in the Micros for GPs scheme thought that the computer had made repeat prescribing easier, even in this activity no time savings were clearly shown. However, the Micros for GPs scheme was conducted between 1983 and 1985, and the computer systems in use today are more sophisticated. It may be that if a similar analysis was conducted on computer systems in use today the findings would be different.

However, despite uncertainty over time savings and the inability of the system to make money, benefits in audit resulted in the users accepting the system [139]. The same conclusions have been drawn by other work [140], which found that the computer didn't save time, although this may have been due in part to doctors continuing to refer to manual notes. Other possible reasons include problems with the computer and orienting work around it.

5.3.2 Cost-Benefit of computers in pharmacy

While the computer may not save time in medical general practice, patient medication record computer system suppliers in pharmacy claim that their system saves time processing prescriptions. This is because much of the data used in producing a label is already held on the system. Consequently, it need not be entered every time a patient returns with a repeat prescription. This time saving may encourage patients to return to a busy pharmacy as they spend less time waiting for their medication. However, in a pharmacy that is less busy and where patients rarely queue, time savings will be small and may not provide as great an incentive for patients to return. Thus it is not always possible to translate time savings into extra revenue. However, the time saved in a pharmacy with a low prescription throughput may be spent counselling the patient and result in a health benefit.

5.3.3 Prescribing

In theory the benefits of computerised prescribing include more legible communication, more accurate records and fewer medication errors [141],[142] [143] [144] [145]. Both the patient and pharmacist appreciate readable prescriptions which are complete and unambiguous [142]. There should be fewer occasions requiring the pharmacist to contact the doctor, thereby saving the time of both professionals. This is the case where well designed software is used in conjuction with accurate data. However, the writer fails to point out that it is sometimes the case that neither of these criteria are true, and the resulting computer generated prescription is inaccurate. Further, this inaccurate data will sometimes be used repeatedly to produce a series of inaccurate repeat prescriptions. There is some evidence that prescribing costs can be reduced by using a computer [146]. This is because the GP can have information about the cost of medicines when the prescription is written.

There is evidence that the incidence of inaccurate prescriptions is unacceptably high as a result of poorly designed software and the inaccurate input of data resulting from users who have little keyboard experience [101].

5.4 Effects of remuneration

5.4.1 General practice

Different claims have been made in the literature as to whether computers are cost beneficial in primary health care computing. Much depends on both the system of remuneration in operation and the activities which are computerised.

In general practice remuneration is partly based on the practitioners list size. However, patients have traditionally been faced with some difficulties in changing their GP and are still largely unaware of the ease with which they can now change practice. Consequently, a GP using a computer may will be able to attract new patients and increase income in the short term, but will retain patients and attract others as patients become more aware of the ease with which they can change GP.

The White Paper "Working for Patients" [147] promotes an internal market for health care in Britain. General practices with large lists will be able to hold their own budgets, and purchase services for their patients from this budget. A computer will be required to monitor the finances of the practices [148]. Non budget holding practices will also have to monitor their prescribing costs [149].

5.4.2 Community pharmacy

As has been discussed above, patients have traditionally faced difficulties in changing their GP. However, this is not the case in community pharmacy, where patients are free to present prescriptions at the pharmacy of their choice. By maintaining patient medication records (PMRs) the pharmacist can attract new patients to the pharmacy and increase income. This is because PMR computer systems can allow pharmacists to provide a higher standard of service to patients, resulting in individual patients being more likely to return to the pharmacy. This higher standard of service results from the pharmacist having more information about the patient's medication. This in turn can lead to the pharmacist detecting drug interactions between medications prescribed on different prescriptions. Pharmacists having more information about patients can also lead to a better rapport with these patients.

A PMR computer system can also allow repetitive chores, such as producing labels for multiple repeat prescriptions, to be carried out more rapidly. This is because the data need only be entered once, and can then printed onto labels as many times as is necessary. Pharmacists are entitled to remuneration for maintaining PMR computer systems. However, the amounts received are small in comparison with the cost of PMR computer systems.

5.4.3 Single user and multi-user computer systems

It is not cost-beneficial from a practice point of view to have a terminal in front of every partner. However there may be clinical benefits in having legible, concise and timely information to hand during the consultation. This information can also allow practice research and clinical audit, as well as ultimately service planning and epidemiological research. Responsibility for meeting the extra cost of a multi-user system can then be argued to lie with both the practitioner and the state.

Multi user systems involve several terminals accessing one patient database. These systems make it possible for all staff involved in the practice to access the patient database simultaneously. With a single user system, only one person can use the computer at any given time.

Although recognised as a financial liability, multi-user computers may contribute to improved patient care. However, there is no evidence of their cost effectiveness. That is, although they could improve patient care, how well do they achieve this compared to alternative health investments? It may for example be more cost effective to use single user or "back office" systems rather than multi-user systems and use the resources saved for another purpose.

It has been reported that the multi-user system offers little advantage in terms of preventative programmes, although it does allow more than one application to be performed simultaneously. A practical application of this is that data can be entered or recall programs run while the computer is printing repeat prescriptions. This is not possible with a single user or "back office" system.
At the centre of any cost effectiveness study must be a measurement of the value of patient information at the time of consultation, for this is the multi-user system's major advantage. It is important to investigate the impact of this information on the outcome of treatment that a patient receives.

5.4.4 Funding general practice computers

Traditionally the practitioner was required to meet the cost of capital equipment. The Government now meets up to half of the cost of the acquisition and running of the system. However, there is an upper limit on the amount that the State will grant to a general practice as a subsidy. The actual sum varies with the individual practice but by setting an upper limit the State avoids subsidising computer equipment which is in excess of the needs of the practice.
This capital payment recognises in part the need created for computers in general practice generated by the requirement to produce a practice report. Another motivation for

subsidising general practice computers is the need for the use of computers in general practice be widespread to support the concept of the internal market (see section 5.4.1). In addition, by paying in part for computer systems, the government may be strengthening its claim to ownership of practice data.

As the State now subsidises general practice computing by up to 50% [21], there is a case for research into which kinds of computer are the most cost effective. Further, these funds could be made conditional on the acquisition of systems from a limited number of suppliers, whose software meets criteria laid down by the Department of Health. This would encourage suppliers to improve software and help prevent the shortcomings that are evident in computer prescriptions.

5.4.5 The internal market and general practice computing

None of the other professions in primary health care receive a comparable subsidy for computers. This may be because no other profession holds as much patient data as GPs, or because no other profession will be actively involved in purchasing services for patients in the internal market. The internal market mean that some GP practices will be responsible for managing a practice budget. This budget will be used to buy certain services on behalf of patients, for example medication and hospital services, and will also pay the salaries of practice staff. A computer will be needed to monitor the costs of each patient in order that the practice can remain within its budget. As a result of this the perceived need for computers in general practice is greater in the eyes of the State.

5.4.6 Cost benefit of computers in optometry and dentistry

There have been no attempts to measure the costs and benefits of computers in either dentistry or optometry. However, both professions can benefit by recalling patients for routine examinations. Recalling patients can be done more efficiently with a computer than by manual methods as once data has been entered into a computer it can be used to print addresses on envelopes many times. In a manual recall system, addressing envelopes is a time intensive process. Thus there is case for the use of a computer in both professions.

5.4.7 Conclusion

There are no recent comprehensive cost effectiveness studies of computer systems in primary health care. As the State subsidises some computer systems, an evaluation of which systems are more cost effective could usefully be conducted, to ensure that public money is allocated to greatest effect.

Any such analysis could usefully consider the relative merits of single and multi user computer systems.

It is possible that the use of a computer system may result in the retention of patients by the professional groups. However, there is no objective evidence to support this idea.

Chapter 6. RESEARCH METHODOLOGY

6.1 Introduction

The following methods of data collection are available in social science research investigations -

* the examination of published literature and statistics.
* postal questionnaires.
* structured interviews with key informants.
* observation.

The research data of the project were gathered using the first three methods listed. All of these methods offer advantages but suffer from some drawbacks.

6.2 Published literature

The research began with a literature search, which was undertaken not only to become acquainted with developments in primary health care computing and the National Health Service, but also to avoid duplicating the work of other researchers. The literature search involved consulting textbooks for background material about the National Health Service, indexing journals for relevant papers in periodicals, reports and Government publications, as well as scanning professional journals for papers on computing. The literature search was updated continuously throughout the project, to keep abreast of current developments. All references have been cited in accordance with BS 5605 [150].

6.3 Questionnaires

Much data were collected by postal questionnaires. The principal advantage of this method is the ability to collect large amounts of data at minimal cost [151]. This is especially true when the sample population is widely geographically dispersed. When the population is large and dispersed other methods of social investigation, such as interviews, become impractical due to limited resources, i.e. time and money do not exist for the researcher to visit every sampled individual in the population. The other advantages of questionnaires are -

* All respondents complete the questionnaire at approximately the same time. This prevents any distortion of the results due to the passage of time, which can occur when many people are interviewed by a small number of interviewers.
* The questionnaire is impersonal. That is, there can be no observer bias, provided that the questions are structured in as unbiased a way as possible and are unambiguous.
* It is possible for the questionnaire to be filled at recipient's convenience [152]. Thus recipients who are busy have the opportunity to complete the questionnaire at their convenience.
* All respondents have exactly the same questions, in the same order, using the same words [152]. This is unlikely to be

the case in an interview where interviewees can anticipate questions and supply answers in advance of a set question.

* Questions can be either open-ended or closed. Open-ended questions leave space for the recipient to write a reply, whereas closed questions require that a user selects one or more responses. It is possible to combine the two types of question by giving a series of responses but leaving space for comment if the recipient finds the available responses inappropriate. Open-ended categories must be mutually exclusive e.g. 2-11, 12 or more, etc. This avoids an ambiguity resulting from one value being eligible for more than one category.

It is often more important to create closed questions and divide people along an imaginary line rather than capture every nuance of opinion. This facilitates the analysis of results, as the population of respondents can be separated into distinct, heterogeneous groups. Open-ended questions allow respondents to qualify their answers and give reasons for their views [152]. However, although open-ended questions are harder to analyse, they can be important when dealing with beliefs. Some analysis is possible by content analysis, where the number of times a particular point is made is counted. As a rule closed questions are used when the alternative replies are known, limited in number, and clear cut. Open-ended questions are particularly suitable for complex issues, where the range of replies is not known. Open-ended questions inevitably use more space and make the questionnaire less appealing to recipients. However, they can be useful in pilot studies for collecting a full range of views or opinions.

Questionnaires suffer from a number of disadvantages. These are -

* The danger of a poor response rates through the indiscriminate use of questionnaires. To combat this, no individual should be surveyed more than once. However, individuals surveyed may receive questionnaires from other sources.
* Poor response rates can drastically reduce the validity of results, as can a sample of respondents that are not representative. The validity of data can be questioned when either only a few responses have been obtained or when only a small percentage of the sampled population have responded. For the results of a survey to be useful, the numbers involved should be large and should represent a large proportion of the total sample.
* It is difficult to ask in depth questions, as this risks an increase in non-response due to complexity and a greater amount of time needed to complete the questionnaire. This can lead to a lack of detailed information in the results.
* There is always the possibility of people marking the wrong box accidentally. It seems likely that this constitutes only a small source of error in a well laid out questionnaire.
* Completing a questionnaire requires the recipient's time without providing any immediate benefit [152]. The researcher can however, stress potential long term benefits

for the recipients in a covering letter. An example is an improved understanding of an aspect of health computing, which could lead to an improved IT strategy, which would itself bring benefits to the profession of which the recipient is a member.

* There is a need to translate shorter technical language into longer everyday speech, which all recipients can understand. This reduces the number of questions that can be asked, or increases the length of the questionnaire, with the attendant risk of discouraging response.
* There is a high degree of self-selection in response [153]. That is, recipients who have strong feelings about the subject of the questionnaire are more likely to respond than are recipients who are indifferent to the subject. Consequently, a section of opinion, that is those with no strong feelings, may be under represented in the results.

The greatest problem of surveys is undoubtedly that of non-response. This phenomenon of varies with the sample population, depending upon factors such as the literacy of the population and the level of interest in the subject around which the survey is based. Response rates are also influenced by the design of the questionnaire, its appearance and the text of the accompanying letter. The inclusion of a reply envelope is essential and sending a second mailing to non-responders if possible will also serve to increase the response rate.

6.3.1 Sampling the population

When the whole population that is of interest to the researcher is large, it becomes impossible to survey all the individuals in that population, due to limited resources. It is then necessary to choose a representative sample of the population. In the project two sampling methods were used -

* Selecting every n^{th} subject in the population, to achieve an approximation of the desired number of individuals to be surveyed.
* Selecting samples randomly, using a facility for generating random numbers on a computer.

In one part of the research the whole population was surveyed. This was possible due to the comparatively small number involved, 98 in total.

6.3.2 Data analysis

All data were analysed using the Statistical Package for Social Science (SPSS-X) software [154]. Data were recorded from the questions into electronic format with two packages Statistical Analysis Package (SAP) and Data Entry [155] [156]. Data entry was used later in the project instead of SAP as it offered greater convenience in recording responses, as well as more powerful error checking features. The University was not licensed to use Data Entry at the time the early surveys were conducted.

Chapter 7. RESEARCH INTRODUCTION

7.1 General practice

The use of computers in general practice had been surveyed extensively by the Department of Health in conjunction with the Family Health Services Authorities (FHSAs) [157]-[159]. These surveys were aimed at gathering data about the hardware and software used in general practice, its cost, as well the applications that were being performed by computers.

However, these surveys did not gather data about -

* The information and help that are available to GPs when selecting a system.
* What training and support are available to GP practices once the computer is installed.
* What procedures are used with regard to the confidentiality and security of clinical data.
* What classification system is used to record the data.
* What opinions GPs hold regarding the use of information technology (IT) to facilitate communication between themselves and organisational bodies and other professional groups.

In view of the limited scope of the DoH survey, the research sought to gather data from these unexplored areas. Several Reports [19], [160], [161] [162] have been published to assist GPs in selecting a computer system. However, there is no evidence that the majority of GPs are aware that these Reports exist.

When GPs install a computer system, a certain number of training days are offered as part of the package. However, the number of days offered may not be adequate for practice staff to become familiar with the computer, and there may be a need for more training later, as new staff begin work at the practice.

The importance of adequate precautions to prevent the loss or damage of data and protect it from unauthorised access have been stressed by the Working Party of the Royal College of General Practitioners [17]. However, there is no information available about the procedures that are routinely employed to achieve these ends. The research sought to gather data about how practices treat backup copies of data as well what procedures are used to protect general practice data from unauthorised access.

The importance of classification schemes has been stressed in section 4.1, and the Read system has since been adopted as a standard for general practice [130]. However, there are many different computer systems in use in general practice, using many different classification schemes. The research sought to measure the diversity of systems in practice, as this is an important factor in unifying the classification of general practice data as it indicates how much change is needed before all of general practice can use one standard system.

The benefits that the use of computers in primary health could bring to patients and the National Health Service (NHS) have been previously described (sections 1.1.4.1 to 1.1.4.4). The research sought to establish whether GPs were in favour of -

* Sharing the data of which they are custodians with other health professionals, given that these professionals could provide a better service to the patient with these data.
* Communicating administrative data electronically between practices and administrative and remunerative bodies.

The questionnaire also sought to test support for the electronic smart card as a mechanism of sharing data between the different health professions.

7.2 Community pharmacy

At the time of the survey of computers in community pharmacy, the overwhelming majority of pharmacists were using a computer of some description. However, many of the computer systems in use were only capable of producing labels for medication. This situation arose from the recommendation that all labels be machine-produced. However, computer systems of greater sophistication were also commercially available to pharmacists. The questionnaire sought to gather data about both the numbers and features of computer systems in use as well as measure the interest of respondents in the more sophisticated features of the computer systems that were available. The White Paper "Promoting Better Health" [25] envisaged pharmacists keeping patient medication records on a greater scale that was previously the case. The research investigated whether pharmacists themselves felt that they could reconcile the initial cost of a PMR computer system with the benefits of improved care that it could bring to patients.

A pilot trial which linked six computer systems of one supplier, John Richardson Computers, with the Prescription Pricing Authority (PPA) had been conducted. The trial had involved the pharmacies sending prescription data to the PPA, and was intended to explore whether this could be done routinely, rather than have pharmacists post the prescriptions that they receive in a month to the PPA, as is now the case. Although there were no plans to extend the pilot trial immediately after its completion, the research investigated whether there was sufficient support for such a scheme to be set up at some time in the future.

Pharmacists have been deeply involved in two of the trials of the smart card in Britain [67], [76]. Collectively, pharmacies hold all the information about a patient's medication. The smart card could allow the pharmacist to add these data to the card and enable pharmacists to have information about the patient's morbidity. However, there are some issues that must be explored before a smart card system could be used widely in pharmacy. These are the pharmacists perception of what data the card should include, e.g. Over The Counter (OTC) medication,how great are the care benefits that the card can provide in relation to the impact of the card could have on the business aspects of a pharmacy.

The second part of the research looked specifically at the impact of PMR computer systems in pharmacy, with particular reference to whether these systems retain patients and increase the number of prescriptions presented to a pharmacy. The questionnaire specifically investigated the impact of PMR computer systems in terms of its effect on -

* Patient loyalty.
* The number of prescriptions presented.
* The job satisfaction of the pharmacist.

The study also investigated the effect of using different methods to inform patients about the PMR system on both patient loyalty and the number of prescriptions presented.

7.3 General practice dentistry

Interest in the application of computers in dentistry was recognised in 1981, when the British Dental Association (BDA) commissioned a report entitled "Computing in General Dental Practice" [27] from Scicon Consultancy. The objectives of the report were to assess the feasibility of computers in general dental practice in both the short and longer term. The BDA were particularly interested in the electronic transmission of National Health Service claims for remuneration.

The Report made many recommendations for dentists to consider before acquiring a practice computer, amongst them were the following -

* that dental surgeons should not contact prospective computer system suppliers until technical literature had been collected and analysed.
* that dental practices which had used a computer for some time should be visited beforehand.
* that dental surgeons arrange to become familiar with computers and computing through:

  computer appreciation courses

  local amateur computer clubs

  exhibitions

  magazines
* that all systems should be of the multi-user, multi-tasking type. The limitations of a single user type system are severe and cannot be recommended.

Further recommendations that electronic communication with the then Dental Estimates Board, now the Dental Practice Board (DPB), should be explored came from the Andersen Report [57], an influential report into the use of computers by Family Practitioner Committees.

Pilot trials have explored electronic communication between dentists and the Dental Practice Board (DPB), and this service is now being made available to dentists nationally. As well as administrative benefits resulting from "vertical" data flows to supervisory bodies, a paper in a medical journal suggested improvements in patient care could result from "horizontal" data flows between dentists and general practitioners [163]. The authors argue that if dentists have more clinical information about patients they can treat them more effectively.

Despite this recognition and interest in dental computing, the numbers of computers in use in dentistry generally are less than in other sectors of primary health care, such as general medical practice, pharmacy and ophthalmic optics. A survey of dental computer use in Scotland revealed that more than 6% of practices currently used a computer and a further 25% were interested in computerising [29].

At the time of the research there had been no national survey of the use of computers in dentistry. The survey therefore sought to gather data about the numbers of systems in use, the suppliers of these systems and the tasks that the computers systems were performing.

In view of the long awareness of the benefits of computers in dentistry, the questionnaire sought to discover what information and help dentists required in order to computerise their practices. The questions approached this on several fronts -

* What printed information would be most helpful.
* What subject matter is of greatest interest.
* What methods are most suitable for delivering this information.

As all dentists will soon be able to send claims for remuneration electronically to the DPB, the questionnaire ascertained whether there was a demand for this service among respondents. A dental practice was also included in a British study of smart cards [76]. As a result respondents were asked whether they consider access to such a device useful.

7.4 Optometry

At the time that this research was conducted very little was known about the use of computers in optometry. Some computer systems designed for use in optometry were available commercially, and some had been evaluated in professional journals. However, the literature gave no indication of how many optometric practices were using a computer system, or what applications were being performed using a computer in practice. The research sought to establish how many optometrists were using a computer, which systems were in use and what aspects of practice management were being computerised.

There had been no investigation of the benefits of computer communication between optometry and the Family Health Services Authorities (FHSAs), despite pilot trials of this between general practice, community pharmacy and dentistry and their remunerative bodies. The research consequently sought to establish whether there was a demand for communication with the FHSAs from optometrists. There was also an attempt to install a network service for optometrists, which would enable optometrists to order materials electronically. Although there are no plans for such a service in the near future, support was this concept was measured as the number of computer systems will increase, creating a greater user base for the service.

7.5 The Family Health Services Authorities

Computing in the Family Practitioner Health Service Authorities (FHSAs) began in 1981, when the FHSAs were known as Family Practitioner Committees (FPCs). The development of software started with a registration system for FPCs designed by Trent Regional Health Authority. This system was implemented in 1981 [164] and by 1984 eight FPCs were using the system in a modified form [165]. The Exeter FPS Computer Unit was formally opened on the 1st of April 1983 with a remit to design both GP and FPC systems. It was funded by the then DHSS, now the DoH, managed by representatives of the Unit, the RHA, the then MSC and the DHSS and was accountable to the South Western RHA. The Unit redeveloped the Trent RHA system and added modules to deal with cervical cytology recall and financial systems in addition to the original registration module [165]. This system has been adopted by almost all of the FPCs in England and Wales. Further impetus to FPC computing came from the Andersen Report [57], which after being commissioned to examine the functions of the then Family Practitioner Services (FPS), now Family Health Services (FHS), in 1983 recommended that -

* the use of computers be greatly extended.
* practitioners should directly input data required for administrative purposes.
* a strategy for automation be drawn up to avoid piecemeal development of systems.

While all FHSAs now have a minicomputer which supports software from the FHS Computer Unit, the questionnaire asked about the hardware and software used. This is because the White Paper "Promoting Better Health" [25] envisaged a managerial role for the FHSAs, and fulfilling this role has involved an increase in the use of microcomputer technology.

In line with this managerial role, FHSAs will increasingly need more information from primary health care. The questionnaire investigated which items of data are considered to be of the greatest importance by FHSA managers.

The Secretary of State for Health fixed a target date of 31 March 1988 for all FPCs to computerise in order to support cervical screening programmes [164]. Following this and studies linking GPs to FPCs, the electronics company Racal was been awarded a contract in September 1989 [166] to install a network for the Family Practitioner Services. This network would allow all FHSAs to exchange data and allow both independent contractors and NHS organisations to communicate with the FHSAs. As a result of these enhanced opportunities for communication with the primary health professions and organisational bodies, the questionnaire sought to draw up a priority list which would establish with which of these bodies electronic communication should be explored initially. This would allow FHSAs to achieve the greatest benefits at the earliest opportunity. From the 1st of September 1990 the FPCs became Family Health Services Authorities (FHSAs).

Chapter 8. COMPUTERS IN GENERAL MEDICAL PRACTICE

8.1 Method

Two separate postal surveys of general practitioners were conducted. One survey of 321 respondents served as a pilot and was conducted among general practitioners in the West Midlands. This pilot included practices with a computer, as well as those without.
The main survey was of the GPs who are members of the Primary Health Care Specialist Group of the British Computer Society. Using the Group membership made available a large sample of computerised practices, 695 in all. In both cases a postal survey was sent with a covering letter and a prepaid reply envelope. A reminder was sent along with another prepaid envelope after five weeks in both pilot and survey. The majority of questions were closed, although some space was left for respondents' comments.

8.2.1 Objectives

The surveys were designed to meet the following objectives -

1) To gather data about the systems used in practice and the after sales support available to practices.
2) To collect data regarding the attitude of GPs to electronic communication and the smart card.

The pilot survey had the following additional objectives -

3) To measure the numbers of systems and the suppliers of these systems in use in general practice, and any future trends in general practice computerisation.
4) To discover the reasons why some practices are not acquiring computers.

8.2.2 Hypotheses

1) That GPs do not have sufficient information about computers prior to system acquisition.
2) That there is a need for training of practice staff in the use of practice computers.
3) That practice staff do not have sufficient training in computing to apply the techniques of good computer practice in relation to the security and confidentiality of practice data.

8.3 Results

8.3.1 Response to the Pilot

321 questionnaires were sent to GPs in Birmingham in 1988. This number represented the total on the Birmingham FHSA list, on which the pilot was based. The initial mailing produced 163 (54%) replies. The reminder letter produced a

further 51 replies, giving a total of 223 (69%). Of these 216 (66%) responses were useable.

8.3.2 Computer use and non-use in general practice

In the West Midlands survey 39 respondents (18%) maintained a computerised record system. A further 48 were actively planning to acquire a computer system, which suggested that over 40% of practices in the West Midlands would soon be using some form of computerised record system.

The main reasons given for the non-acquisition of a system are as follows -

Table 1. Non acquisition of computer by GPs.

* Practice size too small	15%
* No need felt for computer in the practice	15%
* Expense	14%
* Close to retirement	12%
* Both time and expense	7%
* Additional time involved	4%

The reasons for the non-acquisition of a computer have implications for the future computerisation of general practice, especially as the market seems to have stopped expanding with 50% of practices having automated by 1990 [21].

As older GPs retire the market for general practice computer systems will continue to expand. It would appear that practitioners who have previously been reluctant to acquire a computer on grounds of cost may be encouraged by the 50% reimbursement by the Government [21].

A substantial number felt that there was no need for a computer in their practice at present, i.e. 1988 but the New Contract for General Practice of 1990 alters this by setting targets for immunisation and vaccination levels and by the need to produce a practice report. A computer can help meet these contractual requirements by facilitating both recall programmes and opportunistic screening. It is also possible for the computer to print out the data it holds in a report format.

Although the cost of a system can be better borne by a large practice than a small one, both the contractual pressures and the financial incentives described above encourage practices who previously considered themselves too small to computerise.

8.3.3 Data entry

Upon acquisition, 22 (56%) West Midlands respondents were able to use FHSA data, and of those who did not the main reason was the desire to gain experience of the system through manual data entry. Although GPs can now obtain the name, address, age and sex of patients electronically, it is the policy of VAMP Health, one of the major GP suppliers, to advise customers to enter data manually to gain familiarity and expertise with the systems.

Other factors which inhibit the use of FHSA data are reports in professional journals of substantial numbers of inaccuracies in the data. The problem is most acute in inner city areas where the population is highly mobile.
With the ease of record maintenance brought about by computer use in all FHSAs, error rates in data should decrease and more practitioners will be able to make use of this resource. For this to happen it is essential that general practices confirm the patients address at every opportunity and pass on any changes to the FHSA.

8.3.4 Response to the PHCSG survey

An initial mailing of 695, the number of practices identifiable from the membership list, produced 463 replies or a 67% response rate. A second mailing five weeks later increased the total number of responses to 564 (81%). Responses from GPs who did not use a computer or had retired were discarded, as were incomplete responses which left 425 (61%) replies for analysis.

8.3.4.1 The practices

The average number of partners in the practices surveyed in the PHCSG was 4.3, which is larger than the national average of 3.1. This may be because larger practices appear to have more incentive to acquire a computer and are better able to afford a computer than smaller ones.

8.3.5 Information for GPs

The Reports "Micros in Practice "[161], "A Prescription for Change" [160] and "Micros for GPs" [19], all published between 1985 and 1986, go some way to meeting the information needs of GPs considering computerisation. However, only 56% of respondents in the PHCSG were able to see these reports prior to system acquisition.

Failure to see relevant reports prior to purchase can be attributed to three causes

1) the reports being ignored due to their age.

2) GPs not being able to obtain a copy.

3) GPs not being aware of their existence.

Several respondents commented that they saw the reports but did not find them particularly helpful. However, the respondents gave no particular reason why they were unhelpful.

While the reports are some years old and consequently cannot provide an evaluation of the most recent system developments, they do contain information which is still relevant to prospective system purchasers today. GPs wishing to obtain copies can do so through medical libraries, the RCGP and HMSO. It seems reasonable to conclude that these reports are not consulted prior to system acquisition due to

GPs not being aware of their existence. A possible solution to this lack of awareness would be FHSA distributed reading lists for practices considering computerising.

A paper published in October 1988 in the British Medical Journal provides more up to date information in the form of a review of the major systems [167]. In addition a guide for first time buyers is available from the Department of Health (DoH) [168]. The PHCSG survey revealed that in 289 (70%) practices at least one partner had some experience of computers prior to acquisition of a system. If this is true of general practice as a whole, the DoH should consider another guide for the more computer literate GP.

8.3.6 Regional advisors

In order to help bridge this information gap, it was first recommended in 1980 and again in 1988 that Regional advisors should be appointed to assist GPs who are considering computerising their practices [18], [169]. 328 (88%) of respondents considered that this would be useful and only 38 (9%) thought that it would be of little use.

However, several respondents felt that the problem with advisors is the difficulty of finding someone with a wide enough experience. Two or three had reservations that any advisors would tend to recommend the system with which they were most familiar. Despite support for the idea of Regional advisors, there are as yet only two currently in post [170].

A network of informal advisors has already been set up throughout the country by the Primary Health Care Specialist Group (PHCSG). Additionally one FHSA has created a part-time post for a GP computing advisor [171]. Informal advisors could be exploited more fully if they were publicised by FHSAs to local GPs. A large proportion of GPs in the pilot survey (44%) were unaware of the existence of the PHCSG, and its advisors deserve more publicity.

If a greater awareness of the PHCSG existed the demand for government-appointed regional advisers may be partly or wholly met. The PHCSG is also able to put GPs in touch with local user groups who can provide additional support.

8.3.7 Computer systems

Respondents were asked which system they used. Replies are shown in Table 1.

Table 2. Computer systems in general practice.

	Systems Used (N = 423)
Supplier	Number (%)
AAH Meditel	113 (27)
VAMP	96 (23)
Ciba-Geigy/AMC	38 (9)
Own System+	35 (8)
G PASS	29 (7)
Update	21 (5)
Genisyst*	17 (4)

Hungerford/M-Tec	16 (4)
G and G Software	16 (4)
Micro-doc	7 (2)
Image	6 (1)
Other	29 (7)

* Includes both Genisyst and Genisyst Junior.

+ Systems written specifically for that practice in third or fourth generation languages.

Although the figures provide an interesting breakdown of what systems are employed by GP members of the PHCSG, this does not represent an unbiased sample of general practices in Great Britain. There is a geographic bias because the PHCSG is not as active in Scotland as in England.

Two companies supply GP practices with computers effectively free of charge, in return for data on practice activity. Respondents were asked whether they were involved in either of the "free computer" schemes and whether they had been able to meet the data requirements. Although 183 (43%) respondents indicated that they were involved, less than half (82) of these had completed their six month trial period. Ten of the 82 indicated that they had been unable to meet the requirements of the scheme and may have to pay the full cost of renting or leasing the system, or else risk having it removed.

System acquisition among PHCSG members has proceeded at a rapid rate, with 77% acquiring systems within three years. This substantial increase can be attributed to -

* publicity about medical computing in both professional and lay press.
* increasingly sophisticated systems becoming available.
* practitioners being able to acquire systems at no cost.

8.3.8 Morbidity coding

The need for standardized morbidity coding has been discussed previously (see para 4.1). 131 (37%) of the PHCSG respondents used the Read classification system, 96 (24%) used the Royal College of General Practitioners (RCGP) classification scheme and 92 (23%) Oxmis. 56 (14%) of respondents either used no scheme or were unable to say which scheme was used. Several practices had developed their own classification scheme. The popularity and comprehensiveness of the Read classification confirm the suitability of its choice as the new UK general practice standard [130]. However, the majority of practices (63%) were not at the time of the survey using this classification system. Larger suppliers may be able to support Read by automatically replacing one code with another. However, practices involved with smaller suppliers may find it necessary to recode data from previous patient encounters into Read manually - an extremely time intensive process.

8.3.9 Support and help available

Practices need help with simple queries especially when the computer system is unfamiliar, as well as timely assistance should the system fail. 382 (93%) respondents had access to a telephone helpline, 354 (84%) had a hardware maintenance contract and 355 (84%) had a software maintenance contract. Most practices have taken adequate precautions in case of system failure, although a minority of practices without a maintenance contract will find any sudden faults in their system expensive to repair promptly. Ideally a single company should be responsible for both hardware and software maintenance. This prevents two companies denying that a malfunction is their problem.

8.3.10 Staff impact

The "Micros for GPs" [19] scheme suggested that computerisation led to an increase in staff for most practices. In the PHCSG survey 198 (48%) of respondents reported no change in staff, 216 (52%) had needed more staff and 2 (<1%) required fewer staff. There was a positive correlation between needing to employ extra staff and the number of partners using the computer during consultations. Even the more user-friendly systems of today still make staff increases likely. The more partners involved with the system during consultations, the greater the likelihood of more staff being needed. In order to facilitate the entry of clinical data it is imperative to provide an improved user interface. Research into such an interface is currently underway [172].

52% of respondents used the computer during consultations. This relatively large number is partly attributed to the two companies offering no cost systems actively encouraging users to enter data during or in between consultations, although other more modern systems allow users to interact with the system during consultations.

Most practices had had to employ more staff, increasing the running costs of the system. In view of the capital cost and increased staff costs of systems a case exists for the 50% subsidy.

8.3.11 Training courses

For practice staff with no experience of computing hands-on training is invaluable. 315 or 77% of PHCSG respondents were offered some sort of training package. The majority of those who undertook these courses found them useful. Respondents were asked which members of their practice would benefit from further training if it was available. The replies are shown in Table 3.

While suppliers provide training at the onset of practice computerisation, there remains a need for ongoing staff training, especially for reception staff. This need could potentially be met by suppliers, local colleges or the FHSAs.

Respondents appraisal of which practice members would benefit from further training.

Table 3 Training needs in general practice. (N=425)

Category	Training useful (%)
Receptionist	273 (69)
GP	264 (67)
Practice Manager	222 (56)
Nurse	212 (54)
No members of staff	43 (11)

Each respondent was allowed to indicate that training was required for more than one type of practice staff, therefore the total is greater than 100%.

Despite most practices receiving a training package, usually lasting three to five days, a need for follow-up training still exists. It should be possible to take training days at the practice's discretion, as the best time to take all of the training offered is not necessarily when the computer is first installed. This would maximise the training package and reduce the need for additional training.

8.3.12 Practice research and audit

The fact that 253 (61%) PHCSG respondents found that the computer had led to an increase in research, suggests that this is important motivating factor in system acquisition. The value of data in general practice has been pointed out [173], [174] as has the potential of the computer for its analysis [175]. Research can record the outcome of treatment for many groups of patients and so enable practices to measure progress in improving patient care. Examples of measurements of outcomes are blood pressure in hypertensive patients, body mass index for the obese and the glycosylated haemoglobin levels in diabetics [176], [177].

Remuneration in general practice is moving away from a capitation-based system to one where payments are made by meeting targets which reflect a good medical service. The measurements described above could provide the basis for remuneration in future contracts for general practitioners. This would enable those who manage services to set more sophisticated targets and objectives for practices to meet.

8.3.13 Security and confidentiality

Both security and confidentiality, discussed in detail earlier, are of obvious importance in general practice. 98%

of respondents kept backups, generally in a separate building (74%). 12% kept their backups in a fireproof safe but 14% kept them in the practice without a fireproof safe. These practices are failing to protect their data from fire, flood and theft.

131 (31%) used hierarchical passwords, that is passwords which allow different users access to different parts of the system. 227 (54%) used non-hierarchical passwords and 62 (15%) used no form of passwords. Those who do not employ passwords can argue that information in a computer is better protected than in a manual system, such as Lloyd George envelopes or A4 medical records. This is because while accessing a manual system is straightforward, some knowledge of how to operate the computer is needed to obtain information.

However, the computer could allow an intruder to collate information rapidly regarding particular medical conditions, which can serve a sinister purpose.

Although the vast majority of practices do make backup copies of their data, there is a wide variation in the frequency of copying and some backups are made only at irregular intervals. Failure to make backup copies at appropriate intervals will lead to data being lost. If data are worth recording, it must be protected from damage and loss.

From the 11th of May 1986 the Data Protection Act required all GPs with computers to register as data users. 410 (98%) of practices in the PHCSG had registered with the Data Protection Registrar. Failure to register constitutes a criminal offence.

8.3.14 Electronic communication and data sharing

Even before microcomputers were in common use, Hiltz and Turoff recognised that computer-mediated communication is

> "the cheapest, most convenient and potentially most powerful option for geographically dispersed groups of people who must regularly exchange information and opinions" [56].

The questionnaires sought to determine general practitioners attitudes to electronic communication.

When asked with which bodies and practitioners electronic communication would be desirable the respondents answered as shown in Table 4 below:

Table 4. Electronic links and general practice.

