Framework for modelling dental workforce and building for the future

Characteristics of the demand dynamics for dental services
This report, the fourth in a series of Workforce Planning Reports published in Scotland since 2000, provides both an essential context for the development of Dental Services in Scotland and detailed workforce information on which we can take decisions about the future configuration of the workforce, in order to meet the demands of our population.

Of particular note is the utilisation model in Chapter Four which has been developed to predict the future number of dentists required to service the population, and importantly highlights the potential future contribution of Professionals Complementary to Dentistry.

I commend all those involved in the production of this valuable report and I am pleased to recommend it to you.

Malcolm Wright
Chief Executive, NHS Education for Scotland
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Dr J S Rennie
June 2004
EXECUTIVE SUMMARY

Part I
Background and Oral Health in Scotland

Background – Chapter 1

NHS dental services in Scotland are challenged with adapting to the needs of the population in the face of changing demographics and oral health, at the same time as the dental profession is undergoing profound changes. These issues are having significant impact upon the demand for and supply of oral health care.

Workforce planning requires a ‘whole systems’ approach and it is recognised that the system of delivery of oral health care has many of the characteristics of a complex adaptive system.

Workforce planning is a continuous process and is not an exact science. Work to improve the quality of routinely collected data is ongoing.

This report is the fourth in a series of workforce planning reports published in Scotland since 2000. It aims to explore the number and shape of the workforce required to meet the needs of the oral health care system in Scotland now and in the future.

Oral health – Chapter 2

Trends in oral health can be derived from epidemiological data obtained through national surveys, in particular those carried out by the Office of National Statistics, the British Association for the Study of Community Dentistry and the Scottish Health Boards’ Dental Epidemiological Programme.

These show that overall the dental health of Scotland’s children has improved over the last 30 years. For example, the proportion of children with no obvious decay has increased from 40% in 1993 to 45% in 1999. Despite this improvement well over half five year olds in Scotland in 2003 had some dental decay, with those from deprived communities bearing the greatest disease burden.

The oral health of adults in Scotland has improved markedly over the last 30 years and this trend is likely to continue. In future, fewer adults will be without teeth (edentulous) and more will retain more teeth into their older years.

The Adult Dental Health Survey shows trends of reducing edentulousness with greater proportions of people retaining a functional dentition (i.e. having 21 teeth or more). Projections show that the proportion of edentulous people over 65 years is expected to reduce from 55% in 1998 to 20% in 2028.

The evidence implies that improvements in oral health tend to be associated with increased utilisation of dental services, but the relationship is not as straightforward as it might seem and there are a number of potential explanations for this association. Firstly, improved oral health causes increased utilisation of dental care. Secondly, increased utilisation of dental care causes improved oral health. Thirdly, other variables, such as socio-economic changes, may be leading to improvements in oral health and in the utilisation of dental care.
Part II
The Supply and Utilisation Models
Supply model – Chapter 3
The General Dental Service (GDS) supply model which predicts future numbers of General Dental Practitioners (GDPs) has been updated with the addition of the latest data for 2001, 2002 and 2003. These data suggest that dentist numbers (headcount) have continued to increase in the three most recent years.

The principal model projection shows that the number of GDPs will rise from 2,007 in year 2003 to 2,224 by year 2010, to 2,328 by year 2015, and 2,455 by year 2036.

The data show that the percentage of female dentists is expected to rise from 35% in 2002 to 49% by 2036. This is driven by the increase in the percentage of female Vocational Trainees to 65%.

Although not modelled, it should be noted that approximately forty oral health therapists per year will be produced in Scotland from 2007.

The utilisation model – Chapter 4
A utilisation model has been developed to predict the future number of dentists required in Scotland. The model is based on a level of utilisation derived from data for the period of 1997 to 2003. As such, the model is not able to consider unmet demand and/or need that may currently exist in dental service provision. The projections are based on the assumption that the characteristics of dental service provision will remain constant in the future. The model considers only the General Dental Service.

The model can be broadly understood as using historically observed patterns of patient attendance, treatment received by patients, and dentist provision of treatment, considered by age and sex of patients/dentists. These characteristics are combined with projected population information and epidemiological trends to determine the number of dentists required in future.

The utilisation model output does not account for the contribution that Professionals Complementary to Dentistry (PCD) could make to the dental service provision. This is because the information required to reliably predict future numbers of PCD is not available. The contribution of Vocational Trainees (VTs) is also not modelled.

It was found that the quantity of treatments provided by dentists varies by dentist age/sex and type of remuneration. For example, female dentists provide fewer treatments than male dentists, and the average salaried dentist provides 40% of the treatments that the average non-salaried dentist provides. The future age/gender construct of the dentist workforce as predicted by the supply model (Chapter 3) is factored into the utilisation model for the calculation of how many dentists will be required to provide a given amount of treatment.

Outputs from the model indicate that Scotland will need more dentists in the future (Figure 4.14). The projected increase is from 2,223 dentists in year 2003 to 2,592 dentists in year 2036 for the principal (Medium) scenario. A range of outputs (Low and High) is presented to reflect the
uncertainty of these results arising from variations in the historic data.

Comparison of utilisation model outputs with supply model outputs (Chapter 3) provides information on how the projected supply is expected to change relative to utilisation requirements. Should the supply increase at a greater rate than the utilisation requirements, this would suggest an improvement in the level of service being provided.

Results suggest that the utilisation model’s projected rate of increase in GDP requirements is at least matched by the supply model’s projected rate of increase in GDP numbers for the next 12 years. The principal model outputs suggest a shortage of 215 GDPs in 2003, which would reduce to 140 by 2014.

Scenarios to consider the effect of increased VT joining rates, and the contribution of an additional twenty-five PCD per year, show that the predicted shortage of GDPs required to provide the historically derived level of service would be eliminated as early as 2010. In addition, a scenario which examines the service contribution of 120 VTs demonstrates that the 'gap' could be closed by 2008.

Sensitivity analysis of the utilisation model output highlights that one of the main drivers behind the projected increase in the number of dentists required is reducing edentulous rates. The greater maintenance burden of increasing tooth retention amongst the population is clearly a significant issue in workforce planning for dentistry.

It is important to bear in mind the limitations in making any prediction of workforce requirements. The inherent unknowns in such work emphasise the importance of continued data collection to provide additional evidence for ongoing workforce planning.
Part III

The Demand for Dental Services

The utilisation forecasts described in Part II represent an estimate of the trend in aggregate utilisation of dental services over time. In contrast, Part III considers the demand for dental services by individuals. The purpose of this part of the report is to identify and estimate the effect of factors that determine an individual patient’s utilisation of dental services. These factors have not been explicitly included in the aggregate utilisation forecasts of Part II.

Part III provides a framework for analysing the demand for dental services (Chapter 5), reports the key results from the existing literature (Chapter 6), and estimates the utilisation of dental services in Scotland using two good-quality data sources (Chapter 7).

The results from Part III could be used in combination with the aggregate utilisation model in Part II to compile a picture of the utilisation of dental services in Scotland. In the future, the results from Part III will be integrated into the aggregate utilisation model of Part II and the combined data will form the basis of future forecasting models.

An overview of the demand for dental services: Theory and evidence - Chapter 5 & 6

The conventional framework within which economists evaluate the demand-side of markets for goods and services is that consumers (patients) determine the amount of services to consume by comparing the costs and benefits of consumption (treatment). The benefits of dental treatment might include the arrest of pain, a reduction in the probability of pain in the future, or an improvement in aesthetics. The costs might comprise absence from work, travel costs, and the patient charge. In general, the factors that determine the relative costs and benefits of consumption are prices, income and personal preferences.

In response to changes in the relative costs and benefits of treatment, patients may adjust their utilisation of dental services in terms of the frequency with which they attend for dental treatment and/or the amount of dental services used when they attend.

In general, patients are unlikely to be perfectly informed about either the cost or the benefit of dental treatment and consequently the amount of dental services used per attendance or course of treatment is more likely to be determined by the dentist. The situation in which providers of services have more information than the purchaser is termed asymmetric information. This asymmetric information suggests that changes in the relative costs and benefits of treatment will have more impact on the frequency of attendance than on the treatment patients receive when they attend.

A review of the international research evidence suggests that the main determinants of the utilisation of dental services are: the prices of dental services, the income of patients, the patient’s preferences for oral health, demographic factors, the number and type of other available insurance contracts, the number of local providers and the method of provider payment.
However, applying the results of this evidence to dental services in Scotland should be conducted with some caution. All the results reported are a function of the particular environment in which they are observed. The environment differs markedly across countries particularly between Scotland and the US (the predominant source of the results). Thus, to reflect the particular system of dental services in Scotland, robust estimates of the utilisation of dental services in Scotland need to be based on Scottish data.

The utilisation of dental services in Scotland – Chapter 7

Two good-quality data sources were used to estimate the relationship between the utilisation of dental services in Scotland and its determinants.

The British Household Panel Survey (BHPS) is an annual survey of each adult (16 and over) member of a nationally representative sample of more than 5,000 households in Britain. The BHPS is unique in that it enquires about individuals’ utilisation of public and private sector dental services. In particular, the BHPS asks if the respondent had a dental examination in the last year and, if so, was it provided by the NHS, privately or both?

Table 7.2 suggests that the utilisation of public sector dental services has remained constant while the utilisation of the private sector dental services has increased significantly in recent years. Consequently, the percentage of people who do not use dental services in any year has fallen considerably.

Table 7.2: Utilisation of public and private dental services in the UK

<table>
<thead>
<tr>
<th>Wave</th>
<th>No exam %</th>
<th>NHS exam %</th>
<th>Private exam %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>45.25</td>
<td>48.46</td>
<td>6.29</td>
</tr>
<tr>
<td>1992</td>
<td>46.25</td>
<td>47.36</td>
<td>6.39</td>
</tr>
<tr>
<td>1993</td>
<td>44.18</td>
<td>47.37</td>
<td>8.46</td>
</tr>
<tr>
<td>1994</td>
<td>42.91</td>
<td>48.14</td>
<td>8.95</td>
</tr>
<tr>
<td>1995</td>
<td>41.84</td>
<td>47.63</td>
<td>10.54</td>
</tr>
<tr>
<td>1996</td>
<td>41.23</td>
<td>47.19</td>
<td>11.58</td>
</tr>
<tr>
<td>1997</td>
<td>42.44</td>
<td>46.80</td>
<td>10.75</td>
</tr>
<tr>
<td>1998</td>
<td>39.73</td>
<td>47.98</td>
<td>12.29</td>
</tr>
<tr>
<td>1999</td>
<td>39.82</td>
<td>47.44</td>
<td>12.73</td>
</tr>
<tr>
<td>2000</td>
<td>38.96</td>
<td>47.74</td>
<td>13.29</td>
</tr>
<tr>
<td>2001</td>
<td>38.53</td>
<td>48.05</td>
<td>13.42</td>
</tr>
</tbody>
</table>

1 These results are generated from the first 11 waves of BHPS. Individuals’ responses are included in the sample if the respondent answered either yes or no to the question about the use of dental services.
One of the main results from the analysis of the BHPS was to identify the role of previous utilisation on current utilisation. Patients who used dental services in one sector – public or private – were highly likely to return to the same sector in the next period. In contrast, the chance of switching sectors is very small. This suggests that there is a great deal of persistence in the use of dental services.

The Management Information and Dental Accounting System (MIDAS) records information on the NHS treatment provided in the GDS over a number of years. MIDAS was used to estimate the relationship between the utilisation of General Dental Services and the characteristics of individual patients and their treatment using a 1% sample from 1997-2002.

Analysing individual-level dynamic data from MIDAS revealed interesting patterns of utilisation that aggregate or cross sectional data could not identify. In particular, whilst about 50% of Scottish adults use the General Dental Services in any single year, over a period of 6 years almost 80% of adults use the NHS General Dental Services.

The MIDAS results also suggested that the patterns of utilisation were significantly affected by the demographic and socio-economic characteristics of an individual as measured by their age, sex, location and deprivation category.

The accuracy of the predictions from these results was assessed by comparing the actual pattern of utilisation with the expected pattern of utilisation derived from two different methods of predicting utilisation: one that accounted for the persistence in the utilisation of dental services and one that did not. These comparisons suggested that models that account for the persistence in the utilisation of dental services yield very accurate predictions.

Caveats

In common with all modelling experiments of this nature the results must be interpreted with some caution because of the assumptions upon which the results are based. The key assumptions to bear in mind and their implications are:

- Estimates of patient attendance and treatment patterns, together with dentist provision characteristics, are based on recent data. Any interpretation must therefore be considered within the context of the GDS in Scotland

- Estimates are based on the current framework of dental services in Scotland. This may change markedly as a consequence of the current consultation on Modernising NHS Dental Services in Scotland (Scottish Executive, 2003). Thus, changes in the GDS that involve adjustments to the system of patient charges or to the system of remunerating dentists may have large impacts on the level of utilisation of dental services

- A number of factors (Chapter 7), that are important determinants of the utilisation of dental services are currently excluded from the modelling experiments. In particular, the results of Chapter 7 imply that individuals’ income is a significant determinant of utilisation. The expected upward trend in income is likely to impact on the utilisation forecasts
The forecasts should not be used in isolation but rather in combination with other indicators in order to generate a more integrated picture of the future utilisation and provision of dental services in Scotland.

Workforce planning in Scotland cannot be viewed in isolation from the rest of the UK or Europe. The pie chart illustrates the overwhelming size of England in terms of registered dentists. Clearly difficulties with supply in England could have a major impact in Scotland. Currently Scotland produces twice the number of dentists per head of population compared to England.

Finally, robust workforce planning in Scotland depends on the Scottish Parliament deciding the purpose of the future oral health care delivery system. For example, the workforce requirements of a system which provides dental care free at the point of use to all, and all treatments, will be quite different from a system which delivers a core service with the cost of more complex treatments being the responsibility of patients.

**Future work**

We are conscious that workforce planning requires a continuous process that takes account of Scotland’s particular dental health needs. In many ways these are different from the rest of the UK. To secure Scotland’s dental workforce, these differences must be taken into account and built into the planning process.

The next phase of the project will involve further development of the model. In particular, the team will further develop the supply model; assess the feasibility of integrating Parts 2 and 3 of this report to generate more accurate forecasts of utilisation; conduct a variety of scenario planning exercises to estimate the impact of policy change; assess the feasibility of using this approach at regional, rather than national, level; and assess the costs associated with expanding the dental workforce.

There is a long-term commitment to develop the quantity and quality of information upon which the project is based.
**Model development - supply**

The supply model requires to be developed, this should consider the role of dental hygienists and oral health therapists. Other PCD groups should be considered in the future.

A system of graduate tracking would help to monitor and evaluate the development of young graduate dentists and how they contribute to the dental workforce in Scotland.

A more detailed analysis of the determinants of flows in and out of the dental workforce in Scotland should be conducted.

Future work will look to develop planning at regional levels to address need and demand in areas of socio-economic deprivation and rural / remoteness.

**Integration of aggregate and individual level data**

In the future, the results from Part III will be integrated into the aggregate utilisation model of Part II and the combined model will form the basis of future forecasting.

**Scenario planning**

The model may be used to forecast the impact of NHSS policy changes on the utilisation of dental services and the dental workforce. For example, this could include an assessment of the impact of:

- "Modernising NHS Dental Services in Scotland" – changes as a result of the Scottish Executive consultation
- NICE (National Institute for Clinical Excellence) Clinical Guidelines: "Dental recall: recall interval between routine dental examinations"
- The proposed introduction of free dental check-ups
- Changes in emphasis of treatment philosophy from restoration to prevention
- Introduction of population based health improvement measures (e.g. water fluoridation).

**Information development**

The accuracy of the forecasts from the models developed thus far is a function of the quality of the data upon which they are based. Chapter 7 clarified the value of collecting individual-level, integrated data and important avenues for future research and development include:

- Developing primary care IM&T systems that enable the integration of routine oral health and utilisation data
- Integrating more private sector data
- Developing IM&T systems that enable the integration of data across NHS dental providers (GDS, HDS and CDS).
1. BACKGROUND TO THE REPORT

1.1 Introduction

The shape of the system for the delivery of oral health care in Scotland is changing as a consequence of fluctuations in the demand for and the supply of dental services. This process of change is expected to continue for the foreseeable future.

Within Scotland, the NHS, through the General Dental Services (GDS), is the major provider of oral health care. GDS expenditure accounts for approximately 75% of the costs of all NHS Dental Services in Scotland. The General Dental Practitioners (GDPs) and their practice teams are a valuable resource, but recent reports indicate that the distribution of NHS dental care is variable, with shortages reported in rural and remote regions, and unmet need described in areas of socio-economic deprivation. The unmet need and shortages of dental services have been highlighted in media articles, parliamentary questions and national surveys of dentists. Difficulties around access to NHS Primary Care Services, poor oral health and the delivery of dental care to rural and remote communities have added focus to this work which aims to understand better the factors which are shaping the dental workforce.

Workforce planning attempts to balance the numbers of trained professionals (the supply) with the demand for their services (the demand), and the traditional approach to workforce planning generally adopts a reductionist approach to both supply and demand sides of the planning equation. In essence, supply and demand are broken down (reduced) into their constituent elements and factors which impinge on those elements are adjusted in line with the best evidence on prevailing and future trends. A good example would be student numbers, where the output is known from historical data and future numbers are set by Government policy. Planners can alter these figures to model the effects of changes in student output. Other known factors like gender and emigration rates can also be taken into account. This analysis is important as it helps build an understanding of workforce dynamics and supports planning and redesign of service. It also enables planners to communicate with policy makers and the public.

However, a reductionist approach assumes that workforce planning and design is a complicated but predictable system, when in reality workforce planning for the health service requires a ‘whole systems’ approach. It is now recognised that the ‘whole system’ is more than complicated but is complex and adapts to change. The difference between complicated and complex systems, can be explained by using the analogy of building an engine. With a manual, the correct tools and enough time, an engine can be assembled to a working machine. It can then be broken down into its constituent parts and the process repeated. In this complicated system, there is a predictable relationship between the different parts of the system.

However health care systems are more than complicated; they are complex and adapt to a wide range of factors, such as government policy, (e.g. the internal market and socio-economic changes). Complex systems are systems which consist of multiple components and the interaction between components can produce unpredictable behaviour. Complex systems are greater than the sum of their parts, they cannot be
replicated precisely and exhibit behaviour that is unpredictable from analysis of the sum of their parts. With respect to healthcare, Plesk and Greenhalgh (2001) define a complex adaptive system as a ‘collection of individual agents with a freedom to act in ways that are not always totally predictable and whose actions are interconnected so that one agent’s actions changes the context for other agents.

In considering the delivery of a dental workforce fit for purpose, Figure 1.1 demonstrates some of the factors which impinge on the delivery of oral care. However there are many more factors and the two-dimensional diagram could be portrayed in three dimensions with further spheres interacting, e.g. socio-economic and gender balance. It should also be recognised that each sphere is made up of multiple elements which also interact.

**Figure 1.1 Factors affecting the dental workforce**

In producing this report the dental workforce project team recognise that there is a tension between the untidiness, the unpredictability and the socio-demographic complexity of the whole system and the need to understand, forecast, and communicate what is happening. Thus this report describes a model to help understand workforce dynamics. The model is relatively simple and is based on the best evidence available. It is designed to inform key stakeholders and policy makers.

This document is the fourth in a series of workforce planning reports which have been published in Scotland since 20001, 2, 3. This report takes the recommendations of the earlier reports into account and builds on the work carried out by the Scottish Council for Postgraduate Medical and Dental Education (SCPMDE) and the Information and Statistics Division of NHSScotland (ISD) that was published in 2002. This report provides a framework on which development of a model of the whole system has been started, but this work should be seen as part of a continuous process and a learning experience.

It should be noted that work to improve the quality of data collected in Scotland is an on-going process as the data provide the detail to allow modelling to be undertaken. In this respect a number of research projects are underway to build on the evidence base and improve the validity of the model. However the project team believe there is merit in publishing the framework and the analysis generated at this stage to inform discussions on, and policy development of, workforce planning in Scotland.

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2 Education and Training of the Professionals Complementary to Dentistry in Scotland: Summary and Recommendations of Working Group Report, Scottish Executive Health Department, February 2002.
1.2 Project principles
This project is underpinned by principles drawn from policy documents produced by NHSScotland, from workforce planning guidance and from the wider literature. However, the approach taken has emerged primarily from our analysis of the issues and the aim of improving the evidence-based information available to allow the dental workforce to be planned more effectively. Effective workforce planning is based on at least three key principles:

Transparency
The modelling framework should be simple to use and understand, user-friendly and be operated by means of an easily understood guide.

Robustness
The most reliable data sources available should be sought and used. It should be understood that workforce planning is not an exact science and it follows that the findings should be interpreted with an understanding of the difficulties inherent in planning for complex adaptive systems.

Continuity
Workforce planning is a continuous, iterative and evolving process. A long-term view of workforce development is required; data should be regularly monitored and evaluated, and policy adapted where appropriate.

1.3 Policy context and direction
“Our National Health” published by the Scottish Executive Health Department (2001) set out the policy imperatives for improving Scotland’s health. Workforce planning guidance for the NHSScotland workforce has been published in “Planning Together- Final report of the Scottish Integrated Workforce Planning Group” and “Response by the Scottish Executive Health Department” (2002). “Working for Health” (2002) builds on this work and aims to define clearly the actions required to take forward the recommendations of “Planning Together” (2002). Both of these documents emphasise the importance of integrated planning running in tandem with multidisciplinary team development, but also note the need for a uni-professional focus in setting targets for supply.

In addition, there are a number of key strategic indicators, which arise from a raft of Government policy published since 1997. These include the development of partnership working, the requirement for developments to be based on best evidence, and the recognition of workforce planning as a critical requirement of successful service delivery.

The Wanless Report (2002) sets out in great detail what trends and societal changes are likely to affect the health care system in the UK over the next 20 years. The report describes that patients of the future will:

• be better informed and more educated
• not have enough time to get things done
• be more affluent
• be less deferential to authority and professionals
• have more to compare the health service against, and
• want more control and more choice.

Wanless also considers that patients expect the health service to provide:
• safe, high quality treatment
• waiting within reason
• comfortable accommodation services
• a patient-centred service with more choice.

It is likely that the above trends will shape Government policy on the development of the NHS and will inevitably influence the demand for and the delivery of dental services.

The Wanless Report also notes that in line with other parts of the UK, Scotland will experience a steady increase in the number of elderly people. The “Strategic Review of Dental Workforce” (2000) noted that in the year 2000, there were one million more people who required regular dental treatment than in 1972. It is likely that for the foreseeable future, demand for general and specialist dental care in Scotland will continue to increase, but the measurement of demand and trend analyses are challenging tasks.

Workforce planning is a key issue in the development of dental services and this is acknowledged in the “Action Plan for Dental Services in Scotland” (SEHD 2000). The Action Plan aimed to develop the dental workforce through new models of service delivery and health improvement measures.

The report recognised that there needs to be strategic planning to help define the size and shape of the primary care dental workforce.

The first dental workforce report “Workforce Planning for Dentistry in Scotland – A Strategic Review” (2000) explicitly recognised that a whole dental team approach to planning was required. Recommendations were made with respect to developments for the Professionals Complementary to Dentistry (PCD) and for increasing undergraduate numbers. Both of these recommendations are being delivered.

The more recent report, “Workforce Planning for Dentistry in Scotland” (2002), looked at the characteristics and supply dynamics of the dental workforce in Scotland. It demonstrated that previously, planning of the dental workforce in Scotland had not necessarily been based on robust evidence and recognised that future planning should include demand side analyses.

In addition to the reports which deal with dental workforce, aspects of PCD workforce planning have also been considered. The published reports highlight the development of a new type of professional who will have the ‘core’ periodontal, restorative and preventive skills to enable them to become key players in a team approach to the treatment and prevention of dental disease.

1.4 Aims
The overarching aim of the project is to provide a more evidence-based dental workforce planning mechanism, which will support decision making and priority setting in dental workforce planning in Scotland. The project also explores the number and
shape of the workforce required to meet the needs of dental health services in Scotland now and in the future.

This project takes a national (all Scotland) perspective of the dental workforce and prepares the way for more local level workforce planning that could be used specifically to address the problems faced by remote, rural and deprived communities.

1.5 Objectives
The objectives of this project are to:

• update and modify the dental workforce supply model

• assess the key demand factors for dental services

• determine and model demand for dental services

• determine, based on best evidence, whether or not there is a gap between supply and demand.

This report reviews the latest published evidence, assesses the data sources available and their interactions. It must be remembered that workforce planning is a continuous process and that work in Scotland is ongoing.

1.6 Project management
This project was jointly managed by NHS Education for Scotland (NES) and the Information and Statistics Division of the NHS National Services Scotland. The project was overseen by the Dental Workforce Planning Steering Group (Appendix I). The Steering Group established links with the Scottish Advisory Committee on Dental Workforce (SACDW) through the Chief Dental Officer. SACDW is responsible for advising the Scottish Executive on dental workforce matters.

Initial model and data specifications were prepared on the basis of existing data sources and evidence from the literature. Networking and information sharing was achieved through seminars with dental workforce experts from the Departments of Health in England and Wales, the Dental Health Services Research Unit (DHSRU) and the ISD ‘Whole Systems’ project. In addition the project consulted key individuals with an interest and expertise this field (Appendix II).

Day-to-day management of the project was carried out under the guidance of the project team (Appendix III).

1.7 Overview of the report layout
Of necessity this report contains a great deal of information on work designed to better understand the drivers of demand for dental services. To help the reader navigate through the report it should be considered in three parts.

Part I Background to the Report (Chapter 1) and Oral Health in Scotland (Chapter 2)

Part II Chapter 3 provides an update on the supply model published by SCPMDE and ISD in February 2002 and includes data for three further years. It also includes analysis of the effect of recent policy changes on dental student and VT numbers.
Part II  Chapter 4 describes a model which is used to examine what dental workforce (numbers) will be required to meet current levels of utilisation given the known drivers in the system for which there is robust data available. The last section brings together the supply and utilisation models and, by applying different scenarios, attempts to forecast the number of dentists that may be required in Scotland in the future.