	Link desired	Not Desired	Don't Know
	Nos (%)	Nos(%)	Nos(%)
FHSA	394(94)	14(3)	11(3)
PPA	223(67)	47(14)	64(19)
Hospital	386(93)	13(3)	18(4)
Other GP	163(50)	84(26)	80(25)
Pharmacist	232(55)	132(32)	55(13)
Dentist	216(52)	130(31)	71(17)
Optician	191(46)	147(35)	77(19)

Strong support existed for networking arrangements which would allow GPs to communicate with the Family Health Service Authority (FHSA). Electronic communication between the FHSAs and GPs could facilitate capitation and target payments, as well as ensuring that the correct amount is being paid. In addition prescription pads and other FHSA stationery could be ordered electronically, saving both parties time and money.

Electronic communication between general practice and an FHSA has been explored by the DoH in a pilot trial [59]. Although the nature of the remuneration has changed since the trial the basic feasibility of such data interchange has been established.

Electronic communication with local hospitals could result in GPs being speedily alerted and kept informed of the progress of patient treatment. Additionally GPs could have access to information about the length of waiting lists.

Support for direct communication with the PPA was positive among PHCSG members. GPs currently receive information on their prescribing from the PPA in a printed format at quarterly intervals. Electronic interrogation of PPA computer could allow GPs to obtain information on practice prescribing at more frequent intervals. It could also make savings in paper and postage, with connection costs kept low by practices downloading data onto their own computers. That is to say the practice would take data from the PPA computer and store this data in the memory of its own computer. Practices could then be able to construct more sophisticated searches on this data. However, demand for linking with the PPA is not as great as that for other organisations. Both of these studies were conducted prior to the indicative budgets for GP prescribing. Since the introduction of these budgets GPs may have a greater interest in information from the PPA.

A patient's various medical and medication records are currently held between several Family Health Services professionals. GPs hold the patient's medical history as well as details of most of the patient's prescribed medication. One or more pharmacists may hold all medication information about patients, i.e. prescriptions from GPs, dentists and orders from opticians. Over the counter (OTC) products may be included in some pharmacy Patient Medication Record (PMR) systems. Dentists hold some prescription information as well as details of the patient's dental history.

The advent of the Family Health Services network [166] could facilitate improved communication between these professionals.

Respondents were asked if they would be in favour of sharing electronic data with other professionals if this could enable a better service to be provided to the patient. However, the idea of communicating with other Family Health Services professionals was met with less enthusiasm than the FHSA and hospital sector. Support in the PHCSG for communicating with other PHC practitioners varied from 46%-55%: with the hospital sector and FHSA it was at over 80%.

Information available through GP to GP communication could be particularly useful when a patient changes location, either temporarily or permanently. 50% of PHCSG respondents supported electronic communication with other GPs and 26% opposed this idea.

Electronic communication with pharmacists was supported by 55% of respondents but 32% of PHCSG respondents opposed the idea.

Pharmacists frequently have to contact the GP with queries about prescriptions. The reception staff are sometimes perceived as a barrier to the GP by the pharmacist [178]. When the GP has a terminal in the consulting room, the pharmacists could send a message to the GP via e-mail. The advantage of this from the pharmacists point of view is that the GP will become instantly aware that there is a problem and respond rapidly.

Communicating electronically with dentists was supported by 52% of the PHCSG respondents, while 31% opposed the idea. Dentists need information about patients' medical histories as well as details of current medication. This information is usually obtained from the patient in an interview. However, patients may well overlook or forget to impart important information and there is a suggestion that better communication between GP and dentist may lead to better care [163]. In addition, the patient's medical records are incomplete without information on dental prescribing.

46% of PHCSG respondents considered that any electronic communication with opticians would be useful. Currently opticians' communication with GPs is restricted to their informing the GP when a patient is suffering from a pathological condition associated with the eye, although opticians do supply a limited range of medicinal products on their own authority. Electronic communication with opticians was opposed by 35% of PHCSG members.

A possible reason for the reluctance to communicate with other FHS professionals lies in preventing unauthorised access to a network spread over a wide geographic area.

The smart card is a possible solution to the problem of confidentiality inherent in electronic communication. There was overwhelming support (378 or 90%) for the idea of a patient held smart card amongst PHCSG respondents.

In theory the card could allow all health professionals to have timely access to the information they needed to do their job most effectively. The capacity of the latest cards allow room for the patients complete medical record to be held [179], although access to such data would have to be restricted on a need-to-know basis. 308 (80%) of PHCSG respondents were in favour of other health professionals being able to add data to the card. Examples of data that could usefully be added to the card are over-the-counter medications and flags to indicate that prescriptions have been dispensed by pharmacists, information about eye disorders by opticians and prescription information by dentists. 9% of respondents opposed the idea of other professionals adding data to the card.

One of the problems with smart card acceptance lies in equipping the health professions with devices to read the cards. Reading devices must become commonplace throughout both the Family Health Services professionals as well as in the hospital sector for the system to be fully effective.

The smart card could contribute to improving patient care but at present there is a high capital cost of installing the equipment.

8.4 Discussion

Respondents indicated that the cost of computer systems was not the primary consideration in practices that continued to maintain fully manual systems. Of greater importance was a lack of perceived need. Since the survey, several things may have altered GPs perception of need. These are -

* General practice budgets. In the proposed internal health market, which came into being on the first of April 1991, any general practice which holds its own budget will be obliged to use IT to monitor its funds.
* Changes in GP remuneration. A larger part of GP remuneration now comes from ensuring that a large number (70% or 90%) of patients have been vaccinated or screened. Screening services can be carried out much more efficiently with a computer than by manual methods.
* The need to produce a practice report. All practices must produce a practice report. This can be facilitated using a computer system.

Practices installing a computer can import the name, address and sex of their patients from data supplied by their FHSA. However, papers described earlier (See section 3.3.1) indicate that not all FHSA data are of an acceptable standard in terms of accuracy. If practices are to use FHSA data, patient details should be confirmed when the patient is next in the practice.

There is a great deal of literature published for the GP considering computerising. However, few GPs seem able to use this information prior to installing a computer. This may be due to poor information searching skills or being unable to visit a medical library. In order to help overcome this FHSA could maintain lists of useful publications which could be made available to GPs considering computerisation. Other ways in which FHSAs could support GPs prior to the installation or a computer system are by providing -

* Computing advisors - individuals with experience of general practice computing who could give practical guidance to GPs considering computerising their practices. In view of the numbers of GPs within an FHSA, any appointments may need to be on a part time basis or shared between several FHSAs. In addition to assisting GPs, advisors could also inform GPs about courses and seminars held by the Primary Health Care Specialist Group (PHCSG) of the British Computer Society (BCS).

* Computing centres - where GPs can become familiar with a range of computer systems in the absence of salesmen. It is anticipated that these systems should be available at reduced cost from suppliers, as the supply of a system may lead to its adoption later by more practices.

As discussed previously in section 4.2.4 the Read coding system is now the UK standard. However, at present a minority of GPs use this system. It is essential that other systems adopt or interface to Read codes if meaningful data is to be generated from primary health care. Further, the Read codes are not used extensively in secondary care. Coding systems in secondary must use or support Read to facilitate electronic data exchange with general practice.

There is a need for after-sales support and continuing software development in general practice. The overwhelming majority of practices recognise this and have maintenance contracts for both hardware and software. However, these contracts are only useful while the contractor continues to be active in the market. As markets mature, the number of vendors with a product inevitable declines [180]. This will happen in general practice and many practices will no longer have their computer systems supported as companies leave the market. This will necessitate many practices having to invest in different computer systems and re-enter large amounts of patient data.

The questionnaire has identified a need for staff training in the use of the computer. This need is most acute for GPs and receptionists. There are three possible sources of training courses -

* Local colleges - local colleges may provide useful courses about computing generally but are unlikely to provide courses about general practice computing. This is because they are unlikely to have specialist knowledge about general practice computing, or have hardware capable of supporting the multi-user systems often found in general practice.
* Computer suppliers - the suppliers usually provide some initial training but this does not meet the need fully. Further training for an individual practice is expensive. However, as the population of practices without computers diminishes, a greater proportion of suppliers income will come from support activities. Training days, at the company headquarters and open to all system users, may well be a useful way of increasing income generated through support activities.
* FHSAs - if FHSAs had both a range of systems used in general practice and a GP computing advisor, it would be easy to combine the two together in a training programme.

There is an urgent need for training and guidance with regard to aspects of data security and confidentiality in general practice. Practice staff, untrained in the use of computers, are unaware of what constitutes good computing practice. Examples of the advice needed for good practice includes -

* Backups - at what intervals they should be taken and where backup copies should be stored.
* Passwords - how complex to make passwords, which passwords to avoid e.g. car registration numbers, and how frequently they should be changed.

Further, there is a need for each user of the system to have a unique password, which is attached to any data that they enter into the system. This enables the source of any data to be identified in any future medico-legal tribunal. None of the systems in general practice currently offer this facility.

There was an overwhelmingly positive response to the idea that general practice should communicate electronically with the FHSAs and the hospital sector. This level of support was not apparent when respondents were asked about communicating with other primary health care professionals. Communication with FHSAs is necessary for GP remuneration. Hospitals could send information about patients to the GP more quickly electronically. However, electronic communication with other primary health professionals is different from the hospital sector as it involves these professionals accessing more data then they would send to GPs. Thus there may be a territorial component to the concept of data exchange among respondents.

However, very few respondents objected to the patient showing information on a electronic card to other professionals, or even allowing these professionals to write data to the card. Therefore it appears acceptable for the patient to hold information and give it to whoever the patient deems fit but it is not acceptable for the GP to allow other parties limited access to the data. Thus the concept of patients being guardians of their own medical records is acceptable, but the concept of other groups accessing GP-held patient records is less acceptable. This may be because GPs feel unable to give a complete guarantee that patient confidentiality will not be breached over a networked system. As a result they are unwilling to be responsible for the confidentiality of data, but are prepared to allow patients to assume this responsibility themselves.

If this is the case, one way of safeguarding confidentiality would be to use callback modems (fully discussed in section 3.2) to restrict the number of people able to access data in the general practice's computer. Most patients will live near the surgery and visit local pharmacists, dentists, and opticians. The ability to access some data in the computer in the general practice could be restricted to these local practitioners. The use of callback modems would mean that any unauthorised access to a general practice computer would involve not only having to discover a password for the system but also logging in from one of only several locations.

There was an overwhelmingly positive response to the concept of smart cards. However, there are no plans to conduct further card trials in the UK, nor are cards which carry comprehensive patient medical records in widespread use in any country (see section 2.6).

The internal health market, which will exist in 1991, will necessitate fund holding general practices (GPFHs) having to transmit data efficiently to hospitals. This data is needed so that GPs and practices can be invoiced for the services that they have purchased on behalf of patients. One way of sending this data would be by electronic cards. There is a choice of cards available: smart cards or magnetic strip cards, which are different from smart cards as they do not contain a microprocessor. If the data needed in the internal market are purely administrative then the inherent lack of confidentiality in magnetic strip cards is not important. There has been no trial of the administrative benefits of magnetic strip cards in health care in the UK. Trials have concentrated on health benefits. The comparative cheapness of magnetic strip cards could make them an efficient method of transporting administrative data between general practice and secondary health care. However, their lack of a microprocessor means that they can offer no confidentiality if lost or stolen and so are unsuitable for clinical data.

8.5 Conclusions

The following conclusions can be drawn from the research in general practice -

* There is a need for more information about computers and more training in their use.
* There is an urgent need for guidance on the procedures that should be used to protect the security and confidentiality of clinical data.
* There is strong support for exchanging data electronically with organisations and health professionals.

However, there are a variety of methods which would enable the exchange of electronic data. There is a need for further investigation of these methods. The use of a variety of coding systems in primary health care will delay the uniform acceptance of Read codes.

Chapter 9. COMPUTERS IN COMMUNITY PHARMACY

9.1 Method

A postal survey of community pharmacy was conducted in the West Midlands in 1989. After an initial pilot trial of 50, 307 pharmacies were sent a questionnaire along with a covering letter and a prepaid reply envelope. This sample was obtained by taking every third pharmacy in the West Midlands area. This first mailing was followed by a second mailing to pharmacies who had not responded after five weeks.

The statistical analysis package SPSS-X [154] was used to analyse the results.

The questionnaire had the following objectives and hypotheses -

9.1.1 Objectives

1) To gather data about computer systems and the applications that they support in community pharmacy in the West Midlands.
2) To collect data regarding the attitudes of community pharmacists to the smart card, from the perspective of both health care and business.
3) To collect data regarding the attitudes of community pharmacists to patient medication record (PMR) computer

systems, from the perspective of both health care and business.

4) To collect data about pharmacists attitudes to electronic communication and data sharing, both between other primary health care practitioners and with organisational bodies.

9.1.2 Hypotheses

1) That pharmacists have an interest in aspects of computer systems that involve improving patient care as well as administrative functions.
2) That pharmacists feel that they could usefully add data to electronic smart cards.
3) That patient medication records (PMRs) can make a positive contribution to business as well as care aspects of a pharmacy.

9.2 Results

9.2.1 The pharmacies

The first mailing produced 171 (56%) replies, and the reminder increased the response rate to 247 (c. 80%). Respondents were classified as independents, small multiples of between two and ten branches, and large multiples with eleven or more branches. 97% of the respondents used a computer to perform some tasks in the pharmacy. The tasks performed ranged from labelling only to Patient Medication Record (PMR) computer systems.

9.2.2 Computer systems

The systems used can be broken down by supplier as in Table 5 -

Table 5. Computer systems in community pharmacy.

Supplier	Number (%)
Richardson	42 (17)
Link	27 (11)
Image	22 (9)
Park	21 (9)
Riva (Boots)	19 (8)
Acer (Lloyds)	16 (7)
Mawdsley Brooks	13 (5)
More than one system	28 (11)
Other	34 (14)

The larger multiples can afford to have software written specifically for their own needs. This accounts for some 15% of respondents, i.e. Boots and Lloyds Chemists.
The market leader in tailor-made systems for community pharmacy according to this survey is John Richardson Computing, with Link, Image and Park Systems holding an approximately equal market share behind. However, since the

survey, Image have withdrawn from community pharmacy and specialise in supplying computer systems to dispensing doctors.

Mawdsley Brooks is a pharmaceutical wholesaler, which provides a system at no cost, in return for the pharmacy placing orders with themselves electronically. A similar situation exists with Vestric's Link, where the system is sold at low cost in return for a pharmacy ordering a percentage of stock through Vestric. The size of the discount on the computer is linked to the amount of orders placed.

A number (28 or 11%) of pharmacists have retained older systems after the acquisition of new ones and use both systems in the pharmacy. A strong case exists for only having only one system as most pharmacies have a chronic shortage of space. Additionally, two systems necessitate duplication of data entry whereas with one system stock control information can be gathered "off the back" of the data entered to print the label.

It is possible that pharmacists maintain two systems in order to have a backup in case one fails. However, it is more practical to allay this concern by having a maintenance contract which ensures that the pharmacy has a replacement system within a stipulated time period, usually within on working day.

9.2.3 System installation

Pharmacists were also asked when they installed their current system. With regard to pharmacies with more than one system the date of the more recent system was recorded. Installation dates of systems are given in Table 6 below.

Table 6. Date of installation of computer systems.

Date	Number (%) N = 222
1989	30 (13)
1988	58 (25)
1987	48 (21)
1986	29 (12)
1985	28 (12)
1984	28 (12)
Prior to 1984	11 (5)

9.2.4 Computer applications

In the survey, pharmacists were asked about the following tasks: labelling, stock control, stock ordering, drug interaction monitoring, patient medication records, accessing information sources and word processing. Space was left for pharmacists to enter any other tasks performed on the computer but this space was almost universally left blank, with only two pharmacists replying that they used some accounting functions.

The numbers of pharmacists using a computer for the tasks outlined above are shown as follows -

Table 7. Applications in community pharmacy.

Task	Number(%)
Labelling	238 (100)
Stock Ordering	122 (51)
Stock Control	73 (31)
Patient Medication Records	57 (24)
Drug Interaction Monitoring	46 (19)
Word Processing	33 (14)
Accessing Information	11 (5)

9.2.4.1 Labelling

Not surprisingly every pharmacy used their system to produce printed labels. Since 1984 pharmacists have been recommended to machine produce labels and even a simple labelling machine has some advantages over a typewriter. For example, mistakes and typographical errors can be corrected without the necessity of starting again and appropriate warning labels can be printed to accompany the medication. In addition is not usually necessary to type in the whole drug name - dictionaries in the computer will display the drug name after the pharmacist keys in the first few characters. This saves time and also reduces the chance of typographic and spelling errors.

9.2.4.2 Stock control and ordering

Although more than half of respondents found it convenient to use the computer to order stock, less than a third used it for stock control. This is surprising in that accurate information on stock levels can save money in two ways -

* By having accurate information concerning levels of demand the pharmacist can maintain lower levels of stock.
* By being aware of lesser used items the pharmacist is in a stronger position to follow up claims for broken bulk.

However, one of the problems of applying stock control to the pharmacy lies in the fact that most drugs are held in small quantities, which are replenished by a daily delivery. Some stock control systems alert the pharmacist when stock falls below the specified threshold, and expect him to take action regarding reordering. This will occur frequently due to the small quantities held, and tends to disrupt the processing of prescriptions. Other systems can order automatically when a predetermined level of stock is reached. In addition there may be a reluctance to rely entirely on the computer system for re-ordering, coupled with a resistance to alter a long tradition of using manual methods.

9.2.4.3 Drug interactions

Slightly less than one fifth of pharmacists were using any form of drug interaction alert. This figure will have increased since the study, as a software update for the Link system contains a drug interaction program. Although a drug interaction facility is obviously of assistance in preventing patients taking medication which may prove harmful, these facilities suffer two drawbacks.

Firstly systems usually alert pharmacists to all interactions regardless of the clinical significance of the interaction: this can prove irritating and distracting when the many of the interactions are of little clinical significance. Recently, computer systems which offer drug interaction checks rate all interactions with, for example, a star system where one star indicated an interaction of little clinical significance and five stars indicated a life threatening situation.

Secondly, systems which do not have a patient medication record facility can only warn of interactions between two drugs prescribed at the time: if a patient is prescribed a drug which interacts with one which is already being taken the system will not be detected.

9.2.4.4 Patient medication records

Almost one pharmacist in four (57 of 238 or 24%) maintained patient medication records (PMRs) on their computer. As discussed above almost six in ten pharmacists (60%) have recently installed a new computer. After cross-tabulating the use of PMRs and the date on which a system was implemented, it was apparent that approximately 37% of respondents have acquired a system in the last two and half years which has no facility for PMRs.

Unless new equipment is purchased, these pharmacists will not be able to respond to the recommendations of "Promoting Better Health" [25], which encourages them to invest in computer systems capable of handling PMRs. The aspirations of the White Paper will be met more fully as existing computer systems in pharmacy are replaced.

The DoH remunerates pharmacists for maintaining PMRs (see para 1.1.4.2), either in a manual or electronic form. However, this sum is only a contribution towards the average maintenance costs of most PMR systems, far less their capital cost. It may be that PMR systems have other positive influences on the business aspects of pharmacy. This will be investigated further later.

PMR systems are at their most effective when the patient uses one pharmacy exclusively. While 80% of patients use only one pharmacy [27], some 20% do not. This minority are failing to gain the full health benefits of a PMR system, i.e. its ability to monitor drug interactions and to detect any prescribing errors.

9.2.4.5 Other applications

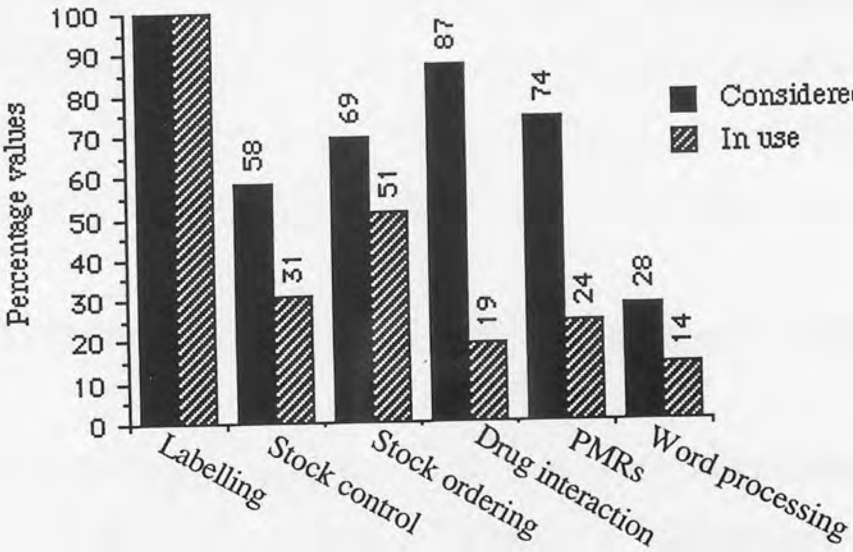
Very few pharmacists make use of online sources of information, largely relying on the standard texts or calling local information services for more complex enquiries. This could be due to either the expense of online systems, the time taken access them or a lack of expertise in information searching coupled with an ignorance of what is available. Another possibility is that the pharmacist can satisfy the majority of queries with standard texts and can make telephone enquiries to find the answer to other problems.

Similarly, few pharmacists use any form of word processing software. Unlike other practitioners in primary health care, pharmacists rarely have to write to other health providers, although the pharmacist quite frequently has to contact the prescriber by telephone.

9.2.5 Pharmacists' expectations of computer systems

Pharmacists were asked how important they thought the following facilities were on a system: labelling, stock control, stock ordering, drug interaction monitoring, PMRs and word processing. They were to indicate their opinion by

choosing alternatives on a five point scale, which consisted of the the following - very important, important, unsure, unimportant and pointless.
The features that pharmacists consider to be important in a system are compared with those that they used in Figure 3.
Figure 3



The largest discrepancies between what pharmacists consider to be important and what they are currently using is in the area of system features which relate to patient care. 87% of pharmacists consider drug interaction monitoring to be important, although only 19% have this facility. Similarly 74% consider PMRs to be important yet only 24% have this facility. The discrepancy between what pharmacists consider important and what they use is less pronounced in terms of stock control and ordering, although still existent.

The response to this section of the questionnaire suggests that in future pharmacists shall be demanding more from their systems then just labelling and that features which enhance care will be at a premium. However, more sophisticated features require more expensive systems and often the pharmacist does not own the business and may not be a position to dictate what features should be available in a new computer system. Even where the pharmacist does own the business there may be a reluctance to invest more money than is necessary, particularly when subsidies are minor when compared with other primary health care practitioners.

9.2.6 Pharmacists' attitudes to information technology

The questionnaire sought to investigate attitudes to various issues in health computing among respondents. Pharmacists were asked whether they agreed or disagreed with a series of statements. A five point scale to indicate strength of feeling was given and the respondents were asked to circle whichever answer corresponded to their opinion most closely. The possible responses were strongly agree, agree, unsure, disagree and strongly disagree. The first of these statements was -

"Computers which order prescription medicines directly by gathering data through labelling are superior to ones which rely on manual ordering."

In total 96 (41%) agreed with this statement while 84 (36%) disagreed, the remaining 54 (23%) indicated that they were unsure. The advantage of ordering systems which gather data from labelling is that the pharmacist does not have to collect data about stock manually, as levels of stock are counted down whenever a medication is dispensed.
However a problem can arise with some of these systems in that the pharmacist cannot easily alter the levels of stock to be ordered in response to some unforeseen circumstance. An example of such a circumstance would be when the patient returned the medication in favour of another as a result of an oversight by the GP. If all ordering systems offered greater flexibility more pharmacists would feel able to benefit by more convenient stock ordering.

"Patient medication records lead to better patient care."

Pharmacists overwhelmingly agreed with this statement, with 192 (81%) falling into categories which indicated agreement and only 13 (5%) disagreeing and 31 (13%) did not express an opinion.
Despite the general agreement with this statement relatively few pharmacists have a computer capable of maintaining PMRs. Several reasons may account for this -

1) The benefits of computerised PMRs over a manual medication record may not justify the cost of the PMR

system, particularly if only special groups of patients are to be entered onto the system e.g. the elderly.

2) Where pharmacists do not own the business, they may not be a free agent and may be unable to install a PMR system on their own initiative.

3) Some pharmacists will have qualified long before the age of the microcomputer and may be reluctant to embrace technology, beyond simple labelling machines, with which they feel unfamiliar.

4) There may be a feeling that the health benefits are not great enough to warrant the cost of installing and running the system.

The number of PMRs will rise rapidly as Boots Chemists are planning a substantial upgrade of their computer system, which will include PMRs. Lloyds Chemists have also upgraded their computer system to include PMRs. However, whether the PMR module of the system is used is up to the discretion of the individual pharmacist.

"Patient medication records cannot be justified on commercial grounds."

More of the respondents (92 or 40%) indicated unsure rather than any other individual category, although a larger number of respondents (78 or 33%) disagreed with this statement than agreed (64 or 27%).

Reasons for disagreeing at the time the question was asked were -

* The DoH were contemplating remunerating pharmacists in return for maintaining PMRs.
* Patient goodwill engendered by PMRs may result in the patient being more likely to continue to present his prescriptions at the pharmacy.
* In addition to the PMR module, other facilities such as stock control and ordering may save money e.g. better stock control improving claims for broken bulk.
* Having data stored allows labels to be produced more rapidly, enabling prescriptions to be dispensed at a greater rate. This may minimise delays for patients in the pharmacy and so encourage them to return.

In fact, the eventual amount of remuneration from the DoH is such that it is unlikely by itself to make pharmacists disagree with this statement, as it fails to meet the cost of maintenance contracts on most systems, far less cover their capital costs. The large proportion of pharmacists indicating that they were unsure displays a scepticism of the assertion and a "wait and see" approach.

Despite the arguments above, and in view of the low level of DoH remuneration, there is still a substantial percentage of pharmacists who feel that there is no financial incentive to keeping PMRs.

Incentives for pharmacists to maintain PMRs are -

* Anecdotal evidence that suggests that having a PMR system encourages patients to return to a pharmacy.
* Maintaining PMRs increases the public perception that the pharmacist provides a professional service. Should there be public dissatisfaction with a profession, Government can act to, for instance, alter the way in which medicines are dispensed to the detriment of the profession. Examples of government intervention are the reform of pharmacy in Holland and in the UK alteration of the law regarding the supply of spectacles.

"Patient medication records slow down the rate at which prescriptions can be processed."

Those sympathising with this statement 103 (44%) outnumber those who disagree 66 (29%), while 67 (28%) were unsure. There is a perception among many pharmacists that PMRs will slow down the rate at which prescriptions can be processed. This may be true when a patient first enters the pharmacy as a new record is usually created and the pharmacist must enter the patient's address. However, once a patient has been entered into the system there is no reason why a PMR system should slow down prescription processing. In fact it can even speed it up by allowing regular patients names to recalled with only a few key strokes rather than entering the full name.

Furthermore the labels of patients with numerous repeat prescriptions can be printed with fewer keystrokes as this information is already stored in the computer's memory.

"The Data Protection Act provides a disincentive to pharmacists maintaining patient medication records."

56 (23%) of respondents agreed, 76 (33%) felt unsure, while 104 (45%) disagreed. Although more pharmacists rejected this idea than gave it support, it is disturbing that the Act is perceived as a barrier by so many pharmacists. The Act requires pharmacists to Register, and to allow patients to have access to their medicinal records. The pharmacist can charge a fee when patients make a request to have a printout of their medicinal records. Coupled with this the Act places a duty on pharmacists to process data fairly, ensure that it is kept up-to-date and ensure that reasonable steps are taken to make it confidential and secure. It would be unfortunate if these safeguards to individual liberty were perceived a barrier to the installation of systems.

"Much of the paperwork currently conducted between pharmacies and the Prescription Pricing Authority could be usefully handled via an electronic link." (A pilot study demonstrating this has been completed, but there are no plans to make this service available to pharmacists.)

121 (51%) of respondents agreed, 79 (33%) felt unsure and 36 (16%) disagreed. This suggests broad support for the idea of electronically transmitting prescription data to the Prescription Pricing Authority (PPA). Despite this support there are no plans to allow pharmacists to send prescription data routinely. The problems that prevent this happening were identified in a pilot trial and are -

* The data that pharmacists keyed in were not as accurate as the data entered by trained operators at the PPA.
* The PPA is extremely efficient at processing prescriptions with each prescription costing less than five pence. It is unlikely that the prescriptions could be processed at a lower cost.
* Some of the data that the pharmacists would have to enter is used to monitor GP prescribing and is not used to remunerate pharmacists. Pharmacists may feel resentment at having to enter this extra data which is not their concern.
* The pharmacists involved in the pilot trial were all extremely enthusiastic. It was felt that pharmacists as a whole might not share this enthusiasm.

Even though the majority of pharmacists supported electronic communication with the PPA, the minority who failed to actively express support is still large. Consequently, it might be difficult to persuade all pharmacists to be a part of a national scheme for sending prescription data to the PPA.

9.2.7 Smart Cards

Although the smart card has been described in the Pharmaceutical Journal [67], its full implications may not have been perceived by all pharmacists. A full description of the smart card and is uses is given in section 2.6. Initially the questionnaire established whether respondents were aware of the "smart card". Respondents who were unaware of the card were asked to return the questionnaire, leaving the remaining questions unanswered. 152 or 69% of respondents were aware of the card and proceeded with the questionnaire. The reduced number of respondents were asked to indicate whether they agreed with the following statements. As before, replies were indicated on a five point scale. Possible responses were strongly agree, agree, unsure, disagree and strongly disagree.

"The smart card will make a significant advance in health care."

Almost two thirds (101 or 66%) of the remaining respondents believe that the smart card will make a significant advance in health care, against a relatively small minority (13 or 8%), who feel that it will not. 40 respondents (26%) were unsure. In pharmacy the smart card can help improve care by -

* Enabling the pharmacist to see all of the medication the patient is currently receiving, and to be in a position to detect any drug interactions.
* Bringing information on the patient's medical history to the pharmacy and so enabling contraindicated drugs to be detected.
* Allowing pharmacists to indicate on the card that a prescription has been dispensed, thus giving some information to the GP about patient compliance.

In addition the smart card could also bring administrative benefits by being a vehicle for sending prescription data to the PPA. When a pharmacist "flagged" a prescription on the card, that is wrote on the card that it had been dispensed, the data could be sent at the same time to the PPA. As the card already contains information about the prescriber, all the necessary data could be collected without anyone having to enter any extra data.

As the respondents to this part of the survey are a subset of the total number of respondents, it is difficult to arrive at firm conclusions from their answers. This is because the subset of pharmacists who try to follow developments may be more receptive to innovations designed to improve care. Similarly, those who fail to read professional journals may have a less positive attitude to change.

"Smart cards will do nothing to improve my business."

A large number of pharmacists (63 or 41%) disagreed with this statement, 36 (23%) agreed and 56 (36%) were unsure.
It is difficult to see how the level of prescriptions presented will increase should the patient carry around a information regarding his or her current medication. It may be that patients who carry such cards will prefer to use a pharmacy which is equipped with a reader and pharmacies who do not have a card reader will suffer a decline in prescription figures.
Much of the impact on the business of a pharmacy by smart cards will depend on the manner of introduction of card readers. If these are distributed to all pharmacies by either the Government or a large company (e.g. by a manufacturer of the cards to facilitate their acceptance) it is difficult to see how an individual pharmacy will benefit financially, although they may allow prescriptions to be processed more rapidly by obviating the need for some data entry by the pharmacy.
If the onus falls on individual pharmacists to pay for a card reader it may well be that the purchase of a reader will give a pharmacy a competitive advantage, in that patients will be more likely to present their prescriptions where the pharmacy is able to read data from the card and so offer a better service.

"Pharmacists should be able to add data on OTC medicines to smart cards."

114 (73%) of pharmacists felt that they should be able to add details on over-the-counter (OTC) medicines to the smart card. A small minority of 15 (10%) disagreed and 26 (17%) did not venture an opinion. Those who disagreed may have felt that the short term nature of OTC medication may have made it unsuitable for the card. Another possible reason is that if OTC medicines are to be added to the card, then all medicines should be added. In practice this may be difficult due to the sale of medicines by non-pharmacy vendors. Examples of such products are analgesics and cough remedies. In addition, by adding data pharmacists are in effect altering records and some may have been concerned about the controversy that this may generate between different professions in primary health care.
Set against these arguments is the concept that the smart card should be a complete record of all medication that a patient is currently taking. Only when this is achieved can pharmacists completely protect patients against drug interactions. In addition with all data on the card it would be possible to detect any adverse drug reactions caused by OTC preparations.

"General practitioners will not want pharmacists to have access to their patient's medical data."

Half (77 or 50%) of the pharmacists indicated that they felt there would be a reluctance on the part of the medical profession to allow pharmacists to have access to data on their patients. Those who disagreed numbered only 20 (13%), while 58 or (37%) felt unsure. Whether GPs actually do feel a reluctance to share part of their medical records (current medication) with other professionals has been investigated and fully discussed (See section 8.3.14). A large percentage of GPs surveyed have no objection to pharmacists having access to parts of a medical record, such as medication details, if this would help improve patient care. Many GPs are aware that should the smart card be employed purely to facilitate data transfer between GPs and doctors involved in secondary care, some of the possible benefits to patients could be lost.

9.3 Discussion

9.3.1 Computers in pharmacy

The survey revealed that many pharmacists are under the impression that PMR computer systems slow down prescription processing. In fact, the reverse is true: by holding patient details and medication information prescription labels can be printed more rapidly.

The survey also discovered a great interest in features of computer systems that could help pharmacists to provide better care for patients, i.e. medication records and drug interaction alerts. Since the survey was conducted the number of pharmacies using these features has increased dramatically. For example, at least 55% of pharmacists are now using PMRs [181]. The majority of pharmacists are meeting the aspirations of "Promoting Better Health" [25], and are prepared to make substantial investments to this end.

The remuneration available from the State for maintaining patient medication records is very small when compared with cost of the systems. The motivation for investing in PMR systems results from improvements in patient care and administrative convenience.

Although most community pharmacists feel that patient care is improved by PMR computer systems, no studies have demonstrated this in a community pharmacy setting. It may be that benefits are only felt occasionally, or only by patients who are treated with many different medicinal products.

A misconception exists among some pharmacists that GPs would be reluctant for them to see data from patient's medical records. Other studies in the project (See section 8.3.14) have established that GPs are concerned not at other professionals accessing this data, but at the prospect of unauthorised individuals breaching the confidentiality of the consultation. A complete record of patient medication is important if all potential drug interaction are to be detected. That is to say that if patients are prescribed interacting drugs on different prescriptions at different times, only a system which keeps a record can detect these interactions.

9.3.2 Electronic communication and pharmacy

The FHSA network [166] offers the possibility for pharmacists to exchange data with both the PPA and other professional groups. However, almost half of all respondents are unconvinced that data exchange with the PPA is worthwhile. This is because some of the data that the PPA needs is not used to remunerate pharmacists. Thus pharmacists may feel reluctant to enter data purely for the benefit of the PPA. This extra data is needed to identify GPs and general practices in order that GPs can have information about their prescribing, and that the overall drugs budget is subject to control. Pharmacists may have a more positive attitude to data exchange if they did not have to enter data that is superfluous to their own remuneration. There are several ways that this could be achieved -

* By the GP sending the prescription and information to identify himself and his practice electronically to the pharmacy, as envisaged in the Nuffield Report [58].
* By having both the prescription and identifying data carried by the patient on an electronic card.
* By having this information stored in the pharmacy's computer, so that it need not be entered each time a prescription is dispensed.

The first option would allow the GP to have a measure of control over which pharmacy the patient would visit. This situation would be opposed by many in the profession of pharmacy and would be in conflict with the ethos of competition so prevalent in the nineteen eighties. It's advantage is that the pharmacy would not have to enter any data, except to correct prescribing errors, and so would avoid duplication of data entry by both GP and pharmacists.

9.3.3 Card based solutions

Two possible card solutions could be used to assist pharmacists in sending data to the PPA. One is a care card, similar to that tested in the Exmouth trial (see para 2.6.2). The advantage of this system is that the card could carry all the data needed by the PPA, that is both the prescription data and the data that identifies both GP and practice. An alternative would be to use a magnetic strip card. This card could not be used to carry prescription data but could identify both the patient and the prescriber. The pharmacist would then only have to enter details of the medicine prescribed. However, this still entails some element of duplicate data entry.

9.3.4 Cluster based approach

The other option necessitates the "cluster" system described in the previous section (see section 8.4). If patients were registered at a particular pharmacy, part of their record in the pharmacy could identify their general practice and individual GP. Thus the pharmacist would only have to enter the data that identified the prescriber once. However, like the magnetic strip scenario, data about the prescribed medication would be entered both by the GP and the pharmacist.