Part III  Chapters 5, 6 and 7 consider the demand for dental services in Scotland. Demand is considered from an:
- economic view (Chapter 5 & 6)
- examination of current utilisation of dental services (Chapter 7).

1.8  References


2. A REVIEW OF RECENT TRENDS IN ORAL HEALTH IN SCOTLAND

2.1 Introduction
One of the key issues that forms the background to workforce planning for dentistry in Scotland is the current and future oral health of the population. As with other areas of health care delivery, changes (improvement) in health are associated with changes in the demand for services and in the shape of delivery of services (Wanless, 2002). It is widely acknowledged that there has been significant improvement in oral health in the UK (Nuttall et al, 2001) and the aim of this Chapter is to use existing data sets to describe trends in the oral health of children and adults in Scotland.

The information presented in this section is routinely collected and can therefore be updated on a regular basis. These data describe the current position of oral health in Scotland, project the likely trends, and expand the evidence base upon which workforce planning can be conducted.

2.2 Children’s oral health

2.2.1 Introduction
Within a UK context, the dental health of Scotland’s children is poor, and there are inequalities in the distribution of dental caries. Trends in the level of dental disease among children in the UK are well documented. National surveys of children’s dental health have traditionally been undertaken every 10 years by the Office of Population Censuses and Surveys (OPCS) – now the Office of National Statistics (ONS). These surveys are complemented by annual caries prevalence studies of wider groups coordinated by the British Association for the Study of Community Dentistry (BASCD), and in Scotland, between 1987 and 1999/2000 by the Scottish Health Boards’ Dental Epidemiological Programme (SHBDEP) – a joint venture between NHS Boards and the Dental Health Services Research Unit (DHSRU) at Dundee. This programme has been superseded by the National Dental Inspection Programme (NDIP) which began data collection in 2002/2003.

2.2.2 Results
The dental epidemiology surveys consistently demonstrate that, together with children in Northern Ireland, Scottish children have more caries than children elsewhere in the United Kingdom. The results of surveys of 5-year-olds provide the most sensitive barometer of change.

Figure 2.1 shows a general view of dental health and the trend in caries prevalence, using the percentage of 5-year-olds with no obvious decay. The latest data from the current survey (2002/03) appear to add to the overall picture of a levelling of the rate of improvement in dental caries prevalence, a phenomenon which is being increasingly observed in other areas of Europe (Marthaler et al, 1996).
Figures 2.1 and 2.2 suggest that for the foreseeable future it is reasonable to expect that the caries experience of 12 and 14 year-old children will continue to improve (albeit at a slower rate) and that the caries experience of 5-year-old children will remain static.1

1 Trends in the make-up of the component parts of the Decayed Missing and Filled Index suggest that the provision of fillings has declined markedly, whilst untreated dentinal decay has risen. This Care Index (ratio of filled to decayed teeth) fell markedly in the early 1990s and is yet to improve, to the extent that less than 10% of carious cavities in 5-year-olds are restored.

14 year-old children, the oral health of 5-year-old children has remained almost constant over the last 20 years.
2.2.3 Inequalities in dental health
The trends in caries experience mask a polarisation of the caries problem in Scotland. Most of the disease experience (76%) is found in a minority of the children (26%), with those from the most deprived areas having a greater dental caries burden compared to those from more affluent areas (Todd & Dodd, 1985 and NDIP, 2003). There is a close correlation between caries levels and Carstairs’ deprivation category –

2.2.4 Future trends in dental caries in children
Cross-sectional epidemiological surveys provide a snapshot of disease levels in a community and their data can be used to predict disease trends. A cohort model was built, based on previous work by the DHSRU in 2000 (Nugent et al, 2000), which utilised dental data collected at age five (Todd & Dodd, 1985, NDIP, 2003 and Nugent et al, 2000) to predict experience of

![Figure 2.3: 2002/2003 NDIP survey of 5-year olds - % caries free or with no obvious decay by Deprivation Category (DEPCAT), and the level of the National Target for the year 2010](image)

* Level 1 is most affluent: level 7 is most deprived

DEPCAT (McLoone, 1991), first reported by SHBDEP (Sweeney, 1997). Moreover, when comparing children in Scotland with children from the same socio-economic background in the rest of the UK, dental caries is more prevalent in children from Scotland (NDIP, 2003). This suggests that the National Target of 60% of children ‘caries free’ will be harder to reach in children from deprived communities (Figure 2.3).

It must be noted that these projections do not take into account the impact of preventive measures, introduced by Scottish Executive Health Department since 2000, in an attempt to address this problem, including community-based and dental service initiatives. The projections are modelled primarily on historical trends.

12 year-olds in 2009. These projections follow the 5-year-old cohort as they become 12 year-olds. From the preliminary analysis, (Figure 2.4) it can be seen that the dmft of 12 year-olds is expected to fall, as the trend in caries experience of 5 year-olds had slightly decreased towards the end of the last century. However, this improvement is set to be all but wiped out with the marginal deterioration seen in 5 year-olds in 2002/2003 (Figures 2.1 and 2.2).
2.2.5 Conclusions
The data presented in this section of the report shows there has been significant improvement in children’s oral health. However, Scotland still lags behind the rest of the UK and in 2003, well over half of Scottish five year olds had some dental decay, with those from deprived communities bearing the greatest disease burden.

Unless recently introduced preventive measures at both clinical and community levels are effective, the projected trend of caries experience for these children and those that succeed them will at best remain at its current level or more likely will deteriorate. The effects of the new preventive measures will be known in the next few years.

2.3 Adults’ oral health

2.3.1 Introduction
The purpose of this section is to examine the trends in adults’ oral health. Data from the Adult Dental Health Study (ADHS) data provides an analysis of trends over 30 years. In general, the dental health of adults in Scotland is improving (SNAP, 1997).

2.3.2 Data description
The most reliable epidemiological data come from the ADHS, which are UK-wide cross-sectional studies undertaken by the ONS every ten years. Scotland has been included in the last three surveys, i.e. 1978, 1988, and 1998. The initial survey in Scotland was carried out in 1972. Information relating to Scotland is presented in the UK surveys as national data, since the sample sizes are insufficient to allow breakdown of the data to NHS Board level.

2.3.3 Results
The dental health of adults in Scotland is poorer than in the rest of the UK, but considerable improvements have been made since 1972 (Nuttall, 2001). Overall, 18% of adults in Scotland were found to be without teeth (edentulous) in 1998, compared with 44% in 1972 (Figure 2.5).
This decreasing trend in edentulousness is seen in all age groups and has been evident since the first survey in 1972 (Figure 2.6). In 1998 most people who had lost all their teeth were over 55, but the general trend of increasing proportions of edentulous adults with increasing age remains. Within these overall trends, there is a pattern for a slightly greater proportion of males than females to be edentulous. Socio-economic status (measured by the occupational socio-economic status of the head of the household) continues to exercise an effect on oral health (measured by edentulousness). The trend for higher proportions of adults with total tooth loss to be found in lower socio-economic groups has been consistent over the last 30 years. However, the general trend of reducing numbers of adults losing all their teeth is repeated across all of the socio-economic groups.
2.3.4 ADHS projections
At the UK level, recent work using ADHS data (Steele et al, 2000) has indicated that the number of adults retaining their natural teeth is likely to continue to grow substantially and the number who are edentulous is likely to decline. However, those who are edentulous will remain so, and a small group, generally from low socio-economic backgrounds, will continue to become edentulous. The replacement of missing teeth with partial dentures will continue to be a common pattern of treatment for the foreseeable future.

Projections should be viewed within the context of the national target set in “Towards a Healthier Scotland” (SEHD, 1999) that, by 2010, 95% of 45-54 year olds will retain some natural teeth. In 1998, 87% of this group had some natural teeth and, among the age cohort 35-44 year olds who will be 45-54 in 2010, 96% had retained some natural teeth. This suggests that some progress is being made towards the national target.

These projections suggest that attitudes to dental care have changed significantly in the last twenty years, with a reduction in edentulousness and many more people retaining teeth into older age. Thus, the type of dental care required by older cohorts will have to reflect the changing needs and expectations of the forthcoming generations who will require more complex dental care. These issues are likely to have a significant impact on future (increasing) demand for dental services.

Using the results from the Scottish ADHS findings, it is possible to determine trends and project these trends into the future. The projections can be applied together with population projections to estimate numbers of people with certain dental characteristics. This may provide some insight into the demand for dental services. The population projections used here are those supplied by the Government Actuary’s Department (GAD) and are described elsewhere in this report (Chapter 4).

2.3.5 Edentulousness
This section examines results from the ADHS on proportions of people edentulous in Scotland.

Figure 2.7 shows historical ADHS findings on the proportions of the population without teeth by age group, together with some projections. The proportions show a consistent decrease between 1972 and 1998. Those in the youngest three age groups show a levelling off after 1988.

Projections have been made which exploit the historical patterns shown and make the assumption that they will continue in the future. The manner in which the historical edentulous rates have decreased amongst the younger age groups has been applied to the older age groups.
The projected proportion lines (Figure 2.7) show that, by 2020, the trends of all but the oldest age group have levelled off. Applying this to population projections (GAD, 2003) produces edentulous population numbers as shown in Figure 2.8.

It can be seen that in all age groups, and in the total population numbers, there are decreases in the number of edentulous people. The total edentulous population decreases by 66% between 1998 and 2028.
2.3.6 Population with twenty one teeth or more

This section reports on the results and the projections for the percentage of the population with 21 teeth or more. Twenty one teeth is the level previously reported as acceptable for a functional dentition (Steele et al, 2000). The oldest age group considered here is the over-55s. This differs from elsewhere in this report since this is the oldest age group detailed in ADHS findings before 1988.

Figure 2.9 displays historical data and projections of the proportions of the ADHS samples by age group with 21 teeth or more.

Figure 2.9: Historical and projected percentages of adults with 21 teeth or more

in Scotland. It can be seen that the proportion of functionally dentate people increases between 1972 and 1998. The rate of increase is generally smaller for the younger age groups.

Similar projections have been made which apply the trends shown for the younger age groups to the older age groups. The projections show that all but the two oldest age groups have levelled off at more than 98% functional dentition by 2028. The 55 and over age band increases from 40% to 68% functionally dentate between 1998 and 2028.

2.3.7 Summary

This chapter has reviewed recent trends in oral health in Scotland and has shown that:

- over the last 30 years there has been an improvement in children’s oral health
- the oral health of adults in Scotland has improved considerably over the last 30 years and this trend is likely to continue into the future. Fewer adults will be edentulous and more adults will retain more teeth into their older years
- taken with the evidence presented in Chapter 7, it appears that the utilisation of dental services has increased over the last
decade. This implies that improving oral health is associated with increased utilisation of dental services.

The relationship between oral health and demand for dental services may not be as straightforward as might first seem and there are a number of potential explanations for this association that are not necessarily mutually exclusive. Firstly, improved oral health causes increased utilisation of dental care. Secondly, increased utilisation of dental care causes improved oral health. Thirdly, other variables, such as income or increased expectations, may be increasing both oral health and the utilisation of dental care. Some of these issues are considered further in Chapters 5 and 6.

2.4 References


Part II The supply and utilisation models

Chapter 3 Supply model update
Chapter 4 Dental service utilisation model
3. SUPPLY MODEL UPDATE

3.1 Introduction

“Workforce Planning for Dentistry in Scotland” (SCPMDE, 2002) described the characteristics of the Scottish dental workforce at the time, and reported results of a model developed to project future supply. For this report, the latest data have been collected to enable a comparison between actual dentist numbers and the numbers projected by the previously reported supply model. The new information has allowed the validity of the assumptions made for the supply model to be reviewed and updated.

This chapter starts by reviewing the data used and their sources. Current knowledge of additional areas such as the PCD and dental student numbers is presented. Finally, the supply model is described and updated results presented.

3.1.1 Data Sources

The data sources used to calculate the numbers of dentists are as follows:

- Practitioner Services Division MIDAS database: data on GDPs, and VTs.
- MEDMAN database: the Medical and Dental Census carried out by ISD which provides information on dentists directly employed by the NHSScotland in hospital and community services.
- NHS Education Scotland: information on Vocational Trainees.
- The Dentists’ Register of the General Dental Council: additional information on dentists, such as country of qualification and registered address.

Dentists are considered to be part of the NHSScotland dental workforce if they;

- have an open list number1 on the Practitioner Services Division (PSD) payments database (MIDAS), i.e. they are registered to perform NHS treatment as a GDP in Scotland.
- were present on the annual Medical and Dental census (MEDMAN) carried out by ISD, i.e. they were directly employed by NHSScotland on the 30th September each year.
- appeared on the PSD payments database or lists held by NHS Education Scotland as a dentist undergoing vocational training.

3.2 Update of dental workforce characteristics

The latest data have been combined with previously reported information to update the characteristics of the dental workforce. This allows insight into changes in the workforce and whether or not the assumptions made in the supply model continue to be valid.

It is important to understand that consistent and accurate interpretation of workforce statistics depends upon an understanding of how the data is constituted. Figures for headcount will differ from whole time equivalent data and overall numbers will vary according to whether or not vocational trainees and assistants are included. To allow comparison with previously published data, the figures shown in Table 3.1 are headcount and include vocational trainees and assistants.

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1 Excluding ‘Commitment’ list numbers, which are not associated with a dentist providing treatment.
assistants. A further source of variance is the use of MIDAS which is a ‘live’ database in that dentists are leaving or joining the GDS on an ongoing basis. Thus small variations in numbers can occur, depending upon when MIDAS is accessed for the workforce data. Appendix IV shows how the dental workforce numbers vary as a consequence of including or excluding certain categories of dentists working in the GDS in Scotland.

3.2.1 Dental workforce as a whole

Table 3.1 shows the headcount of dentists in Scotland by service sector. The figures for 1992-1999 have been extracted from the previous report; those for 2000-2003 are new. Figures for the GDS in year 2000 have been revised following the exclusion of Commitment list numbers.

The headcount of dentists has continued to show a year on year rise for the additional years of 2001, 2002 and 2003 in line with earlier years. The average annual increase in total NHS dentist headcount between 1992 and 2003 is 1.8%; whilst for dentists in the General Dental Service (GDS), the average annual increase is 2.0%. There was a small increase (5) between years 1999 and 2000. The additional 2001-2003 data for those working in the Community Dental Service (CDS) show figures for 2001 which are consistent with previous years. There were relatively greater numbers working in the CDS in 2002 and 2003, which is in part reflected by an increase in dentists working in both the GDS and Community services. The Hospital services show no significant change.

Table 3.1: Headcount of dentists by sector

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>NHS Dentists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Dental Service&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1,710</td>
<td>1,803</td>
<td>1,823</td>
<td>1,867</td>
<td>1,874</td>
<td>1,919</td>
<td>1,966</td>
<td>2,010</td>
<td>2,014</td>
<td>2,159</td>
<td>2,089</td>
<td>2,118</td>
</tr>
<tr>
<td>Community Dental Service&lt;sup&gt;2&lt;/sup&gt;</td>
<td>287</td>
<td>283</td>
<td>279</td>
<td>281</td>
<td>265</td>
<td>275</td>
<td>283</td>
<td>278</td>
<td>292</td>
<td>287</td>
<td>339</td>
<td>323</td>
</tr>
<tr>
<td>Hospital Services&lt;sup&gt;3&lt;/sup&gt;</td>
<td>299</td>
<td>291</td>
<td>293</td>
<td>299</td>
<td>310</td>
<td>312</td>
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<td>341</td>
<td>331</td>
<td>346</td>
<td>343</td>
<td>350</td>
</tr>
<tr>
<td>Dental working in more than one sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital/CDS</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>10</td>
<td>6</td>
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</tr>
<tr>
<td>Hospital/GDS</td>
<td>82</td>
<td>95</td>
<td>86</td>
<td>87</td>
<td>87</td>
<td>88</td>
<td>93</td>
<td>101</td>
<td>85</td>
<td>94</td>
<td>83</td>
<td>80</td>
</tr>
<tr>
<td>CDS/GDS</td>
<td>43</td>
<td>45</td>
<td>39</td>
<td>51</td>
<td>35</td>
<td>50</td>
<td>62</td>
<td>53</td>
<td>68</td>
<td>70</td>
<td>94</td>
<td>87</td>
</tr>
<tr>
<td>Hospital/CDS/GDS</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
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<td>4</td>
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<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>146</td>
<td>128</td>
<td>141</td>
<td>125</td>
<td>143</td>
<td>159</td>
<td>160</td>
<td>161</td>
<td>171</td>
<td>189</td>
<td>175</td>
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<tr>
<td>Total NHS Dentists&lt;sup&gt;4&lt;/sup&gt;</td>
<td>2,161</td>
<td>2,230</td>
<td>2,266</td>
<td>2,305</td>
<td>2,324</td>
<td>2,360</td>
<td>2,414</td>
<td>2,467</td>
<td>2,472</td>
<td>2,518</td>
<td>2,580</td>
<td>2,614</td>
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<tr>
<td>Annual Charge</td>
<td>+69</td>
<td>+36</td>
<td>+39</td>
<td>+19</td>
<td>+36</td>
<td>+54</td>
<td>+53</td>
<td>+5</td>
<td>+46</td>
<td>+62</td>
<td>+34</td>
<td></td>
</tr>
<tr>
<td>Annual % charge</td>
<td>+3.2%</td>
<td>+1.6%</td>
<td>+1.7%</td>
<td>+0.8%</td>
<td>+1.5%</td>
<td>+2.3%</td>
<td>+2.2%</td>
<td>+0.2%</td>
<td>+1.9%</td>
<td>+2.5%</td>
<td>+1.3%</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Consists of those registered to provide NHS treatment as a GDP at 30 September. Also includes assistants and persons on the Vocational Training Scheme.

<sup>2</sup> In post at 30 September. Source: MEDMAN, ISD.

<sup>3</sup> Dentists who work in three sectors require to be subtracted from the overall twice to achieve the total across all sectors. See note 4.

<sup>4</sup> Total across all sectors taking into account those who work in more than one sector. Dentists who work in three sectors require to be subtracted from the total twice.

<sup>5</sup> These data vary from those previously published. This is a result of ongoing work to improve quality and completeness of data.
Figure 3.1 shows the number of joiners and leavers updated to include the new data.

For the NHS dental workforce as a whole it can be seen that for 2001, 2002 and 2003 the annual number of joiners is higher than in previous years. The annual numbers of leavers shows a consistent trend for 2000 to 2003 which is higher than for the previous seven years.

Figure 3.2: Number of GDPs registered to provide treatment
3.2.2 The GDP workforce

Figure 3.2 displays historical information on the number and gender of GDPs registered to provide treatment in Scotland updated with the latest data from 2001-2003. Note that vocational trainees (VTs) are excluded from these data.

The trend of an increase in GDP numbers and an increasing percentage of female GDPs has continued in line with that observed historically for the additional three years of data. The number of GDPs (to 2003) has increased by 70% since 1975. The percentage of females has increased from 12% in 1980 to 35% in 2003.

The number of joiners and leavers for the GDP workforce over the past decade is shown in Figure 3.3. The number of joiners in 2001 is the highest noted. Joiners for 2002 and 2003 are consistent with previous years, and leavers for 2002 and 2003 are lower than for 2000 and 2001.

3.3 Dental student numbers

Information on the future shape of the dental workforce can be drawn from the current student numbers at the two dental schools in Scotland. Table 3.2 shows current numbers of dental students and their expected graduation dates. In 2000, a recommendation was made by the Scottish Advisory Committee on Dental Workforce (SACDW) to standardise the output of the two dental schools in Scotland, by setting an output target of 120 dental graduates (70 from Glasgow and 50 from Dundee) over the 5 year period 2000 to 2005 (SEHD, 2000). Progress toward this target has been presented in Table 3.2. Furthermore, the Scottish Executive has recently set a revised output target of 134 which is likely to be matched by a similar number of VT places for graduates from August 2006.

To put these levels of dental graduates in context, it is worth noting that Scotland produces more than twice the number of...
There are seven groups of PCD who make up the dental team. For the purposes of this report, only hygienists and therapists are discussed. Changes to primary legislation have meant that all PCD groups will have to be registered with the General Dental Council (GDC, 2003), and additional clinical duties have been agreed for hygienists and therapists. In addition, legislation has been passed to permit an expansion of the clinical role of therapists so that they can now work within the GDS.

In 1995 the dental hygiene training course was extended from 1 to 2 years and, as a consequence, the number of hygienists qualifying each year in the UK fell to about 100. Currently, there are approximately 30 hygienists qualifying each year in Scotland, and these numbers have been consistent for some years (Ross et al, 2003). Prior to 2000, hygienists were not the subject of detailed workforce planning (SACDW, 2001).

In 2002, there were 381 dental hygienists registered with the GDC in Scotland. In a recent study of this group of hygienists (Ross et al, 2003), 290 of those registered responded, and 88% stated they were employed as a hygienist – 43% full-time and 57% part-time. The geographic locations of employment showed that the vast majority worked in ‘central belt’ NHS Board areas (72%). Most hygienists reported working in a general dental practice (69%), with only 18% in the CDS, 12% in the HDS, and 1% in the armed forces, although many hygienists reported working in more than one setting.

In 2002, there were only 21 dental therapists registered with the GDC in Scotland. In a recent study of those therapists (Ross et al, 2003), 17 of those registered responded, of whom 14 stated they were employed as a therapist. The geographic locations of employment showed that the majority worked in the ‘central belt’ NHS Board areas (n=11). All worked in either the CDS or HDS.

Given the lack of extensive information on their workforce characteristics and the

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**Table 3.2: Number of dental students**

<table>
<thead>
<tr>
<th>Graduation date</th>
<th>Year group</th>
<th>Glasgow</th>
<th>Dundee</th>
<th>Total</th>
<th>% female</th>
</tr>
</thead>
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<tr>
<td>July 2004</td>
<td>5th</td>
<td>67 (7)</td>
<td>49 (0)</td>
<td>116 (7)</td>
<td>53</td>
</tr>
<tr>
<td>July 2005</td>
<td>4th</td>
<td>63 (3)</td>
<td>52 (7)</td>
<td>115 (10)</td>
<td>48</td>
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<tr>
<td>July 2006</td>
<td>3rd</td>
<td>77 (4)</td>
<td>59 (3)</td>
<td>136 (7)</td>
<td>57</td>
</tr>
<tr>
<td>July 2007</td>
<td>2nd</td>
<td>76 (3)</td>
<td>58 (1)</td>
<td>134 (4)</td>
<td>65</td>
</tr>
<tr>
<td>July 2008</td>
<td>1st</td>
<td>81 (3)</td>
<td>62 (7)</td>
<td>143 (10)</td>
<td>55</td>
</tr>
<tr>
<td>July 2009*</td>
<td>*</td>
<td>90 (3)</td>
<td>67 (3)</td>
<td>157 (6)</td>
<td>-</td>
</tr>
</tbody>
</table>

*target intake
*Overseas student numbers are shown in parentheses and are included in the total.
rapidly changing policy framework, it is difficult to predict future numbers of PCD accurately. Hence, in terms of dental workforce supply, the scope of this project has been restricted to projecting numbers of GDPs, although the agreed output of hygienists and therapists is shown in Table 3.3.

Table 3.3: Hygienist and oral health therapist future outputs

<table>
<thead>
<tr>
<th>Location</th>
<th>PCD details</th>
<th>Projected output</th>
<th>From</th>
</tr>
</thead>
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<tr>
<td>Dundee</td>
<td>Oral Health Therapists</td>
<td>10 per year</td>
<td>2007</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>Hygienists</td>
<td>10 per year</td>
<td>2004</td>
</tr>
<tr>
<td></td>
<td>Oral Health Therapists</td>
<td>16 per year</td>
<td>2005</td>
</tr>
<tr>
<td>Glasgow</td>
<td>Oral Health Therapists</td>
<td>10 per year</td>
<td>2005</td>
</tr>
</tbody>
</table>

Figure 3.4: Supply model

This shows that the stock of GDPs receives inputs from Joiners from VT, Returners and Other Joiners, whilst output from the stock arises from Leavers. This is summarised by the following equation:

\[
\text{Stock}(\text{age})_{t} = \text{Stock}(\text{age}-1)_{t-1} - \text{Leavers}(\text{age}-1)_{t-1} + \text{Joiners from VT}(\text{age})_{t} + \text{Returners}_{t} + \text{Other Joiners}_{t}
\]
The model has been updated by the addition of three years’ data for 2001, 2002 and 2003.

The assumptions made for the model were based partly on current data and partly on estimates of how these parameters will behave in future. This resulted in several model outputs for high or low dentist number expectations. With the addition of data for 2001, 2002 and 2003, the parameter assumptions for the updated model are summarised in the following sections:

3.5.2 VT numbers
Vocational Trainee numbers here are quoted as being the number of trainees in each cohort year. Note that some persons may undertake VT part-time over two years (such as those on the longitudinal General Professional Training scheme).

Previously, the core model run assumed VT intakes of 100 for 2001 and 110 for 2002 onwards. Actual figures are 95 for 2001, 101 for 2002, and 102 in 2003. For future VT numbers, current information states there will be 120 VTs in 2004 and 2005. Thereafter, 134 VTs are assumed, in accordance with the greater dental student numbers and the Scottish Executive’s policy for this number of VT places.

It is assumed that the gender construct of VTs will follow historically observed trends and that the female VT proportion will increase at the rate of 1% per year, up to a level of 65% (in 2009).

The rates of VTs joining the GDP workforce have been updated and are based on the historical values from 1994 to 2003. Rates identified for 2001-2003 were inconsistent in that they were lower than for previous years. If VT joining rates continue at the level seen since 2001, there will be fewer GDPs than predicted in section 3.7.

3.5.3 Joiners/returners assumptions
With respect to the previously published model, the principal or ‘medium’ model run assumed 27 other joiners and 41 returners from 2001 onwards. These were average values for 1994-2000. Figures for 2001-3 are generally consistent with these figures. Parameters have been updated and the average for 1994-2003 has been used. This has resulted in very little change: 29 joiners and 42 returners.