The idea of registration in pharmacies is not new. Patients have traditionally registered with their GP, and the process of registration and remuneration for continuing care has now been extended to dentistry. One advantage of having registration at pharmacies is that all of a patients medication data would be held at the same place. Thus some of the benefits of the smart card could be derived without the investment in the infrastructure needed to support smart cards. What registration alone cannot deliver, that the card can, is information about patients' medical conditions. For pharmacists to have this data some form of communication with the computer in the local general practice surgery would be necessary. However, open access to any surgery creates problems of safeguarding confidentiality. A solution to this problem is the use of callback modems and "clusters" of care providers. The concept of clusters is more fully discussed in section 8.4. The infrastructure to support concept of clusters of care providers is largely in place. That is many individual practitioners are already computerised and the FHSA network could support data transfer between these computer systems.

Pharmacists presently have to contact GPs on numerous occasions for a variety of reasons, e.g. a drug interaction with a prescribed medicine, or an error in the prescription. This communication is usually in the form of a telephone call. However, the number may be engaged, and in any case the pharmacist will have to be put through to the GP by the receptionist. These barriers waste the time of both professional groups. GPs are increasingly using terminals routinely during patient consultations, and pharmacists dispensing with the aid of a computer. A method could usefully be explored whereby the pharmacists sends queries electronic mail message to the prescriber. This would result in mistakes being rectified more rapidly and save time for pharmacists, general practice reception staff and the patient. As traffic on this e-mail messaging system could be handled by the FHSA network, connect time charges would be lower than telephone charges, thereby saving National Health Service resources.

9.3.5 Coding systems

One of the great barriers to the exchange of electronic data between pharmacy and medicine lies in the coding systems used. The adoption of Read codes as a national standard is a positive step forward. However, the codes at present lack the detail needed to support communication with pharmacy. It is vital that the classification scheme is extended to include pharmacy and so facilitate data exchange between general practice and community pharmacy. This problem is a barrier to data exchange in either a smart card or a network based communication system.

9.4 Conclusions

The following conclusions can be drawn from the study -

* That there is a strong interest in features of computer systems that are intended to assist the pharmacist in providing better patient care.
* The issue of what privileges a pharmacist should have of writing data to a smart card must be resolved before any such system can be used nationally.

* There is an acceptance of PMR computer systems both on grounds of improving patient care and from a commercial perspective.

The smart card is only one of a number of ways of exchanging data between pharmacy and other sectors of primary health care. Regardless of which approach is eventually chosen, the Read coding system must be extended in order to facilitate data transfer between general practice and medicine.

Chapter 10. COMPUTERS IN GENERAL PRACTICE DENTISTRY

10.1 Method

The Dental Practice Board (DPB) supplied duplicate addresses of two thousand dental practices. The lists represented a random sample of practices in England and Wales. A postal questionnaire was sent to each of the practices, along with a covering letter and a prepaid reply envelope. The majority of questions were closed and the recipients indicated their response by circling a number. Some sections of the questionnaire were applicable only to dentists with computers, others to dentists without computers and a few questions, such as the practice's size, were applicable to both. Some space was left for respondents' comments, both at the end of the questionnaire and after certain questions. A questionnaire was designed to meet the following objectives and hypotheses -

10.1.1 Research objectives

1) To gather data about the number and type of computer systems used in general dental practice and what tasks are being performed by these computer systems.
2) To discover what factors limit the use of computers in general practice dentistry.

3) To gather data about which members of the practice are using the systems.
4) To collect data about the attitudes of dentists to developments in dental computing, especially electronic data interchange (EDI).
5) To assess future trends in dental computing, as well as what information dental surgeons need in order that dental computing can best progress.

10.1.2 Hypothesis

1) Cost is not the primary factor in the non-installation of computers in general practice.
2) There is an information need among dentists regarding the application of computers in dental practice.

10.2 Results

10.2.1 Respondents and practices

An initial mailing resulted in 1056 (53%) replies. A second mailing was sent out five weeks later increased the response by 311 to 1367. Seven responses were unusable and eight arrived too late to be of use, which left 1352 (68%) replies for analysis. The average number of dentists in a practice (principals and associates) was 2.2. Respondents were grouped according to the year in which they qualified in five year brackets. Numerically most respondents qualified between 1975 and 1979, but the average length of time in practice was between 16 and 20 years.

10.2.2 Computer systems

283 or 21% of respondents indicated that they used a computer of some description. Practices were considered to have automated if they possessed a word processor. This is because word processing software, in conjunction with mail merge facilities, can support more sophisticated operations such as patient recall. In addition, the hardware used in word processing can be used with other programs, e.g. accounting software.
Of those who did not use a computer, 238 of the 1069 (22%) indicated that they had plans to acquire one in about a year. The majority of the systems in use (151 of 283 or 53%) were installed in the last two years and almost all (240 or 91%)

within the last four years, i.e. since 1986. The systems used varied from simple word processors through to multi-user, multi-tasking systems, that is computers with several terminals which allow all members of the practice to use the computer at the same time. These systems are specifically intended for use in dentistry.

A full breakdown of the systems used is given in Table I.

Table 8. Computer systems in dental practice.

Supplier	Number	(%) N=1352	(%) N=275*
In house system	45	3.3	16.4
Clockwork	23	1.7	8.4
SDS	21	1.6	7.6
MediData	10	.7	3.6
TMS	7	.5	2.5
Status	5	.4	1.8
Stroud	4	.3	1.5
Xtrax	4	.3	1.5
Apollonia	3	.2	1.1
Paladin	3	.2	1.1
Sigma	3	.2	1.1
Other dental system	22	1.6	8.0
Other software+	62	4.6	22.5
Amstrad PCW	40	3.0	14.5
Word processor	23	1.7	8.4

* This figure is less than the number of respondents using a computer as some respondents indicated that they used a computer but gave no further details.

+ General office software

Computer use is mostly by dentists and receptionists (68%), with systems being used by dental surgeons' assistants in 114 (44%) cases and by practice managers in 106 (41%) of cases.

Dentists can automate aspects of their practice in different ways. Software can be specially written for the practice, software intended for general office use can be acquired or software specially written for general practice dentistry can be leased or purchased.

The majority of respondents (125 or 45% of computer users) have employed software suitable for general office use, for example a word processor. A significant proportion (105 or 38%) of practices are using software designed for use in dentistry, either as a stand alone system for use by one member of the practice at any time or as a multi-user system. Many computer suppliers are competing in this sector, indicating a relatively new and immature market. A smaller minority (45 or 16%) have in-house software. Writing in-house software can be time-consuming if done in practice or expensive if obtained from a commercial source. Furthermore, continuous software development is needed to keep abreast of change, for example, increases in dental charges or alterations in the dental contract.

Computer systems designed for use in dentistry are likely to be more expensive than general office software as a result of a much smaller potential market. However, a maintenance contract that includes software updates can ensure that the system can evolve in response to change. Such a contract should ensure that the computer will be replaced within 24 hours should it malfunction. Responsibility for the maintenance of both hardware and software should rest with one company. This prevents two contractors claiming that any malfunction is the other's responsibility.

10.2.3 Computer applications

The most common use of computers was for word processing. Other common applications were patient recall, practice accounts, patients' accounts, schedule reconciliation, practice information leaflets and treatment plans and estimates.

Accounting functions enable the practice to monitor payments owed and owing to the practice. This enables practices to identify bad debts and follow up patients who are late in settling accounts. In these cases patients are effectively obtaining an interest-free loan from the practice. Schedule reconciliation allows the practice to ensure that all claims for treatment that have been made to the DPB are being processed. The dental contract agreed in October 1990 stipulates that practices must produce leaflets to inform patients of the services that the practice offers. Word processing facilities on computing packages can facilitate the production of these leaflets.

Less common applications include staff wages, FP17 remittance, that is sending treatment claims to the DPB, appointment booking, stock control and tooth charting. However, as dentists are still required to maintain manual records of their patients the use of an electronic charting system means that two systems must be run in parallel. In addition it is not yet possible to hold X-ray images in an electronic record. At the time of this research sending FP17 dental claim forms was restricted to the sixty practices participating in the pilot trial. This service is currently (early 1991) being made available to dentists nationally. Stock control facilities may help monitor the use of dental materials. Appointments can usually be made as easily manually as electronically. However, an electronic record can give information about when the practice is most busy, and this information can be taken into account later, when recall programmes are instigated.

A full breakdown of the applications of computers in responding practices is given in Table 9.

Table 9. Computer applications.

Application	Number(%)
Word processing	247 (90)
Patient Recall	149 (55)
Practice accounts	139 (52)
Patients' accounts	127 (47)
Schedule Reconciliation	114 (42)
Practice information leaflets	113 (42)
Treatment plans and estimates	108 (40)
Record of treatment claims	94 (35)
Staff wages	71 (26)
FP17 Remittance	45 (17)

Appointments	24 (9)
Stock control	22 (8)
Tooth charting	14 (5)

More than one response is possible for each respondent, hence the total is greater than 100%

10.2.4 Barriers to computer use

The questionnaire sought to discover what inhibited dentists from acquiring computers. Respondents were presented with a series of reasons for not computerising and were asked to circle those that they felt were applicable to themselves. Respondents were allowed to circle as many reasons as they felt applicable, and some space was left for respondents to add any other reasons that they felt were applicable. The list of reasons and responses to them are shown in Table 9.

Table 10. Reasons for-non acquisition of a computer.

Reason	Number(%)
Uncertainty of advantages	364 (58)
Cost	314 (50)
Unfamiliarity with computers generally	295 (47)
Waiting for official direction as to a suitable system	232 (37)
Time involved in initial data entry	164 (26)
Due to retire	104 (17)
Staff reluctance	64 (10)

More than one response is possible for each respondent, hence the percentage is greater than 100.
Some dentists also indicated that they felt that their practice size was too small to make a computer viable. However, the three most common reasons given are -

* uncertainty of the advantages of the computer.
* the cost of computer systems.
* a lack of knowledge about the computer and how it might help in dental practice.

10.2.5 Information for dental practitioners

Information about computers has not been made available to dental surgeons on the same scale as in other professional groups, particularly general practitioners. The Report "Computers in General Medical Practice" [18] was followed up with further Reports: Micros for GPs [19], Micros in Practice [161], A Prescription for Change [160]. Accompanying these Reports were the books Computers in Primary Care [182], Information Handling in General Practice [183], Trends in General Practice Computing [184] and numerous papers in both the British Medical Journal and the Journal of the Royal College of General Practitioners (now the British Journal of General Practice). In addition to this literature, general practices have both financial incentives and contractual pressures to computerise. These are described in para 1.1.4.1.

Information about dental computing in the British Dental Journal has been much more sporadic: some papers between 1986 and 1989 [29], [30] [31] [185] [186] and a series of letters [28], [32], [33] in 1984, some of which were published in journals that are unlikely to be read by most dental surgeons such as the Family Practitioner Services Journal. Similarly, the Department of Health (DoH) produced guidelines for GPs advising on what to look for when acquiring a computer system: the Royal Pharmaceutical Society did the same for pharmacists, albeit after many had already installed computers. There have been no such guidelines for dentists.

It is arguable that any dentist who adhered to the recommendations of the Scicon Report would fail to gather sufficient literature for analysis and so would be unlikely to reach the stage of contacting system suppliers. That is, so little literature has appeared in the dental press about computing, that it is not possible to gather a "sufficient amount".

Given that there is a lack of information available to dental surgeons, the questionnaire sought to establish what information dental surgeons felt that they needed in order to overcome the problems identified and consider automating aspects of their practices. Respondents were asked to indicate the usefulness of information about computers and methods of delivering this information on a five point sliding scale.

10.2.6 Information needs

Over 80% of respondents felt the need for information which would help in the selection of a suitable system. A similar number expressed a need for information on the benefits and problems of computers in dentistry. A surprisingly large number (59%) were interested in basic computer literacy, such as how a computer works and technical terms associated with computers. It is doubtful as to whether such theoretical knowledge about computing is as useful in practice as practical guidance on computer applications in dental practice. The full responses are shown in Table 11.

Table 11. Subject evaluation. N = 980-990

Subject matter	Very Helpful	Helpful	Unsure	Not Helpful	Pointless
	Nos(%)	Nos(%)	Nos(%)	Nos(%)	Nos(%)
Basic computer literacy	460(47)	120(12)	203(21)	77(8)	125(13)
Benefits and problems of computers in practice	597(60)	198(20)	128(13)	29(3)	38(4)
Criteria for system selection	608(62)	198(20)	111(11)	28(3)	35(4)

10.2.7 Meeting information needs

A large majority 82% (806) stated that the most useful way to learn about computers would be to have hands-on experience of several systems in the absence of a salesman. Evening courses and seminars would be acceptable. The full details are given in Table 12.

Table 12. Methods of information dissemination. N = 968-972

Method of Information Dissemination	Very Helpful Nos(%)	Helpful Nos(%)	Unsure Nos(%)	Not Helpful Nos(%)	Pointless Nos(%)
Seminars/exhibitions	223(23)	295(30)	256(26)	123(12)	75(8)
Evening courses	262(27)	291(30)	227(23)	101(10)	90(9)
Distance learning	102(11)	166(17)	288(30)	222(23)	190(20)

Respondents were also asked how helpful they would find a listed range of printed sources of information. A comparative report of systems available was considered to be the most helpful. DPB guidelines on which systems offer the facility of electronic links with the Board would also be found helpful, as would guidelines from the BDA on what features computer systems should offer. Over half of the respondents considered that articles in dental journals would also be considered helpful. **Table 13.** gives a full breakdown of the results.

Table 13. Evaluation of printed information N = 980-989.

Printed Source	Very Helpful Nos(%)	Helpful Nos(%)	Unsure Nos(%)	Not Helpful Nos(%)	Pointless Nos(%)
A comparative report of systems	572(58)	209(21)	112(11)	49(5)	47(5)
DPB guidelines	506(51)	267(27)	115(12)	52(5)	48(5)
BDA guidelines	284(29)	326(33)	205(21)	76(8)	89(9)
Articles in the BDJ	267(27)	251(25)	248(25)	93(10)	122(12)

In view of the debate over which kind of system is most appropriate for the practice considering computerisation, guidelines should have two separate sections, advising on both single and multi-user systems. Any guidelines should also contain information about which systems provide suitable interfaces to allow links with the DPB.

10.2.8 Sources of information

The questionnaire tried to ascertain from which source advice on dental computing would be most credible. Respondents were asked to rank various organisations and sources of information according to their suitability as an information provider. The Dental Practice Board emerged as the most credible source of advice about dental computing, followed by the British Dental Association, dental journals and magazines, the Primary Health Care Specialist Group of the British Computer Society and the computer suppliers themselves. Many dentists indicated that they considered information from other dentists who already have computers to be the more credible than any of the source listed and this is borne out by the substantial number (470 or 49%) who considered that dentist computer user groups would be a helpful innovation.

10.2.9 Electronic data exchange

The questionnaire asked respondents about both transmitting electronic data for remuneration purposes and "smart" cards. These are electronic cards, of similar dimension to credit cards, on which patients medical details and medication can be stored. They are more fully described in section 2.6.
Smart cards have the potential to improve care by alerting the dentist to medication which might interact with anaesthetics, as well as warning dentists about infectious diseases such as hepatitis, from which the patient might be suffering. There is no doubt that electronic information is more comprehensive and accurate than history taking from the patient's recollection [163]. 887 (70%) of respondents felt that the card was useful while only 9% (116) felt that it would not be useful and 21% were unsure. Those dentists with computers were asked how useful they considered it would be to communicate electronically with the DPB. 205 (76%) considered it useful as opposed to 22 (8%) who felt that this service would be of little use.

10.3 Discussion

The majority of dentists do not use a computer, nor are actively considering acquiring one. The advantages that a computer can bring to a dental practice were discussed in section 1.1.4.3. They can be briefly summarised as -

* Information about the money owed to the practice. In terms of administration, dental practices are similar to small business. Business need information about their financial standing. A microcomputer can allow partners to know how much money is owed by patients and the DoH at any time.
* Administrative benefits. Once entered data can be printed to assist clerical tasks. Examples are filling in the name and address on the FP17 treatment form, and printing the same information on envelopes which encourage patients to attend the practice for an examination.
* Word processing facilities. These are useful for producing standard letters, for example to refer a patient for orthodontic treatment. This facility can also be used to produce practice information leaflets, required by the Dental Contract of 1990.

Although only a minority of dentists have taken steps to computerise aspects of their practice, a substantial number have indicated an interest in investing in a computer. This failure to transform interest in computing into the acquisition of a system by dentists has been an important factor in fewer systems being installed in dentistry than in other primary health care professions. The reasons for this are -

1) that less printed information about the application of computers in dentistry is available.
2) the absence of professional, contractual or legal pressures toward automation.
3) the absence of any guidance from the professional bodies that represent dentists.
4) the absence of financial incentives seen in some other professions.

The cost of computer systems is not the major barrier to automation. Of greater importance is a knowledge gap about how a computer can help to improve practice administration. In order to bridge this gap there is a need for information about the practical application of computers in dentistry and advice about how to acquire a suitable computer system.

In general practice for example, a few practitioners installed microcomputers. Papers in professional journals described these systems, which in turn encourage more professionals to invest in computer systems. However, in dentistry, very few papers have been published despite the appearance of computers in practice.

This information need can be met by published information about computers and an evaluation of the systems that are currently available on the market. Dentists could also greatly benefit from independently organised practical, hands on experience of systems. Such facilities have already been established a Family Health Service Authority (FHSA) in Cumbria for general practitioners. If the routine remittance of FP17s electronically is envisaged, a prerequisite is the widespread use of computers in dental practice. To this end, access to computer facilities should be made available to dentists in the way that they are now for general practitioners. In addition to informing practising dentists about computers there is a strong case for educating dentists in the application of computers at an undergraduate level.

The barrier of the cost of computers mentioned above could be overcome by either by compensating dentists for submitting FP17s electronically, or by subsidising the purchase of computer systems. There are precedents for both these approaches. In Britain, computer systems are subsidised in general practice by up to 50%, while in Australia pharmacists receive extra income for every prescription they submit electronically. The use of health resources to subsidise computers is justifiable as it results in both savings at the Dental Practice Board when dentists transmit claims electronically and potential health benefits to patients through improved clinical care in the long term.

The primary aim of encouraging computer use by dentists is to enable claims for remuneration to be transmitted electronically to the Dental Practice Board. It would therefore seem more logical to remunerate dentists for submitting claims electronically, rather than subsidising the acquisition of systems. Thus the risk that resources could be spent without the primary aim being met is avoided.

Groups of people who are using the same computer system often form an association for mutual support. These associations are known as user groups. User groups can allow individuals to share experiences of the system, provide support for new users and play a part in continuing system development. Although there is support for a user group few suppliers currently have user bases large enough to support such groups.

The Primary Health Care Group of the British Computer Society is interested in representing primary health care rather than just general medical practice and could fulfil the role of a user group for dentists by bringing together interested individuals. However, the Group is currently unknown to the majority of dentists and largely oriented around general practice. Despite this, the Group is committed to representing primary health care as a whole, rather than just general practice. If the Group could set up a system of informal advisors for dentistry in the way it has for general practice, and this could be publicised by the FHSAs and DPB, there are benefits for both dentists and the National Health Service. There is a precedence for this in that the Group has set up an unpaid, informal network of GP computing advisors.

The National Health Service as a whole would benefit through by advisors facilitating the progress of dental computing and dentists would benefit through free advice and membership of a Group which could represent their interests in computing both to suppliers and the Department of Health.

As well as the Primary Health Care Specialist Group many other bodies have a potential interest in dental computing, albeit little recognised. For the electronic remittance of FP17s explored in the DPB trial to become routine, more dental practices must use systems designed for use in dentistry. Family Health Service Authorities (FHSAs) have a managerial role that extends beyond general medical practice to general dental practice. Many FHSAs have appointed GP computer facilitators: one has a large selection of computer systems with which the GP considering computerisation can become familiar. The same services could usefully be made available to dentists. This would not be expensive as dental software could be mounted on the hardware used to support general practice software.

The BDA also has a role to play, and it is recognising this by providing courses for dentists in computing up and down the country. Other professional bodies, for example the Royal Pharmaceutical Society, have produced guidelines to computer systems: the BDA could usefully do the same.

The Department of Health (DoH) has been active in the field of GP computing: much research has been done through the FHSAs in the form of annual computer surveys [133], [134], guidelines of what to look for from a supplier have been drawn up and some remuneration has been offered to GPs. For the linkage of dentists to the DPB to be successful in the long term similar initiatives must take place in dentistry.

The extent to which practices should automate is an open question. Some suggest that the humid atmosphere in the surgery is a hostile environment for a terminal, that will lead to equipment malfunction, and that any administrative benefits over a single user system are minimal. However, a terminal in the surgery can give the dentist accurate information about the patient at the time of treatment and also allows records to be more easily updated. Set against this, it can be argued that few dentists have any experience of computers and many are poorly prepared for the radical changes that a networked system will bring to the practice. A compromise is to start with a single user system which is capable of later expansion if desired.

Another problem of the dentist considering computerising the practice lies in selecting a supplier who will still be active in the market in several years time. The Dental Practice Board have identified over a hundred vendors with a computer system. However, many of these systems are only in use in one practice, leaving effectively between thirty to forty computer system suppliers. Nevertheless, the market will support less than ten suppliers, and many dentists will be left with systems rendered useless by the absence of ongoing software support caused by the supplier going into receivership. Practices whose suppliers go into liquidation will need to invest in a new computer system in order to keep up with continual changes in dental charges and the dental contract. While it is true that computer equipment is replaced after several years, in the case of liquidation, it will not be possible to transfer the data to the new system.

Changes in the dental contract have placed greater emphasis on continuing care for patients. This will result in less movement of patients between dental surgeons and more stability of any patient database - allowing greater benefits to be gained from the computer.

Nearly three quarters of the respondents were in favour of an electronic smart card and only a small minority were against. As well as giving the dentist information which can help in treating patients, there is an incentive for dentists to make use of the smart card, as it can give warning of diseases that may infect the dentist. An example would be hepatitis, which if contracted can prevent a dentist from working in practice. However, it would be illegal for smart card to carry information about AIDS.

A terminal in the surgery would allow smart cards to be more fully exploited, in terms of the ability to provide an automatic alert to any contraindications and drug interactions between drugs prescribed by the GP or supplied by the pharmacist and the intended treatment of the dentist. A terminal in the surgery would also allow dentists to write data onto the card. This is essential if the card is to be as complete as possible a record of patient medication. The alternative to the smart card is the "cluster" concept of care providers, where all primary health care practitioners can access data held in the computers of other professionals in the same locality. This concept has been fully discussed previously (see section 8.4).

10.4 Conclusions

The following conclusions can be drawn from the research -

* That cost is not the most important limiting factor on the use of computers in dentistry.
* That dentists have a need for information about computing.
* That this need can best be met by a variety of printed literature, courses and training centres.
* Of those dental practices that use a computer, there is a wide variety in the sophistication of computer systems used. The NHS as a whole can reap financial benefits by dentists routinely submitting claims for remuneration electronically. For this to happen more dentist must install dental computing systems. To this end more information, help and guidance must be made available to dentists.

Chapter 11. COMPUTERS IN OPTOMETRY

11.1 Method

A nationally based random sample of one thousand optometrists were sent a postal questionnaire which asked questions about their use of computers in practice. The questionnaires were sent with an introductory letter and a prepaid reply envelope. Most of the questions were closed, i.e. the responses were indicated by circling a number, except where all conceivable answers could not be accommodated. Space was left at the end for respondents to comment.

The questionnaire was designed to meet the following objectives and test the following hypotheses:

11.1.1 Objectives

1) To estimate the numbers and types of systems in use in optometric practice.
2) To collect data regarding the tasks which are currently performed using IT by optometrists.

11.1.2 Hypotheses

1) A large number of optometrists are interested in applying information technology (IT) to their practices.
2) Optometrists feel that they could benefit from claiming remuneration electronically from the FHSA.
3) Optometrists feel that they could benefit by submitting orders for optometric products electronically to manufacturers over a network.

11.2 Results

577 (58%) replies were received. However, of these fifteen questionnaires were returned marked "gone away" and seven replies were unusable. Five hundred and fifty five replies were analysed. All percentages quoted are on the basis of 555 responses, unless otherwise stated.

11.2.1 Practices

The size of responding practices was classified by four groups:

1) Single practice — an individual practitioner working alone.
2) Group practice — several practitioners working together in one or more branches.

3) A small multiple — a small company of between 2 and 10 branches.

4) A large multiple — a large company with optometrists in 11 or more branches.

There were 188 (34%) respondents using a computer, while 366 (66%) did not. Respondents who did not use a computer system were then asked if they were planning to acquire a system. 99 (27% of the 366) indicated that they had plans to acquire a computer and 266 (73%) replied that they had not. There were no significant difference between the type of practice and the use or non use of a computer.

11.2.2 Computer systems

Large optometric practices enter into contracts with major computer suppliers, who will develop software to satisfy the group's requirements. A comparatively recent paper suggested that almost all major optical chains now use a computer [43]. Dollond and Aitchison, Great Britain's largest optometric concern, has been computerising since 1986 [48]. However, the survey indicated that only 36 of 93 (39%) branches of large chains that had responded used a computer. A possible reason for this discrepancy may be that other commentators defined "large" practices as having minimally more branches than did the survey, i.e. more than ten. The definition of large used in the survey is the same as that used in the survey of pharmacy, which was originally used by a Pharmaceutical Society survey and was quoted by Phelan [187].

A recent paper estimated that one small optometric practice in twenty now uses a computer and commented that this figure is exceptionally low when compared to similar businesses. The writer did not suggest which businesses he considered similar to a small optometric practice [42]. However, other research differs [43], indicating that one small practice in five has a computer.

In the current study, 66 out of 220 (30%) small practices who responded indicated that they used a computer. The low estimate [42] may represent the number of software packages designed for optometry in use, rather than the number of computers. 24 out of 44 (55%) small optometric practices have invested in word processors and database packages in order to recall patients efficiently or send out advertising information. Additionally some smaller practices have also had programs commissioned specifically for their needs from software houses.

The use of computers by optometric businesses in different categories was similar, varying between 30% for small practices and 39% for large multiples, with the other two categories, group practices and small multiples, at 34% and 36% respectively. There is no significant difference between the groups ($p = 0.46$).

The breakdown of systems used by respondents is shown in Table 14.

Table 14. Computer systems in optometry. N = 188.

Supplier	Number	Percentage (%)
Specially written software	51	28
OTS Package*	34	19
Kalamazoo	28	15
Practice Management System	16	9
Word Processor only	14	8
Mint Opticians	10	6
Optic	6	3
Proven in Practice	3	<2
Other	12	7

* Off The Shelf

The bulk of systems in use are written specifically to meet the needs of a particular practice or group. Although Kalamazoo emerges as a market leader, more optometrists have opted for software suitable for general business applications, e.g. database and spread sheet packages, than have bought any one system specifically intended for optometrists. Although an "off-the-shelf" program may be less expensive than a dedicated system for one application, if many aspects of practice administration are to be automated, dedicated systems should ultimately prove cheaper.

11.2.3 Computer applications

Tasks for which the computer was commonly used were patient recall (137 or 78%), patient records (86 or 49%) and word processing (119 or 68%). One of the greatest benefits to optometrists of using a computer is sending letters to patients, reminding them to attend the practice for an examination, e.g. a sight test. In addition, the combination of patient data and "mail merge" facilities can produce letters to advertise special offers and services to target groups of patients. This maximises the efficiency of any advertising campaign.

Word processing is straightforward to learn and saves practice members' time when altering letters and documents. For example, a letter an optometrist would send is one to inform the patient's GP about a suspected disease such as glaucoma.

Most word processors have a mailing facility, allowing them to be used for recall purposes. However, it is harder to target mail to more potentially receptive groups with a word processor than with an dedicated optometric package. This is because dedicated packages store more information about patients' clinical conditions, and therefore patients whose condition may make them receptive to a particular offer can be targeted.

Other applications respondents reported using include practice accounts (59 or 34%) and stock control (54 or 31%). Less common applications are sight prescription processing (37 or 21%), appointments (26 or 15%) and invoice generation (26 or 15%).

Although appointment diaries can enable practitioners to view their schedule for the coming weeks conveniently, there are no clear time savings when compared to a conventional desk diary. However, appointment modules can be put to greater advantage by using them retrospectively, to discover at which times of the year the practice had the smallest number of patients. This knowledge can then be used to send out recall letters prior to these periods, or alternatively the optometrist can arrange holidays at quiet times of the year and minimise inconvenience to patients.

Processing spectacle prescriptions can be accomplished more rapidly manually than electronically, giving optometrists a disincentive to automate this application. This is because it takes time to enter data, and this data is unlikely to be used again. Stock control and practice accounts are both areas where the computer could give the optometrist a competitive advantage. Stock control facilitates more careful monitoring of frames and lenses, enabling smaller numbers of both to be held and so freeing resources.

Small optometric practices can either buy dedicated optometric software packages, have software written for their own practice, or buy software intended for office use generally.

Acquiring software intended for general office use rather than a dedicated system is only likely to be cheaper when one or two applications are to be utilized. Optometrists who pursue this option will possibly have facilities for word processing and recalls but are unlikely to use stock control or practice account modules. Purchasing all of the software to support these application would be prohibitively expensive, and the time involved in switching between packages would make its use much less convenient and even impractical.

An essential issue when automating is that of after sales support. This support should include maintenance of both software and hardware, as well as updating software to take into account any changes in the practice, e.g. an increase in the fee for a sight test. It follows that when general office software is purchased, this sort of support is not available. Likewise, practices who have software written for them will require their programs to be updated as the optometrist's contract changes.

Although the main benefits of computers in optometry revolve around practice administration, many practices now include patient data generated by optometric examinations. While this data can be useful in selecting patients with particular eye disorders for follow up treatments, it raises issues of confidentiality and the proper handling made mandatory by law in the Data Protection Act. If any data other than the names and addresses of patients is kept, optometrists keeping records must register with the Data Protection Registrar.

Optometrists will keep to an increasing extent clinical data on their computer systems. There is no guidance to advise practitioners of which examination items should be included in the record. In comparison, in America fourteen states have stipulated mandatory minimum record contents [188]. In the UK guidelines of good clinical practice could usefully be drawn up.

11.2.4 Electronic communication

Optometrists currently need to communicate with both other professional groups and administrative bodies. They notify GPs of patients whom they consider have specific optical/clinical conditions, and occasionally order medicinal products from pharmacists. They also make claims for remuneration from their local FHSAs.

When asked if an electronic link to the FHSA would be useful, 77 (45% of those with computers) replied in the affirmative, while 58 (34%) felt that this would be of little use. Pilot trials to exchange data between GPs, pharmacists and dentists and organisations involved in their remuneration have all taken place. No such trial has taken place in optometry, nor is any planned.

Support (45%) among optometrists for communicating electronically with remunerative bodies is considerably lower than GPs (94%), but not much less than pharmacists (51%). A greater number of optometrists (31%) indicated negative responses, compared with GPs (3%) and pharmacists (15%). The lower levels of support and greater disinterest could be explained by fewer computers in optometry leading respondents to believe that such trials in optometry would be inappropriate. Alternatively, optometrists receive less remuneration from the FHSA than previously, and so exchange less data. There may be a feeling that the reduced amount of communication necessary between FHSA and optometric practice would not warrant a networked arrangement. There may also be a feeling that optometry is being eased out of the National Health Service, rendering the examination of electronic linkage pointless. This is because the patient rather than the State increasingly meets the full cost of examinations and treatment.

From the Department of Health's viewpoint, the optometrists' submission of remuneration claims electronically may be less cost effective than that of other primary care professionals. This is because the lower volume of claims may result in insufficient savings to recover the cost of providing the service.

Respondents were asked how useful they would find communicating orders electronically to their suppliers. Kalamazoo, a large international business systems company which also supplies an optometric computer system, had planned to introduce a service called Optinet. This would allow practices of all sizes to communicate with major optometric suppliers.

119 (68% of respondents with computers) of the respondents asked considered that such a service would be useful, as opposed to 34 (20%) who thought it would be of little use. Response to this question was much more positive than to the idea of communicating electronically with the FHSA, possibly due to the greater volume of transactions between the practice and the optometric supplier and because the respondents can see the practical advantage of such a system.

Despite quite strong support from optometrists for a network service, there are no longer any plans to install Optinet. It has been suggested [44] that the problem with such a service is that both manufacturers and practitioners will wait on each other to subscribe to the network. Another explanation is that manufacturers were unhappy with one company having so great an involvement in the ordering of optometric products [189]. If a company that controlled a network was also supplying a computer system, it could in theory restrict competition by creating obstacles to network use by other computer system suppliers.

11.3 Discussion

The use of computers by optometrists does not appear to be influenced by practice size.

Although software intended for general office use can support the automation of some tasks, extending the number of tasks automated beyond a limited range is not practical. When more than a few activities are to be automated, dedicated packages are more practical than several general application packages.

Practices of all sizes could benefit from direct ordering from manufacturers of frames and lenses, if an optometric network was available. For such a network to be useful the majority of optometric suppliers would need to involved. However, a possible barrier to the installation of such a network is that both the optometric practices and manufacturers are likely to wait for each other to subscribe.

Some larger groups are already benefiting from existing electronic data interchange services, such as TRADANET, as well as from electronic point of sale (EPoS) systems. Smaller optometric groups could also benefit from EPoS by

* facilitating the collection of data in the practice.
* rapidly identifying popular frames and supplying more.
* identifying which frames are more popular at one time of the year and orienting frame displays accordingly.

Pilot trials exploring electronic communication between practices and remunerative bodies have taken place in general practice, pharmacy and dentistry. Support for electronic communication with the FHSA among optometrists was relatively low, compared to other professions, and opposition comparatively high. This could be due to -

* a feeling that optometry is being progressively removed from the range of services for which the FHSAs are responsible, making any linkage pointless. An example of this is the patient being responsible for the cost of an eye examination.
* the patient now meeting the full cost of almost all optometric treatment. This results in greatly reduced volumes of communication with the FHSA and there may be a feeling that these lower volumes would not be enough justify an electronic link.
* there may be a feeling that the use of computers in optometry is not yet widespread enough to make such a link worthwhile.

Computer use was widespread in general practice and pharmacy when the electronic linkage of these professions with their remunerative bodies was explored. However, this was not the case in dentistry; indeed there were relatively fewer computers recorded in use in dentistry capable of links with the then DEB, than there are in optometry. Despite this at present no pilot trial is planned to link optometrists with the FHSAs. This is because once the trial in dentistry proved successful, the volume of communication and consequent savings that could be made justified an investment in dental computing. The lower volumes of communication in optometry will not justify this investment in optometric computing.

However, should the use of computers in optometry become widespread, and the need for investment in optometric computing obviated, then electronic communication with the FHSAs could save resources.

These saved resources would arise as FHSA staff currently have to enter claims manually into a microcomputer. The planned FHSA network could carry the extra volume of traffic and costs would be restricted to training staff in both FHSAs and optometric practices to use a new system. If optometry is to remain under the management of the FHSAs, and the use of computers in optometric practice was widespread, then there are economic grounds for a pilot trial exploring an electronic link between FHSAs and optometric practices, despite the reduction in the volume of communication between optometric practices and FHSAs.

The Data Protection Act and its requirements of health practitioners have been the subject of papers in journals of other primary health care health professions [190] - [193]. There have been no similar papers in British optometric journals. As optometrists are increasingly keeping electronic records of patients there is a need for optometrists to respond to their obligations under the Act.

Information should be disseminated to the profession through papers and features in professional journals.

Trials of the smart card have not included optometrists, and so its potential benefit to patient care have not been explored. A wide range of diseases can have an impact upon the eye, and optometrists could provide better care if they had access to the parts of patients' medical histories and medication that relate to the eye. The converse is also true, that optometrists need to communicate information revealed by eye examinations to GPs and medication used to community pharmacists, and could conveniently do so through the smart card. Any further trials of card technology should investigate potential benefits by giving optometrists both read and write access to the card.

In addition there is the issue of possible problems with ocular medicines. The use of medicines prescribed by general practitioners is monitored by the "yellow card" reporting system, whereby when a patient complains of a problem with a medicine, the GP can report this suspected problem with to the Committee for the Safety of Medicines (CSM). Although optometrists use and can order for a patient's use a limited range of medicinal products there is no similar reporting system. The smart card could provide information on optometric orders to the GP, who could then report any suspected problems to the CSM via the yellow card system.

While there are no plans for further trials of the smart card in primary health care in the near future, any later trials could usefully include exploring the benefits of the smart card, or any alternative in optometry.

At present the diversity of computer systems in use in optometry would make the widespread use of the smart card difficult. This is because every supplier would need to write a software interface to connect the card to their computer system. However, in any market there is a tendency for several companies to dominate the market and consumers are left with a choice of several products. This will happen in optometric computing and the several companies remaining will be able to write interfacing software for the smart card.