Previously, the ‘low’ and ‘high’ scenarios modelled the numbers of joiners and returners by using the minimum and maximum values for each year respectively. This approach has been continued and the minimum and maximum number of joiners and returners for 1994-2003 has been used to obtain new low and high scenarios.

The number of joiners and leavers for both the original and updated supply models in each of the three scenarios is summarised in Table 3.4:

3.5.4 Leavers
The number of leavers is derived from the historical data according to age, sex and whether qualified within or outside Scotland. Average figures for 1994-2003 have been incorporated, which are consistent with those used for years 1994-2000 previously.
3.6 Comparison of GDP numbers with original supply model predictions

Table 3.5 lists actual GDP numbers for 2000-3, along with the supply model outputs as previously published.

Table 3.5: Comparison of actual GDP numbers with original supply model projections

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Original Model Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>2001</td>
<td>1954</td>
<td>2019</td>
</tr>
<tr>
<td>2002</td>
<td>1978</td>
<td>2038</td>
</tr>
<tr>
<td>2003</td>
<td>2007</td>
<td>2063</td>
</tr>
</tbody>
</table>

It can be seen that all original model outputs are higher than actual GDP numbers for years 2000-2003. Several factors have played a part in causing this trend. Firstly, actual GDP headcounts for 2000 were revised downwards following the exclusion of Commitment list numbers (see Section 3.2.1). Secondly, the base year for the original supply model was year 1995, and its resultant projection for year 2000 was already high at 1,985 GDPs compared to the revised figure of 1,913 GDPs. Thirdly, there was an uncharacteristically small increase in GDP numbers between years 1999 and 2000. These factors combined to project higher numbers than actually appeared in the workforce. The differences are up to 56, 90 and 113 GDPs for the low, medium and high projections respectively.

However, whilst the actual figures do not closely accord with projections, the relative increases in GDP numbers projected by the model are in better agreement. Actual figures show annual increases in the GDP headcount of 41, 24 and 29 for years 2001, 2002 and 2003 respectively. Annual increases projected by the original supply model low output are in best agreement with the actual GDP headcount increases, being 34, 19 and 25 for years 2001-3.

These results suggest that the original supply model was predicting the growth of the GDP workforce reasonably accurately, but the outputs were subject to an ‘offset’. The updated supply model has been corrected for this by having its base year set to 2003 so that the previous offset has been eliminated. This also means that the projections are derived from the most up to date workforce characteristics.

---

*Note that actual GDP numbers presented in Table 3.5 differ from the GDS headcount given in Table 3.1, as they do not include persons on Vocational Trainee schemes.*
3.7 Updated supply model results

Figure 3.5 shows the three different output scenarios from the updated supply model. Recall that these data do not include Vocational Trainees.

Key results of the new outputs are that the:
- low scenario peaks at 2,106 GDPs in year 2015
- medium scenario increases to 2,455 GDPs in year 2036
- high scenario increases to 2,704 GDPs in year 2036.

Table 3.6 details the number of GDPs projected for certain specific years. Appendix VI details the figures for all years to 2036.

The medium output suggests that the number of GDPs increases by 11% (to 2,224) by 2010, and by 18% (to 2,359) by 2020.
3.8 Projected age and gender structure of GDP workforce

The projected age and gender structure of the GDP workforce has been examined using the medium supply model output. Figure 3.6 shows the age distribution of the GDP workforce currently (2003) and for the years 2010, 2020 and 2036. It can be seen that the proportion of dentists under 30 is expected to increase, being at its greatest in 2010. Between 2003 and 2010, the proportion of dentists between 35 and 45 is expected to fall, which is matched by a corresponding increase in dentists between 45 and 55, indicating an ageing dentist workforce. The ageing of the profession is still evident in 2020, with increases in the proportions aged 55 and over.

Figure 3.7 shows the percentage of the projected GDP workforce who are female. The graph shows that the proportion of female GDPs rises from 35% in 2003 to 49% by 2036. This rise is a consequence of the increase in the percentage of females in VT (to 65%).

The ageing workforce, coupled with increasing proportions of females has significant implications for dental workforce planning, as highlighted in Chapter 4.

3.9 Sensitivity analysis on VT joining rates

In section 3.5.2 it was noted that since 2001, the rate at which VTs join the GDS has fallen. If the VT joining rate falls, there will be fewer dentists in the system. Sensitivity analysis has been undertaken to determine what the impact would be if these rates should continue at the recent levels, and to show what the effect would be if they were to revert to their historic levels.
Table 3.7 details the expected number of GDPs in the workforce under different assumptions of VT joining rates. Different combinations of rates, based on averages from 1994-2003 (as used for the main model outputs), from 1994-2000 (the previously observed higher rates), and from 2001-2003 (the recently observed lower rates), are shown. The second and third columns of Table 3.7 show the corresponding percentage of VTs joining the GDS during the first and second years following completion of their training\(^3\). As a comparison with the other outputs, the effect of a higher rate (70%) of VTs joining the GDS within one year is presented. Higher rates such as these may give an indication of the impact that improved incentives could have on future GDP numbers.

Table 3.7: Effects of changing years of data used to derive VT Joining rates on the medium supply model output.

<table>
<thead>
<tr>
<th>Years used for VT Joiners rate</th>
<th>Percentage joining after 1 year</th>
<th>Percentage joining after 2 year</th>
<th>Number of GDPs for year (change compared to main output):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2010</td>
</tr>
<tr>
<td>94-03</td>
<td>56%</td>
<td>9%</td>
<td>2224</td>
</tr>
<tr>
<td>01-03</td>
<td>48%</td>
<td>14%</td>
<td>2189 (-35)</td>
</tr>
<tr>
<td>94-00</td>
<td>60%</td>
<td>8%</td>
<td>2252 (28)</td>
</tr>
<tr>
<td>-</td>
<td>70%</td>
<td>8%</td>
<td>2322 (98)</td>
</tr>
</tbody>
</table>

\(^3\)Note that the model also accounts for VTs joining beyond 2 years after completion of their training; however most VTs who do join the Scottish GDS do so within 2 years and hence these are the most significant figures to consider.
It can be seen that if the VT joining rates continue at levels shown since 2001, there would be at least 70 fewer GDPs from 2020 onwards than shown in the main model results. In contrast, should the rates revert to levels shown up to 2000, this would result in at least 50 additional GDPs compared to the main model output from 2020 onwards. Were the VT joining rates to increase to 70% for the first year following completion, the increases in the workforce would be greater; 100 extra GDPs in 2010 and 190 extra in 2020.

3.10 Summary
Chapter 3 updates the GDS dentist supply model with the addition of the data available for 2001, 2002 and 2003. These data suggest that:

- the number of GDPs (headcount) has continued to increase in the three most recent years
- the medium projection of the updated supply model predicts 2,455 GDPs by 2036
- the percentage of female GDPs will rise from a level of 35% in 2003 to 49% by 2036. This rise is driven by the increase in the number of females entering Vocational Training.
- although not modelled, approximately 40 therapists per year will be produced in Scotland by 2007.

3.11 REFERENCES


4. DENTAL SERVICE UTILISATION MODEL

This chapter describes the development of a model to estimate future utilisation of dental services and numbers of dentists required to provide those services. There are four interlinked areas of work. Firstly, the introduction outlines the distinction between dental demand and utilisation. Secondly, previous approaches to modelling using dentist to population ratios and scenario models are considered. Thirdly, the utilisation model development is described and results presented. Finally, a comparison between the utilisation model and supply model (Chapter 3) outputs is presented.

4.1 Introduction

Conventionally, the demand for dental services by patients is expressed as the level of utilisation that maximises their net benefits. This is explored further in Chapters 5 and 6. In contrast, the demand for dentists by the purchasers of health care is neither clearly nor uniquely defined. For example, the following are all reasonable, and in some cases explicitly stated, policy objectives:

- To ensure a given dentist to population ratio
- To ensure equity of access to dental services (SEHD, 2000a; and SEHD, 2003)
- To maximise the net benefits of dental services (SEHD, 2003)
- To ensure a given amount of utilisation (SEHD, 2000a)
- To satisfy the demand for dental services by patients (SEHD, 2003).

Clearly, the number of dentists required to satisfy these different objectives is not likely to be the same. For example, the number of dentists required to ensure a target dentist to population ratio is unlikely to be the same as the number of dentists required to ensure a target level of utilisation. Moreover, measuring the demand for dentists implied by some of these policy objectives is not a simple task.

Hence, understanding the future demand for dentists is a complicated matter that is not only difficult to derive from the data currently available, but is also subject to changes in government policy. This project has concentrated on predicting the future utilisation of dental service relative to a level derived from historical data, and calculating the number of GDPs that will be required to provide that level of service in the future.

4.2 Review of approaches to modelling

In the past, a variety of measures have been used to determine the demand for dentists. These include:

- dentist-to-population ratio
- practitioner surveys – which rely on participation of practitioners and have a tendency to give biased views or aspirational goals
- oral health needs approach – which relies on analysis of experts’ opinions to translate disease trends into treatment needs
- scenario models – which combine various approaches and data sources to predict workforce requirements based on the development of future scenarios.
Neither practitioner surveys nor expert opinion provides a reliable long-term method of workforce planning. Accordingly, only dentist to population ratio and scenario models will be discussed further.

4.2.1 Dentist-to-population ratios

The dentist-to-population ratio is a simple and widely used indicator of workforce supply. It is relatively straightforward to compute and the use of the ratio is enhanced by estimates of future workforce numbers. Such analyses generally suggest an under or over supply of dentists according to an arbitrary ratio of the dentist number to the population. The ratio is often benchmarked against other areas or countries. In the UK this approach has been used at national and regional levels (SEHD, 2000a and Eaton et al, 1998).

Dentist-to-population ratios have been used to provide a measure of the dental workforce in the UK but they do not take into account the demographic structure of Scotland’s population. In the past such models have indicated that the UK had an over supply of dentists. This measure was one of the main factors which was used in the evidence to support a 10% reduction in UK dental undergraduate intake in 1984 (DHSS, 1983). This was largely on a pro-rata basis across the UK, but also involved the closure of the Royal Dental Hospital in London. An additional 10% reduction was introduced in 1988 to avoid over-production of dentists, again based on similar measurements (University Grants Committee, 1988). Furthermore, in Scotland the Dental Review Working Party chaired by Sir Donald McCallum published a review of dental provision in Scotland in 1989, which recommended the closure of Edinburgh Dental School on the basis of a UK oversupply of dentists in terms of dentist-to-population ratio (Scottish Office, 1989).

A major weakness of dentist-to-population ratios is that the benchmark or even relative comparison of such ratios does not take into account changing patient oral health needs and the demands of the population, nor the characteristics and dynamics of the dentists who supply the service to that population. Another key criticism is that applications of the ratios assume that technology and productivity in dental services is fixed both across areas and through time.

4.2.2 Scotland’s dentist-to-population ratio

As mentioned previously, dentist-to-population ratios provide a crude measure of workforce requirements, but they do allow comparisons with other countries. However, comparisons are complicated and often compromised by the varied way that figures are compiled in different countries.

Figure 4.1 illustrates dentist-to-population ratios expressed as numbers of dentists per 1000 population for a selection of countries for the years 1997 to 1999 (where data are available). Note that the data presented are rounded to one decimal place.

It can be seen that Scotland has a higher dentist-to-population ratio than the UK as a whole (0.5 for Scotland as opposed to 0.4 for the UK figure per 1000 population). Given the trends in Scotland of a diminishing population and increasing dentist workforce, this ratio would be expected to increase in the future.
Scotland’s ratio is similar to countries such as Canada and Ireland, but Scotland compares less favourably with Germany and Scandinavia where ratios are typically between 0.8 and 1.0 dentists per 1000 population.

When comparing dentist to population ratios, one should bear in mind that they do not take account of the oral health requirements of a populace, the socio-economic context and the systems of payment.

4.2.3 Scenario models
Published work details previous attempts at modelling the demand for dentists in other parts of the world, and models from the Netherlands, USA, Australia and the UK have been reviewed.

A model to predict the demand for dentists in the Netherlands was developed in 1994 (Steering Committee on Future Health Scenarios, 1994). The structure of the model considered population, attendance patterns, caries, periodontal disease and the resultant treatment needed. Development of the model was based on information derived from both observation and theory into how various factors influence the interactions between attendance, disease and treatment.

The National Institute of Dental Research published results of a micro-simulation model (Brown et al, 1995). This model utilised USA-based datasets from health insurance information, an oral health survey, and demographic and socio-economic characteristics of the population. The model identified individual preferences in dental

Figure 4.1: Dentist to population ratios for a selection of countries
service utilisation according to a variety of measures including dental insurance coverage, family income, socio-demographic variables and oral disease indicators.

The Dental Statistics and Research Unit at the University of Adelaide, Australia, published results on the demand for dental care which included projections of future demand (Australian Institute of Health & Welfare, 2003). This utilised data from four surveys conducted over a period of years. An aggregate approach was adopted whereby edentulous rates, visits per year and dental services (or treatments) per visit were projected and combined, together with national population projections, to estimate the demand in terms of total numbers of dental services.

Work published in 2000 presented predictions of the supply and demand for dentists in the UK over a 40-year period (Try, 2000). The modelling combined projections of population numbers and edentulous rates together with workforce characteristics. Relatively little information was available for the modelling and various assumptions were needed.

All of these models were developed in light of information specific to their environment. The characteristics of dental service provision in Scotland differ from those in other areas, and the application of these models in Scotland would not be wholly appropriate. Moreover, the information sources for Scotland are relatively comprehensive, further assisting the development of a model specific to this country. Nevertheless, these reports provide useful insight into previous work and approaches to the problem. Indeed, the approaches adopted for the Australian and UK models are similar to those adopted in this project.

4.3 Utilisation model

The aim of the utilisation model is, on the basis of the best evidence, to predict how the utilisation of dental services in Scotland will change relative to the present, and what impact this will have on the numbers of dentists required.

The model can be broadly understood as using historically observed patterns of patient attendance, treatments received by patients, and dentist provision of treatment, considered by age and sex of patients/dentists. These characteristics are combined with projected population information and epidemiological trends to determine the numbers of GDPs required to provide the current utilisation of dental services.

The modelling is based on a level of utilisation derived from historical data; hence it makes the assumption that future utilisation characteristics remain constant.

Utilisation is a function of a variety of elements. For this project, the drivers incorporated into the modelling of utilisation projections are changes in population demographics and trends in oral health. These factors are those for which robust and reliable information on their impact on service utilisation is available.

Other factors will also influence service utilisation, e.g. employment status, income, increased tooth retention. Chapters 5 and 6 examine further these factors and the effects
they are likely to have on utilisation and demand. The incorporation of these factors into the utilisation model has been deferred for future work, but the model has been designed with flexibility in mind to allow for the incorporation of new data.

The model is based on the current uptake or utilisation of dental services. Utilisation plus some unknown factor would account for unmet demand and/or need. From the data that is available, it is not possible to reliably estimate the magnitude of unmet demand. To illustrate what effect addressing unmet demand could have on workforce numbers, a number of key factors are varied and presented.

The reader should be aware of the limitations highlighted when considering the results. The reader should also bear in mind that the utilisation projections assume that the characteristics of dental service provision remain constant.

The following sections describe the development and output of the dental service utilisation model.

4.3.1 Overview of the utilisation model

The approach taken and structure of the model has to an extent been determined by the data sources available. Since the model considers dental service utilisation Scotland-wide, an aggregate approach has been adopted. The model has been constructed to allow flexibility in future work. It is intended that individual-level data, such as those presented in Chapter 7, will be included in later work.

The range for which utilisation projections are provided is 30 years. As the remit of this work is to provide advice on the dental workforce, and that it takes around 7 years from application to University until a trained dentist is produced, it was thought that 30 years is more than sufficient to illustrate patterns of workforce provision; additionally, this approach fits with available demographic data.

The model structure evolved to be a series of calculations relating to particular aspects, each of which can be thought of as a sub-model. The sub-models are:

- **Population**: projections of population are applied
- **Participation**: numbers of people participating are calculated
- **Attendance**: numbers of claims are calculated
- **Treatment**: total cost of treatments are calculated
- **Dentist Activity**: number of dentists required are calculated

This design accounts for the principal dynamics behind dental service utilisation: the population to be serviced; the patterns of participation and attendance of that population; the treatment they receive once at the dentist; and the number of dentists required to provide the treatment. Figure 4.2 is a diagrammatic overview of the utilisation model.

Starting from the top in Figure 4.2, the diagram shows how information on the

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*Participation is defined as a patient attending the dentist at least once in a 12-month period.*
population is passed into the Participation sub-model and combined with edentulous rates to calculate the number of participants. From this the Attendance sub-model calculates the numbers of claims (or courses of treatment). The Treatment sub-model uses this information to calculate quantities of treatments for the four treatment categories presented. The Dentist Activity sub-model then calculates the numbers of GDPs required to service the total amount of treatments. For this calculation the sub-model takes data on the future number of salaried dentists and the future dentist age/sex distribution from the supply model (Chapter 3). This construct is flexible enough to allow incorporation of other factors within the sub-models. For example, changes in income or oral health could be accounted for by relevant adjustments to the participation, attendance and/or treatment sub-models.

As previously stated, an aggregate approach has been adopted for the utilisation model. The population is broken down into a set of categories according to the following gender and age bands:

- Under 15
- 15-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65 and over
These age bands were chosen to coincide with findings as reported in the Adult Dental Health Survey (ADHS)\(^1\). This was to enable projections derived from ADHS data to be applied in the utilisation model.

There are seven age bands and each age band is broken down into male and female categories, producing 14 categories altogether. A separate calculation is made for each of these categories at each stage of the model.

The model considers only the GDS; other areas of NHS dental service provision are not considered. Specialist Orthodontists are not included in the utilisation modelling. Orthodontists require additional training, and this normally occurs at some point during an already qualified dentist’s career. Hence, utilisation of orthodontic specialist services can be considered a separate issue to that of GDPs. It is also unknown how the utilisation of Orthodontists may change, as trends in the use of orthodontics are also subject to social factors and policy that are hard to predict. However orthodontic care provided by non-specialist GDPs is included.

The model equates an amount of general dental services utilised to number of GDPs that would be needed to supply these services. No adjustment is made to account for the contribution that therapists and hygienists would make to dental service provision, because there is little information on PCD workforce characteristics. Since the model output of the number of dentists required is calculated with the assumption of no contribution from therapists and hygienists, actual need for dentists would in reality be lower, given the presence of these groups in the workforce. Estimates of the contributions of a hygienist/therapist relative to a dentist are provided.

Similarly, the contribution of VTs to dental service provision is not included in the calculation of the number of dentists required. This also results in an overestimate of numbers of dentists required.

During the data analysis and model development, where appropriate, parameters have been chosen in such a way that they err on the side of over-predicting utilisation. However, by varying the way that the model parameters are derived, a range of outputs is presented to illustrate the uncertainty surrounding the results achieved. The outputs have been labelled ‘Low’, ‘Medium’ and ‘High’, with the Medium output being thought of as the principal output.

4.3.2 Data sources

Two principal data sources have been used in the construction of the utilisation model:

Adult Dental Health Survey (ADHS). The Adult Dental Health Survey has been described previously along with some dental health projections (section 2.3). Some of these projections are used in the utilisation model.

MIDAS. Practitioner Services uses the Management Information and Dental Accounting System (MIDAS) database to process, authorise and store all claims for the GDS in NHS Scotland.

\(^1\) Except for the 15-24 age band, where the difference in the lower limit of 1 year is not expected to be significant.
Dentists in the GDS make claims for payment on GP17 forms, which include details of the patients registered and the NHS treatments provided. Reliable data within MIDAS are available from 1997 to 2003. Data are available from before this time but are not considered sufficiently reliable for workforce planning purposes. All data from MIDAS are subject to errors that may arise from the processing of claims, such as unclear entries on the GP17 forms.

The MIDAS database was designed for processing payments to dentists. Using it for a different purpose has revealed limitations in the data available, for example, no tooth specific treatment information is available.

Information from other sources was also available and, where appropriate, has been used to validate results from the ADHS and MIDAS. This includes the Toothousand project (SCPMDE, 2000), which is a survey of Scottish GDPs, and Denplan data on private activity (described in more detail in Chapter 7).

The following subsections explain the data analysis and development of each of the utilisation sub-models and the manner of their calculations. Details of the data extracted from MIDAS can be found in Appendix V.

4.4 Population sub-model

4.4.1 Background

This section describes the projected population data available, which are required in a prediction of dental service utilisation.

The population sub-model incorporates the population projections that are available from the Government Actuary’s Department (GAD). The projections are published every 2 years, and those used in this report are 2002-based (GAD, 2003). The ‘principal’ projections have been used, which incorporate the primary expectations of how fertility, mortality, migration, and other rates will behave in the future. Other ‘variant’ projections are available which simulate scenarios such as high fertility or low migration and could be applied in future work.

The projections provide population numbers by age and gender yearly up to 2027, and thereafter every 5 years to 2042.

4.4.2 The projections

Whilst the utilisation projections have been made up to 30 years ahead, the full population projections up to 40 years ahead are shown here, for reference. Figure 4.3 shows the 2002-based projection for the total population of Scotland up to 2042. It can be seen that the population is expected to decline from 5.06 million in 2002 to 4.90 million in 2022 and to 4.50 million in 2042 (declines of 3% and 11% respectively compared to 2002).

However, it is not just the total population figures that are important, but also the demographic breakdown. Figure 4.4 shows the population numbers by age group up to 2042. The patterns shown over this period clearly illustrate an ageing population. The 0-14 age group declines consistently from 2002 onwards, with projected reductions of 18% to 2022 and 30% to 2042 compared to 2002. Other age groups show rises and falls, as a relatively large cohort of the population ages. For example, numbers of 45-54-year-
olds peak in 2013, and 55-64-year-olds peak in 2023. The 65 and over age group shows a consistent increase in numbers, rising by 34% between 2002 and 2022 and by 64% between 2002 and 2036.

Clearly, these changes in the age structure of the population are likely to have an impact on the provision of any service where utilisation by older age groups is different relative to younger ages, as is the case with dentistry.

4.5 Participation sub-model
Participation is defined as at least one attendance by a patient in a 12-month period.

Participation rates per population have been derived using MIDAS. The participation
The supply and utilisation models

rates presented here have been derived from an aggregate of all data held by MIDAS. Further work investigating individual participation patterns is presented in Chapter 7.

The integration of the individual micro-level results of Chapter 7 with the macro-level forecasts presented here has been deferred for future work. The potential benefits of this integration would be to evaluate the impact on utilisation projections from changing variables to account for, for example, the number of patients exempt on grounds of income.

The MIDAS database has been used to provide information on participation rates per population for each of the model categories. Counts of unique numbers of patients who had made a claim for each age and sex category were extracted. Together with historic population data for Scotland, participation numbers per population for each model category were derived. Patients aged 18 and over who had treatment of zero value have been excluded. This arises when a GP17 form is processed for patient registration only, that is, with no associated treatment. However, zero value claims were included for patients aged under 18. This is because the capitation agreement dentists enter into (under which they receive a capitation payment for registration of someone of these ages) states that the dentist should provide assessment and, if necessary, treatment to these patients (SEHD, 2003). Hence, it can be assumed that patients under 18 submitting zero value claims are participating and not merely registering.

The results were generally consistent for the period 1997-2003, for which MIDAS data were used, and this was confirmed by analysis of the standard deviations. However, results from 1997 showed potentially anomalous low values in some age bands.

It was decided to use the maximum participation rates for each category shown from 1998-2003 for the principal model run.

**Figure 4.5: Participation rates by age band**
since these data are the most consistent. The use of the maximum errs on the side of caution by, if anything, over-predicting utilisation.

Figure 4.5 shows the results for each of the age bands using maximum participation rates from 1998-2003.

It can be seen that participation rates are generally highest amongst the younger age bands and decrease for ages above 45. There tends to be a fall in participation amongst young adults. Females participate more than males except for over-65s. The patterns displayed here are corroborated by registration rates (SDPB, 2003).

Any reduction in edentulous rates will positively affect future participation rates. The projections of edentulous rates from the ADHS (section 2.3) are utilised here to adjust the MIDAS participation findings. Modifications were only applied to ages 45 and over, since changes amongst younger ages are insignificant.

To provide the appropriate adjustment, it was necessary to make an assumption of how frequently edentulous patients are currently participating. The ADHS includes a question on how many attendances were made in the last 5 years. For 1998 those questioned in Scotland who were edentulous, recorded an average of 0.6 visits in the previous 5 years. This corresponds to a 12% annual participation rate of edentulous persons. It was decided to assume a 10% annual edentulous participation rate in the calculations to err on the side of caution. The MIDAS participation rates were used together with current and projected edentulous rates to calculate what the future increase in participation would be.

The sub-model uses these results and the input from the population sub-model to calculate the number of participants as follows. For each category:

\[
\text{Participants} = \text{population} \times \text{participation rate}
\]

4.6 **Attendance sub-model**

The attendance sub-model calculates the frequency of patient attendance given participation in terms of numbers of claims (or courses of treatment). Here an attendance is defined as one claim. Counts of claims were extracted from MIDAS. As with the participation analysis, a correction has been made for claims of zero value.

The results over the period from 1997 to 2003 are generally consistent which was confirmed by analysis of standard deviations. However, some trends are evident in that under-15s attendance rates reduced while all other age groups increased in the last four years of data (Appendix V).

For the principal model run, it was again decided to take a conservative approach by favouring over-prediction of utilisation and using the maximum attendance rate exhibited for each category from 1998 to 2003.

From Figure 4.6 it can be seen that attendance rates fall between the ages of 15 and 25. Above age 25, treatment course rates tend to increase with age (apart from female over-65s, where there is a slight fall). Female claim rates are higher than for males, except amongst over-65s.
The supply and utilisation models

The sub-model uses the results and the input from the participation sub-model to calculate the number of treatment courses as follows. For each category:

\[ \text{Claims} = \text{participants} \times \text{attendance rate} \]

4.7 Treatment sub-model

This section describes the data pertaining to the quantity of treatments provided per claim (or course of treatment).