11.4 Conclusions

It is possible to conclude from the research -

* A large number of optometric practices have installed a computer.
* There are a range of systems in use in optometry, and the number of activities computerised varies widely within each practice.
* Greater support exists among optometrists for communicating with suppliers of optometric materials than with the FHSAs.

Despite the lower levels of remuneration from the State when compared with other primary health care professions, the electronic communication of remuneration claims from optometry to the FHSAs could still save NHS resources. Any strategy for the computerisation of optometry must take into account the future of optometry within primary health care.

Chapter 12.

COMPUTERS IN THE FAMILY HEALTH SERVICES AUTHORITIES

12.1 Method

A postal questionnaire was piloted at one of the then Family Practitioner Committees in 1989 and then sent to the remaining 89 in England and 8 in Wales. A covering letter and a prepaid reply envelope were enclosed with the questionnaire. The majority of questions were closed, although some space was left for respondents' comments. This first mailing produced 45 replies or a 46% response rate. A reminder letter and questionnaire three weeks later increased the total number of responses to 67 (68%). Two of the questionnaires returned were unusable, resulting in the analysis of 65 (66%).

The questionnaire was designed with the following objectives and hypothesis -

12.1.1 Objectives

1) To gather data about the computer systems used by the FHSAs.
2) To ascertain what services are provided by the FHSAs.
3) To assess how the networking of the Family Health Services (FHS) can best progress.

12.1.2 Hypothesis

1) That there is a role for the smart card in the management of FHSA services.
2) That there is need for information in order that FHSAs can carry out their new managerial role.

12.2 Results

12.2.1 Computer systems

All respondents used software supplied by Exeter FPS Computer Unit on minicomputers. These minicomputers were either DEC PDP's or Systime Series 6400. In addition to the FPS Computer Unit software, all save two who answered this question used a variety of commonly available commercial packages on IBM PCs and clones. The majority used a DBMS and spreadsheet packages as well as wordprocessing software. Several respondents used a PC network and one had networked Apple MacIntosh microcomputers. The acquisition of a wide range of microcomputers by FHSA results in part from the need to management information created by the White Paper Promoting Better Health [25].

53 (82%) of respondents were satisfied with ability of the software to meet their operational needs, as oppose to 4 (6%) who expressed dissatisfaction. A lower figure, 29 (45%), expressed satisfaction at the ability of the software

to meet their need for management information, with 21 (32%) expressing dissatisfaction.

The FPCs were purely administrative in nature and the software produced on their behalf reflected these administrative needs. However, the FHSAs of today have a managerial role in addition to that of an administrative one and the software produced has not kept pace with these developments. As a result FHSAs are looking towards general application packages based on microcomputers to fulfil this need. In 1984 the Andersen Report [57] expressed concern that developments in FPC computing might occur piecemeal and without an overall strategy. The Report was dealing with the minicomputer systems that were intended to assist the FPCs with their administrative responsibilities. However, this problem is now re-emerging in relation to the FHSAs use of microcomputers to deal with their need for management information.

If every FHSA used the same software packages it would be easier to establish centres to train staff in the use of these packages. In addition, if all FHSAs were organised along similar lines it would be facilitate the movement of staff from one FHSA to another.

12.2.2 Family Health Services Authorities services

Cervical cytology modules for FPCs have been under development since 1984 [165]. As a result of this long-standing commitment to computing, data held electronically on patients within an FHSA is more comprehensive and accurate than that of any other NHS organisation. As such it is used as the basis of a call and recall system for the prevention of some diseases. 60 (92%) of respondents indicated that their FHSA were involved in cervical screening, 3 (5%) indicated that their FHSA was not. 51 (79%) were involved in breast screening, as opposed to 13 (20%) who were not. However, only 3 (5%) of respondents indicated that they were involved in hypertension screening. There is a variation in the screening programmes conducted using FHSA data. Part of the reason for this can be explained by differing morbidity patterns. For example in an area where there is a high incidence of hypertension it may be advisable to institute a screening programme, whereas this may not be the case in another part of the country. Another factor may be the perceived benefits of a screening programme by local medical experts. There may a feeling that the benefits of a breast screening system do not merit the resultant costs, due a range of factors including false positive results, the inability of the procedure to detect the disease in all suffering patients and a failure by a substantial number of the population to attend a screening clinic. However, it may also be the case that some FHSA are more diligent at making the maximum use of their database.

There have been recommendations that computing advisors for GPs could facilitate GP computing [18], [169]. In light of the FHSAs new managerial responsibilities there is a case for FHSAs appointing such advisors. 18 (28%) of responding FHSAs had appointed a general practice computing advisor, while 45 (69%) had not. Despite the low numbers of advisors in post some 47 (72%) respondents considered that an advisor would be useful, and only 11 (17%) felt that such an advisor would serve no practical use. There are several explanations for the wide discrepancy between the number of people in favour of advisors and the number in post. One Region has appointed an advisor, making an FHSA appointment largely superfluous. It is unlikely that one FHSA could provide enough practices interested in automating at any one time to justify a full time post, and it may be difficult to find an appropriately qualified individual for a part time appointment. Alternatively an advisor at one FHSA may assist practices in neighbouring FHSAs.

In addition to appointing advisors, some FHSA have set up centres where GPs can gain hands on experience of general practice computer systems. The hardware that supports these systems could also be used to support software intended for dentists and optometrists. Thus the range of services offered could be extended to other primary health care practitioners at comparatively little cost.

12.2.3 Computer records in general practice

One feature of electronic medical records is the ability to alter the data that they contain at any time. This can present a problem in a medico-legal context in that details of a patient's treatment can be altered, resulting in falsified evidence in a court case. 49 (75%) of respondents thought that medical records should be structured to prevent the complete erasure of any treatment, 5 (8%) did not. At the time of writing few general practices have completely dispensed with paper records. However, there will be an increasing tendency to do so in the future and electronic records must be altered to reflect this at some stage. In addition to being resistant to erasure records must also identify the source of data - this is not done by computer systems at present. This is necessary so that there can be no ambiguity later over which member of practice was responsible for a particular treatment. PMR computer systems in pharmacy prevent the complete erasure of a record, as does the Apollonia system in dentistry [194].

12.2.4 Electronic communication

54 (83%) of respondents considered that GPs could usefully make claims for remuneration electronically. 68% also considered that GPs could usefully order FHSA stationery. A barrier to claiming remuneration electronically lies in the

regulation to validate claims with a signature. 44 (68%) of respondents felt that the regulation should be amended but 15 (23%) rejected this amendment.

Software has been developed which makes an electronic signature verification program capable of recognising a signature on 95% of occasions. The program is intelligent in that it recognises gradual changes in the user's writing. However, no data has been presented as to its ability to detect forgeries, nor any discussion of how temporary writing problems caused by hand injuries could be overcome. In addition there is an argument that verification of electronic data is not crucially important as contractors intent on defrauding the FHSA will invariably be successful, at least on a short term basis. An example of this of this would be a GP presenting prescriptions to a pharmacy for non-existent patients and both GP and pharmacist then sharing the remuneration. Legal opinion suggests that computer-generated signatures for prescriptions are unacceptable [195].

Respondents were also asked whether this "electronic signature" would be acceptable verification by the claimant. 45 (69%) considered that this would be an acceptable solution but 7 (11%) opposed this development and a further 11 (17%) felt unable to answer. Electronic signature recognition is only one way of verifying claims. Other approaches are for claimants to maintain a paper record of all claims which can be scrutinised by auditors or issue claimants with a password which serves as a unique identification. However, the support for the electronic signature verification approach suggests that the system has potential for adoption and the program should be developed further to overcome the problems of forgery and temporary handwriting problems.

Pilot trials have all explored the possibility of pharmacists, GPs and dentists communicating electronically with remunerative bodies. This has not been the case for optometrists. 44 (68%) of respondents felt that a pilot trial to remunerate optometrists should be instigated but 10 (15%) opposed such a trial and a further 10 (15%) felt uncertain about the issue. The reasons for not communicating electronically with optometrists are -

* That the amount of remuneration received by optometrists from the FHSA is comparatively small.
* That optometry may be being progressively removed from the management of the FHSAs.

In favour of FHSA networking with optometrists is the fact that the network to carry the data already exists and additional costs would be marginal. As a consequence cost savings would result through FHSA staff not having to enter claims for remuneration from optometrists manually.

12.2.5 Management information

FHSA respondents were asked how useful information on GP services and patient morbidity would be in managing practitioners and planning services. Respondents were asked to indicate usefulness on a scale of 1 to 5, with 1 being the most useful. The average values are shown in Table 15.

Table 15. Data from general practice.

Data	Response Category (%) 1	2	3	4	5
Child immunisation	38(67)	6(11)	2 (4)	3 (5)	8(14)
Screening the over 75s	33(59)	10(18)	5 (9)	4 (7)	4(7)
Chron. morbid. record.	33(60)	8(15)	8(15)	1 (2)	5(9)
Developmental checks for the under 5s	33(58)	9(16)	7(12)	3 (5)	5(9)
Malignant disease recording	25(46)	14(26)	9(17)	2 (4)	4 (7)
Drug use	25(46)	12(22)	5 (9)	5 (9)	7(13)
Mammography	20(36)	17(30)	4 (7)	6(11)	9(16)
Cervical cytology	29(51)	8(14)	5 (9)	2 (4)	13(23)
Hypertension screening	21(38)	13(24)	13(24)	1 (2)	7(13)
Rubella vaccination (for girls of 10-11)	16(30)	14(26)	13(24)	6(11)	5 (9)
Tetanus vaccination	14(26)	11(20)	12(22)	5 (9)	13(24)
Flu vaccin. provision	9(17)	10(19)	16(30)	7(13)	12(22)
Family planning info.	10(18)	15(27)	14(25)	6(11)	11(20)

Changes in the contract for general practitioners have made it obligatory for them to maintain surveillance of the very young and the very old. The White Paper "Promoting Better Health" [25] places a responsibility on the FHSA to manage independent contractors, of which GPs are part, and to ensure that the contractors fulfil their contractual obligations. As a result FHSAs will need to know whether individual GPs on their lists are fulfilling their obligations with regard to surveillance of the young and old.

Changes in the GP contract have resulted in GPs being remunerated for reaching immunisation targets, rather than being paid for administering each vaccine. In order to make these payments FHSAs need reliable information about both the number of vaccinations made and the number of patients eligible for this treatment.

Interest in chronic morbidity and malignant diseases were also high, although these have no direct bearing on the management of the FHSAs.

Also of interest were the rates at which GPs carried out preventative procedures such as breast, cervical and hypertension screening. GPs are remunerated if a certain percentage of their patients have been screened for cervical cancer, and FHSAs require this data to remunerate GPs accordingly. However, interest was higher in information about breast screening, which is not connected with remuneration. Hypertension screening was also of interest, although not directly related to remuneration or service management.

Of least interest was information about GPs services with regard to vaccination for tetanus, rubella and flu, as well as family planning.

The role of the FHSA has changed from that of purely administering primary health care services to that of a managerial capacity. In practical terms this means in addition to being responsible for paying PHC practitioners, the FHSAs are now responsible for the quality of services that their contractors, the PHC professions provide. To fulfil this responsibility and to monitor the provision of services, FHSAs need information on the activities of all practices under their jurisdiction. With this information the can ensure that the services provided are of an acceptable standard.

12.2.6 Community index

The community index or District Information Support System (DISS) is a list of patients within a district and contains the patients name, age and sex [79] - [82]. The index would be the basis of call and recall programmes and health professionals in both community care and primary health care would be able have current information about patients and be able to add data to the index. The addition of data by health professionals after seeing the patient would ensure that the information in the index was as accurate as possible. It could also save resources as only one database would be updated, rather than several different databases. Respondents were asked how useful they considered a community index to be in facilitating communication between health professionals. 57 (88%) of respondents considered it to be useful. Although there is strong support for using a community index or DISS to overcome some the problems of many separate databases, some issues remain to be addressed. These are -

* The confidentiality of the data. Although the data will not be of a sensitive nature, steps must be taken to prevent unauthorised access.
* Decisions as to who should be responsible for this index. As the index would cover a District, there is a case for each District having control of the index. However, any index would inevitably have to use data from the FHSAs, as their data is more accurate than that of the DHA. The FHSAs, having provided the data, may feel that they are responsible for it and should maintain any index.

12.2.7 Smart cards

Respondents were also asked whether they saw any application of the smart card in the management of the Family Health Services. 45 (70%) indicated that they did, 10% that they did not and 6 (20%) were unsure. Few went on to elaborate any managerial uses of the card. Potential applications are -

* Recording patient exemption status on the card. It would then be easy to check a patients exemption status when a prescription is dispensed, and so prevent fraudulent claims of exemption, provided that the the card was regularly updated.
* A patient held treatment record in case of complaints of malpractice. If complaints are made about independent contractors, it is possible that contractors could alter electronically held data to improve their position in any hearings. The smart card could give patients a record of treatment which cannot be altered.
* Using the card as the basis of a system of data capture. When a new item of data is added to the card, the same data could be sent anonymously over the FHSA network to a remote data base. This data could be used collectively to assess whether immunisation and screening targets had been reached, monitor prescribing, referrals and investigations, as well as providing data about morbidity in each FHSA. Resources could then be allocated on the basis of these morbidity figures.

12.2.8 The Family Health Services Authorities network

In light of the installation of the FHSA network, there will soon be improved opportunities for electronic communication for the FHSAs. Respondents were asked to rank from 1 to 11 organisations and professions with which they felt that electronic communication would be most beneficial. A rank of 1 indicated the highest priority and 11 the least. The mode for each organisation and practitioner are shown in **Table 16**, in order of priority indicated by respondents.

Table 16. Electronic communication and the FHSA network.

Organisation/Practitioner	Mode
General Practitioners (GPs)	1
Other FPCs	2
The Prescription Pricing Authority (PPA)	2
The District Health Authority (DHA)	3
The Dental Practices Board	4/5*
Dentists	6
Pharmacists	6
The Regional Health Authority (RHA)	10
Optometrists	11
The Department of Health (DoH)	11
The National Health Service Central Register	11

* An equal number of respondents opted for these categories.

General practitioners have a crucial role to play in data exchange with FHSAs. The FHSA database is ultimately dependent on the GP for ensuring that data on patients is accurate. GPs inform the FHSA of new patients, patients who have moved away, and patients who have died. These events must be known by the FHSA for two reasons -

* The FHSA database is used to remunerate GPs. For these contractors to receive the correct amount of money, the FHSA database must be accurate.
* The FHSA database is used for the call and recall of patients to screen for cervical cytology, breast cancer and hypertension. The success of these screening programmes is related in part of the accuracy of the database used to identify patients who are at risk.

There is a prima facae case for having GP to GP communication over the FHSA network. This would enable a patients records to be sent immediately to a new practice when the patient moves and re-registers. However, this would entail highly sensitive data being sent from one location to any one of around 10 000 locations. In practice the needs of confidentiality could be met better by a practice sending a patient's records to the local FHSA, who then send the records to the remote FHSA, who in turn send them to the appropriate practice. This is in effect what happens with the transfer of paper based records.

The Prescription Pricing Authority (PPA) currently give information to the FHSAs to enable them to remunerate pharmacists and dispensing doctors for dispensing prescriptions. The PPA send the FHSA a magnetic tape with this information every month. The FHSA upload this data into their own microcomputer prior to paying pharmacists. However, the time taken to access data from a magnetic tape is comparatively slow. By sending the data electronically over a network, the time needed to upload these files could be saved.

District Health Authorities maintain lists of patients within their jurisdiction. However, the data that they hold is not as accurate as that of the FHSAs. The FHSA network could allow FHSAs to routinely update the databases of DHAs.

The Dental Practice Board (DPB) validate claims for remuneration from dentists and pass this data to the FHSAs, who then make payments. The data that the FHSAs currently receive from the DPB is in a printed format and must be manually entered into the FHSA computers. The network could allow this data to be sent electronically, and obviate the need for FHSA staff to enter data manually.

Pharmacists may claim remuneration for maintaining patient medications records directly from the FHSA. Dentists also receive some funds for the patients on their books. Alterations in the dental contract, effective from 1990, places greater emphasis on the capitation element of dental remuneration. All these claims could be processed more efficiently electronically than manually via the FHSA network.

The FHSAs are now accountable to RHAs, rather than the Secretary of State, as was previously the case. This will lead to a need for greater communication between the two bodies, a need that may be met more cheaply and conveniently through electronic mail than by written communication.

Optometrists make some claims for remuneration from the FHSAs, although the volume of these claims has been reduced in recent years. Optometry alone in primary health care has not seen an assessment of the benefits of linking computers to exchange data, although there may still be a possibility of administrative savings.

The National Health Service Central Register (NHSCR) is a body which exists to make it possible to trace patients. This is important when a patient registers at a practice and is unable to give details of the previous practice attended. If it was impossible to trace such a patient, then that patient's records would effectively be lost and the database of another FHSAs would be inaccurate by the inclusion of a patient who had moved away. The recently computerised NHSCR, in conjunction with the FHSA, can result in more rapid tracing of patients. This in turn leads to more accurate FHSA data. In addition by reducing the amount of clerical effort involved, the network can save resources at both the NHSCR and at FHSAs.

The DoH routinely sends out circulars to individuals and organisations involved in the NHS. The information in these circulars could be sent directly to targeted individuals via an electronic mail system.

12.3 Discussion

One of the principles of data processing is that any item of data should only be entered once. Unfortunately, this is not the situation in the NHS, nor specifically in the FHSAs. There are many different reasons, some of them good, why the same item of data will be entered by several individuals associated with the health service. These are -

* The need for confidentiality with some data leading to a deep concern over of networked arrangements.
* The inability of some workers to enter data with a sufficient level of accuracy: an example of this is the trial which linked pharmacists to the PPA.
* Technical problems created through different computer systems using similar but not identical data sets.
* Problems of audit caused by the need for verification of some data.

Some of these issues need not become barriers to the full realisation of the benefits of the FHSA network. Verification can be achieved through a password or PIN number: these have already proved successful as a method of verification for cash dispensers in the banking sector. Technical committees can be established to work towards defining data sets which are acceptable to users and suppliers. All organisations and individuals involved in the NHS must become aware of their responsibilities with regard to patient data, even when this data is no more than an

address list. Technical solutions such as encrypting data can also allay concern over data in transit.
However, a continuing problem will be the accuracy of data in all computer systems. This is because few of the individuals involved in inputting data are trained in data entry: indeed many have other professional qualifications and utilizing information technology is a novelty. Overcoming this problem will be partly through training all staff involved with IT but also through better systems designed to make data entry easier. The problem of accuracy is particularly acute in terms of the patients NHS number. This will be used to identify patients in any electronic communication, for example to update FHSA registers. If this number is inaccurate then further inaccuracies will be generated throughout databases in the NHS.
The idea of one master patient index to overcome the problems of separate databases being maintained by DHAs and FHSA has been discussed. However, now that both are responsible to the RHA, it could be argued that a merger of the two organisations would save resources. This is because only one patient database would need to be maintained. There is a precedent for combining DHA and FHSA functions in the Scottish Health Boards.
In addition careful consideration must be given to the scope of the network's use. Exploration of the benefits of linking various primary health profession has met with varying degrees of success. While the FHSA network could potentially

allow pharmacists to send prescriptions to the PPA this application will not be pursued in the near future. This is because the PPA requires additional information about the prescriber to be sent with the prescription and in a trial pharmacists were unable to supply this information accurately. However, if the pharmacist did not have to enter this data, then prescriptions could be sent electronically to the PPA. A possible mechanism to achieve this would be uploading data from a smart card.

12.3.1 Management information

The White Paper [25] has created a need for management information in the FHSAs and the FHSAs have responded to this by investing in microcomputer technology. A strategy for microcomputing must be developed to maximise benefits. One such benefit that could be realised is the possibility of harmonising practice reports and enabling all FHSAs to analyse these reports in the same way. This would make possible comparison of practice reports between practices in an FHSA and between practices nationally on predefined criteria. In addition to a strategy for FHSA microcomputing this would also require standardisation of practice reports, which itself relies on the data in general practice computers. To this end it is vital that consistency be established in the data held in general practice computer systems.

12.3.2 Screening

A highly organised and computerised general practice can probably provide more effective screening services at lower cost, than can be provided using the FHSA registers. However, computerisation and good organisation are not uniform in general practice. If screening were the sole responsibility of general practice, patients would receive a highly variable service. As a result screening must be provided at present by FHSA registers. Despite this, general practice may be able to provide comprehensive screening facilities in the future, when computerisation is more widespread in general practice.

In addition to necessitating screening campaigns by FHSAs rather than GPs, non computerisation of parts of general practice has other implications. These are -

* the necessity to run paper based systems in addition to any electronic systems.
* the severe limitations on using the FHSA network as an alternative way for practitioners in primary health care to communicate with one another.

12.3.3 The network

Much consideration has been given to using the FHSA network to allow organisations in the NHS to communicate. However, it could also be used to allow different professionals within primary health care to communicate with one another. The benefits of PHC practitioners sharing data have been demonstrated in the Exeter care card trial. However, the FHSA network presents another mechanism for realising these benefits. One of the problems of this approach lies in the necessity for primary health care practitioners to have their computers permanently attached to modems connected to the network. This situation leaves them vulnerable to the unauthorised access of the patients records. A possible solution to this problem is the use of callback modems. This would mean that when a connection was made and a caller identified, the connection would be broken and the computer would contact the caller on a predefined number. This would mean that anyone intent on unauthorised access would need both the password and be at the one location where that password was valid. This would give a high measure of security but would restrict the number of professionals that could be contacted. This restriction would not be too important as many patients will use practitioners in a defined location. However, when patients use other practitioners, for example when on holiday, the professional visited would not be able to obtain the benefit of access to information about that patient.

Until all primary health care practitioners use computers, the full benefits of the FHSA network cannot be realised.

12.4 Conclusions

These conclusions can be drawn from the research -

* There is a wide range of microcomputers and associated software used in the FHSAs.
* There is considerable variation in the services provided to both patients and professionals in different FHSAs.
* There is an increasing need for information among the FHSAs to realise their managerial role.

A strategy for the use of microcomputers within the FHSAs could usefully be drawn up. This will result in resources being saved by preventing different FHSAs expending resources on solutions to common problems. There is a need to investigate different solutions to the problem of exchanging data between primary health professionals and the FHSAs in order that the full benefits of the computerisation of the services can be achieved.

Chapter 13. COST BENEFIT OF COMPUTERS IN PHARMACY

13.1 Method

After an initial pilot survey, 1 000 pharmacies were sent a postal questionnaire in June 1990. These pharmacies represented a random sample of pharmacies nationally. A covering letter and a prepaid reply envelope were sent with the questionnaire. All questions were closed but some space at the end was left for respondents comments. The questionnaire was based on these hypotheses and had the following objectives -

13.1.1 Objectives

* To ascertain whether respondents had a PMR computer system, and how they informed patients about the system.
* To ascertain whether they felt that patient loyalty had improved as a result of the system.
* To investigate the impact of PMR systems on the levels of prescriptions presented to a pharmacy.
* To measure the pharmacists level of job satisfaction.
* To collect the total monthly number of prescriptions presented over a thirty two month period, in order to make an objective, quantitative analysis of patient behaviour possible.

13.1.2 Hypotheses

* PMR computer systems encourage patients to return to a pharmacy and can attract patients to a pharmacy.
* The ability of PMR systems to attract patients is dependent upon the information that patients receive about the PMR system.
* PMR systems can bring about an improvement in pharmacists job satisfaction.

The letter and questionnaire promised complete anonymity to the recipient, as prescription data is sensitive business information. Consequently, no reminder letters could be sent to non-respondents. SPSS-X was used to analyse the results of the replies to the questionnaire.

13.2 Results

461 (46%) replies were received, but of these three were unusable and two arrived too late to be of use. 454 (45%) replies were analysed.

200 (44%) of the respondents used a PMR computer system, of whom the majority (169 or 87%) had installed the PMR computer system within two years of the survey in May 1990. This represents a substantial increase over the number of pharmacies that were using PMR computer systems in the survey of pharmacy. PMR computer systems are marketed partly on the basis that there is an advantage to the patient to

return to the same pharmacy for subsequent prescriptions. To do this patients must be aware of the system and pharmacists use four methods to inform patients of the system.

* Leaflets - Pharmacists can give patients a leaflet which explains the benefits of the system when a patient's details are initially entered into the system.
* Cards - Pharmacists can distribute cards to patients when their details are first entered into the PMR system. The cards usually contain a patient identification number and information about the benefits of the PMR system and resemble a credit card.
* Verbal Information - Pharmacists can discuss the uses of the system and how it can improve the service they provide with a patient when a record is made and maintained for that patient.
* Any combination of the above methods.

In the study of the 200 pharmacists who used a PMR computer system, 71 (36%) indicated that they used leaflets, 132 (66%) used cards and 141 (71%) gave information verbally. Surprisingly 25% (49) of respondents with PMR systems indicated that they gave out no specific information about the system to patients.

In practice most pharmacists use a combination of the three methods. Verbal advice and leaflets, although useful, can suffer from the disadvantages of being respectively forgotten or discarded. However, a plastic card which the patient carries as identification for the PMR system, serves as a permanent reminder of the benefits of the system.

In view of marketing claims made about PMR systems ability to retain patients at the pharmacy, respondents with PMR systems were asked if they felt prescriptions had risen since the installation of the PMR system. 62 (33%) felt there had been an increase, 120 (65%) felt that their had been no change and 4 (2%) claimed to have noticed a decrease.

All respondents were asked whether they observed any changes in patient loyalty over the previous six months.

113 (26%) indicated that they had noticed an increase, 308 (71%) had noticed no change and 16 (4%) had noticed a decline in patient loyalty.

<u>Table 17. PMRs and patient loyalty.</u>

		Loyalty N = 437	
PMRs in use	Increase	No change	Decrease
Yes	63	123	2
No	50	185	14

The Chi-squared statistical test was applied to the data to test the significance of the use of PMRs to patient loyalty. There was a very high correlation between the use of PMRs and respondents perceiving an increase in patient loyalty ($p = 0.001$).

When all respondents were asked how the prescription side of their business had been in the previous six months, 197 (45%) had noticed an increase, 199 (46%) had noticed no change and 40 (9%) indicated that their prescription numbers had decreased. Although there was an association between using PMRs and an improvement in prescription numbers, this narrowly failed to reach a significant level ($p = 0.054$).

The questionnaire also asked about job satisfaction. Of those pharmacists who used PMRs 100 (74%) felt that it had led to an increase in their job satisfaction, 33 (24%) felt that it had made no difference and 3 (2%) felt that their job satisfaction was reduced as a result of the system. This reduction in job satisfaction may be due to problems with the system or the system failing to meet the pharmacists expectations.

Both survey populations, that is pharmacists with and without PMR systems, were asked to indicate their overall job satisfaction. 160 (48%) of respondents felt that their job satisfaction was high, 144 (43%) considered it to be satisfactory and 28 (8%) felt that it was low. These results were cross-tabulated with the use of a PMR system. A Chi-squared test on this cross-tabulated data indicated that there was a significant association ($p = 0.05$) between the use of PMR systems and job satisfaction. That is, that those who used PMRs were more likely to have a high job satisfaction.

The questionnaire also looked to see whether the methods of informing patients about PMRs had any bearing on either patient loyalty or prescription numbers. The Chi-squared test showed a significant ($p = 0.05$) association between those who gave out verbal advice and a perceived increase in patient loyalty. This significance was not apparent with those who gave out cards or leaflets. Further, those who used PMRs but gave no information about the system to patients were significantly less likely ($p = 0.05$) to notice an increase in patient loyalty.

13.3 Discussion

The results indicate that pharmacists who use a PMR computer systems are likely to derive greater satisfaction from their work. This may be due to several reasons -

* As a result of improving patient care through detecting drug interactions and prescribing errors.
* By being more aware of their patients conditions, pharmacists may develop a better relationship with patients, which in turn improves job satisfaction.
* Through administrative tasks in pharmacy being more effectively facilitated by stock control and ordering modules which accompany most PMR systems.
* An improved relationship with local GPs.

A very small minority of respondents felt that their job satisfaction had been diminished by PMRs. This may be due to having acquired a system which they consider disappointing, or having trouble with the system as a result of limited experience with computers. Examples of this are irritation at the time needed to make a back-up of patient data, or frustration at malfunctioning equipment.

The results also strongly suggested that patients are more loyal to a pharmacy that maintains PMRs. However, this loyalty does not appear to lead to increases in prescription numbers over non PMR pharmacies during the very limited time scale of the survey. This may be because patients have positive feelings about the PMR system and so return. However, these positive feelings are not so strong that patients are encouraged to tell acquaintances who use other pharmacies about the benefits of the PMR system. It may be that an increase in loyalty will lead to increased prescription numbers over a longer time period, as new patients start to use the pharmacy and existing patients continue to return. There was no evidence that the amount of time since the installation of the PMR system had any significant effect on prescription numbers. However, as most systems had been installed relatively recently, this effect may not yet be apparent.

Of all the methods of informing patients about the PMR system, only verbal advice was shown to have a significant effect on patient loyalty. Neither the distribution of leaflets or cards were shown to have a significant impact upon loyalty. It may be that many patients soon forgot about leaflets or mislaid cards, and so were not continually reminded about the PMR system. However, it would appear that patients were able to retain information disseminated verbally more easily.

It is possible that the impact of verbal communication was greater than cards or leaflets because it is symptomatic of the relationship between care provider and patient. That is, pharmacists who spend more time communicating with the patient are more likely to achieve a rapport with the patient which, in conjuction with services such as patient medication records, increases patient loyalty.

Given that there is strong evidence of an increase in patient loyalty associated with PMRs, and that a substantial minority of pharmacists believe that the PMR system contributed to more prescriptions being presented at the pharmacy, the research moved on to examine quantitative parametric data to detect any increase in prescription numbers.

13.4 Time series analysis of prescription data

13.4.1 Method

A pilot study was conducted whereby pharmacies with PMRs were visited and prescription data collected. The aim was to couple these pharmacies with controls, to have a matched pairs design. Pharmacies which were suitable controls, that is nearby pharmacies without PMRs were suggested by the pharmacies visited. The pharmacies were then approached for prescription data. However, it soon became apparent that it would not be possible to assemble a sufficient number of matched pairs in the necessary time scale. The prescription data from twelve matched pairs was analysed, and from this analysis a time series analysis was considered appropriate.
In the event the data were gathered from a survey, and were in the form of the total number of prescriptions presented to a pharmacy every month over a thirty two month period. This period was constant for all pharmacies. The data was used to construct a model, using a time series analysis approach [196], [197].
The time series analysis approach involved the construction of a model which would explain the variation in the number of prescriptions presented to each pharmacy over time.
The model would filter variations due to pharmacy size and general trends such as population movements, as well as variation due to seasonal and morbidity factors. After

filtering out these components, the existing "random" component would remain. If this random component was larger in pharmacies after the installation of the PMR system, this would indicate evidence that the PMR system was responsible for improving prescription numbers and therefore NHS business. The model used is described by -

$$Y_{it} = a_i * T_{it} * S_t * M_t * R_{it}$$

The asterisk (*) implies multiplication. In the equation -

Y_{it} = the number of prescriptions presented to pharmacy i in month t.

a_i = the average number of prescriptions in the pharmacy i.

T_{it} = the Trend component, that is the general tendency for prescriptions to go up or down in a pharmacy.

S_t = the seasonal component for month t.

M_t = the morbidity component for month t.

R_{it} = the "random" component or unaccounted for variation in pharmacy i for time period t.

The model therefore assumes that the total monthly numbers of prescriptions is dependent upon the pharmacies size, a general time trend, seasonal and morbidity factors, as well as a "random" component. Part of this random component may be due to the influence of the PMR system.

The statistics package SAS was used to encode this model [198]. This package is particularly suitable because -

* It was able to perform the statistical operations demanded by the model (simple linear regression).
* It provides a programming language to manipulate the data and derive further variables, thus making it possible to isolate the various components of the model (R_{it}, S_t, M_t).
* It has facilities for sophisticated graphical output.

The prescription data, in the form of monthly totals, was entered into the VAX minicomputer using text editing facilities available on the system. This necessitated recording the data for each pharmacy sequentially, rather than in the form of columns, in which form SAS reads the data.

196 variables were used in the construction of the model. An extra variable was added to indicate a series. This variable, called Z1, consists of thirty two observations, which are the numbers 1 to thirty two.

The first step was to alter the data so that each column represented a pharmacy, or a variable. Each variable consisted of a series of observations, from one to thirty two. Missing observations were denoted by a period or full stop (.).

For the purposes of the model then, each pharmacy is a variable, and each monthly prescription figure is an observation of that variable.

The code that created and processed columns of variables from the sequential data is shown in Appendix 6.3.

13.4.2 Results

The output of the model was examined in two ways, both by looking for trends in the data and by counting the residual "random" variation. Only two pharmacies using PMRs displayed a continuous rising trend since the PMR's installation. One of the controls also displayed a similar trend. In the majority of pharmacies no clear trend was apparent. Figures 3 to 6 show examples of trends and the absence of trends.
The model should produce an output of one, and deviation from one is the result of random factors or the PMR system. This random factor was examined by counting the number of values above (+) and below (-) one in pharmacies that use PMRs after the installation of the PMR. This process was repeated throughout all the time periods for the control pharmacies. Thus a comparison can be made of the impact of the random variation between pharmacies using PMRs and the control factors, i.e. those pharmacies who do not use PMRs.

Figure 4. Time Series analysis. PMR pharmacy.
The line indicates the date of system installation. Residual variation rises after system installation.

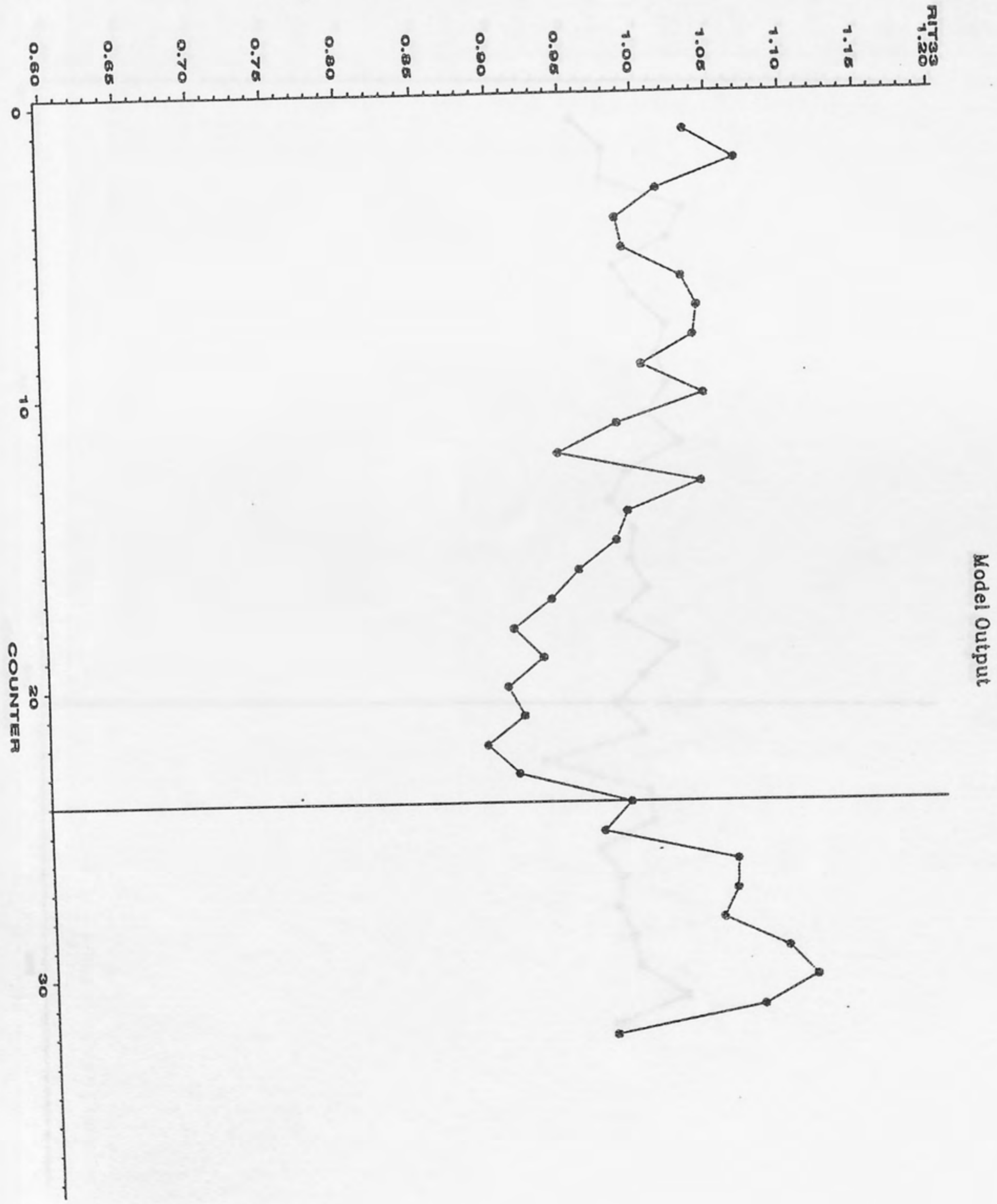


Figure 5. Time Series analysis. PMR pharmacy.