4.7.1 Treatment categories

It was initially hoped that trends in dental health could be determined from patterns in the treatments being prescribed. However, many items of dental service could be provided for either dental caries or periodontal (e.g. extractions and bridges) disease. Findings from MIDAS show that between 1997 and 2003, of all the treatments supplied for dental caries or periodontal disease, 28% were of a type for which the diseases treated could not be determined by the treatment code. These uncertainties reduce the accuracy of deduction of dental disease trends in the population.

In light of this, it was decided that treatments would be broken down into categories that would encompass both dental caries and periodontal disease. The treatment categories were chosen to enable determination of utilisation that could be met by dentists and/or hygienists and therapists. The following list details the treatment categories along with descriptions:

- **Assessment and Diagnostic** – procedures that would be performed by dentists to plan the treatment, if any, a patient requires
- **Core** – treatments that can be performed by dentists as well as hygienists and therapists (General Dental Council, 2003)
- **Complex** – treatments more advanced than those in the Core category, which can only be performed by dentists (e.g. root canal treatment and crown / bridge work)
- **Orthodontic** – orthodontic treatments

Recall that specialist orthodontic practitioners (who are separately identified by MIDAS) are excluded from this modelling – this represents orthodontic treatment carried out by non-specialist practitioners.
4.7.2 Treatment cost

Treatment cost was chosen as the index for measurement of treatment quantity. This index held the advantage of allowing inter-comparison between the four treatment categories. Furthermore, it is expected that the cost of treatment is closely related to length of time needed to provide the treatment. Hence cost should provide a good proxy for the amount of clinical time a dentist is required to work.

Clearly, any relationship between cost and clinical time will be compromised for treatments where material expense is relatively high (such as precious metal crowns or bridges). However the time required for these more complex treatments will also be greater than other treatments of relatively low material expense, possibly resulting in a non-linear relationship.

Further investigation was made into how realistic the assumption of a treatment cost – time relationship is. The 1999 BDA Heathrow Timings Inquiry (Bearne & Kravitz, 2000) consisted of a panel of 16 dentists working primarily in the GDS who were chosen to represent a cross section of gender, age and geographic distribution. These dentists provided estimates of the length of time required to provide a sample set of treatments, from which an overall average time for each treatment was obtained. These results have been used along with treatment costs (gross fees) for 2003 to illustrate the relationship between cost and time (Figure 4.7).

It can be seen that for the treatments considered, apart from three points, the data show that cost is linearly correlated with time. The outliers (labelled) are for treatments that have high material costs, as expected. In spite of these outliers, in general there is still a positive relationship, in that greater cost implies more time. The increments in time tend to reduce for higher costs, as this is the result of more expensive treatments having a greater proportion of
their cost absorbed by material factors.

4.7.3 Patterns of treatments
Total costs of treatment prescribed by dentists were extracted from MIDAS for each of the treatment categories. Note that this was the gross fee cost that the dentist would claim and not the cost to the patient.

All costs have been adjusted for the increases applied in April of each year, being corrected to 2003 cost levels. The total treatment costs were divided by the number of claims, to give an indicator of the average treatment cost per claim for each category.

For the period 1997-2003, MIDAS data were generally consistent for each year, which was confirmed by analysis of standard deviations. However, some downward trends were evident, particularly amongst complex treatments (see Appendix V). This may have been due to a drift towards greater provision of private treatment. Also, data from 1997 did not fit smoothly with these trends.

It was decided to take the average treatment levels from 1997-2003 for the principal model run. These represent a typical treatment pattern over this time. While they are not at the most recent levels, they will tend to overestimate the utilisation of general NHS dental treatment compared to the latest data, given the downward trends. As these levels are kept constant for projections, they assume that there is no change from the current manner of utilisation.

Figures 4.8a to 4.8d show treatment costs per claim by age band for each of the treatment categories.

The Assessment and Diagnostic category shows that maximum costs are for the 25-34 age band. Costs for under-15s are very low in comparison with other ages. This would be in part due to the fact that costs for examinations are covered by a capitation fee. This has not been included in these results. Similarly, this would skew the 15-24 age band downwards, since the capitation applies to under-18s. For 35s and over there is a general decreasing trend with greater age. Overall, both male and female results are very similar.

The Core treatment category shows a similar pattern to that for Assessment and Diagnostic, with a maximum amongst 25-34 years. The lower costs amongst younger ages may be an indicator of the high proportion of untreated decay, corroborated by national epidemiology study findings. Above 34 years, costs decrease with age, suggesting the more straightforward treatments in this category are of less use amongst older patients. Claims for males are more expensive, except for under-15s.

The Complex treatment category shows increasing costs with age. Again this is as expected, in that older teeth require extra maintenance which tends to be of a more complicated nature. Claims for males cost more generally, except for over-65s.

The Orthodontic treatment category shows, as expected, that most orthodontic activity occurs in the young age bands. There is limited activity above 34-years-old. Claims for females are the most costly.

Given the trends in increased tooth retention and restoration, as illustrated in Chapter 2,
characteristics of future levels of treatment are likely to change. It is probable that treatment amounts per claim will increase with time, as the average patient retains more natural teeth which will require more maintenance. However, given the lack of tooth specific data in MIDAS or elsewhere, the actual change in treatment resulting from dental health improvements cannot be estimated reliably. The result of this is that the use in the model of current treatment patterns for the future may under-predict utilisation estimates.

The treatment sub-model calculates total treatment costs using the results presented here and the input of numbers of treatment courses. For each patient age/sex category, the treatment total is derived from the sum of totals calculated for each treatment category:

\[
\text{Total treatment} = \sum \text{claims} \times \text{treatment rate}
\]

**Figure 4.8a: Assessment and Diagnostic treatments**
Figure 4.8b: Core treatments

Figure 4.8c: Complex treatments
To calculate numbers of dentists required to provide a given cost of treatment, it was necessary to develop insight into how dentists operate and what their typical output is. This includes accounting for variations according to the age and gender of the dentist, as well as other factors such as the manner in which the dentist is remunerated.

GDS dentists are remunerated in two ways, according to whether they are salaried or non-salaried. Salaried dentists receive a fixed income with practice, premises, equipment and support provided entirely by NHS Scotland. Non-salaried dentists receive remuneration according to the Statement of Dental Remuneration (SEHD, 2003) in which a fee is set for each treatment they provide. They also receive payments related to the number and type of patients registered with them and special payments to cover aspects such as operating in remote areas. Non-salaried dentists tend to provide more treatments than salaried dentists.

Salaried dentists are generally employed in areas where there is lack of access to NHS dental care, particularly remote and rural areas. Numbers have increased in recent years, from about 50 in 1997 to about 70 in 2003, and these trends have been accounted for in the model outputs. Any policies to provide additional salaried dentists at a greater rate would result in more dentists being needed overall than the model results here present, due to their lower activity rates.

Dentist activity also varies as a consequence of other factors. These include geographic location and number of patients. Evidence has shown that, all other things being equal, dentists with fewer patients tend to provide more treatment per patient, whereas those with more patients tend to undertake less
treatment per patient (Chalkley & Tilley, 2003). Since the modelling considers an aggregated viewpoint, these differences should be borne in mind when the long-term implications are being considered.

4.8.1 “Toothousand” survey into Scottish dentist activity

Results from a survey into the working characteristics of dentists in Scotland have been examined. These results can be used as a comparison with MIDAS output, in that results from one source can help reinforce those from another.

The Toothousand survey was carried out in 2000 (SCPMDE, 2000). It consisted of a questionnaire sent to all non-salaried GDS dentists in Scotland and included questions regarding their working patterns and future intentions. The response rate was 71%.

Figure 4.9 shows how the numbers of hours worked per week in both private and NHS sectors varies by non-salaried dentist age and gender. The results are plotted for 5-year age bands; however, analysis of the private hours was made on 10-year age bands to smooth out the deviations shown in these more variable data.

It can be seen that NHS work tends to reduce with increasing age amongst males. Females work fewer hours on average than males. They also tend to work fewer hours with increasing age (within the variability of the data). Their hours are lower between the ages of 30 and 45, which may be a consequence of part time work and/or careers breaks.

Average numbers of private hours worked per week increases with older age. This corresponds with the trend of working fewer NHS hours with older age, suggesting that as dentists progress through their careers, they take on more private work, which is in part at the expense of NHS work. Females perform less private work than males.

Figure 4.9: Toothousand average NHS and private hours worked by non-salaried GDPs
4.8.2 Denplan data

Data from the private dental health insurance company Denplan have been made available for this project (Chapter 7). From these data it was possible to obtain the age distribution of dentists with Denplan patients operating in Scotland. These are presented in Figure 4.10, along with a comparison of the GDS dentist age distribution.

The age distribution shows that the proportion of GDS dentists aged 25-34 is greater than the proportion of Denplan dentists in the same age band. However, for all older age bands, the reverse is true. This suggests that younger dentists are less likely to provide private dental services, the reason for which may be that they need to establish their career before being able to take advantage of opportunities to work in the private sector.

The results here corroborate those from the Toothousand survey, which showed that, on average, the time dentists spend working in the private sector increases with age.

The Denplan workforce was 85% male in 2002, compared to 65% in the GDS workforce. This suggests that male dentists are more likely to provide private dental services.

4.8.3 MIDAS data

Costs of treatments claimed by dentists were extracted from MIDAS for 1997 to 2003. Non-typical GDS dentists were excluded, such as emergency service practitioners, those also working as community service dentists, and orthodontists. It should be noted that the results only account for NHS activity – dentists may also undertake private work that cannot be accounted for from MIDAS data.

Note that these are treatment costs only – they do not represent the total income that dentists receive, since they exclude other payments such as capitation fees.
The treatment costs were adjusted for inflation to the level on April 2003. Over the period 1997 to 2003 claims cost per dentist changed little, which was confirmed by analysis of standard deviations. However, amongst male dentists a downward trend is evident (Appendix V).

All available evidence suggests increasing ‘drift’ to the private sector. Accordingly it was felt, for this parameter, that the most realistic data were the averages from the four most recent years, 2000-2003. These have been used in the medium output. If the average figures for 1997-2003 had been used there would be a reduction in the numbers of dentists required to meet the level of utilisation.

For non-salaried dentists, it can be seen that the distribution of male non-salaried dentists has two peaks. Female dentists also show a double peaked curve, albeit to a lesser extent and with less skew towards providing many treatments. The different pattern for females suggests more of a tendency towards working part time, as expected.

The nature of a double-peaked distribution corroborates the results of a survey of GDPs in Britain (Buck & Newton, 2001). This found that GDPs tend to fall into one of two categories: those who concentrate on the NHS sector and those who work predominantly privately. The numbers of GDPs who work an even split in both sectors are relatively low.

In contrast, the salaried dentists of either sex display a similar pattern of tending to provide far less treatment compared to non-salaried dentists (Figure 4.12). There is also

*Figures are for item of service fees only.*
very little skew towards salaried dentists providing many treatments.

Dentist output is considered further by analysing the variation with dentist age. No significant variation with age was found amongst salaried dentists; however non-salaried output was found to vary. Figure 4.13 shows the average non-salaried dentist output broken down by dentist gender and age, and average salaried output is shown for comparison.

It can be seen that male output is, at all ages, higher than female output. Apart from under-35s, male output declines with age,
particularly for 60-years and over. This may be in part due to a greater tendency for older dentists to provide more private treatment and/or work part time. Female dentists show a similar pattern, except for a relatively lower output between 35 and 49, which may be due to more part time work and/or career breaks.

The patterns shown in Figure 4.13 for non-salaried dentists are similar to those from the Toothousand survey shown in Figure 4.9, which further corroborates the results.

To calculate the future output of non-salaried dentists the age and gender distribution of the supply model output for the appropriate year has been used. This makes the assumption that any addition to/reduction of the workforce not predicted by the supply model will not result in a different age/gender structure from that forecast.

Figure 4.13 also shows how salaried dentist output is lower compared to non-salaried dentists for all age and sex categories. It was found that salaried dentist output is 40% that of the average non-salaried dentist output (using the age and sex distribution of GDPs in 2003). However, it should be emphasised that these relative earnings data take no account of case mix, numbers of support staff, or other infrastructural differences that exist between general dental practice and the salaried service.

The future number of salaried dentists draws on current trends. For the past seven years these show an upward trend of approximately 5 new salaried dentists per year. For the principal model output it is assumed that this will continue into the future. The assumption made here is that any addition to/reduction of the future dental workforce will be of non-salaried dentists.

Given the input of total treatment costs, the numbers of dentists required to service this are calculated as follows:

\[
\text{Number of GDPs required} = (\text{treatment cost} - N_{\text{sal}}_t \times \text{sal-activity}) + \frac{N_{\text{sal}}_t}{\text{non-sal-activity}_t}
\]

where \(N_{\text{sal}}_t\) is the number of salaried dentists at time \(t\), sal-activity is the output of a salaried dentist, and non-sal-activity\(_t\) is the output of a non-salaried dentist at time \(t\) which is calculated using the following formula:

\[
\text{non-sal-activity}_t = \sum_{\text{dentist age, sex}} \text{activity(age,sex) \times age-propn}_t \times \text{sex-propn}_t
\]

where \(\text{activity(age,sex)}\) is the activity for a non-salaried dentist of age and sex, \(\text{age-propn}_t\) is the percentage of non-salaried dentists of age at time \(t\), and \(\text{sex-propn}_t\) is the percentage of non-salaried dentists of sex at time \(t\).