The line indicates the date of system installation. Residual variation remains constant after system installation.

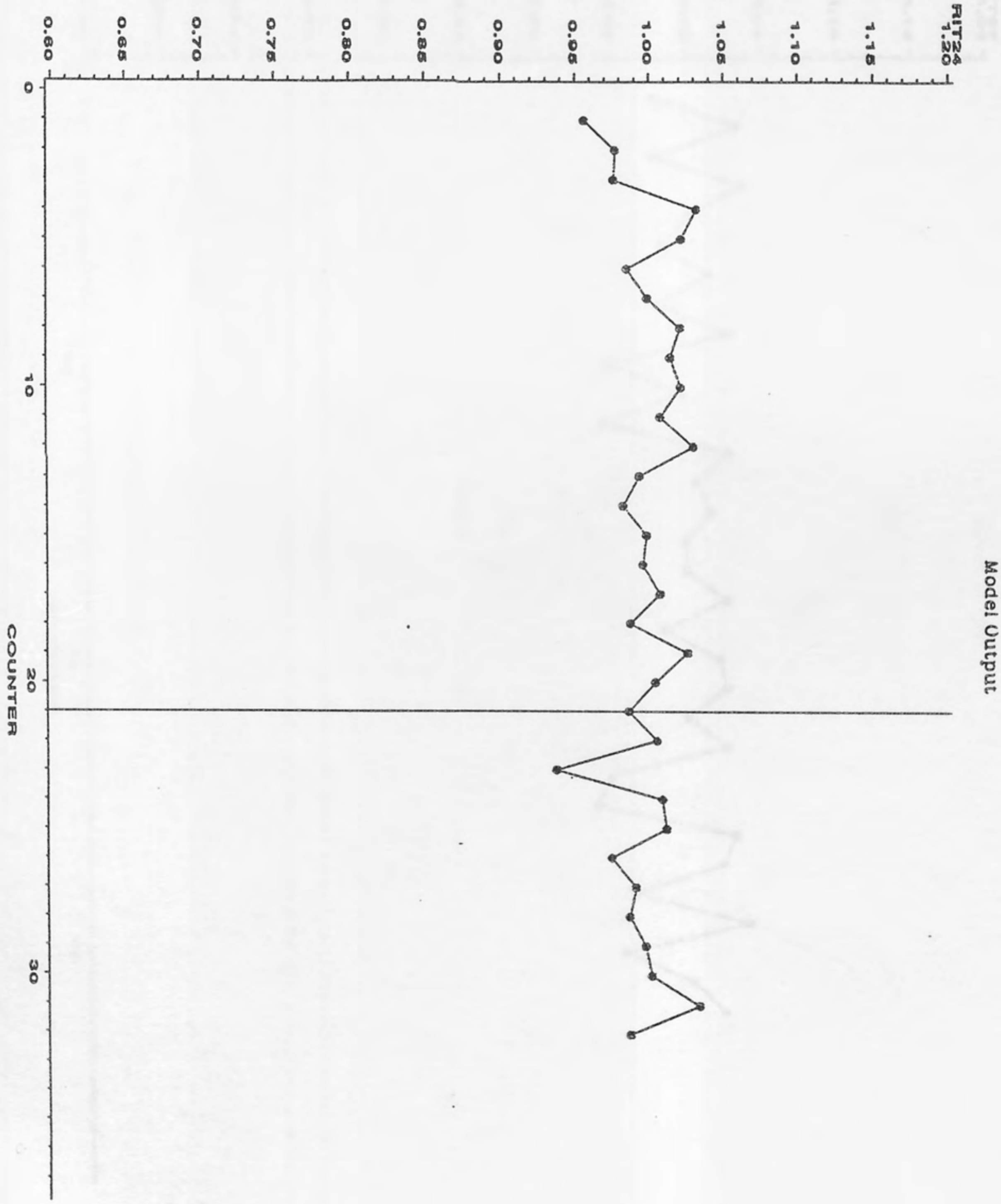
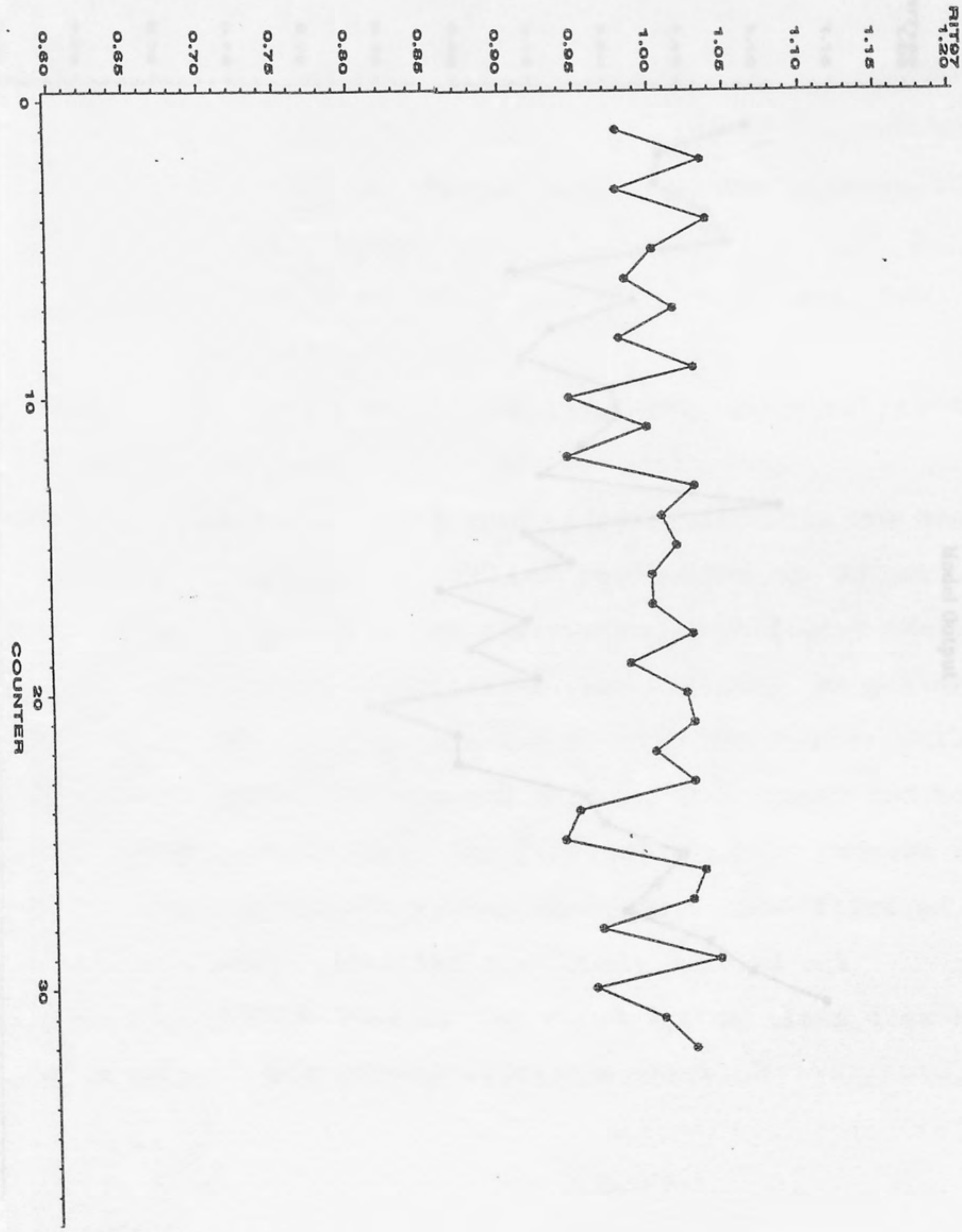


Figure 6. Time Series analysis. Non PMR pharmacy.

Residual variation remains constant.



Model Output

Figure 7. Time Series analysis. Non PMR pharmacy.

Residual variation rises.

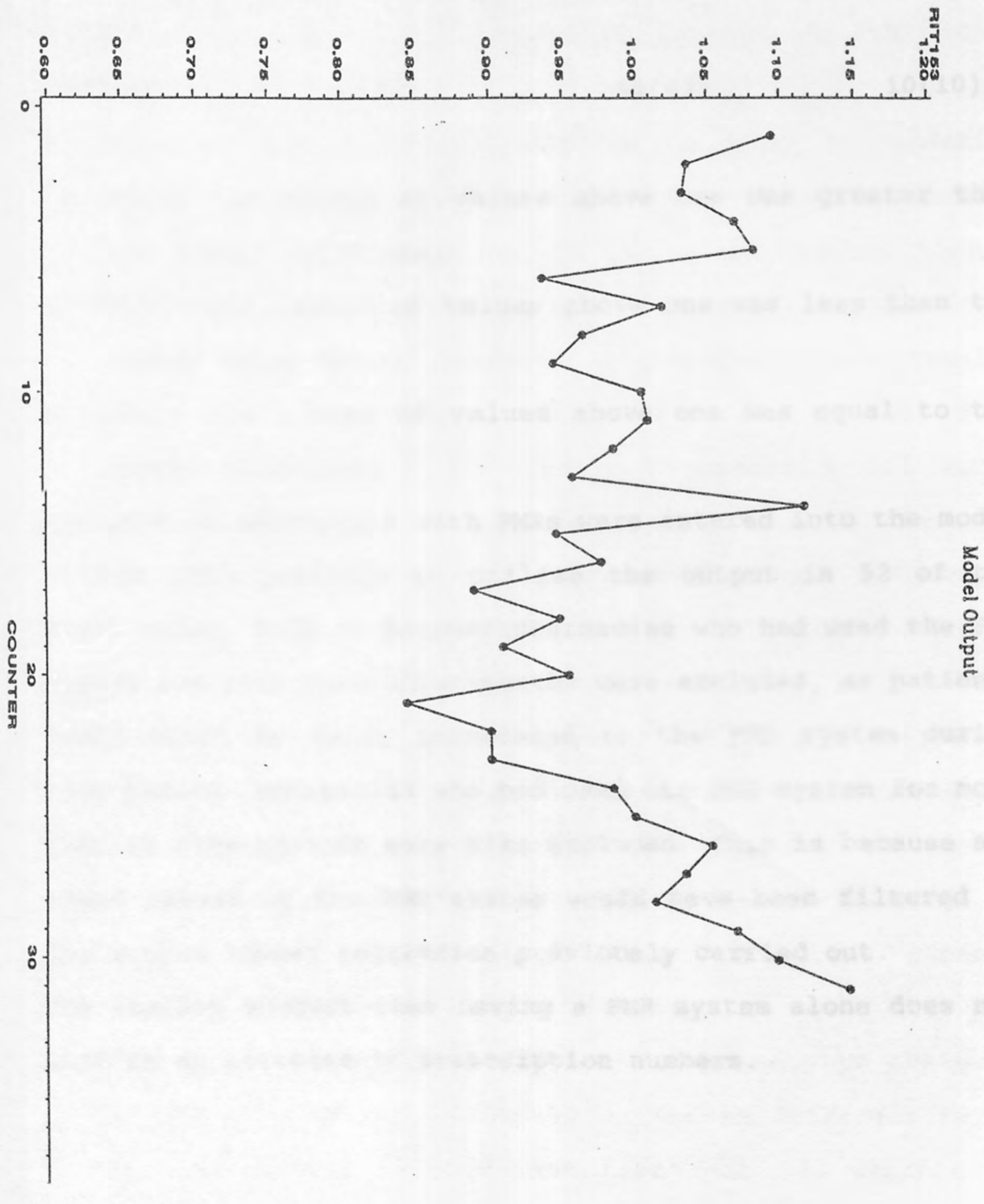


Table 18. Residual variation.

	Where +>- Nos(%)	Where +<- Nos(%)	Where +=- Nos(%)
PMR Pharmacies	16(31)	27(52)	9(17)
N = 52			
Controls	50(48)	45(43)	10(10)
N = 105			

+>- where the number of values above one was greater than the number below one.

+<- where the number of values above one was less than the number below one.

+=- where the number of values above one was equal to the number below one.

Although 91 pharmacies with PMRs were entered into the model it was only possible to utilise the output in 52 of the these cases. This is because pharmacies who had used the PMR system for less than three months were excluded, as patients would still be being introduced to the PMR system during this period. Pharmacies who had used the PMR system for more than 22 time periods were also excluded. This is because any trend caused by the PMR system would have been filtered by the simple linear regression previously carried out.

The results suggest that having a PMR system alone does not lead to an increase in prescription numbers.

13.4.3 Criticisms of the model

Mathematical models can only ever approximate a real life situation. This is because there are many variables and factors which cannot be taken into account. In this case these factors are -

* A multiplicative model was chosen over an additive model. This implies that alterations in prescriptions numbers will be of a percentage nature, rather than a numerical change. For example, the model assumes that in the case of an epidemic, a pharmacy which usually processes 800 prescriptions a month may process 900, while a pharmacy that usually processes 8 000 would process 9 000. While this may not be exactly the case it seemed more reasonable than assuming that both would increase by an equal amount, e.g. 900. This would be the case if an additive model was chosen.
* The model cannot fully reflect the complexities of the real life situation. For instance, in the above example patients who are ill may be more likely to use a smaller local pharmacy as they feel too unwell to travel to work, where they normally present prescriptions at the larger pharmacy.
* The model assumes that morbidity component is the same in all pharmacies. Morbidity varies in different parts of the country at different times. In the example of the epidemic, not all parts of the country would suffer

at exactly the same time. The epidemic would affect all areas over a period of several months.

* The seasonal component will affect pharmacies in different areas in different ways. For instance, during summer a pharmacy in Brighton will process more prescriptions than one in Birmingham, as more people visit Brighton at this time.
* The model cannot take into account local factors. Examples of these are prescriptions increasing through a local pharmacy closing, improved access for patients by parking facilities being built nearby, or alterations in prescription numbers caused a change of GP.
* The model does not take into account any alterations in overall prescribing patterns. GPs have been under pressure to reduce prescribing costs and may be prescribing less.

In addition there may be inaccuracies in the model caused by rounding. Calculations were made to five decimal places, so such inaccuracies are of a minor nature.

13.4.4 Improvements to the model

The model could be improved by -

* Estimating different seasonal and morbidity components for pharmacies in different regions.

* Screening pharmacies involved for localised factors which could distort the results.

Morbidity and seasonal components will vary within different areas of the country. However, there will also be variations in seasonal and morbidity trends within these areas. The time and resources needed to group areas according to seasonal and morbidity factors is not possible within a PhD studentship, if possible at all. Likewise, it is impractical for an individual researcher to visit every pharmacy that was included in the model to ask about local factors.

13.5 Conclusions

Although PMRs may result in increased prescriptions in some pharmacies, there is no evidence from the prescription data that this is happening to the majority of pharmacies within the first twenty two months of the installation of the system. It may be that perceived increases in patient loyalty will lead to an increase in prescription numbers, but this will happen in the longer term.

Chapter 14. DISCUSSION

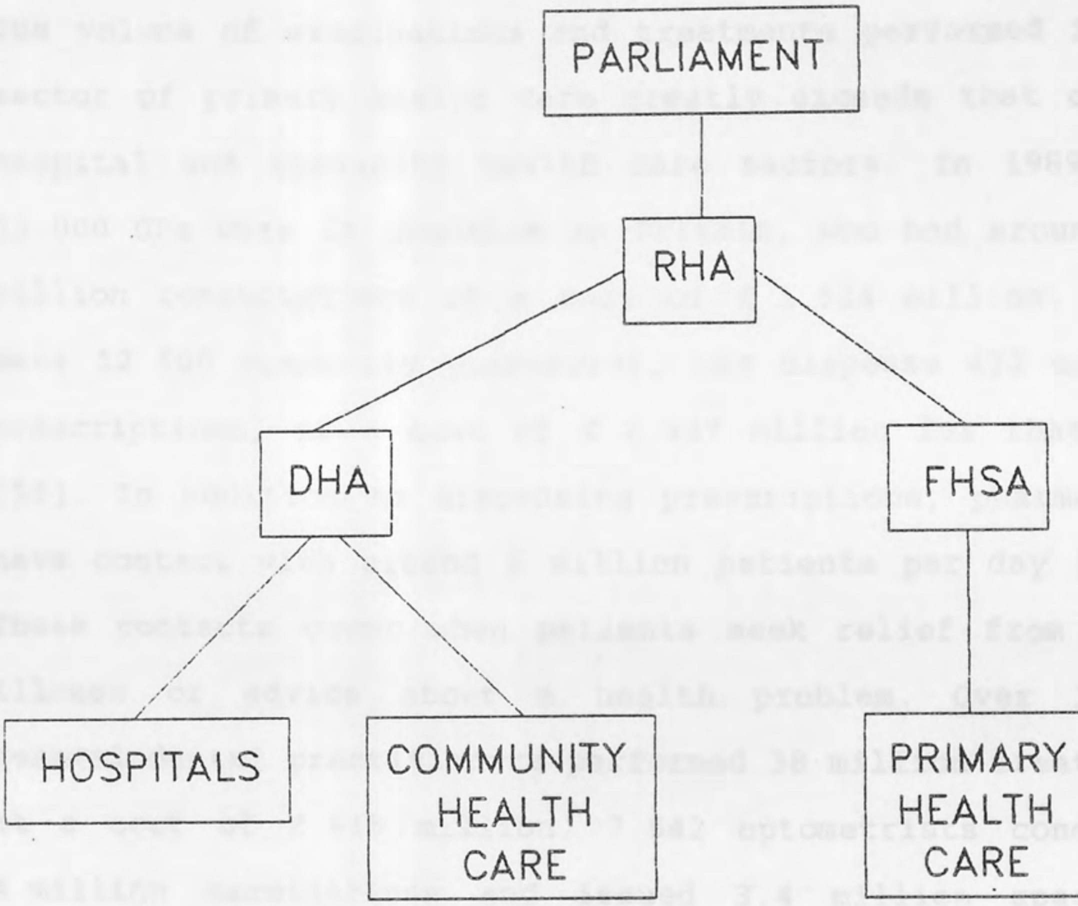
14.1 PRIMARY HEALTH CARE IN THE NATIONAL HEALTH SERVICE

The National Health Service has three tiers of management, with Parliament at the top. Parliament sets the budget of the NHS and the Secretary of State for Health acts as its "chief executive". The second tier consists of fourteen Regional Health Authorities, who manage the policies of the third tier of the system which is that of the 98 Family Health Services Authorities (FHSAs) and 192 District Health Authorities (DHA) [199].

District Health Authorities have overall management of hospital and community services, while FHSAs now manage the services provided by general practitioners, community pharmacists, general practice dentists and optometrists. This hierarchy is illustrated in Figure 7.

These four professional groups enter into contracts with individual FHSAs, which allow them to provide services to patients which will be paid for by the National Health Service. The FHSAs are responsible for the remuneration of the professional groups for the services that they provide to patients. They also manage individual contracting practitioners to ensure that the services provided are of an acceptable standard.

Figure 8. The Hierarchy of the NHS.



It is legally permissible for any of these health professionals to also practice privately, without a contract with the FHSA. The patient could then be required to meet the full cost of treatment.

The services provided by general practitioners, community pharmacists, general practice dentists and optometrists has previously been defined as primary health care (See section 1.0).

The volume of examinations and treatments performed in the sector of primary health care greatly exceeds that of the hospital and community health care sectors. In 1989 over 33 000 GPs were in practice in Britain, who had around 257 million consultations at a cost of £ 1 634 million. There were 12 500 community pharmacies, who dispense 472 million prescriptions, at a cost of £ 2 527 million for that year [55]. In addition to dispensing prescriptions, pharmacists have contact with around 6 million patients per day [200]. These contacts occur when patients seek relief from minor illness or advice about a health problem. Over 16 000 general dental practitioners performed 38 million treatments at a cost of £ 915 million. 7 542 optometrists conducted 4 million examinations and issued 3.4 million spectacle prescriptions at a cost of £ 171 million [55]. Figure VII shows illustrates this as a pyramid of contacts with patients.

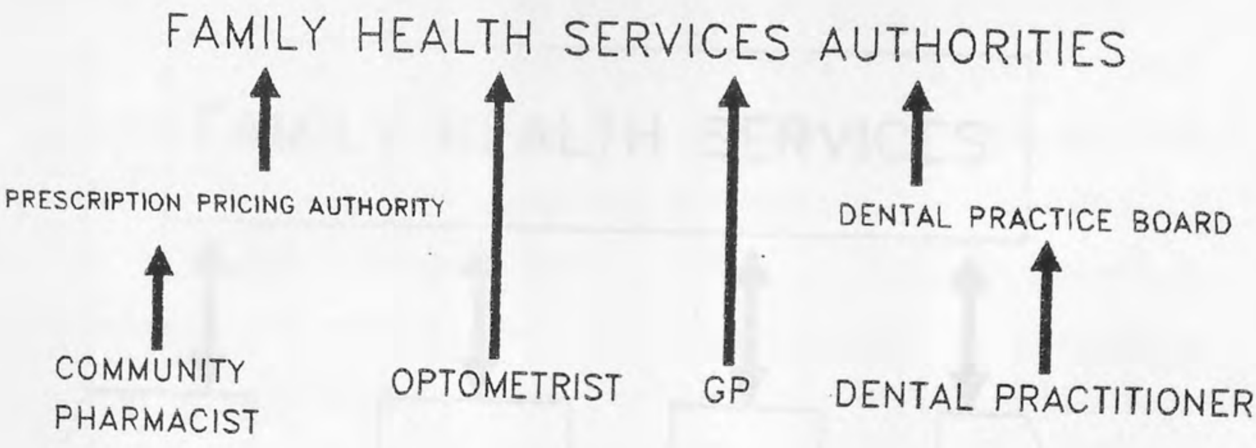
14.1.1 Payment for services

The FHSAs remunerate practitioners in different ways for providing these services. Some payments are made on a capitation basis, that is according to the number of patients for which the practitioner is responsible. Examples are the payments made to GPs and general practice dentists for the number of individual patients that are registered with a practitioner at any one time.

Figure 9. The Health Service by Patient Contacts

Other payments to practitioners result directly for other services provided for patients. Community pharmacists are paid for each prescription dispensed, as are dispensing doctors. Dentists also receive direct payments for the treatment of patients, e.g. fillings, scaling or the fitting and supply of dentures. The payments due to community pharmacists are calculated by the Prescription Pricing Authority (PPA) and for dentists by the Dental Practice Board (DPB). These organisations inform the FHSAs of the amount owed to individual contractors on a monthly basis and the FHSAs then make the payments.

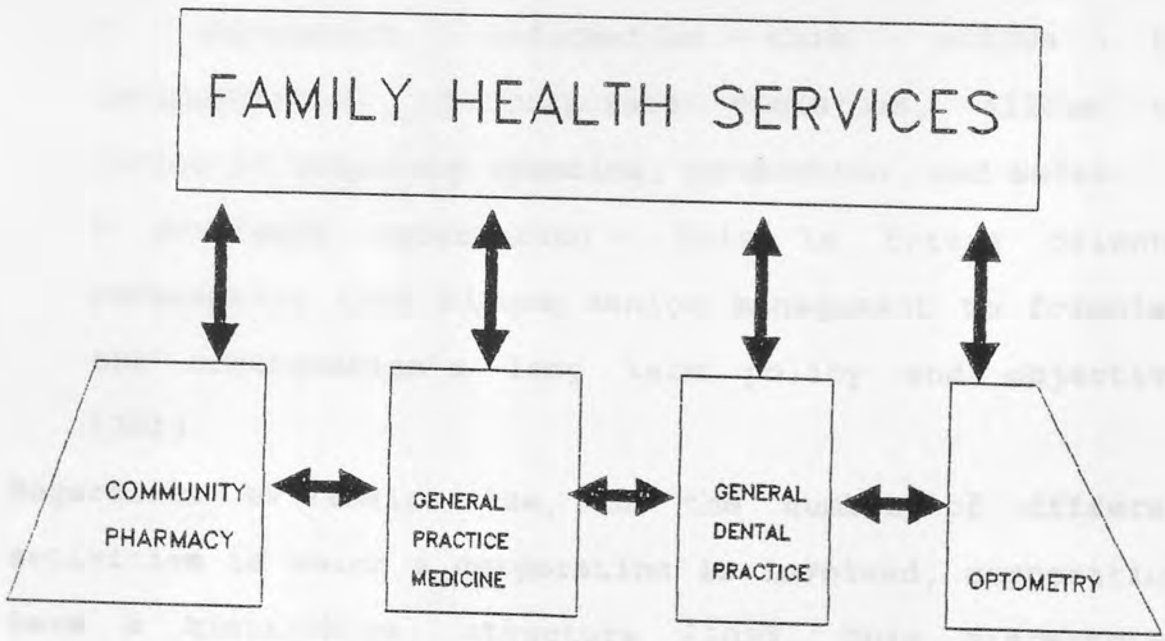
Figure 10. Data flows for remuneration.



Some general practice remuneration is also based upon work done with patients. Payments are made when a percentage of a GPs' patients have received preventative treatments, such as cervical screening and immunisation.

In order to be remunerated then, practitioners must provide data on their activities to the FHSAs. In the case of GPs and optometrists, these data are supplied directly between practitioner and FHSA but in the case of community pharmacists and general practice dentists, this data is supplied indirectly as described above. Data are also transmitted between primary health care practitioners. The data flows among practitioners and to remunerative bodies illustrated in Figure VIII.

Figure 11. Horizontal and vertical flows in PHC.



At first sight the NHS appears to be a monolithic organisation, employing a great number of individuals at many geographically dispersed sites. In this respect it is not unlike a large multi divisional company. The decisions made by those that manage the NHS have a great impact on the quality of treatment that each patient receives.

14.2 CORPORATE INFORMATION

Large corporate organisations, such as multi-divisional companies, have information needs which are apparent at different levels of management. These needs can be broadly classified into three groups -

* Operational information - this deals with the day to day needs of the corporation, such as purchasing of raw materials to manufacture products.
* Management information - this allows the implementation of corporate decisions, allows the review of budgetary spending, production, and sales.
* Strategic information - this is future oriented information that allows senior management to formulate the organisation's long term policy and objectives [201].

Regardless of their size, or the number of different activities in which a corporation is involved, corporations have a hierarchical structure [202]. This hierarchical structure forms the basic framework for the corporate information system. Information is used for decision making at different management levels throughout the organisation. A multi-divisional company will collect information about its costs, sales and revenues from all its divisions. Within each division this information will be used to remunerate employees, purchase raw materials, increase or decrease production and direct the marketing of products.

In a summarised form this information will also be used to make decisions about corporate strategy by the most senior executives [203]. Thus decisions on whether to expand or contract divisions, or whether to develop or maintain activities in sectors, will be made as a result of data gathering across the organisation as a whole. By gathering data throughout the organisation, executives can review and control corporate activities, as well develop a corporate strategy for the future. This allows large, geographically spread organisations to remain efficient and successful.

It can be seen that for a large corporation to remain commercially viable, information must be collected and used at all levels of the organisation.

14.3 INFORMATION COLLECTION IN THE NATIONAL HEALTH SERVICE

The NHS is not unlike corporate organisations in either its size or its hierarchical structure. It has been suggested that the benefits of systematic data gathering and exploitation, which corporate organisations have reaped, could also be realised in the NHS. In an NHS context benefits from data gathering would not be measured only in financial terms, but in terms of quality of care, cost containment and access to services at the point of need.

The systematic collection of data was the aim of the Steering Group which Mrs E Korner chaired and which was discussed in section 1.2. The Steering Group was given the following as part of its terms of reference -

* to agree, implement and keep under review principles and procedures to guide the future development of **health services** information systems.
* to identify and resolve **health services** information issues requiring a coordinated approach [49].

(Made bold for emphasis - SDP)

As a result of the Reports of the Steering Group, minimum data sets were established and all face to face encounters between patients and carers in the hospital and community care services were recorded.

However, the terms of reference of the Steering Group did not exclude primary health care professionals, as they are within the "health services". Despite this, no specific recommendations were made about data capture in primary health care. The reports confined themselves to indicating that -

> "General medical practice is central to the provision of many services that we have considered in this Report. We are very conscious of the fact that, without data about certain aspects of the work of general medical practitioners, district health authorities will have available only very incomplete information about the extent to which services are reaching the population for whom they are planned... This cannot but inhibit authorities' ability to plan, evaluate and account for the services the provide. We believe that this important issue deserves further study." [53]

There has been no further study and there is as yet no comprehensive system of data collection from primary health care.

14.3.1 Information at different levels

The management tiers of the NHS are responsible for administering health services and are required to make decisions that have important, far reaching implications for patients. These decisions are made not only to ensure the smooth running of the present service, but also to give the service strategic goals and objectives for the future.

On a day to day basis information is needed for the allocation, control and planning of scarce, finite resources. The data required concerns the throughput of patients, that is to say providing a measurement of the availability and use of facilities. Information about this can be used to identify limiting factors in the service and bottlenecks, such as under use of existing capacity, or an inadequate service provision resulting in long waiting lists. Without information about throughput it becomes impossible to monitor routinely the use of services and to identify areas of over or under provision of services.
In addition to this, there is also a need for information to set longer term objectives of the direction in which the service is heading, and the future challenges that the service will face. This entails reviewing existing facilities and manpower used in different activities and geographic areas. To achieve this more general information is needed about communities as a whole, the occurrence of disease in communities and the health needs of patients as a whole. Without this information it is impossible to expand facilities in targeted areas where such facilities are needed most.

14.4 DATA IN PRIMARY HEALTH CARE

Collectively, primary health care should hold almost all the morbidity and medication data that are captured in the NHS. It also holds data that describe the population as a whole in terms of age, sex and geographic location.

14.4.1 Medication data

The PPA collects data from all NHS prescriptions dispensed. This represents a substantial but incomplete subset of all prescriptions, as some that are written by GPs are not brought to pharmacies by patients. Prescriptions alone are a subset of the total set of patient medication. Pharmacists treat the symptoms of a variety of minor illnesses with OTC medication. On a smaller scale, optometrists also supply patients with a variety of medicinal products to assist in the diagnosis and treatment of eye disorders. Dentists can recommend OTC medicines and write prescriptions for patients.

14.4.2 Morbidity data

Almost all morbidity data are held in general medical practice. Patients who are unwell usually present themselves to a GP, who either effects treatment or refers the patient to a specialist. Regardless of which option is pursued, the diagnosis, treatment and eventual outcome should be recorded in the patient's record. Possible exceptions to the comprehensive nature of morbidity data in general practice can occur when -

* The patient is treated for a minor injury in the casualty department of a hospital.
* The patient is successfully treated for minor illness at a pharmacy.
* Self medication or neglect occurs.

Dentists maintain records of a patient's dental history, in terms of the number and type of fillings, as well as any missing teeth. When a patient registers with a new dental practice and is treated for the first time, the dentist creates a new record for the patient.

Optometrists maintain records about the eye conditions of their patients. They also maintain information about the medical conditions that have an effect on vision, e.g. diabetes. Optometrists who recognise morbidity in patients as a result of an eye examination refer the patients to their GP.

14.4.3 Administrative data

General medical practice holds the name, address, age and sex of almost the entire population of Great Britain. This information is useful when coupled with medication and morbidity data as it provides a population denominator against which the incidence of morbidity can be measured.

As has been shown in Figure VIII primary health care has more contact with patients than other health sectors and holds more information about morbidity and mortality than hospital and community sectors. In addition primary health care is able to relate all data held to individual patients. Thus the data forms a continuum over a patients life span.

Data that is linked allows episodes of illness to be related to occupation, environment, lifestyle and other health treatments, giving epidemiologists a greater understanding of disease. This in turn benefits patients, who will receive advice and treatment to avoid or reduce the incidence of morbidity.

Unlike other health sectors, primary health care holds information about both the whole community as well as morbidity. Thus there is a population denominator against which to judge the numerator of disease. Illness can be quantified in terms of the total population for any given area and compared with other areas.

Gathering information about morbidity and medication in the community allows decision makers to draw up long term plans and strategies for responding to illness. When this data is coupled with age, sex and geographic data, it is possible to forecast morbidity patterns and geographic variations, and so anticipate future problems and challenges.

14.4.4 Information exchange in primary health care

The benefits that vertical information flows can bring to the planning and control of services have been discussed. However, horizontal information flows between different primary health care professionals could bring both administrative benefits to practitioners and health benefits to patients. Administrative benefits result from reduced duplication of effort. Both GPs, dental practitioners and pharmacists enter the same prescription details into separate computers. Patients benefit by the health professional having more information about them during their treatment. Pharmacists now provide an alerting system for drug interactions, but could extend this to include contraindications if they could access GP morbidity data. OTC information could let GPs know for how long a patient has been suffering the symptoms of an apparent minor illness - which may in fact indicate a more serious disease. Dentists require morbidity data to ensure, for example, that an appropriate anaesthetic is given. Similarly optometrists require morbidity data, such as the diagnosis of diabetes, to ensure the correct diagnosis of eye diseases.

14.5 THE GENERAL APPLICATION OF COMPUTERS

The electronic digital computer is the most powerful management tool ever devised, capable of bringing a revolution in management [204]. It achieves this through the combination of two distinct features -

* The ability to perform logical operations.
* The speed at which it can manipulate data.

Logical operations consist of comparing data values and taking action as a result of the comparison. An example is comparing the amount of stock used with a prearranged level. When the level is reached, more stock is ordered. Thus the computer is in effect taking a management decision as a result of processing data.

In the majority of businesses, managers are required to make major decisions which may have a long term impact on the success of their companies. In the NHS these decisions can affect the lives of the public and it therefore even more important that decisions are based on good information.

The ability of the computer to assimilate, collate and sort data, as well as disseminating and summarising information at high speed, i.e. millions of instructions per second, has enabled it to provide decision makers with up to date information. With this information it is then possible to make more informed decisions, and exercise closer control.

The systems that make this data available to managers are known as management information systems (MIS). Fundamental to the working of a MIS is the database that supports the system. Ideally, data is organised around files in order that duplication and redundancy are avoided. Data is captured once, validated and entered into the appropriate location in the database. Then each subsystem utilizes the same database in satisfying information needs. This avoids maintaining a different database to support each application [203].

In the NHS for example, the FHSAs and DHAs maintain indexes of all patients who use their services. Both organisations capture and update data separately. However, if both organisations could access common data files, the data need only be entered or updated once.

GPs enter prescription details into their practice computer. The prescription is then printed and presented to a community pharmacist. The pharmacist then enters the details of the prescription into a PMR computer system and sends the printed prescription to the PPA for remuneration. The PPA enters data from the prescription into a computer before remunerating the pharmacist. Thus the same items of data are being captured and entered into three separate computers.

14.5.1 Linking files

In order to serve managers at both middle and upper mode, it is necessary for data to be accessible to both horizontal and vertical modes. [203] Vertical modes allow data to be gathered in summary or cumulative mode from one file, while horizontal mode allows data to be derived across file boundaries. In the NHS aggregate data about patient contacts from all four groups in primary health care can be gathered vertically by the FHSAs for remuneration and planning, while data items about an individual patient need to be related horizontally between the files of all four practitioners. For example, the relation of data in different files will allow medication information for one patient, now distributed among four computer systems, to be collated.

14.5.2 Microcomputers

Apart from being used to gather and manipulate data about the activities of the company, computers can be used to support managers in their daily work [205]. Microcomputers can support a variety of applications which allow managers to operate more effectively and efficiently.

The cost of a computer's processing power has dropped dramatically since the development of early computer systems [206]. This has resulted in microcomputers becoming commercially available to primary health care practitioners at comparatively low prices. There are many popular commercial applications of microcomputers which can be used in primary health care. Typical applications include -

* Word processing - in conjunction with mail merge facilities these could facilitate sending call and recall letters to patients.
* Database packages - allow large amounts of data to be stored with the facility of retrieving a specified subset of this data. These allow information about a patient to be retrieved during contact with the patient.
* Graphics packages - allow the production of charts, diagrams and pictures to convey and disseminate information. An example would be producing a graph which listed all diabetics registered with a practice, but broken down by age and sex.

14.5.3 Computer usage in primary health care

Estimates in 1990 has indicated that 50% of general medical practices are using a computer [21], [159]. The research indicated that 97% of pharmacies use a computer of some kind, although only a minority of these are using PMRs [133]. Only 20% of dental practitioners and 34% of optometrists use computers (see sections 9.2.1, 10.2.2 and 11.2.1). This has implications for data capture, as only a minority of practices in primary health care are at present capable of routinely recording encounters with patients. Before data collection can become routine throughout primary health care, all practitioners must have computer systems in practice.

14.5.4 Computer networks

It can be seen that in general terms, computers are a powerful management tool and that they relate to a number of specific needs within the health service. The NHS is a large organisation and, like any large corporate organisation, needs information on which to base decisions. The need for information and the ability of computers to gather, aggregate and disseminate information has been discussed. Information that is gathered must be capable of dissemination for there to be any purpose in its collection. Data that is held on a computer can be sent to remote locations via a network. This has the following advantages -

* Reduced clerical effort. Data is entered at one site and transmitted to another. This obviates the need to type in data from pieces of paper sent via the post, as is now done in both the PPA and the DPB.
* Accuracy. Sending computer information directly avoids errors caused by transcribing data between paper and the computer. Inevitable transcription errors at the DPB slow down payments for work done.
* Speed. Electronic transmission is almost instantaneous, allowing more up to date information for managers and speedier remuneration for practitioners.

If, as we have argued, the concept of information is important, then a network becomes important too, as it facilitates the transfer of more accurate and timely information.

14.5.5 Standards

Common standards in computer systems now allow data to be transferred between different computer systems. Thus data files gathered by one part of an organisation can be accessed and exploited by the organisation as a whole. The absence of standards can result in the inability to connect computers physically, or can mean that data in one system is unintelligible to another computer system.

The successful introduction of a system of information gathering in the NHS requires more than the physical attachment of computers at all sites. It is necessary to define what information is to be collected and to agree on which codes to use to represent data. If different items of data are collected at different sites, then any aggregation of this data will result in a data set with some missing data items.

Information is often coded rather than represented as text in computer systems. This allows more information to be stored, and facilitates its aggregation, manipulation and analysis. The use of different coding systems prevents data from being aggregated and analysed. As such, the establishment of a standard set of codes and core data items is of vital importance.

14.6 NETWORKING OF THE FAMILY HEALTH SERVICES

The administration of the Family Health Services Authorities (FHSAs) and the Dental Practice Board (DPB) has been computerised. The Prescription Pricing Authority (PPA) has also seen investment in information technology, and now maintains the worlds largest database.

14.6.1 The Family Health Services Authorities

FHSAs maintain registers of patients in their area of responsibility. These registers contain data about the name, address, age and sex of patients. This data is used to calculate remuneration due to contracting professionals and to enable comprehensive prophylactic services to be administered to the public. Examples of such services are call and recall programmes for cervical cytology and breast cancer [122], [207].

14.6.2 The Dental Practice Board

The DPB can receive claims for remuneration electronically from dental practitioners over the FHSA network. This data, as well as data entered manually from FP17 claim forms, is used by the DPB's ICL mainframe to calculate the fees and allowances due to every dentist on a monthly basis. The DPB then pass this information to the FHSAs, who make the payments to individual contracted dental practitioners.

14.6.3 The Prescription Pricing Authority

Every month, contracted community pharmacists send all the prescriptions that they have dispensed to the PPA. Staff trained in data entry then transfer the information to the PPA's computer. The information transferred consists of data about the medication, the prescriber and the pharmacist who dispensed the prescription. This information is then used to remunerate the pharmacist who dispensed the prescription, and to provide information about prescribing to GPs.

Three levels of information, called PACT, Prescription Analysis and Cost are available to GPs to assist them in monitoring their prescribing costs [208].

The PPA and the DPB send information that they have processed to individual FHSAs on reels of magnetic tape. However, with the advent of the FHSA network, the FHSA computers can be updated automatically.

14.6.5 Exploiting Prescription Pricing Authority data

The PPA database consists of information on the use of prescribed medicines to treat disease. This information can be broken down both in terms of therapeutic groups (as classified in the British National Formulary) and the geographical use of medications. It is frequently possible to infer, to some extent, disease from the medication prescribed to patients. Thus it is possible to infer the incidence of morbidity in any part of the country. This data could be used for planning, epidemiology and resource allocation in different NHS Districts.

The data collected by the PPA can identify specific brands of medicines prescribed. This information is useful to pharmaceutical companies, who wish to monitor the use of their products in relation to the use of rival medicinal products. The PPA database could be used to generate income through charging pharmaceutical companies for conducting searches on the PPA database.

14.7 BARRIERS TO EFFECTIVE COMPUTERISATION IN PRIMARY HEALTH CARE

Barriers which can prevent the full realisation of the benefits that computers could bring to primary health care are included in Table 19 -

Table 19. Barriers to computerisation.

1 The low numbers of computers in many practices of primary health care providers.
2 The capture of different data items by different computer systems within each profession.
3 The use of different codes to classify captured data.
4 Doubts over the ownership of electronically held data in primary health care.
5 The accuracy of computer captured data.
6 Meeting the requirements of the Data Protection Act.
7 The constraints of some existing computer systems.
8 A need for IT training in primary health care.
9 Fears of practitioners over the confidentiality of data in networked systems.
10 Professional barriers which result in territorial attitudes to data.

Each of these points is considered in detail in the following sections.

14.7.1 LOW NUMBERS OF COMPUTERS

The greatest problem to widespread data collection is the absence of computers in many practices.

14.7.1.1 Reasons for low usage

This research investigated the reasons for the limited use of computers and demonstrated that cost is a factor, but not the major barrier to the acquisition of computers. The study (See section 12.4) which modelled the prescription numbers of pharmacies with and without patient medication (PMR) records, found that having a PMR system did not lead to an increase in prescription numbers for the majority of pharmacies, at least in the short term of the study, which was for up to two years after the introduction of the system. Nor did a significant number of pharmacists indicate that their prescription totals had increased. (See section 12.2.)

The survey of dental practitioners revealed that a lack of knowledge about the computer and an uncertainty of its advantages are important reasons for practitioners not installing computers (See section 10.2.4).

14.7.1.2 Consequences of low usage

The consequences which will result from the non-use of computers by some practitioners are -

* the need for remunerative organisations to maintain two systems in tandem, one system achieving some of the benefits of the computerisation of the majority of practices and the other supporting practices which employ manual methods of administration.
* Some of the data that is in primary health care will not be readily accessible to managers.

14.7.1.3 Promoting computer use

There are several possibilities to overcome the problem of the non-use of computers in primary health care. These are shown in Table 20 -

Table 20. Increasing Computer Usage

1 Meeting the cost of computer systems in whole or in part.

2 Informing and advising practitioners to overcome the barrier of a lack of perceived need.

3 Providing training to practitioners in primary health care. This is more fully discussed in section 14.7.8.

The first option has been pursued in Scotland and the Scandinavian countries. In Scotland the General Practices Administrative System for Scotland (G PASS) has been supported by the Scottish Home and Health Department. The software is available to general practices at no cost, and support and training is provided by the Department. However, users must pay for the necessary hardware. In 1989 it was established that 50% of practices in Scotland used G PASS. Some advisors are already in post [170]. However, if computers are to be used routinely, then an advisor must be available in all parts of the country.

14.7.1.4 The benefits of a common system

In Scandinavian countries too, the use of a uniform system is widespread in all practices. The advantages of this approach are that almost all practices will use the same computer system. All practices will collect the same items of data, and use the same codes to represent this data. It is then fairly straightforward to collect data on a large scale for planning purposes. By introducing standards for the data items collected and the coding systems use, the accessibility of the data has also increased.

14.7.1.6 The benefits of a range of systems

In community pharmacy and general practice in England and Wales a "free market" philosophy has been adopted and the number of systems in use has been encouraged by State subsidies. In general practice this subsidy is of up to 50%

[21], and in pharmacy £ 165. This has led to different practices installing different computer systems which use different codes to classify data items. This has created barriers to the collection, aggregation and manipulation of information. However, an advantage of this approach has been that the competitive pressures of the market have produced more sophisticated computer systems. For example, many computer systems in England and Wales were capable of supporting more than one user at a time, while G PASS was unable to support this facility.

Another advantage of a free market approach is that more companies are formed, which employ more people with a resulting economic benefit.

With hindsight, the benefits of information technology in primary health care may have been reaped earlier if the State had provided a free computer system to all primary health care practices or had insisted on one specified system.

However, it is too late for England and Wales to adopt one computer system, such as G PASS, as a standard. It may be impractical in political terms, and impractical for the practices, which would have to re-enter large amounts of data. Despite this, it is still possible to work towards creating a national information system based on the widespread use of computers.

Funding computers in a primary health care is one mechanism of encouraging their use. However, the research showed that of greater importance is information about computers. The research has revealed that an overwhelming majority (88%) feel that advisors could play an important part in assisting the installation of computers. In addition to advice, a very large majority (82%) of respondents to the dental survey called for practical experience of computers prior to purchase. Other findings of this study indicate that the publication of both papers about computing in professional journals and guidelines which help practitioners choose a computer would be of assistance (See section 10.2.7). Information and guidance, especially through the establishment of advisors and the provision of centres where practitioners can have hands on experience of systems, is as important as financial subsidies for computer systems.

14.7.2 DATA ITEMS CAPTURED BY COMPUTER SYSTEMS

In England and Wales market forces have largely determined which computer systems are used in primary health care. Although the market has resulted in only the most competitive computer systems remaining, there has been no strategy in the development of the computer systems. As a result of this the computer systems used now capture different items of data.

The research conducted with the FHSAs has indicated that they require information about a wide range of services that are provided by primary health practitioners in order to fulfil their managerial role (See section 11.2.5). They also expressed an interest in morbidity patterns in the community. In order to make the supply of this information possible, it is necessary to give direction to the computer systems in the market.

The issue of what data should be collected must be addressed in order to fully realize the potential for information gathering. Without the definition of these items, different computer systems will continue to collect different data. Thus if a systems of data collection is introduced, some practices will not be able to supply certain data as there is no facility for its capture on their computer. This could ultimately lead to the data collected centrally, i.e. by the FHSA, being of a fragmented nature which would reduce its usefulness for decision making. One way of ensuring that a basic minimum of uniform data is captured would be the formation of a Steering Group to serve the primary health care services.

14.7.2.1 A Steering Group for primary health care

As previously mentioned Mrs. Korner chaired a Steering Group which contained representatives from all relevant disciplines in secondary and community care [49]. This Steering Group was then able to define which data should be collected from the disciplines represented. A similar Steering Group should be set up to define the data to be collected from primary health care.

The Steering Group would be responsible for defining a core specification of data to be collected. Such a definition would allow the suppliers of computers to alter their systems to ensure that they captured the defined data.

Like the Group chaired by Mrs Korner, the Steering Group should contain representatives from all the professions in primary health care, as well as representatives from the DoH, FHSAs, RHAs and some representation from patients. However, it should go beyond the Group chaired by Mrs Korner to include representatives from the computer suppliers. This is because information collection can begin more quickly if both data and information technology solutions are considered together. Thus not only will the required data be defined but the information technology necessary for its collection will also be available to practitioners in primary health care.

With both the data collection from primary health care defined, and computer systems to support such a programme in existence, the Terms of Service of contractors to the FHSA can be altered to make the remittance of such data mandatory.

There is a precedent for the obligatory supply of data from primary health care in the requirement for general medical practices to produce practice reports for the FHSAs. There is also a precedent for State intervention in clinical prescribing following the issue of the Limited List. However, perhaps we should learn from these that the imposition of new ideas should be preceded by the careful reasoning as to why the data is needed. All professions involved can be informed, however payments will need to be made for any additional work required.

14.7.3 CLASSIFICATION SYSTEMS

14.7.3.1 Classification systems in primary health care

Due to the free market in computer systems described in a previous section, there is a wide range of computer systems in use in all the professions which constitute primary health care. This range of computer systems was confirmed by the survey of the membership of the Primary Health Care Specialist Group (See section 8.3.8). Different computer systems use different codes to record clinical data. The result is that within general medical practice different practitioners are attributing different codes to clinical items of data. This means that if different computer systems were to exchange data, the data from one system would not be meaningful to another system. Similarly, it is impossible to collect and aggregate data, as the different codes in use cannot be grouped.

The survey of the PHCSG confirmed the extensive use of several recognised classification systems, i.e. Read, RCGP, Oxmis and also identified the occasional system designed specially for an individual practice (See section 8.3.8). A few practices indicated that they used no classification system, or were unable to say which system was in use.

In an attempt to facilitate data exchange, Read codes have been adopted as a national standard for general practice. It is hoped that this should ultimately result in their use in

all general practice computer systems. This would allow different computer systems in general practice to exchange and aggregate meaningful data.
However, general practice itself needs to communicate with other health professionals in primary health care and with the hospital sector. At present acceptance of Read is confined to general practice.
Further, there will be an increasing tendency within the Single European Market after 1992 for medical data to cross national borders. This will result from patient movements between nations in a free labour market as well as District Health Authorities purchasing patient treatments from hospitals abroad. This will create a need for an internationally recognised code, which can provide information regardless of language barriers.

14.7.3.2 Extending Read classification schedules

Read codes [127] are well placed to allow the efficient exchange of data throughout the health service. Computer systems in general practice which now use other classification schemes can either adopt Read, or ensure that their computers can translate their own non standard codes into Read codes for data transmission.
Despite the comparatively comprehensive nature of Read codes, still more work is needed to extend the schemes' schedules. This is necessary so that the size and nature,

i.e. brand name or generic, of medicinal products can be identified. This data is needed by the PPA in order to remunerate pharmacists for dispensing these products. Consequently, extension of the schedules is necessary to allow for the use of Read codes in parts of primary health care other than general practice.

This extension of the Read classification system as described above should ultimately result in its support by all primary care health computer systems, facilitating information exchange within primary health care.

However, there is a need for data communication both between primary health care and secondary health care. This need was indicated by the vast majority of respondents in the postal survey of the PHCSG, with 93% indicating their support. It is therefore necessary that the classification systems used in secondary health care computer systems either adopt or recognise Read codes.

To support cross border data transmission it is important that the issue of the classification of medical and medicinal data is discussed by a technical working party at a European level.

14.7.4 DATA OWNERSHIP

It is unclear who owns the data in primary health care computers and in general practice in particular. Both the GP and the Secretary of State for Health have a claim to own the data. The patient has a right of access to the data but no claim to ownership. The Secretary of State owns the manual records maintained by GPs, but this ownership may only be of the physical record itself, rather than the data that it contains. As GPs own the computer, they have a claim to ownership of the data held in the computer.

AAH Meditel and VAMP Health have created a network of computerised general practices which supply prescribing and morbidity data, in exchange for a financial payment. Since April 1991, these two companies have concentrated solely on supplying computer systems, and independent companies have taken on the data collection aspects of their businesses.

The pharmaceutical industry pays to have information searches conducted on this data, usually with a view to evaluating the performance of their products in comparison with their competitors products. The companies who now collect data have effectively set up an information system in general practice.

The Department of Health through the FHSAs also continues to collect information from general practice, and now includes an annual practice report, which contains information about total morbidity in any practice. However, the DoH could collect more detailed information from all of primary health care and general practice in particular.

This could easily lead to a situation where both the DoH and commercial companies wished to collect the same or similar data from general practices.

The State may in the future collect data electronically on such a scale that the resulting database is of more interest to pharmaceutical companies than the database of the commercial companies. These companies that now collect data from general practice could instigate legal proceedings to prevent the capture of data by the State. Ownership of the data would then be decided by a court with potentially disastrous consequences for one party, in that they would no longer have a right to collect this data.

14.7.5 DATA ACCURACY

Two papers in 1991 [120], [121] and an unpublished study in 1989 have demonstrated that the quality of data entered into computer systems is not as accurate or comprehensive as data captured manually. The value of an information system is only as good as the database from which it is derived. If data of poor quality are collected, the usefulness of that data for service planning, epidemiology and research will be limited.

Of greater importance, reliance on inaccurate clinical information could result in an inappropriate treatment being selected for a patient.

One reason for the problem is that some of the software currently used in primary health care is poorly designed. The software allows practitioners to enter highly improbable data values with no verification.

14.7.5.1 Improving the accuracy of data

A possible improvement in software design would be to compare any data entered with a series of "usual values" or acceptable parameters. If the data was outside these values, the user would be prompted to confirm that these values were correct. An example would be a GP prescribing two temazepam tablets. Although an unusual number, they may be intended to help a patient sleep on one long overnight journey.

There is also a role for "cleaning" facilities in GP software to help ensure the accuracy of data. Such facilities scan the database and detect data that are obviously erroneous, and notify the user accordingly. These features can also reveal items of data which individually may appear valid but together are improbable. An example would be a patient who is 150 cms tall but weighs 90 kilograms.

The possibility of an improved user interface may also assist staff in general practice to enter data with greater levels of accuracy. Such an interface could utilise "mouse" input, rather than keyboard input and consequently be of assistance to users with limited keyboard skills.

An examination of these features could form part of the terms of reference of the Steering Group for primary health care. However, despite these possibilities the problem of ensuring that the data entered into computer systems in primary health care are of a high standard of accuracy will remain for some years. Health care workers require greater experience of and training in IT before computer held data reaches the standard of paper based systems.

14.7.6 THE DATA PROTECTION ACT

Overcoming the problems of data accuracy, security and confidentiality are now not merely desirable but have been made mandatory by the Data Protection Act [111]. The Act requires that those who maintain records on a computer, beyond a list of names and addresses, ensure that

* The data held is accurate.
* Measures are taken to prevent the loss or damage of data.
* Measures are taken to ensure the confidentiality of data.
* The practice is registered with the Data Protection Registrar.

At the time of writing no individual practitioner has been served with an enforcement notice, i.e. required to improve some aspect of their computing practice. However, that is not to say that this will not happen in the future.

The Act also requires that practitioners do not keep records for longer than necessary. However, "necessary" in a medico-legal context is 21 years after the patient's treatment. This is because practitioners can still be liable for treatments that have harmed patients 21 years after the treatment took place.

14.7.6.1 Complying with the Data Protection Act

The Data Protection Act has made mandatory principles of good computing practice. Training primary health care practitioners in good computing practice is essential in meeting the requirements of the Act. However, there are specific measures which all practitioners should take to comply with the principles of the Data Protection Act. These are that practitioners -

* Utilise passwords protection. Where different data is to be accessed by different levels of staff, hierarchical passwords should be used. Surprisingly, only a minority (31%) of practices use passwords in this way (See section 8.3.13).
* Take regular backup copies of all data held. The research established that a majority (85%) of practices are protecting their data adequately (See section 8.3.13).
* Practices should only install systems from suppliers who are fully aware of their obligations under the Act. This is because it is inevitable that representatives of computer companies will have access to sensitive data.
* Shred computer generated printouts after use. The Act places the same importance on restricting access to printouts as it does to electronically held data.

* Take care when siting terminals near areas that are accessible to patients, e.g. the reception area. This will prevent patients seeing data about another individual while they are waiting to make another appointment.
* Use formatting routines when sensitive data is to be removed from storage media, as opposed to a deletion command. This is because the data in a file after deletion can still be made accessible, given appropriate software and expertise.

The Data Protection Act essentially places a statutory duty on primary health care practitioners to follow good computing policy. To achieve this, practitioners need greater expertise with computers. Training will play a vital role in providing health professionals with this expertise.

14.7.7 CONSTRAINTS OF EXISTING COMPUTER SYSTEMS

Postal surveys of pharmacy and general practice dentistry revealed that some of the computer systems in use have been designed for highly specific applications only (See sections 9.2.4 and 10.2.3). Examples of these are computer systems dedicated to producing labels in pharmacy and calculating fees in dentistry. Practitioners using such systems will need to reinvest in more sophisticated systems which are capable of capturing patients' details during an encounter between patient and practitioner and of transmitting this information for service planning purposes. Subsidies exist for general practitioners to claim up to 50% of the costs of computer systems. Similar subsidies could be usefully introduced to encourage all the other professional groups to invest in more powerful computer systems.

An alternative would have been for the State to have insisted on the adoption of one system of quality. This would have obviated the need for subsidies later to encourage more sophisticated systems.

14.7.7.1 Improving computer systems

A Steering Group for primary health care should look not only at the modifications to computer systems that will allow data to be collected from primary health care, but should also lay down standard features for the software used by computer systems in primary health care. Examples of such features are -

* the identification of the source of all data entered.
* recording the time of any data item entered.
* the ability to leave audit trails, so that no piece of information can be completely erased.
* the prevention of user entry of obviously erroneous data.

There is a need to identify any user who enters data into a computer system in primary health care. This is because such data could be important years later in legal proceedings. As computers will increasingly replace paper based records, it is realistic to recognise that they may serve as evidence in court. If computer data has to be used as evidence, computer systems must be designed in such a way that it is not possible to tamper with any previously written record.

In view of the DoH's subsidy of general practice computer systems by up to 50% [21], there is a responsibility to ensure that this money is spent on computer systems of appropriate quality and specification. Computer systems which fail to meet criteria defined by the Steering Group should not be eligible for State subsidies.

14.7.8 TRAINING FOR PRIMARY HEALTH CARE

The postal survey of the PHCSG revealed that the majority of respondents felt a need for training for all members of the practice (See section 8.3.11). The survey of dental practitioners reinforced this, and indicated the specific training measures that dental practitioners required (See section 10.2.6).

Training in primary health care could come from several sources. These are -

1 The suppliers of computer systems.
2 The academic institutions, as part of a health professionals undergraduate curriculum.
3 The FHSAs as part of their managerial role.
4 Professional organisations and the Department of Health.

14.7.8.1 Computer system suppliers

Most computer system suppliers will provide training to users upon the acquisition of their computer system. However, the research has demonstrated that this training is usually insufficient for the needs of most users (See section 8.3.11). Computer system suppliers will also provide additional training upon a user's request. However, any such additional training is usually expensive.

14.7.8.2 Academic institutions

In addition to the training needs of practising professionals, all practitioners would benefit from experience of computers prior to receiving their professional qualification. The use of computers is becoming so widespread among all groups in primary health care that undergraduates must benefit from more information about the application of computers in their particular profession.

14.7.8.3 The Family Health Services Authorities as a manager of training

The FHSAs now have an obligation to manage the services provided by the contractor professions. Part of this managerial responsibility is arguably ensuring that the installation of computers in primary health care proceeds efficiently.
A step towards achieving this is the appointment of computer advisors and the acquisition of sufficient computer hardware to allow the installation of the most popular software on the market. This will enable advisors both to offer guidance to those considering computerisation and also allow the advisor to hold training days for the FHSA staff and their contractors. Thus the advisor has a role to play in overcoming both the short and medium term problems of GP computing. In the short term, advice will encourage the

installation of computers at a more rapid rate. In the medium term an advisor, in conjunction with appropriate computing facilities, can provide training for computerised practices. These steps would meet the need expressed by 82% of dental practitioners for hands on experience of computer systems (See section 10.2.7).

In the financial year beginning April 1991 £19 million has been allocated as a subsidy of up to 50% for GP computing. Appointing computer advisors in conjunction with sufficient hardware to provide a training facility could achieve the same goal at a lower cost.

14.7.8.4 Professional organisations

The Royal Pharmaceutical Society, British Medical Association and British Dental Association and the Department of Health have shown interest in primary health care computing. These bodies could usefully publish guidelines on aspects of computer systems about which they have an interest. The research established that the vast majority of practitioners who do not yet have systems would find such guidelines useful (See section 10.2.7). The professional organisations could also explore ways of improving aspects of computer systems with suppliers.

14.7.8.5 The benefits of training

Advice and help prior to the installation of computer system will result in a system which meets the needs of the practice. Training after the introduction of the computer system will help establish good computing practice with the following practical results -

* Accuracy - better training will result in more accurate data in primary health care.
* Security - making copies of data will prevent the loss or damage of data.
* Confidentiality - both professionals and staff in primary health care will be more aware of possible situations where confidentiality can be compromised and will able to take steps to avoid such situations arising.

14.7.9 CONFIDENTIALITY

It has been recognised that the trust of the patient is of paramount importance in the doctor patient relationship. This trust, based on the knowledge that what is said during the consultation will remain confidential, encourages patients to be completely frank with their GP. This relationship could be seriously damaged if information, given in confidence, was not subject to strict protection. There may be a reluctance on the part of some GPs to remit information elicited in the consultation, for fear that the information may be compromised. This fear may be enhanced by the knowledge that even anonymous, aggregate data can be used to reveal the medical conditions of individuals.

Training health professionals in computing procedures is vital in preventing breaches in confidentiality at practice level. However, there is a risk that issue of confidentiality can be used as a reason for restricting the movement of data in the health service.

14.7.10 INTERPROFESSIONAL BARRIERS

There is a reluctance to extend information given to practitioners of one profession, to other professional groups without the patient's specific informed consent. This is illustrated in the survey of GPs in the PHCSG, where 90% indicated their willingness to supply data on cards to patients, which could be shown to other professional groups. However, direct communication with these groups received a more lukewarm response, with around 50% giving their approval (See section 8.3.14).

Direct communication with FHSAs was strongly supported (94%) by GPs, with few respondents displaying any reservations about confidentiality. It is surprising that GPs trust practice staff and clerical staff at the FHSA to maintain patient confidentiality but have reservations about other professionally qualified pharmacists, dentists and optometrists.

The principal beneficiary of primary health care practitioners sharing data are patients, who will receive a better service if practitioners have a greater awareness of their problems and needs. Information must be free to flow both vertically and horizontally but at the same measures to protect the confidentiality of individual patients must be built into the system.

14.8. INFORMATION EXCHANGE AND PRIMARY HEALTH CARE

There are four possible mechanisms for sharing data between all the practitioners in primary health care -

1 An electronic smart card which the patients carries and presents to every health professional.

2 A central index which holds data about patients and is accessible by all health professionals.

3 Computer to computer communication between health professionals.

4 Patient Registration.

Each of these mechanisms is discussed in the following sections.

14.8.1. Smart cards

The smart card can permit different health professionals to have access to the medical and medicinal records of a patient while ensuring the confidentiality of the data. It has been discussed in detail in section 2.6. The advantages of the smart card are -

* It can allow hierarchical access to all professionals on a need to know basis.
* Patients are given guardianship over their own health data. Thus, patients themselves are responsible for protecting the confidentiality of their data and its compromise need not detract from the doctor/patient

relationship. Further, a card gives them the right to withhold data from practitioners if desired. For example patients trying to register with a new dentist may not reveal information which they believe might influence the dentist to decline treatment.

* Clinical data is available to health professionals with whom the patient has had no previous contact in the event of sudden, serious illness. An example would be a patient having a heart attack or a hypoglycaemic attack.
* There is the long term potential that data held on cards could be used if a patient becomes ill abroad. This use of internationally recognised codes creates the possibility that information could be available regardless of language barriers.
* The card could transport all the information on a prescription that the PPA requires between GP and pharmacist. This data could then be easily uploaded from the pharmacy to the PPA.
* The smart card does not rely on transmitting sensitive data over a network. Thus one possible source of compromise of patient data is eliminated.

However criticisms of the smart card are that -

* The cost of equipping patients with cards and health professionals with reading devices will run to millions of pounds.

* In addition to hardware costs, there are hidden costs of training and distribution.
* A proportion of patients will not carry their cards routinely. An evaluation of Britain's largest trial of smart cards found patient carrying rates to be "highly variable".
* Comparatively few patients collapse in the streets. This small number would not justify the investment in cards and readers.
* The widespread use of patient data cards internationally is still hypothetical. Investment in cards for this reason cannot be justified.

The research has indicated that the concept of the smart card enjoys support among the professional groups, with between 66% and 90% of respondents indicating their approval (See sections 8.3.14, 9.2.7 and 10.2.9). However, this alone does not necessarily make it the best method for horizontal, interprofessional, data exchange. Issues of cost and the number of patients who will fail to carry cards routinely, make it only one of several different options.

14.8.2. Centrally held indexes

The basis of any centrally held indexes would be FHSA registers, but with clinical as well as administrative data. Such indexes were discussed (section 2.8) and the advantages are -

* All health professionals can have hierarchical access to the data that they need.
* The infrastructure for such a system is already in place, i.e. FHSA registers and the FHSA network.
* The State could have access to this data for service planning purposes, thus combining some aspects of vertical and horizontal communication in one system.

The disadvantages are -

* Ensuring the confidentiality of the clinical data held.
* The cost of telephone and network charges for being connected to the computer that held the index. As the FHSA network would carry most of calls the cost of connection may not be prohibitive.

The reason for utilizing the FHSA network for data exchange as opposed to the smart card is that the infrastructure of the network is in place. There is no need for investment as with the cards and their reading devices. Patients frequently give health professionals information, in strict confidence, about their private lives. This type of information can sometimes be very relevant in treating patients. However, the concept of this sensitive data becoming the responsibility of individuals outside the health professions may cause practitioners grave concern.

14.8.3. Computer to computer communication

A possible solution to the problem of some sensitive data no longer being completely within the control of primary health care professionals would be direct computer to computer communication within primary care. To ensure an acceptable level of confidentiality, data exchange would be limited to clusters of health professionals. Callback modems would be used to ensure that data could only be accessed by predefined individuals from fixed locations, consequently resulting in a secure system.

Acceptance of the concept of clusters requires that these clusters hold all, or almost all of the data about patients in common. They suffer from the following disadvantages -

* The cost of writing interfacing software to connect different computer systems.
* The FHSA network would have to extended so that every practitioner was connected.
* The telephone line could be used to connect practitioners to the network but this would mean that the telephone would be unavailable for long periods.
* Practitioners would need to meet telephone costs when connected to other practitioners computers.

14.8.4. Universal patient registration in primary health care

Patients now register with both a GP, and with a dentist. Separate registration means that medical data is being held at one location and the dental data at another. At present, the patient is not required to register with a community pharmacy or with an optometrist. Although many patients will use only one optometrist or pharmacist exclusively, some will use more than one. Thus medication and optometric data may often be dispersed between several locations. This is unhelpful in that it makes it impossible for GPs and dentists to have access to full information about a patient's medication.

If computer to computer communication over the FHSA network is to serve as a vehicle for data exchange between primary health care practitioners, and if complete medication information about patients is to be available, then patient registration must be introduced in pharmacy. Similarly, if prescriptions are to be sent routinely over the FHSA network between GPs and pharmacists, then only registration will satisfy the criteria of allowing patients the freedom to choose the pharmacy where they will register and giving the GP an electronic address for the transmission of the prescription. In addition, registration necessitates practitioners maintaining records, which improves the service provided to patients as well as creating a data resource for the health service.

However, although the registration of patients at one pharmacy goes some way towards bringing together data which are currently dispersed, it still means that data on dispensed medication and morbidity data are located at separate locations. Only where a pharmacist is working alongside a GP, is there the possibility to collate fully information on morbidity and all medication on one computer system. In addition, patients have traditionally been free to present a prescription at whichever pharmacy is most convenient at any moment. Registration will mean using only one practitioner normally, but arrangements can be made, as in the case of general practice, so that if emergency treatment is needed while the patient is away from home, any practitioner can be consulted.

14.8.5. Using more than one approach

The card and network concepts are not mutually exclusive. It may be that the use of comparatively inexpensive magnetic strip cards could allow purely administrative data to be transferred between health practitioners. For example, it could carry administrative prescription data between GP and pharmacist. The pharmacist would then upload this data and enter medication data. The network would then be used to transmit both administrative data and medication data to the PPA.

The data held on such a card could also be used by hospitals when a patient is admitted. The data would identify the GP and any other health professional with whom the patient is registered and could then be used to produce an invoice for that practice for the cost of treatment. As the data held on the card is not of a sensitive nature the loss of the card and any potential unauthorised access is comparatively unimportant. Further, the comparative low cost of magnetic strip cards makes them suitable as a large scale pilot for more sophisticated and expensive card technologies. That is, if the widespread use of cards to support the transfer of administrative data was successful, then it may be feasible to move forward to cards which also contain clinical data.

That there is a need for data to move more freely around the NHS is not in question. However, there are different solutions to achieve this result. The choice of solution to adopt will depend on the relative costs of the solutions and the benefits that they bring both in terms of administration and improved patient care.

14.8.6. Investigating the alternatives

There is a need to investigate and evaluate the costs and benefits of all potential solutions to find in which direction the computerisation of the NHS should best progress. That it needs to progress goes without saying. Improvements are necessary if the vast amount of data gathered by primary health care professionals are to be used for the ultimate benefit of Government, the Health Service and most importantly patients.

15. CONCLUSIONS

Information is vitally important for decision making in a large organisation. To maximise the benefits of information, lines of communication are essential so that this information can travel throughout the organisation.

The computer is a very important tool in the manipulation of information. The representation of information by codes and connecting computer systems through a network are essential to make information accessible.

Primary health care holds more data than the other sectors of health care. The value of these data relies upon the comprehensive recording of illness and treatment, the ability to link episodes of disease and treatment over a long time period and coverage of practically the whole population. The efficiency of the National Health Service could be improved if data were routinely gathered in primary health care and remitted to the managerial tiers. The service that health professionals provide to patients could be improved if data were shared within primary health care.

The majority of practitioners in primary health care do not yet use computers. This is the paramount barrier to the collection of data. The research implies that in many situations computers do not appear to result in immediate financial benefit to practitioners but represent a long term investment. They can provide intangible benefits of improved job satisfaction and a better relationship with patients.

Practitioners are interested in using computers to improve patient care as well as facilitate administration. Computers provide benefits to both the practices that use them and to the health service in general.

Cost is not the most important barrier to the acquisition of computers, although it cannot be ignored. Of greater importance is a lack of a perceived need for a computer among many health professionals.

Overcoming the lack of perceived need will involve informing, advising and training health professionals in the use of computers. Training is especially important as it should instill good computing practice. This is essential to ensure the accuracy, security and confidentiality of data in computer systems. The Family Health Services Authorities can achieve this by appointing advisors and establishing training centres. Safeguarding data is of particular importance as it is the most difficult part of the computer system to replace.

The adoption of a common computer system for each health profession would greatly facilitate data collection. Where however, different systems are used it is essential that a common set of data are collected and the same codes must be used to record this data.

Patient care could be improved if primary health care practitioners were able to share information. Concerns over confidentiality are perceived by some as a barrier to data sharing. However, most GPs stated that they are prepared to allow other health professionals appropriate access to the records of their patients.

There are several distinct options available for exchanging data between professionals in primary health care. These include the smart card, where data are collated and held by patients, the community index, where data are collated at a central location, and patient registration, where data is collated with the individual primary health care practitioners.

The concept of the smart card enjoys wide support across the health professions. The issues of cost and feasibility of introducing a health care smart card are nevertheless also important. All of these options need to be subject to further investigation to discover how the benefits of information, especially for the patients, can be maximised and the service as a whole best progress.

16. RECOMMENDATIONS

The following recommendations are put forward as a result of the research -

* That comprehensive medical and medicinal data be gathered from all practitioners across the whole of the primary health care sector.
* That the data gathered be made available in aggregate form to managers at all levels throughout the National Health Service.
* That the data held in records about an individual patient by several primary health care practitioners are capable of being related. This will enable all episodes of treatment to be linked.
* That representatives of all four professions meet to define the information that each profession requires to provide optimum treatment to patients.
* That the Read classification system schedules are extended so that it can be used throughout primary health care, rather that just within general practice.
* That FHSAs act in conjunction with professional organisations and the Department of Health to support and encourage the use of computers in primary health care.

* That the application of computers in practice form a significant part of curriculum of all undergraduate education in the health professions.

* That a Steering Group, consisting of representatives from the Department of Health, the primary health care professions, the Family Health Services Authorities, the Regional Health Authorities, patients and the suppliers of computer systems in primary health care be established.

* That this Steering Group should have within its terms of reference -

  -> To work towards agreed specifications for computer systems in primary health care.

  -> To define the items of data that should be captured routinely in primary health care.

* That the following mechanisms of data exchange be investigated in a pilot project -

  -> The use of magnetic strip cards to transfer administrative data within primary health care and between primary and secondary health care.

  -> Computer to computer communication between the different practices in primary health care.

  -> Practitioners accessing clinical data at a remote location.

  -> The use of registration to collate data in community pharmacy and optometry.

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LIST OF APPENDICES

APPENDIX 1.1 PHCSG Questionnaire.

SURVEY OF COMPUTERS IN GENERAL PRACTICE

Official Use Only

Please circle the appropriate response.

How many partners are involved in the practice? 5-6
(If single handed enter '1')

Before you bought your computer, did you see a computer in operation at another practice?

Yes 1 No 2 7

Reports such as "Micros in Practice" (DHSS, 1986) and "A Prescription for Change" (DHSS and the Joint Computer Policy Group, 1985) contain information which is helpful to GPs intending to purchase a computer system. Did you study these reports prior to purchase?

Yes 1 No 2 8

It has been suggested that Regional advisors should be set up to assist and advise GPs considering practice automation. Do you feel that this service would be

Very useful	Useful	Unsure	Of little use	Pointless	
1	2	3	4	5	9

Did any partner have any previous experience with computers before the decision was taken to purchase a system?

Yes 1 No 2 10

Which system is used -

AAH Meditel	1	
Ciba-Geigy/AMC	2	
Genisyst	3	
GPASS	4	
Micro-doc	5	11-12
Update	6	
VAMP	7	
Own system	8	
Other (please specify)		

....

-1-

Please circle the appropriate response . . .

When was the system installed?

Within the last year	1	
Within the two years	2	
Within the last three years	3	13
Within the last four years	4	
Other (please give date)		
....		

Does the company provide a telephone enquiry service or "help desk" to answer simple queries?

Yes 1 No 2 — 14

Does the practice have any maintenance contract regarding either the hardware or the software?

Hardware maintenance contract	Yes	1	No	2	15
Software maintenance contract	Yes	1	No	2	16

How useful is the manufacturer's documentation?

Very useful	1	
Useful	2	17
Satisfactory	3	
Unhelpful	4	

With the acquisition of a system there is often a need for staff training. Did the supplier of the system offer training courses?

Yes 1 No 2 — 18

If you attended any such courses, did you find them -

Very useful	1	
Useful	2	
Worthwhile	3	19-20
Of little use	4	
Of no use	5	

Which members of the practice would benefit from further training courses if they were available?
(please circle one or more response)

None	1	21
Doctors	2	22
The practice nurse	3	23
Receptionists	4	24
The practice manager	5	25
Others (please specify)		26

....

-2-

Please circle the appropriate response . . .

How many doctors use terminals during the consultation or in between consultations?

.... 27-28

Which of the following backup procedures are used to protect data in your practice?

Backup copies are stored in a separate building	1	29
Backup copies are stored in a fireproof safe	2	30
Backup copies are stored in the practice	3	31
No backup copies are made	4	32

Ensuring the confidentiality of patient data is very important. Does the practice operate any of the following?

Use a password system	1	
Use a hierarchical password system	2	33
Not employ passwords	3	

Have you registered with the Data Protection Registrar?

Yes 1 No 2 34

In the literature there is conflicting evidence about the effect of the computer on the amount of staff required. In your practice has the acquisition of a computer led to any alteration in the number of non-medical staff required?

No change in staff 1 More staff 2 Fewer staff 3 35

If the number of staff needed has changed, please indicate -

a) by how many and 36
b) what kind of staff. 37

Various classification schemes of medicine exist to improve patient care indirectly through epidemiology. Does the practice computer use any of the following classification schemes to record morbidity?

Read	1	
ICD-9	2	
ICHPPC	3	
ICPC	4	38-39
Oxmis	5	
RCGP	6	
Don't Know	7	
Other (please specify)		

....

Has the computer led to an increase in practice research?

Yes 1 No 2 Don't know 3 40

-3-

Please circle the appropriate response . . .

Are you involved in either of the "no cost option" computer schemes offered by AAH Meditel or VAMP?

AAH Meditel	1	
VAMP	2	41
Neither	3	

If so, have you been able to meet the data requirements stipulated by the scheme?

Yes 1 No 2 Don't know yet 3 — 42

Much of the paperwork currently conducted between general practice and various organisations could be handled via electronic mail. With which of the following would you consider electronic mail to be useful -

FPC	Yes	1	No	2	Don't know	3	43
PPA	Yes	1	No	2	Don't know	3	44
Hospital	Yes	1	No	2	Don't know	3	45
Other GP practices	Yes	1	No	2	Don't know	3	46

Other (please specify)

....

If other Family Practitioner Service professionals (i.e. dentists, pharmacists & opticians) felt that they could provide a better service if they had more relevant information about the patient, would you be in favour of sharing electronic data with any of these professionals? (Assuming that access was restricted to only part of the record)

Pharmacists	Yes	1	No	2	Don't know	3	46-47
Dentists	Yes	1	No	2	Don't know	3	48
Opticians	Yes	1	No	2	Don't know	3	49

Would you be in favour of the patient carrying around part of his medical history (medication) on an electronic 'smart card' and presenting such a card to other primary health care professionals?

Yes 1 No 2 Don't know 3 — 50

If yes, would you accept that other health care professionals could add data to the record as well as access data?

Yes 1 No 2 Don't know 3 — 51

Do you wish a summary of the results of this questionnaire? (If yes, please enclose address)

Yes 1 No 2 — 52

May I take this opportunity to express my gratitude to you for taking the time to complete this questionnaire. If you have any queries please do not hesitate to contact either me or my supervisor, Mr. Michael Jepson, at the address given below. Any additional comments that you wish to make would be greatly appreciated.

Yours faithfully,

Steven Di Ponio

Dept. of Pharmaceutical Sciences
Aston University
Aston Triangle
Birmingham
B4 7ET
021 359 3611 Extn. 4192/4202

APPENDIX 1.2 PHCSG Covering letter.

ASTON UNIVERSITY

PHARMACEUTICAL SCIENCES

Professor of Pharmaceutical Microbiology: M R W Brown MSc PhD DSc FPS
Professor of Pharmacology: C B Ferry BPharm BSc PhD FPS
Professor of Experimental Chemotherapy: M F G Stevens BPharm PhD DSc MPS CChem FRSC
Head of Department this Session

May 1989

Dear Pharmacist,

I am a research student in the Department of Pharmaceutical Sciences at Aston University and I am looking at how far the computerisation of primary health care has progressed and is capable of further development.

I would be very grateful if you could assist me by completing and returning the enclosed questionnaire. As almost all of the questions are answered by circling a number, it should take no more than a few minutes to complete.

If you do not use a computer please return the questionnaire after completing the second question.

The analysis of the questionnaire will give me a much better understanding of the uses and future trends of computers in pharmacy in Britain. From this analysis I can progress to consider how pharmacy computerisation fits into the computerisation of the health service as a whole.

The replies to this survey will of course be treated with the strictest confidence and no individual will be identified. It is hoped that a summary of the results will be published in a professional journal.

Thank you for your assistance,

Yours faithfully,

Steven Di Ponio

Steven Di Ponio.

Aston Triangle, Birmingham B4 7ET. Telephone 021-359 3611. Telex 336997 UNIAST G
Electronic Mail PHARMSCI@UK.AC.ASTON

APPENDIX 2.1 Community pharmacy Questionnaire.

COMPUTERS IN PHARMACY

Official Use Only

Please circle the appropriate response.

1) Is the pharmacy?

An independent	1	5
A small multiple (2-10)	2	
A large multiple (11 or more)	3	

2) Does the pharmacy use a computer?

Yes 1 No 2 — 6

If no, please RETURN the questionnaire in the envelope provided. Thank you for your time and trouble.
If YES, please continue.

3) Which system is used?

Image	1	
Link	2	
Park	3	7-8
Richardson's	4	
More than one system is used	5	
If any other system is used, please specify.		

....

4) When was the system installed?
(Please circle more than one if appropriate)

During 1989	1	
During 1988	2	
During 1987	3	9-10
During 1986	4	
During 1985	5	
During 1984	6	
Other (please give date)		

-1-

Please circle the appropriate response.

5) For which of the following purposes is the computer used? (Please circle one or more as appropriate) — Official Use Only

		Official Use Only
Labelling	1	12
Stock control	2	13
Stock ordering	3	14
Drug interaction monitoring	4	15
Patient medication records	5	16
Accessing information sources (eg PINS)	6	17
Word processing	7	18
If any other please specify.		19-20

....

6) How important do you consider the following facilities to be in a system?

6a) Labelling

Very important	Important	Unsure	Unimportant	Pointless	
1	2	3	4	5	21

6b) Stock Control

Very important	Important	Unsure	Unimportant	Pointless	
1	2	3	4	5	22

6c) Stock Ordering

Very important	Important	Unsure	Unimportant	Pointless	
1	2	3	4	5	23

6d) Drug Interaction Monitoring

Very important	Important	Unsure	Unimportant	Pointless	
1	2	3	4	5	24

6e) Patient Medication Records

Very important	Important	Unsure	Unimportant	Pointless	
1	2	3	4	5	25

6f) Word Processing

Very important	Important	Unsure	Unimportant	Pointless	
1	2	3	4	5	26

6g) If any other please specify in rank.

.... 27-8

....

Please circle the appropriate response.

	Official Use Only
7) Please indicate your reaction to the following statements.	
7a) "Computers which order prescription medicines directly by gathering data through labelling are superior to ones which rely on manual ordering."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	30-1
7b) "Patient medication records lead to better patient care."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	32
7c) "Patient medication records cannot be justified on commercial grounds."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	33
7d) "Patient medication records slow down the rate at which prescriptions can be processed."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	34
7e) "The Data Protection Act provides a disincentive to pharmacists maintaining patient medication records."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	35
7f) "Much of the paperwork currently conducted between pharmacies and the Prescription Pricing Authority could be usefully handled via an electronic link." (A pilot study demonstrating this has been completed, but there are no plans to make this service available to pharmacists.)	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	36

-3-

Please circle the appropriate response.

	Official Use Only
8) Are you aware of the existence of an electronic 'smart card', which allows medication information to be carried by the patient on a credit card style plastic card?	
Yes 1 No 2	38-9
If No, please go to the final paragraph. If YES, please indicate how strongly you feel about each of the following statements.	
8a) "The smart card will make a significant advance in health care."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	40
8b) "Smart cards will do nothing to improve my business."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	41
8c) "Pharmacists should be able to add data on OTC medicines to smart cards."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	42
8d) "General practitioners will not want pharmacists to have access to their patient's medical data."	
Strongly agree 1 · Agree 2 · Unsure 3 · Disagree 4 · Strongly disagree 5	43

May I take this opportunity to express my gratitude to you for taking the time and trouble to complete this questionnaire. If you have any queries please do not hesitate to contact either me or my supervisor, Mr. Michael Jepson, at the address given below. Any additional comments that you wish to make would be greatly appreciated.

Yours faithfully,

Steven Di Ponio

Dept. of Pharmaceutical Sciences
Aston University
Aston Triangle
Birmingham
B4 7ET
021 359 3611 Extn. 4202

....

....

....

-4-

APPENDIX 2.2 Community pharmacy Covering letter.

ASTON UNIVERSITY

PHARMACEUTICAL
SCIENCES

Professor of Pharmaceutical Microbiology:
M R W Brown MSc PhD DSc FPS
Professor of Pharmacology:
C B Ferry BPharm BSc PhD FPS
Professor of Experimental Chemotherapy:
M F G Stevens BPharm PhD DSc MPS
CChem FRSC
Head of Department this Session

May 1989

Dear Pharmacist,

I am a research student in the Department of Pharmaceutical Sciences at Aston University and I am looking at how far the computerisation of primary health care has progressed and is capable of further development.

I would be very grateful if you could assist me by completing and returning the enclosed questionnaire. As almost all of the questions are answered by circling a number, it should take no more than a few minutes to complete.

If you do not use a computer please return the questionnaire after completing the second question.

The analysis of the questionnaire will give me a much better understanding of the uses and future trends of computers in pharmacy in Britain. From this analysis I can progress to consider how pharmacy computerisation fits into the computerisation of the health service as a whole.

The replies to this survey will of course be treated with the strictest confidence and no individual will be identified. It is hoped that a summary of the results will be published in a professional journal.

Thank you for your assistance,

Yours faithfully,

Steven Di Ponio

Steven Di Ponio.

Aston Triangle, Birmingham B4 7ET. Telephone 021-359 3611. Telex 336997 UNIAST G
Electronic Mail PHARMSCK@UK.AC.ASTON

APPENDIX 3.1 Dental practice Questionnaire.

COMPUTERS IN GENERAL DENTAL PRACTICE

Please circle the appropriate numbers.

1) How many partners and associates are there in the practice?
(If single please enter "1")
....

2) In which year did you qualify? 19 ....

3) Does the practice have a computer?

Yes 1
No 2

If YES please continue.
If NO please go to question 9).

4) Which system do you use in your practice?

Apollonia 1
Clockwork 2
MediData 3
Paladin 4
SDS Specialist Dental Services 5
Status 6
TMS Arthur Dental Systems 7
Xtrax 8
Other (please specify)

....

5) When was the system installed?

Within the last year 1
Within the last two years 2
Within the last three years 3
Within the last four years 4
Other (please specify)

....

6) Which of the following members of your practice currently use the system? (Please circle more than one if applicable)

The receptionist 1
DSAs 2
Dentists 3
Hygienists 4
The Practice Manager....................... 5
Others (please specify)

....

-1-

Please circle the appropriate number.

7) For which of the following applications is the computer used?

Practice accounts 1
Patients' accounts 2
Schedule Reconciliation 3
Patient Recall 4
Record of treatment claims 5
Staff wages 6
Stock control 7
Tooth charting 8
FP17 Remittance 9
Appointments 10
Word processing 11
Practice information leaflets 12
Treatment plans and estimates 13
Other (please specify)

....

8) Much of the paperwork currently conducted between dental practices and the Dental Practice Board DPB (formerly the DEB) could be handled electronically. (A pilot trial to test this is currently underway). How useful would you consider this service to be?

Very useful	Useful	Unsure	Not useful	Pointless
1	2	3	4	5

Please go to question 17).

9) Are there any plans for the acquisition of a computer?

Yes 1
No 2
Don't Know 3

10) If no, is this due to -
(please circle one or more as applicable)

Cost 1
Uncertainty of advantages 2
Due to retire 3
Time involved in initial data entry 4
Staff reluctance 5
Unfamiliarity with computers generally 6
Waiting for official direction
as to a suitable system 7
Other (please specify)

....

....

Please circle the appropriate number.

11) From which of the following sources would you find advice on dental practice computing most credible? (please rank in order of credibility, 1 being the most credible.)

The British Dental Association .... _____
The Dental Practice Board .... _____
The suppliers of practice systems .... _____
Dental magazines .... _____
The Primary Health Care Specialist
Group of the British Computer Society ... _____
Other (please specify)

....

12) How helpful would you consider information and courses on the following subjects to be in helping you purchase a computer? (Please circle a number, with 1 being the most helpful and 5 the least.)

a) Basic computer literacy: what a computer is, how it operates and terms associated with computers.

1 2 3 4 5

b) The benefits and problems of computers in general dental practice.

1 2 3 4 5

c) Criteria for system selection: how to choose a computer system for your practice.

1 2 3 4 5

13) How useful are the following methods of learning? (Please circle a number, with 1 being the most convenient and 5 the least.)

a) Distance learning through printed material and film.

1 2 3 4 5

b) Seminars consisting of speakers and an exhibition of computer systems by their suppliers.

1 2 3 4 5

c) Evening courses at local colleges.

1 2 3 4 5

d) Hands on experience of several systems in the absence of salesmen.

1 2 3 4 5

Please circle the appropriate number.

14) How helpful would you find the following printed sources of information? (Please circle a number, with 1 being the most helpful and 5 the least.)

a) A comparative report of all dental systems currently on the market.

1 2 3 4 5

b) A series of articles in the British Dental Journal about computers in dentistry.

1 2 3 4 5

c) British Dental Association guidelines on what computer systems should offer.

1 2 3 4 5

d) Dental Practice Board guidelines on which computer systems offer electronic links to Eastbourne.

1 2 3 4 5

15) How useful would "user groups" of dentists using computers be to you?

1 2 3 4 5

16) Which of the following features do you consider to be the most useful in a computer system? (Please indicate usefulness on a scale of 1 to 5, with 1 being the most useful.)

Appointments .... _____
Communication with the DPB (formerly DEB) ..... _____
Patient recall .... _____
Patients' accounts .... _____
Practice accounts .... _____
Record of treatment claims .... _____
Schedule reconciliation .... _____
Staff wages .... _____
Stock control .... _____
Tooth charting .... _____
Word processing .... _____
Practice information leaflets .... _____
Treatment plans and estimates .... _____

17) The smart card (an electronic readable credit card style medical record kept by the patient) could allow the dentist to have information about the patients current medication and medical history. How useful do you consider the smart card to be in improving care and informing the GP of dental prescribing?

Very useful	Useful	Unsure	Not useful	Pointless
1	2	3	4	5

May I take this opportunity to express my gratitude to you for taking the time to complete this questionnaire. If you have any queries please do not hesitate to contact either me or my supervisor, Mr. Michael Jepson, at the address given below. Any additional comments that you wish to make would be greatly appreciated.

Yours sincerely,

Steven Di Ponio

Dept. of Pharmaceutical Sciences
Aston University
Aston Triangle
Birmingham
B4 7ET
021 359 3611 Extn. 4192

APPENDIX 3.2 Dental practice Covering letter.

ASTON UNIVERSITY

March 1990

Dear Dentist,

I am research student at Aston University and am studying the use of computers in primary health care, of which dentistry is a part.

I have designed a questionnaire in conjunction with the Dental Practice Board (DPB), in order to find out how many dentists currently use computers and whether dentists would find information about computers helpful.

As answering the questions involves circling a number, the questionnaire should take no more than a few minutes to complete. From the analysis of the results I hope to be able to construct a picture of computer use in dentistry, as well as finding out how dental computing can best progress.

The replies to this questionnaire shall be treated with the strictest confidence and the results used only in aggregate form.

May I take this opportunity to thank you in advance for your help,

Yours sincerely,

Steven Di Ponio

Steven Di Ponio.

Aston Triangle, Birmingham B4 7ET. Telephone 021-359 3611. Telex 336997 UNIAST G

APPENDIX 4.1 Optometrist Questionnaire.

COMPUTERS IN OPTOMETRY AND OPHTHALMIC OPTICS — Official Use Only

Please circle the appropriate response. — 1-5

1) Is the practice -

A single practice	1	
A group practice	2	
A small multiple (2-10)	3	6
A large multiple (11 or more)	4	

2) Does the practice own a computer?

Yes 1 No 2 — 7

3) Are there any plans to buy a computer for the practice?

Yes 1 No 2 — 8

If you do not have a computer please RETURN the questionnaire in the envelope provided. Thank you for your time and trouble. If you do have a computer, please continue.

4) Which system is used -

Autoprac Computerised Practice Management System (Contact Lens Supplies Ltd)	1	
Focus (JRAssociates)	2	
Kalamazoo	3	
Mint Opticians (JRAssociates)	4	
The Only One (Twenty Twenty Vision)	5	
Optic (Integral Business Systems)	6	9-10
Optical Management System (Software Analyst Services)	7	
Optician (MBA Consultants Ltd.)	8	
The Optometric Database (Datamation Computer Services)	9	
Practice Management System (JLG)	10	
Proven in Practice (Peter Ralph Computers)	11	

If other please specify.

....

....

Please circle the appropriate response.

5) For which of the following operations do you use the computer? (Please circle one or more as appropriate.)		Official Use Only
Patient records	1	12
Patient recall	2	13
Appointments	3	14
Invoice generation	4	15
Practice accounts	5	16
Spectacle prescriptions	6	17
Stock control	7	18
Word processing	8	19
Other (please specify)		20

....

6) How useful would you consider the ability to process claims to the FPC electronically to be?

Very useful	Useful	Unsure	Of little use	Pointless	
1	2	3	4	5	21

How useful do you consider the ability to place orders electronically with suppliers to be?

Very useful	Useful	Unsure	Of little use	Pointless	
1	2	3	4	5	22

May I take this opportunity to express my gratitude to you for taking the time to complete this questionnaire. If you have any queries please do not hesitate to contact either me or my supervisor, Mr. Michael Jepson, at the address given below. If you wish a summary of the results of this questionnaire, please enclose your address. Any additional comments that you wish to make would be greatly appreciated.

Yours faithfully,

Steven Di Ponio

Dept. of Pharmaceutical Sciences
Aston University
Aston Triangle
Birmingham
B4 7ET
021 359 3611 Extn. 4202

....

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-2-

APPENDIX 4.2 Optometrist Covering letter.

ASTON UNIVERSITY

PHARMACEUTICAL
SCIENCES

Professor of Pharmaceutical Microbiology:
M R W Brown MSc PhD DSc FPS
Professor of Pharmacology:
C B Ferry BPharm BSc PhD FPS
Professor of Experimental Chemotherapy:
M F G Stevens BPharm PhD DSc MPS
CChem FRSC
Head of Department this Session

July 1989

Dear Optician,

I am a research student in the Department of Pharmaceutical Sciences at Aston University and I am looking at how far the computerisation of primary health care has progressed and is capable of further development.

I would be very grateful if you could assist me by completing this questionnaire, which should take no more than a few minutes, and returning it in the envelope enclosed. If you do not have a computer please return the questionnaire after answering questions one to three.

The analysis of the questionnaire will give me a much better understanding of the distribution and uses of computers in optometry and ophthalmic optics. From this analysis I can progress to consider how primary care computerisation fits into the computerisation of the health service as a whole.

I hope to have a preliminary analysis completed by autumn and if you would like a summary, please enclose your address.

The replies to this survey will of course be treated with the strictest confidence and the answers only used in statistical analysis.

Thank you for your assistance,

Yours faithfully,

Steven Di Ponio

Steven Di Ponio.

Aston Triangle, Birmingham B4 7ET. Telephone 021-359 3611. Telex 336997 UNIAST G
Electronic Mail PHARMSCI@UK.AC.ASTON

APPENDIX 5.1 FHSA Questionnaire.

COMPUTERS AND THE FAMILY PRACTITIONER COMMITTEES

1) Please give details of the computer hardware used in your FPC.
(Please include more than one if appropriate.)

....

....

....

2) Please give details of all software used in your FPC.

Exeter 1
Other (Please give details)

....

....

3) How satisfied are you with the software in terms of its ability to -

a) meet your FPC's operational needs?

Very Satisfied	Satisfied	Unsure	Dissatisfied	Very Dissatisfied
1	2	3	4	5

b) provide management information?

Very Satisfied	Satisfied	Unsure	Dissatisfied	Very Dissatisfied
1	2	3	4	5

4) Which of the following services does your FPC provide?

Cervical screening	1
Breast screening	2
Hypertension screening	3
Part time GP computer advisor	4

5) It has been suggested that advisors should be employed to assist GPs considering computerisation. Do you consider that your FPC could usefully fulfil this role through a part time appointment?

Yes	1
No	2
Don't Know	3

-1-

6) A dental computer system is structured to prevent complete erasure of treatment details. Do you consider that all medical computer records should be similarly structured, as is the case with paper records?

Yes	1
No	2
Don't Know	3

7) How useful do you consider the idea that item of service (IOS) claims from GPs should be made electronically?

Very useful	Useful	Unsure	Not useful	Pointless
1	2	3	4	5

8) In addition to processing IOS forms a pilot scheme also enables GPs to order FPC stationery. Do you feel that any other services could usefully be accessed electronically?

Yes	1
No	2
Don't Know	3

If yes, please give details -

....

....

9) Do you feel that the regulation requiring a signature for IOS payments should be amended to facilitate the electronic processing of IOS payments?

Yes	1
No	2
Don't Know	3

10) A company involved in GP computing has developed a means whereby signatures can be verified electronically. If electronic signatures can be verified at low cost, do you consider this to be a solution to the problem?

Yes	1
No	2
Don't Know	3

11) Optometrists also make claims for remuneration to the FPC. Do you consider that a mechanism for electronically submitting these claims should be explored?

Yes	1
No	2
Don't Know	3

If no, please give reason -

....

....

12) A current project is collecting data from GPs practice computers, which is used to assess and plan both hospital and FPC services for a District Health Authority. How much would your FPC benefit from having access to the following information? (please indicate on a scale of 1 to 5, with 1 having the greatest benefit.)

Cervical cytology ....____
Mammography ....____
Hypertension screening ....____
Child immunisation ....____
Tetanus vaccination provision ....____
Flu vaccination provision ....____
Family planning information ....____
Developmental checks for the under 5s ....____
Screening of the over 75s ....____
Chronic morbidity recording (eg asthma, epiplepsy,
rheumatoid arthritis) ....____
Malignant disease recording ....____
Drug use ....____
Rubella vaccination for girls of 10-11 ....____

Please indicate the three most important of the above.

....

....

13) How useful do you consider the idea of a community index, (based on a FPC Registers but linked to and accessible by both GP and local hospital systems) to be in facilitating communication between all health professionals?

Very useful	Useful	Unsure	Not useful	Pointless
1	2	3	4	5

Comments ....

....

14) The smart card (an electronic readable credit card style medical and drug record kept by the patient) has the potential to facilitate data transfer within the NHS. Do you foresee any application of the smart card in the management of the FPS?

Yes	1
No	2
Don't Know	3

-3-

If yes, please describe.

....

....

16) A contract to network different agencies and professionals involved in care has recently been awarded. What order of priority would you give to communicating electronically with each of the organisations and contractors listed on the next page? (Please indicate priority by ranking them from 1 to 11, with 1 being of the greatest importance).

Organisation/Contractor	Rank
The Regional Health Authority (RHA)	....
The District Health Authority (DHA)	....
Other FPCs	....
General Practitioners (GPs)	....
Pharmacy contractors	....
Dentists	....
Optometrists	....
The Prescription Pricing Authority (PPA)	....
The Dental Practices Board (formerly the DEB)	....
The Department of Health (DoH)	....
The National Health Service Central Register	....

Others ....

....

....

May I take this opportunity to express my gratitude to you for taking the time and trouble to complete this questionnaire. If you have any queries please do not hesitate to contact either me or my supervisor, Mr. Michael Jepson, at the address given below. Any additional comments that you wish to make would be greatly appreciated.

Yours faithfully,

Steven Di Ponio

Dept. of Pharmaceutical Sciences
Aston University
Aston Triangle
Birmingham
B4 7ET
021 359 3611 Extn. 4192/4202

....

....

-4-

APPENDIX 5.2 FHSA Covering letter.

ASTON UNIVERSITY

PHARMACEUTICAL SCIENCES

Professor of Pharmaceutical Microbiology: M R W Brown MSc PhD DSc FPS
Professor of Pharmacology: C B Ferry BPharm BSc PhD FPS
Professor of Experimental Chemotherapy: M F G Stevens BPharm PhD DSc MPS CChem FRSC
Head of Department this Session

February 1990

Dear Sir,

I am a research student in the Department of Pharmaceutical Sciences at Aston University and I am looking at the computerisation of the FPCs and their contractor professions.

I would be very grateful if you could assist me by completing and returning the enclosed questionnaire which should take no more than a few minutes to complete.

The analysis of the questionnaire will give me a much better understanding of the role FPCs are and will play in primary health care computing. From this data I hope to be able to produce a current evaluation of networked computers in the health service, with particular reference to the FPC contractor professions.

I hope to have a preliminary analysis completed early next year and if you would like a summary, please enclose your name and address.

The replies to this survey will of course be treated with the strictest confidence and the answers only used in statistical analysis.

Thank you for your assistance,

Yours sincerely,

Steven Di Ponio

Steven Di Ponio.

Aston Triangle, Birmingham B4 7ET. Telephone 021-359 3611. Telex 336997 UNIAST G
Electronic Mail PHARMSCI@ UK.AC.ASTON

APPENDIX 6.1 Cost effectiveness Questionnaire.

PATIENT LOYALTY AND COMPUTERISED PATIENT MEDICATION RECORDS

Please **circle** the appropriate number.

1) Is the pharmacy

An independent	1
A small multiple (2-10 branches)	2
A large multiple (11 or more branches)	3

2) Is the pharmacy situated in -

A town centre	1
A suburb	2
A village	3

3) Does your pharmacy maintain computerised patient medication records?

Yes 1 No 2

If **NO**, please go to question 8).

4) Please give the year and month that the system was installed

Year 19..... Month ....

5) Which, if any, of the following methods do you use to inform patients about the PMR system? (Please circle the number that corresponds to the method or methods that you use.)

a) Presenting patients with a card which they then carry with them 1

b) Presenting patients with a leaflet which describes the advantages of the system 2

c) When patient details are first keyed in, do you give the patient information about the system verbally? 3

d) Do you inform patients in any other way? (Please give details)

....

....

6) What effect, if any, have PMRs had upon your job satisfaction?

Large increase	1
Increase	2
No Change	3
Decrease	4
Large decrease	5

7) How would you describe the effect on the overall number of prescriptions processed in the pharmacy since the installation of the patient medication record system?

Large increase	1
Increase	2
No Change	3
Decrease	4
Large decrease	5

8) Can you discern any alteration in patient loyalty over the last six months?

Large increase	1
Increase	2
No Change	3
Decrease	4
Large decrease	5

9) How would you describe the trend in the number of prescriptions processed in your pharmacy during the last six months?

Large increase	1
Increase	2
No Change	3
Decrease	4
Large decrease	5

10) How would you quantify the job satisfaction obtained from your present work?

Very high	1
High	2
Satisfactory	3
Low	4
Very low	5

What are your personal views about the effect of patient medication records on your pharmacy business in general and how important are these effects?

....

....

....

....

....

....

....

....

We are interested in comparing the levels of prescriptions presented at pharmacies who use computerised patient medication records with other pharmacies who do not, both before and after the installation of the patient medication record system. To do this we would be very grateful if you would send me the monthly prescription numbers for your pharmacy up to the last two and a half years. The replies to this questionnaire are completely anonymous and it is not possible for me to link any data supplied with any one pharmacy.

If you feel unable to supply this data, please return the questionnaire in any case, in the envelope provided.

Thank you for taking the time and trouble to complete this questionnaire.

Month	Prescription Numbers
June 1990 (if available)	....
May	....
Apr	....
Mar	....
Feb	....
Jan	....
Dec 1989	....
Nov	....
Oct	....
Sep	....
Aug	....
Jul	....
Jun	....
May	....
Apr	....
Mar	....
Feb	....
Jan	....
Dec 1988	....

Nov	....
Oct	....
Sep	....
Aug	....
Jul	....
Jun	....
May	....
Apr	....
Mar	....
Feb	....
Jan	....
Dec 1987	....
Nov	

My thanks again for all you help,
Yours sincerely,

Steven Di Ponio BSc.

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APPENDIX 6.2 Cost effectiveness Covering letter.

ASTON UNIVERSITY

PHARMACEUTICAL SCIENCES

Professor of Pharmaceutical Microbiology: M R W Brown MSc PhD DSc FPS
Professor of Pharmacology: C B Ferry BPharm BSc PhD FPS
Professor of Experimental Chemotherapy: M F G Stevens BPharm PhD DSc MPS CChem FRSC
Head of Department this Session

July 1990

Dear Pharmacist,

I am a research student in the Pharmacy Practice Research Group of the Pharmaceutical Sciences Institute at Aston University and am studying the use of computers in primary health care, especially pharmacy.

I am particularly interested in examining the effect, if any, of computerised patient medication records on patient loyalty (that is whether patient allegiance is more likely!) I am attempting to measure this both through opinion, which is subjective but also objectively by comparing monthly prescription figures of pharmacies with and without patient medication records.

I enclose a questionnaire which I hope you will feel able to complete. It will provide some initial evidence of whether PMR systems have any effect on prescription numbers and loyalty. **The questionnaire will be completely anonymous and it will not be possible for me to link any response to any particular pharmacy.** Consequently I will not be able to send you a copy of my results but I will be sending the overall results to the **Pharmaceutical Journal** for possible publication. If you have any queries please do not hesitate to contact me or my

Content has been removed for copyright reasons

May I take this opportunity to thank you in advance for your help,

Yours sincerely,

Steven Di Ponio

Steven Di Ponio BSc.

Aston Triangle, Birmingham B4 7ET. Telephone 021-359 3611. Telex 336997 UNIAST G

APPENDIX 6.3 Time series analysis model code.

```
libname pmr '[diponiosm.sas.model]';
data pmr.dataset;
 infile pmrmodel;
 input ob1-ob32;
proc transpose prefix=z;
proc print pmr.dataset;
```

Where -

Libname - identifies a library to store an SAS permanent data set. In this case it is in the user account DIPONIOSM, in the subdirectory SAS.MODEL.

Data - gives the name of the file under which the output will be stored, in the case "dataset".

Infile - imports data from the raw data file "pmrmodel".

Input - tells SAS that there are 32 variables, called OB.

Proc transpose - converts OB1-OB32, to Z1-Z196, that is transforms a 32 variables with 196 observations to 196 variables with 32 observation.

Proc print - lists the variables in the permanent data set called "dataset".

PMR - relates the file dataset to the SAS library.

The data file "pmrmodel" is entered into the SAS system and the SAS procedure (PROC TRANSPOSE) alters its structure into the desired columnar form. The variables are labelled as Z, and the results are stored in a permanent data set, in this case called "dataset". The use of permanent datasets obviates the need to start from the beginning at every session and saves both time and processing power. The results are then printed (PROC PRINT) to check that correct results have been achieved.

```
libname pmr '[diponiosm.sas.model]';
proc glm data=dataset;
 model z2-p197=z1;
 output out=pmr.ratio2 predict=x2-196;
```

Where -

Proc glm - tells SAS to perform a linear regression.

Data= - enters data from the permanent data set called "dataset".

Model - tells SAS which variables are to be used in the regression.

Output out - tells SAS to store the predicted values as variables x2-x196 in the permanent dataset ratio2.

PROC GLM instructs SAS to make a general linear model, that is to calculate the line of least squares for each of the variables. The data= command enables SAS to access the variables stored in "dataset". The MODEL statement indicates the variables that are to be used. This step yields the values of $a_i * T_{it}$. The OUTPUT statement tells SAS to record the predicted values of the model as X2-X197 etc.

```
libname pmr '[diponiosm.sas.model]';
data pmr.ratio2;
 set pmr.predict;
array actual{196} z2-z197;
array pred{196} x2-x197;
array ratio{196} r2-r197;
do i=1 to 196;
 ratio{i}=actual{i}/pred{i};
 end;
```

Where -

Data - tells SAS the name of the file in which the results of this job will be output.

Set - enters data from the permanent data set called "dataset".

Array - creates an array of specified variables.

Do and end - created a loop which performs a repetitive procedure, in this case the division of variables in two arrays, i.e. the division of Z2-Z197 by X2-X197.

The ARRAY command creates an array of the variables specified. Arrays were used to manipulate the data. The DO command produced values for the array called ratio, Ratio contains variables formed by dividing the original variables by the predicted variables. The variables in Ratio represent the $S_t M_t R_{i\,t}$ values.

```
libname pmr '[diponiosm.sas.model]';
data pmr.average;
 set pmr.ratio2;
array actual{196} z2-z197;
array pred{196} x2-x197;
array ratio{196} r2-r197;
sum=0;
den=0;
do j=1 to 196;
 if ratio{j}<>. then sum=sum+ratio{j};
 if ratio{j}<>. then den=den+1;
  end;
average=sum/den;
drop sum;
drop den;
```

Where -

Sum and den are new variables which are used to count. SUM and DEN calculate average values for each observation in the array ratio. DEN ensures that missing values are excluded from the denominator in this averaging process.

The variable AVERAGE has thirty two observations and is used to calculate the seasonal component (S_t) in the model. The seasonal component varies with each month and the thirty two observations were condensed into twelve months manually, i.e. observations 1, 13 and 25 were summed and the result divided by 3, as were observations 2, 14 and

26, etc. This process was done manually as this proved easier than computing the values within SAS. The condensed AVERAGE values represent the seasonal (S_t) component of the model. The seasonal component was re-entered into SAS as the variables a1-a12.

```
libname pmr '[diponiosm.sas.model]';
data pmr.season;
 set pmr.average;
array ratio{196} r2-r197;
array morbid{196} m2-m197;
a1=1.02065;
a2=1.02278;
a3=0.94374;
a4=1.04579;
a5=0.94728;
a6=1.01816;
a7=1.06668;
a8=1.02077;
a9=0.99304;
a10=0.97334;
a11=0.96183;
a12=0.96593;
do k=1 to 196;
 if 12<_n_<25 then _n_=_n_-12;
 if _n_>24 then _n_=_n_-24;
 if ratio{k} gt . & _n_=1 then morbid{k}=ratio{k}/a1;
 if ratio{k} gt . & _n_=2 then morbid{k}=ratio{k}/a2;
 if ratio{k} gt . & _n_=3 then morbid{k}=ratio{k}/a3;
 if ratio{k} gt . & _n_=4 then morbid{k}=ratio{k}/a4;
 if ratio{k} gt . & _n_=5 then morbid{k}=ratio{k}/a5;
 if ratio{k} gt . & _n_=6 then morbid{k}=ratio{k}/a6;
 if ratio{k} gt . & _n_=7 then morbid{k}=ratio{k}/a7;
 if ratio{k} gt . & _n_=8 then morbid{k}=ratio{k}/a8;
 if ratio{k} gt . & _n_=9 then morbid{k}=ratio{k}/a9;
 if ratio{k} gt . & _n_=10 then morbid{k}=ratio{k}/a10;
 if ratio{k} gt . & _n_=11 then morbid{k}=ratio{k}/a11;
 if ratio{k} gt . & _n_=12 then morbid{k}=ratio{k}/a12;
end;
```

The season values, represented by the variables a1-a12 are used to create the M_t * R_{it} values. This process is repeated to obtain the R_{it} values as follows -

```
libname pmr '[diponiosm.sas.model]';
data pmr.random2;
 set pmr.season;
array morbid{196} m2-m197;
array random{196} rit2-r197;
```

```
sum2=0;
den2=0;
do l=1 to 196;
 if morbid{l} gt. then sum2=sum2+morbid{l};
 if morbid{l} gt. then den2=den2+1;
  end;
illness=sum2/den2;
drop sum2;
drop den2;
do n=1 to 196;
 random{n}=morbid{n}/illness;
 end;
```

The illness variable represents the morbidity component, M_t. M_t * R_{it} is then divided by M_t (ILLNESS) to leave R_{it}, the random component or unexplained variation, which may be due to the influence of the PMR system. It only remains to examine R_{it} on a case by case basis, bearing in mind the date of the installation of the PMR system and any methods used by the pharmacist to inform patients of its use.

6.3.2 Time Series analysis: Seasonal coefficients

June:	S_t=1.02065;
May:	S_t=1.02278;
April:	S_t=0.94374;
March:	S_t=1.04579;
February:	S_t=0.94728;
January:	S_t=1.01816;
December:	S_t=1.06668;
November:	S_t=1.02077;
October:	S_t=0.99304;
September:	S_t=0.97334;
August:	S_t=0.96183;
July:	S_t=0.96593;

6.3.3 Time Series analysis: Morbidity coefficients

June 1990:	M_t=0.98192
May 1990:	M_t=1.05734
April 1990:	M_t=0.99354
March 1990:	M_t=0.99397
February 1990:	M_t=1.09547
January 1990:	M_t=0.92988
December 1989:	M_t=0.97532
November 1989:	M_t=1.02901
October 1989:	M_t=0.96423
September 1989:	M_t=0.96058
August 1989:	M_t=0.98130
July 1989:	M_t=0.98171
June 1989:	M_t=1.03206
May 1989:	M_t=1.07409
April 1989:	M_t=1.01732
March 1989:	M_t=0.92445
February 1989:	M_t=1.00902
January 1989:	M_t=0.95331
December 1988:	M_t=1.03140
November 1988:	M_t=1.04104
October 1988:	M_t=0.96762
September 1988:	M_t=0.96307
August 1988:	M_t=0.96538
July 1988:	M_t=1.00437
June 1988:	M_t=1.04832
May 1988:	M_t=1.06860
April 1988:	M_t=1.04361
March 1988:	M_t=0.92386
February 1988:	M_t=1.03287
January 1988:	M_t=0.94803
December 1987:	M_t=1.03162
November 1987:	M_t=0.99189

APPENDIX 6.3.3 Model Data

Each group of 32 values represent a pharmacy. Missing values are denoted by a period (.).

```
   .    .  1761 2007 1583 1860 1931 1876 1902 1799
1852 1692 1573 1882 1797 1854 1932 2108 2018 1948
1902 1883 1847 1905 2070 1879 1736 2154 1875 1916
1982 1892
4695 5172 4575 4930 4355 5105 5311 5371 5081 4566
4737 4606 4908 4980 4564 4895 4388 5102 5161 5411
4920 4925 4623 4718 4880 4731    .  5094 4897 4770
4997    .
   .    .  6362 7214 6358 7291 7916 7210 6497 6223
6313 5807 6708 6917 6041 6492 5677 6574 7650 6968
6441 6267 5969 6155 6560 6461 5830 6904 6530 6355
   .    .
   .    .  1956 2271 1953 2189 2121 2028 1963 1773
2045 1897 2056 1979 1829 1886 1874 1871 1875 1764
1728 1622 1696 1541 1639 1589 1575 1751 1535 1543
1544 1408
   .    .  4179 4384 4032 4461 4316 4527 4338 4218
4526 4382 4641 4550 4462 4476 4134 4616 4864 4598
3990 4321 4505 4001 4330 4501 3734 4549 4270 4090
4571 4035
   .    .  3470 3656 3028 3658 3786 3776 3437 3213
3269 3127 3558 3532 3170 3169 3084 3585 3967 4005
3143 3019 3188 2982 3223 3275 3013 3738 3254 3159
3490 3170
   .    .  6175 7035 5946 6593 7534 6950 6480 6509
6491 6299 6655 6756 5941 6843 5839 6436 7029 6760
6581 6597 6414 6082 6347 6036 5695 6836 6745 5982
   .    .
   .    .   806  894  815  768  863  795  789  702
 710  717  790  792  707  717  675  697  809  725
 543  636  638  620  697  536  522  649  562  503
 599  540
   .    .  2645 2784 2497 2915 2630 2774 2680 2433
2319 2514 2684 2757 2432 2354 2205 2411 2476 2428
2555 2389 2523 2340 2811 2388 2349 2888 2726 2503
   .    .
   .    .  3742 4153 3516 4008 3969 4070 3696 3675
3886 3762 3976 3927 3882 3946 3518 3860 4129 3529
3337 3496 3431 3534 3772 3396 3209 3855 3649 3508
3582 3246
   .    .  5531 5941 5155 5712 5967 6070 5821 5714
5737 5884 6193 6119 5608 5923 5218 5638 6002 5910
5683 6065 5621 5684 6085 5662 5621 6749 5852 5750
6307 5816
```

.	.	1537	1467	1787	1673	1870	1913	1681	1511
1690	1590	1834	1917	1521	1611	1460	1541	1716	1652
1476	1417	1376	1665	1589	1736	1503	1852	1797	1578
1726	1566								
.	2712	2763	2797	2416	2780	2736	2728	2573	2500
2457	2451	2632	2719	2523	2574	2428	2440	2808	2689
2554	2558	2434	2347	2419	2286	2194	2465	2355	2070
2471	2004								
.	.	2598	2846	2621	2745	3015	2845	2696	2681
2540	2628	2594	2650	2407	2694	2431	2581	2969	2682
2634	2572	2504	2632	2802	2605	2446	2964	2469	2626
2776	2342								
.	1317	1069	1226	1232	1588	1580	1229	1129	1087
1015	1019	1239	1035	1049	1170	1206	1122	1378	1265
1153	1224	1091	1289	1267	1065	1271	1705	1195	1405
1182	1706								
.	.	2894	3344	2857	3413	3553	3212	3345	3209
3093	2584	3849	3270	3117	3121	2998	3294	3340	.
3145	2777	3146	2726	3456	3026	2944	3597	3204	3502
.	.								
.	.	.	.	.	2357	2471	2553	2266	2004
2049	1924	2036	2042	1920	2083	1998	2124	2398	2390
2006	2217	1953	2125	2277	2215	1990	2544	2328	2288
2604	2421								
.	3975	3700	3950	3400	3850	3750	3650	3700	3130
3600	3700	3650	3750	3475	3650	3250	3450	3750	3600
3450	3375	3425	3600	3450	3550	3300	3550	3250	3050
3350	3200								
.	3099	2831	3094	2764	3329	3094	3074	3024	2657
2835	2959	3181	3123	2776	2872	2684	3036	3134	2976
2772	2629	2769	2883	3124	2921	2411	2037	2781	2727
2945	2825								
.	.	1995	1782	1715	2250	2132	1784	2164	1839
1944	1825	1994	2451	1895	1978	1964	2373	1887	1870
1877	1926	1615	1443	1672	1213	1403	1604	1293	1542
1689	1587								
.	2866	2498	2938	2656	3059	3174	3328	3199	2757
2549	2714	3003	3021	2693	2548	2329	2750	2885	2834
2603	2663	2818	2925	2998	2916	2764	3158	3280	2933
3233	2733								
.	.	3801	4124	3794	4320	3924	3947	4103	3585
4147	3657	3803	4172	3579	3814	3418	3769	3938	3841
3546	3730	3954	3356	3700	3506	3418	3687	3336	3388
3704	3349								
.	3826	3681	3565	2924	3439	3820	3615	3257	3171
3124	3043	3368	3171	3039	3087	2992	3199	3300	3140
2918	3103	2886	2916	3097	2818	2649	3254	3031	3128
3004	2907								
5439	5909	5250	5682	5016	5677	5705	5795	5523	4922
5253	5166	5646	5699	5058	5449	4923	5418	5616	5443
5353	5223	5169	5141	5508	5096	4780	5825	5325	5024
5339	4840								
3128	3097	2795	3485	2880	3204	3441	3114	2944	3021
2937	2768	3212	3042	3082	3229	2925	3127	3374	3142

3101 3061 2913 3116 3003 3064 2969 3597 3309 3586
3697 3330
2804 2889 2544 3087 2743 2898 3146 2969 3018 2773
2515 2550 2840 2797 2589 2627 2470 2641 2960 2936
2783 2486 2495 2535 2668 2442 2367 2739 2431 2543
2912
2601 2573 2348 2568 2311 2378 3016 2690 2374 2384
2259 2379 2486 2556 2327 2462 2254 2383 2810 2591
2311 2514 2414 2462 2669 2356 2372 3019 2655 2511
2808 2307
6348 6860 6089 6503 6010 6793 6331 6666 6735 6358
6726 6588 7057 6845 6253 6520 5740 6756 6683 6631
6254 6265 6361 6064 6364 6469 5306 6514 6367 6095
6354 6093
1709 1632 1571 1822 1560 1936 1828 1902 1781 1736
1566 1649 1804 1773 1703 1714 1541 1768 1811 1766
1689 1737 1725 1833 1901 1781 1670 2018 2164 2055
1816 1860
5436 5461 5832 5452 4740 5477 6211 5396 5127 5236
4894 4744 5444 5542 4850 5390 4491 5244 5478 5000
4857 4704 4497 4709 4958 4440 4262 5144 4865 4828
4815 4765
4611 4345 4026 3566 3922 4646 4628 4440 4377 3978
4167 3860 4578 4051 3841 4049 3803 4319 4280 4432
4149 3838 3897 4067 4278 3911 3891 4530 4216 4647
4509 4141
5861 6153 5540 6167 5656 6251 7003 6702 6468 6385
6483 6342 6633 6340 6136 6712 5833 6348 6827 6674
6281 6814 6466 6526 6929 6439 6163 7485 6550 6241
7340 6065
3045 3498 3327 3568 3069 3503 3594 3230 3158 2805
2737 2833 3016 3074 2784 3036 2842 3217 3429 3466
2993 3125 3247 3133 3466 3299 3119 3537 3199 3294
3695 3326
2680 2561 2491 2641 2376 2665 2834 2816 2814 2515
2361 2429 2448 2576 2621 2447 2375 2553 2790 2662
2392 2530 2081 2268 2424 2069 2202 2634 2381 2640
2522 2247
2202 2470 2383 2218 2217 2313 2370 2587 2134 2192
2050 2264 2313 2190 2025 2113 1872 2144 2171 2022
1989 2142 2122 1975 2312 1952 2106 2192 2296 2017
2274
2692 2886 2620 2926 2461 2973 2803 3158 2805 2705
2662 2686 2872 2747 2578 2616 2385 2818 2825 2755
2715 2722 2594 2658 2797 2707 2465 3148 2709 2725
2697 2693
2044 2165 1884 2260 1934 2132 2121 2193 2071 1771
2049 2004 2259 2153 2043 2191 2017 2092 2125 2111
1965 1930 1940 1826 2254 2043 1996 2395 2069 2091
2252 2024
7186 7770 6881 7665 6720 7901 7725 7455 6990 7029
7227 7084 7407 7374 6723 7198 6541 6777 7542 7583
7087 6997 7223 7232 7329 7119 6429 7676 6802 6592
7228 6384

5072	5533	4848	5378	4822	5165	5326	5019	5103	4854
4550	4873	5133	5345	4906	4951	4286	5047	5158	4685
4686	4823	4894	4822	4906	4955	4533	4283	2707	3166
.	.								
2057	2444	2204	2204	2064	2243	2237	2277	2264	2137
2352	1832	2368	2227	2035	2227	1989	2031	2456	2315
2197	2240	2344	2231	2131	2153	2015	2864	2196	2195
2446	2384								
2683	3915	3590	4292	3713	4340	4905	4741	4213	4124
3779	4014	4003	4145	3934	4026	3801	4177	5055	4563
4326	4049	3917	4310	4327	4109	3826	5163	4293	4483
4944	4379								
2108	2250	1909	2194	1915	2067	2388	2089	1872	1905
1862	2065	1977	1882	1901	1924	1725	1961	2029	1791
1792	1593	1642	1664	1757	1689	1718	1941	1710	1729
1929	1712								
2949	2856	2978	3006	2855	3145	3135	3009	2785	2881
2821	2950	3120	3112	2987	3078	2677	3055	3144	3293
3086	2863	2973	2707	2937	2638	2747	2986	2647	2792
2681	2760								
2246	2611	2465	2457	2299	2715	2515	.	2315	2377
2425	2382	2517	2679	2375	2598	.	2541	2578	2451
2373	2359	2349	2348	2675	2049	2104	2609	2172	2208
2428	2268								
1201	1231	1097	1349	1050	1130	1478	1425	1222	1078
1062	1100	1174	1182	1117	1172	1074	1050	1250	1119
1042	1250	1085	969	1019	1174	1012	1249	1111	975
1183	1199								
5066	4266	4438	4802	4226	4332	5309	4582	4523	4211
4535	4473	5420	4215	4283	4684	4306	5246	4380	4746
5004	4759	4193	4623	4494	4678	4479	5148	4394	4543
5012	4391								
942	1031	933	1011	890	1039	1042	1021	911	957
924	864	977	1033	932	1011	893	901	1092	1021
923	900	1046	905	952	921	814	955	891	800
1001	.								
1748	1993	1629	1893	1657	1851	1597	1662	1608	1360
1562	1444	1612	1526	1412	1474	1349	1339	1579	1122
1013	1044	942	981	1045	884	805	961	850	722
870	681								
2020	2003	1848	2052	1813	2004	2040	2273	1949	1800
1702	1803	2099	1711	1675	1770	1527	1947	1876	1876
1806	1642	1586	1362	1513	1958	1624	1601	2023	1835
1747	1905								
1996	2109	1936	2121	1896	1882	2161	2177	2087	1913
1994	1776	1954	2123	1802	2205	1732	1898	2242	2016
2018	2062	2042	1722	1977	1909	1794	1991	1808	1814
2085	1929								
1903	1941	1785	2042	1814	1873	2069	1712	1837	1793
1840	1722	1999	1903	1711	1883	1616	1744	2040	1781
1562	1836	1783	1591	1986	1799	1673	1945	1785	1636
1943	.								

1940	2230	2281	2304	2186	2416	2310	2209	.	2302
2441	2289	2534	2305	2263	2370	2154	2579	2436	2449
2450	2376	2452	2204	2312	2202	2194	2443	2300	2281
2516	2242								
2783	2749	2579	2738	2391	2697	2962	2673	2877	2544
2787	2633	2809	2795	2556	2900	2547	2746	2880	2789
2688	2719	2503	2445	2562	2685	2928	2501	2510	2851
2320	2518								
6490	6521	6109	6836	5790	6688	6504	6367	6626	6181
5853	5777	6408	6320	5737	6218	5634	6113	6450	6144
5626	5949	5666	6099	5877	5756	5554	6318	5880	5897
6579	5420								
1624	1356	1258	1437	1226	1220	1671	1301	1468	1119
1577	1310	1373	1473	1440	1262	1259	1539	1798	1544
1447	1439	1245	1336	1444	1254	1302	1514	1245	.
.	.								
5539	5434	5175	5740	4786	5221	5375	5977	5572	5131
5153	5307	5506	5405	4859	5462	4753	4632	4962	5439
5308	5478	5430	5497	5673	5357	5217	5425	5465	5325
5246	5561								
3548	3694	3393	3801	3144	3703	3479	3487	3648	3490
3522	3650	3686	3678	3192	3725	3154	3553	3801	3571
3391	3633	3461	3507	3948	3625	3282	4064	3676	3702
3887	3532								
3300	3487	3229	3365	3078	3516	3553	3454	3282	3070
3176	3092	3461	3294	3198	3177	3020	3264	3628	.
.	.	.	.	.	.	.	.	.	.
.	.								
6700	7200	6300	6800	5900	6700	7000	6800	6500	6400
6400	6100	7000	7000	6200	6700	5800	6200	6800	.
.	.	.	.	.	.	.	.	.	.
.	.								
2700	2900	2900	2800	2900	2700	3000	3000	3000	2600
2700	2450	2850	2700	2500	2800	2500	2600	3000	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	2461	2317	2319	2413	2479	2461	2398	2214	2617
2163	2241	2259	2316	2744	2116	2198	2163	1998	.
.	.	.	.	.	.	.	.	.	.
.	.								
2741	2562	2134	2345	2097	2282	2324	2107	2104	2023
1970	1892	1976	1966	1955	1932	1782	1910	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
2381	2351	1845	2065	1855	1923	2031	2203	1883	1883
2002	1781	1911	1989	1697	1815	1670	1870	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
957	932	894	896	763	782	869	870	820	777
700	863	847	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.								

.	1833	1682	1983	1874	1988	2000	2194	2224	1904
1947	2044	2201	2059	1942	2033	1843	2209	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	.	2943	3093	2930	3040	3203	3100	2809	2907
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2804	.	.	.	.	.	.	.	.	.
.	.								
.	.	6295	7096	6198	6972	6931	6824	6629	6196
6299	6096	7050	6232	5951	6584	5864	6346	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	468	469	488	401	499	469	505	495	428
369	404	426	539	409	404	385	420	447	.
.	.	.	.	.	.	.	.	.	.
.	.								
4094	4371	3857	4432	3894	4485	4468	4006	3943	3825
3685	3843	4023	3972	3892	3839	3647	3973	4462	3907
3882	3714	3737	4055	4032	3898	3541	4251	3796	3718
4109	3782								
.	.	.	.	.	.	.	.	7921	7301
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7347	7123	7074	7262	7592	7316	6623	7923	7437	7030
8042	7056								
.	.	.	.	.	.	.	.	.	2800
2695	2673	2719	2705	2405	2400	2161	2449	2510	2505
2280	2166	2005	2092	2259	.	.	.	.	.
.	.								
.	.	.	.	.	.	.	.	4598	4119
4010	4345	4261	4263	3987	4164	4020	4702	4768	4938
4557	4315	4094	4270	4696	4591	4264	5342	4426	4768
5140	4462								
.	.	.	.	.	.	.	.	.	5746
5533	6107	6132	6283	5634	6098	5478	6191	6811	6660
6077	5785	5927	6134	6376	6261	5798	.	.	.
.	.								
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2471	2445	2710	2505	2406	2503	2393	2516	2713	2540
2646	2600	2356	2457	2728	2448	2363	2725	2622	2448
2729	2339								
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3017	3205	3040	3198	3442	3417	2838	3504	3439	3570
3208	3110	3009	3480	3097	3132	2968	.	.	.
.	.								
.	.	.	.	.	.	.	.	.	2154
2215	2018	2213	2091	1877	2023	1777	1907	2076	1929
1842	1809	1727	1728	1816	1801	1539	1899	1829	1658
1977	1618								
.	.	.	.	.	.	.	4513	4241	4117
3643	3956	4323	3879	3699	3980	3563	4000	4252	4028
3722	3961	3630	3790	3896	3701	3514	4013	3698	3633
3892	3429								

.	.	.	.	.	.	.	5402	5449	5236
4809	4700	5379	5431	4732	5378	4508	5230	5453	5024
4835	4553	4281	4805	4974	4450	4269	5150	4797	4750
4928	4802								
.	.	.	.	.	.	.	4873	4680	4806
4337	4371	4914	4646	4210	4485	4048	4790	4730	4695
4537	4731	3656	4125	4731	4347	4115	5219	4914	4734
5041	4738								
.	.	.	.	.	.	.	1984	2129	2136
2017	2273	2211	1967	1998	1887	2128	2168	2064	2025
2200	2028	2060	2138	2120	1904	2462	2096	2107	2222
2045	2248								
.	.	.	.	.	.	.	2156	1823	2240
2286	1943	2133	2131	2241	1799	1802	2163	2120	1700
1740	1803	2133	1772	1702	1732	1726	1702	1601	2120
1690	2140								
.	.	.	.	.	.	.	4886	4870	4660
4698	4569	5155	4784	4370	4965	4359	4693	4517	4715
4051	4154	4141	4140	4381	4317	3832	4806	4151	4040
4451	3880								
.	.	.	.	.	.	.	1850	1800	1813
1629	1639	1729	1798	1755	1665	1490	1624	1679	1481
1419	1485	1484	1472	1413	1396	.	.	.	.
.	.								
.	.	.	.	.	.	.	1688	1648	1852
1740	1609	1598	1827	1744	1605	1551	1459	1436	1554
1651	1484	1655	.	.	.	.	.	.	.
.	.								
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3753	3734	4202	4082	3896	3987	3556	4138	4102	4186
4071	3944	3594	3678	4034	4249	3925	5147	4608	4633
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.	.	.	.	.	.	.	.	.	1932
1872	1752	1743	1910	1642	1688	1663	1800	1770	1956
1651	1690	1561	1674	1968	1746	1651	1964	1830	1656
1827	1686								
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2533	2248								
3706	4043	3552	3732	3530	4115	4025	4027	4133	3621
4061	3968	3967	4236	3826	3916	3988	4047	4001	4166
3950	3878	4175	3927	4129	3886	3583	4405	3900	3973
3996	3792								
2360	2341	2128	2074	2193	1906	2096	2111	2160	2085
1873	2071	2036	2031	1940	1930	1911	1800	1631	.
.	.	.	.	.	.	.	.	.	.
.	.								
1663	1729	1723	1726	1506	1922	1780	1856	1697	1618
1668	1681	1696	1807	1551	1657	1576	1593	1668	1668
1594	1518	1466	1556	1582	1597	1611	1601	1410	1725
1540	1548								

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. .
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1919 2023 1978 1961 1843 1892 1839 1947 2071 1997
2073 2184 2029 1645 . 1943 1643 . 2002 1728
1849 1938 2112 1865 1890 . 1795 1825 1499 1768
1776 .
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3771 3812
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2936 2701

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1500 1403
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4404 4680 4362 4818 4862 4363 4314 4938 4367 4871
4900 4484
2012 2100 2093 2118 1906 2113 2184 2182 2072 1929
1983 2004 1982 1916 1854 2018 1770 1943 2108 1902
1882 1949 1911 1893 2044 1892 1869 2155 1843 1928
2047 1882
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5080 4637
2114 2135 1987 2125 1930 2138 2071 2076 1996 1913
1955 1928 2264 1890 1881 1906 1900 1970 2224 2023
2051 2119 2089 1901 2275 2096 1947 2297 2132 2048
2007 1841
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2570 2849 2698 2783 2651 2733 2478 2841 2668 2945
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2263 2476 2452 2368 2487 2345 2195 2988 2241 2263
2659 2244
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1653 1611 1756 1727 1625 1798 1522 1708 1927 1753
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1838 1763
1814 2002 1710 2027 1745 1934 1855 1911 1950 1798
1656 1796 1924 2045 1853 1967 1785 1952 1938 1932
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4762 4598 4566 4630 4201 4628 4008 4520 4573 4596
4473 4286 4378 4101 4772 4291 4064 4784 4461 4059

2308	2526	2393	2748	2297	2720	2677	2841	2572	2243
2260	2377	2636	2505	2390	2427	2272	2564	2773	2581
2506	2398	2256	2374	2319	2405	2335	2849	2631	2501
2770	2526								
4184	3781	3833	3260	4012	4332	4097	4023	3893	3377
3144	3373	3559	3789	3172	3311	3011	3543	3807	3293
3027	2933	2801	2673	3013	3162	2828	2928	2614	2678
2650	2451								
886	941	791	915	796	910	952	904	828	783
823	815	908	896	800	839	744	769	776	781
735	785	743	692	796	830	709	961	729	750
823	785								
2226	2827	2209	2486	2160	2528	2722	2602	2384	2386
2282	2181	2559	2633	2192	2398	2206	2236	2686	2458
2286	2467	2339	2083	2553	2423	2209	2528	2421	2320
2599	2383								
2249	2460	2081	2397	2211	2462	2855	2516	2365	2108
2304	2060	2172	2287	1935	2028	1990	2134	2126	2222
2216	2022	1838	1851	2009	1962	1808	2185	1979	2083
1817	2003								
1777	1601	1416	1560	1425	1683	1858	1856	1671	1532
1398	1510	1501	1545	1427	1511	1349	1810	1796	1675
1541	1453	1429	1667	1598	1421	1329	1705	1571	1698
1627	1474								
3984	4025	3725	4225	3346	3821	3931	3646	3624	3392
3676	3661	3588	3470	3240	3599	3200	3388	3489	3434
3346	3384	3426	3579	3377	3149	3302	3594	3307	3150
3451	3046								
6065	6244	6129	6201	5912	6750	6911	6008	5849	5821
5492	5530	5704	5855	5382	5614	5587	6050	6171	5470
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5534	5607								
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3068	3052	3483	3339	3049	3299	2842	3155	3384	3153
3196	2964	3089	2959	3016	2938	2900	3145	2849	2617
2948	2710								
2940	3197	2896	3048	2744	3377	3497	3482	3263	3191
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3102	3201	3001	2881	3194	3029	2963	3306	3153	3280
3365	3258								
1444	1396	1189	1220	1182	1190	1431	1297	1283	1093
1054	1039	1131	1217	988	992	996	1103	1106	1202
1016	1025	1097	1149	1092	1145	1030	1264	1104	1142
1221	978								
1113	1079	1047	1066	1040	1160	1134	1157	1139	1000
1005	1065	1126	1156	1119	1064	1036	1281	1207	1296
1069	1083	911	964	1172	1050	1002	1325	1208	1338
1300	1140								
2515	2643	2269	2675	2382	2615	2657	2834	2571	2294
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2326	2268	2072	2455	2432	2358	2292	2587	2424	2447
2484	2336								

1708 2067 1817 2048 1836 1901 1926 1934 1766 1763
1846 1675 1879 1867 1668 1966 1636 1803 2024 1824
1787 1851 1792 1567 1459 1964 1669 1966 1684 1646
1941 1766
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5446 5564 5282 5590 5682 5281 4860 6005 5393 5304
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7470 7212 8156 7852 7419 7745 7097 7443 8606 8380
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5942 5906 5881 5674 5538 5118 5335 5315 6445 5783
6095 5626 5784 5745 5597 5401 5592 6052 5643 5772
6296 5453
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6155 6057 5926 5842 6307 5935 5339 6863 6146 5951
6694 6429
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. 2890 2503 2937 2521 2873 2894 2617 2547 2676
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. 7403 6401 7712 6925 7896 7599 7963 7406 7203
7443 6984 8239 8459 7758 8336 7819 8624 8947 8895
8926 8763 8503 7501 9016 8113 7750 9652 8682 8419
9196 8899

.	2105	1855	1986	1851	2192	2104	1976	1997	1825
1835	1934	1996	1936	1725	1900	1752	2039	1976	2098
1936	2007	1871	1851	2081	1989	1825	2122	1942	1954
1910	1986								
.	.	1330	1475	1128	1612	1507	1405	1265	1217
1228	1214	1346	1374	1289	1299	1195	1390	1403	1401
1323	1285	1311	1337	1341	1305	1385	1373	1279	1343
1485	1369								
.	.	1935	2132	1875	2090	2031	2208	2098	1981
2192	2084	2214	2442	1989	2254	2176	2266	2353	2253
1989	2375	2578	2441	2647	2480	2213	2676	2436	2352
2453	2429								
.	.	5871	6669	5586	6272	6404	6609	6024	6408
6217	5832	6988	6003	5555	6404	5896	5900	6410	6266
6120	6368	5681	5900	6466	5539	5314	6412	5591	6069
6325	5614								
792	970	877	899	811	868	1024	925	935	851
857	896	843	865	786	894	772	802	942	858
839	927	816	747	851	862	790	918	788	741
874	825								
.	.	4006	4439	3736	4652	4684	4753	4382	4123
4219	4011	4539	4376	4032	4130	4089	4887	4891	4679
4423	4489	4188	4166	4654	4276	4031	4671	4550	4557
4826	4653								
.	.	3133	3658	3200	3415	4296	4317	3275	3101
2964	3478	3600	3056	2977	3347	3018	3136	3714	3444
3187	2851	3111	2836	.	3320	3002	3552	3279	3101
3528	2948								
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1926	2077	2207	2325	2085	2206	2057	2221	2480	2282
2256	2125	2220	2044	2353	2009	2239	2336	2217	2201
2006	2078								
.	.	3456	3544	3363	3721	3630	3685	3408	3320
3260	3505	3649	3614	3409	3488	3244	3528	3819	3586
3201	3152	3306	3198	3590	3177	2661	3675	3217	3061
3607	3030								
.	.	2217	2406	2225	2408	2425	2507	2417	2256
2439	2375	2570	2603	2346	2569	2316	2507	2381	2622
2421	2382	2427	2285	2579	2580	2202	2746	2448	2518
2663	2483								
.	1715	1508	1599	1353	1558	1621	1508	1421	1248
1243	1167	1419	1338	1287	1276	1282	1364	1697	1396
1365	1395	1358	1279	1392	1392	1218	1656	1482	1429
1523	1492								
.	.	3034	3364	3007	3314	3538	3234	3096	3417
3061	3284	3466	3320	3283	3417	3100	3301	3713	3397
3283	3221	3152	3332	3370	3184	3156	3557	3244	3271
3506	3048								
.	.	1214	1444	1280	1430	1460	1424	1378	1254
1214	1325	1410	1318	1207	1232	1261	1229	1356	1247
1326	1228	1217	1246	1350	1152	1142	1376	1169	1329
1260	1232								

.	2128	1986	2052	2105	2219	1922	2308	2025	1989
1963	1786	2020	2084	1791	2178	1945	2079	2263	2193
2012	2017	1964	1666	2109	1993	1897	2211	2154	2030
2275	.								
.	3570	3142	3355	3010	3462	3422	3589	3214	2995
3069	2930	3534	3178	2785	3479	2555	3205	2802	3371
3081	3180	3055	2546	3237	3032	2720	3355	2896	3084
3089	3056								
.	1769	1532	1657	1447	1609	1517	1471	1447	1331
1365	1461	1447	1603	1286	1336	1211	1334	1370	1203
1127	1177	1163	1104	1160	1066	1047	1266	1114	1059
1094	1059								
.	.	3719	3803	3370	3968	3831	3712	3590	3604
3471	3519	3801	3918	3493	3623	3193	3594	3725	3650
3529	3458	3201	3603	3482	3560	3200	3877	3523	3566
3518	3233								
.	5676	5357	5515	4986	5882	6398	6251	3808	5252
4867	5178	5598	5516	4937	5532	4884	5899	5945	6256
5613	5489	5091	4993	5795	5134	4939	6469	6103	5580
.	.								
.	.	856	988	940	1022	1086	1006	951	877
828	910	902	987	846	822	888	851	995	919
797	795	765	793	932	793	837	1117	1039	.
.	.								
.	4300	4012	4538	3929	4686	4967	4453	4304	3941
3896	4148	4845	4738	4212	4450	3887	4269	5045	4372
3994	3827	3828	.	.	.	.	.	.	.
.	.								
.	.	2342	2657	2158	2550	2464	2395	2255	2214
2373	2334	2812	2592	2168	2384	2234	2346	2462	2186
2279	2080	2119	2233	2560	2329	.	.	.	.
.	.								
4500	4000	4360	4300	3840	4265	4440	4270	4040	4050
3950	4650	4100	3625	3980	3675	3720	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	.	4057	4287	3432	3830	4100	4085	3682	3731
3794	4126	3812	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	.	3177	3611	2857	3546	4060	3848	3536	3155
3591	3282	3641	3265	3008	3326	3027	3486	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	.	2186	1912	2037	2491	2389	2150	1787	2183
1740	2157	2330	2315	2023	2160	1982	2193	2315	2161
2195	2002	.	.	.	.	.	.	.	.
.	.								
.	.	3228	3665	3119	3671	3547	3450	3393	3372
3217	3458	3593	3665	3086	3289	3099	3125	3521	3091
3294	3059	.	.	.	.	.	.	.	.
.	.								

.	.	3694	3760	3315	3786	3934	3499	3519	3673
3688	3566	3774	3901	3602	3892	3284	3881	3493	.
.	.	.	.	.	.	.	.	.	.
.	.								
.	7273	5907	6695	5953	6406	6653	6473	6508	5998
6028	6488	7142	7028	6002	6615	6036	6464	6841	.
.	.	.	.	.	.	.	.	.	.
.	.								
593	637	546	617	518	582	502	623	644	.
607	552	744	650	628	694	544	644	628	638
.	.	.	.	.	.	.	.	.	.
.	.								
2636	2704	2369	2740	2416	2701	2611	2869	2618	2436
2588	2409	2532	2576	2147	2448	2329	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
3920	4312	3959	4097	4010	4014	4702	4278	4213	4004
4038	4002	4146	4208	3912	4158	3900	3902	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
1621	1623	1489	1752	1502	1641	1732	1741	1609	1511
1460	1488	1459	1568	1510	1676	1466	1641	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
3509	3415	3295	3547	3260	3760	3330	3213	3327	3615
3080	3588	3304	4071	3168	3752	3387	3514	.	.
.	.	.	.	.	.	.	.	.	.
.	.								
1820	1834	1654	1923	1892	1924	1941	1895	1789	1798
1786	1808	2007	1779	1809	1882	1631	1724	1979	1884
1778	1742	1614	1737	.	.	.	.	.	.
.	.								
1450	1592	1439	1580	1394	1696	1605	1763	1586	1565
1478	1565	1776	1649	1440	1777	1434	1742	1838	.
.	.	.	.	.	.	.	.	.	.
.	.								
2621	2862	2462	2523	2267	2493	2414	2404	2302	2286
2355	2188	2551	2367	2216	2320	2068	2264	2597	2400
2257	2338	2300	2281	.	.	.	.	.	.
.	.								
976	919	1003	1041	930	1082	931	1044	1009	863
800	804	837	842	874	750	864	1018	1017	973
897	.	.	.	.	.	.	.	.	.
.	.								
958	976	907	1068	949	1067	1168	965	1017	977
882	941	1085	957	942	961	920	1020	1084	1009
1058	940	925	947	953	952	798	932	.	.
.	.								
2561	2847	2433	2619	2546	2852	2617	2745	2329	2467
2606	2499	2686	2704	2321	2541	2519	2613	2212	.
.	.	.	.	.	.	.	.	.	.
.	.								

2702 2620 2687 2848 2325 2921 2853 2944 2717 2732
2620 2829 2881 2813 2686 2719 2515 2805 2978 .
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1380 1362 1450 1542 1439 1660 1575 1543 1493 1294
1182 1229 1414 1430 1272 1505 1189 1508 . .
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1664 1762 1565 1687 1562 1728 1735 1857 1502 1528
1548 1402 1559 1615 1301 1374 1251 1411 1433 1409
1179 1161 1149 1157 1155 1169 . . . .
. .
. . . 819 716 804 785 858 765 646
687 699 723 705 722 748 589 706 800 .
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3605 3858 3327 3998 3179 3505 3576 3517 3480 3436
3577 3512 3560 3528 3253 3490 3314 3424 . .
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4818 5108 4550 5104 4543 4960 4911 5111 4639 4961
4599 4962 5242 4860 4488 5104 4545 4578 . .
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3628 3250 3150 3495 3005 3479 3818 3307 3178 3297
3249 3016 3567 3321 3098 3353 3114 3343 3782 3282
3078 2978 2915 2896 3515 2911 2607 3363 . .
. .
1126 1252 1133 1187 1085 1255 1257 1228 1173 1032
1074 1018 1071 1104 966 1042 895 969 907 941
807 857 818 830 868 765 690 871 731 649
602 .
3066 3201 3028 3113 2861 2945 3186 3401 2801 3047
2530 2824 3095 3038 2712 3047 2568 2902 3094 2835
2916 2962 2838 2667 2916 2680 2820 2998 2823 2753
3039 2736
. . . . . . 3189 3022 2948 2891
2432 2781 2823 2973 2497 2744 2503 2758 2759 2661
2691 2463 2329 2501 2474 2389 2315 2695 2559 2496
2655 2483
. . . . . . 3650 2974 3355 2653
2935 2991 2846 3059 2852 3469 2589 3301 3017 2737
2720 2497 2539 2997 2790 3069 3077 3233 2679 2567
3042 2325
. . . . . . 2665 2475 2528 2385
2635 2360 2691 2724 2340 2367 2350 2552 2695 2595
2472 2523 2510 2802 2020 2613 2517 . . .
. .
. . . . 1421
1350 1285 1405 1399 1296 1216 1226 1435 1339 1391
1402 1462 1440 1317 1372 1368 1310 1531 1402 1398
1528 1461

.	.	.	.	.	.	.	1753	1771	1609
1600	1778	1655	1720	1478	1661	1539	1800	1737	1721
1421	1534	1405	1613	1618	1503	1379	1841	1602	1611
1682	1668								
3050	2911	2559	3285	2762	3030	2732	2455	2570	2548
2616	2528	2766	2802	2329	2790	2359	2433	2621	2301
2177	2367	2128	2255	2317	1981	1770	2130	1748	1661
1719	1460								

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