### 4.8.4 Therapist and hygienist activity

This aspect of the model considers the capacity and extent to which PCD (hygienists and therapists) can contribute to the dental service. The contribution from PCD is not accounted for by the main model.
output', which states how many GDPs are required to provide a given amount of treatments.

Previous research (Galloway et al, 2002) has shown that the addition of one therapist increases the output of a single-handed dental practice previously without the therapist by 46%. Similarly, for the addition of one hygienist, the increase is 35%. These results suggest that, on average, hygienists and therapists contribute approximately 40% of a dentist’s output.

In future, it will be possible to model the contribution of therapists and hygienists and their effect on the dental workforce when robust data on their numbers are available. It will be important to differentiate between the existing singly qualified therapists and the future workforce who will be dually qualified (hygienist and therapist). The new generation will have a different and greater contribution to make.

4.9 Utilisation model results
4.9.1 Model outputs
Several utilisation model outputs are presented. These are based on the uncertainties inherent in modelling projections. The parameters used are mostly based on results from MIDAS data. These data show patterns for 1997 to 2003 only.

The sub-model sections described how the parameters were selected for the ‘principal’ model run. These parameters were chosen to be what was thought the most likely, with a bias towards over-predicting utilisation. The principal run can be thought of as the ‘Medium’ utilisation estimate. Two further outputs are presented for ‘Low’ and ‘High’ utilisation estimates. These are based on different selections of the model parameters for an optimistic and pessimistic utilisation estimate respectively.

The manner in which the parameters were chosen for each of the outputs is summarised in Table 4.2. The terms refer to the method and period for which the parameters are extracted. For example, ‘Avg97-03’ means the average between 2000 and 2003; ‘Max97-03’ means the maximum value between 1997 and 2003.

Table 4.2: Choice of parameters for different utilisation model outputs

<table>
<thead>
<tr>
<th>Output</th>
<th>Participation Rate</th>
<th>Edentulous Participation Proportion</th>
<th>Attendance Rate</th>
<th>Treatment Rate</th>
<th>Dentist Activity</th>
<th>Salaried dentist increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Avg97-03</td>
<td>15%</td>
<td>Avg97-03</td>
<td>Avg98-03</td>
<td>Avg97-03</td>
<td>0</td>
</tr>
<tr>
<td>Medium</td>
<td>Max98-03</td>
<td>10%</td>
<td>Max97-03</td>
<td>Avg97-03</td>
<td>Avg00-03</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>Max97-03</td>
<td>5%</td>
<td>Max97-03</td>
<td>Max97-03</td>
<td>Min97-03</td>
<td>10</td>
</tr>
</tbody>
</table>

The reasons for the choice of the parameters for the Medium output have been described in the relevant sub-model sections. They can be thought of as the best guess, with an element of caution, providing a bias towards over-predicting utilisation.

\footnote{This is because there is very little information on future numbers of PCD.}
Parameters for the Low output use the average from 1997-2003 for both rates of participation and attendance, which could be interpreted as the typical level of attendance in recent years. This is opposed to the maximum used elsewhere, which could be thought of as the highest observed level and may reflect more what the population would use, if it were available. The treatment rate uses the average from 1998-2003; this excludes the data for 1997, which showed possible anomalous values. The use of the average from 1997-2003 for dentist activity will be skewed towards higher levels, due to the declining trends shown by dentists providing relatively fewer treatments in recent years. It is assumed that there is no increase in the numbers of salaried dentists.

Parameters for the High output differ from the Medium in the use of the maximum participation and treatment rates, and the minimum dentist activity from 1997-2003. For the treatment rates, this represents the highest level of treatment observed provided to patients in the MIDAS data period. As such, it could represent the treatment levels patients would opt for, if they were readily available. For the dentist activity, this uses the lowest output by dentists observed over the MIDAS dataset period. For the High output, the attendance rate is unchanged from the maximum it is set to for the Medium output. The numbers of salaried dentists are assumed to increase at the greater rate of 10 per year.

The edentulous participations were chosen to be 15% for the Low output and 5% for the High output. Lower percentages will result in an increasing effect on utilisation from reducing edentulous rates.

4.9.2 Model results
The results from the Low, Medium and High outputs are presented in Figure 4.14. Tabulated results can be found in Table VI.2 (Appendix VI).

Figure 4.14: Utilisation model output
All the outputs show an increasing trend in the utilisation for at least the first 20 years. The High and Low outputs differ from the Medium by about 190 and 310 GDPs respectively in 2003. These gaps increase with time as the different assumptions on edentulous participation and the rising numbers of salaried dentists take effect.

- The Medium output suggests a requirement of 2,223 GDPs in year 2003, rising to 2,592 in year 2036
- The Low output shows 2,032 GDPs required in year 2003, rising to a peak of 2,221 in year 2023, thereafter declining
- The High output displays requirement of 2,537 GDPs in year 2003, rising to 3,143 GDPs in year 2036.

### 4.9.3 Sensitivity analysis – effect of changing the parameters individually

This section reports on analysis into how changing the parameters of the utilisation model individually affect the output. This allows insight into which of the parameter changes between the different model outputs causes the greater change in results.

Table VI.3 (Appendix VI) presents the results of changing each of the parameters, using the Medium output as a basis for comparison (middle row). The results are given for the specific years of 2003, 2010, 2020, 2031 and 2036.

The results show that, between the years 2003 and 2010, the greatest difference arising between the Low and Medium outputs is due to the change in the Dentist Activity parameter. After year 2020, the changes to the Participation Rate parameter have the greatest effect.

Between the Medium and High outputs, changing the Treatment Rate and Dentist Activity parameters cause the greatest differences.

### 4.9.4 Sensitivity analysis – effect of fixing driving factors

To provide a better understanding of the extent to which the various factors influence the projected increase in utilisation, analysis has been made whereby some of these factors are artificially held fixed within the model at 2003 levels. The relative change in outputs from fixing these factors one at a time can highlight which have the greatest effect.

The factors considered are:

- population age distribution
- population edentulous rates
- dentist age distribution
- dentist sex distribution.

Results of this sensitivity analysis can be seen in Figure 4.15, using the Medium model output as a basis. The amount of difference between the output with a factor held fixed compared to applying no change indicates the influence of that factor on the utilisation – the greater the difference, the larger the influence.

It can be seen that by far the greatest effect on driving increased utilisation are edentulous rates. This highlights how reducing edentulous rates within the
population, combined with the general low attendance of edentulous persons, leads to a larger proportion of the population retaining teeth and, as a result, attending the dentist more frequently.

The second largest effect is due to the dentist sex distribution. This arises because the increase in proportions of female GDPs results in more dentists whose characteristics are to provide fewer treatments, through factors such as part time working and career breaks.

4.9.5 Implications of increased utilisation

This section examines the implications of increases in the level of utilisation and the impact this would have on dental workforce requirements. Increases in the utilisation level could arise from a variety of factors. For example, this may be necessary to address areas of unmet need and/or demand for dental services that may currently exist. Increases in the level could also arise from factors that are discussed in Chapters 5-7, which were not incorporated into the model. For example, increases in the level of income, changes in employment rates or a change in the geographical distribution of dentists. These are factors that are likely to alter over time and, hence, will involve a change in the slope of the utilisation model output.

The effects of increasing the utilisation level by 10, 20, 30 and 40% throughout the period considered have been examined (these increases can equally be applied to either participation, attendance, or treatment rates – all result in the same effect). These amounts have been chosen arbitrarily and may not reflect the increments required to meet any necessary rises in the utilisation level. The intention is to provide a ‘feel’ for the extra workforce that would be required to service an increase in the level of utilisation.

Figure 4.16 shows the results of applying the utilisation increments to the Medium model output.
To service increases in utilisation of 10, 20, 30 and 40% would require an additional 9, 19, 28 and 38% dentists respectively. The resultant percentage dentist increases are lower than the percentage utilisation increases because of the assumptions made on numbers of salaried dentists. For the base year 2003, the increases correspond to a requirement of 2,434, 2,645, 2,856 and 3,067 GDPs respectively, compared to 2,223 required with no adjustment to the utilisation level.

Further results are presented in Table VI.4 (Appendix VI), which includes the application of this method to Low and High model outputs.

Figure 4.16: Utilisation model Medium output with adjustments to the level of utilisation

<table>
<thead>
<tr>
<th>Year</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>2,200</td>
<td>2,223</td>
<td>2,246</td>
<td>2,269</td>
<td>2,292</td>
</tr>
<tr>
<td>2006</td>
<td>2,300</td>
<td>2,323</td>
<td>2,346</td>
<td>2,369</td>
<td>2,392</td>
</tr>
<tr>
<td>2009</td>
<td>2,400</td>
<td>2,423</td>
<td>2,446</td>
<td>2,469</td>
<td>2,492</td>
</tr>
<tr>
<td>2012</td>
<td>2,500</td>
<td>2,523</td>
<td>2,546</td>
<td>2,569</td>
<td>2,592</td>
</tr>
<tr>
<td>2015</td>
<td>2,600</td>
<td>2,623</td>
<td>2,646</td>
<td>2,669</td>
<td>2,692</td>
</tr>
<tr>
<td>2018</td>
<td>2,700</td>
<td>2,723</td>
<td>2,746</td>
<td>2,769</td>
<td>2,792</td>
</tr>
<tr>
<td>2021</td>
<td>2,800</td>
<td>2,823</td>
<td>2,846</td>
<td>2,869</td>
<td>2,892</td>
</tr>
<tr>
<td>2024</td>
<td>2,900</td>
<td>2,923</td>
<td>2,946</td>
<td>2,969</td>
<td>2,992</td>
</tr>
<tr>
<td>2027</td>
<td>3,000</td>
<td>3,023</td>
<td>3,046</td>
<td>3,069</td>
<td>3,092</td>
</tr>
<tr>
<td>2030</td>
<td>3,100</td>
<td>3,123</td>
<td>3,146</td>
<td>3,169</td>
<td>3,192</td>
</tr>
<tr>
<td>2033</td>
<td>3,200</td>
<td>3,223</td>
<td>3,246</td>
<td>3,269</td>
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<tr>
<td>2036</td>
<td>3,300</td>
<td>3,323</td>
<td>3,346</td>
<td>3,369</td>
<td>3,392</td>
</tr>
</tbody>
</table>

4.10 Comparison of utilisation and supply projections

The utilisation model presents projections of the number of GDPs required to provide a given level of dental service utilisation. The utilisation projections are based on a level of utilisation derived from data for the period 1997 to 2003. The utilisation model provides a set of Low, Medium and High outputs, which reflect the uncertainty in the estimation of the utilisation and numbers of GDPs needed to service this. The supply model projects the expected number of GDS dentists.

Figure 4.17 illustrates the difference between the utilisation and supply model projections by comparing the Medium supply model output with the Low, Medium and High utilisation model output. This represents how the projected supply is expected to change relative to the projected utilisation requirements. An increasing difference would suggest deterioration in service provision, relative to the recent past, whilst a decreasing difference would suggest an improvement.

Note that this is comparing projected numbers of GDPs required (utilisation model output) with projected numbers of GDPs present (supply model output). There will be additional contributions to dental
service provision that the modelling outputs do not include – namely VTs, hygienists and therapists. These groups are currently an important part of the workforce, and are likely to play an increasingly important role in the future. The effect of including VTs and therapists is shown in section 4.11.

For the High utilisation model projection there is an initial difference of about 530 GDPs, which increases to 700 in 2026.

The analysis above compares the three utilisation model outputs with the Medium supply model inputs. Further comparisons have been made using various combinations of the Low and High supply and utilisation model outputs. This results in a greater spread of outcomes which, whilst less likely to occur than the principal ‘Medium’ outputs, nevertheless display the full range of outcomes that could arise, given the range of historical characteristics observed in the GDS.

Table 4.3 summaries the projected difference using different combinations of the model outputs.

Figure 4.17: Difference between supply and utilisation model outputs

It can be seen that for the Medium output, there is an initial difference suggesting that around an additional 215 GDPs would be required to service the level of utilisation on which the model is based. The difference for the Medium output reduces to 140 in 2014, and thereafter increases. Remember that any gap in service provision will be reduced by the presence of VTs and PCD in the workforce.

In contrast, for the Low utilisation model projection, beyond 2005 there are at all times sufficient GDP numbers to provide the level of utilisation estimated.
It can be seen that comparing the extremes of utilisation High and supply Low outputs shows a difference of 686 GDP by year 2010, which would increase to 1,078 in year 2036.

Additional implications of any required increases in the level of utilisation can be factored in here by considering the results of Table V.4. For example, should an increase of 10% in the utilisation be required, Table V.4 suggests this would need an extra 202-261 GDPs additional to the figures reported in Table 4.3 by 2010.

4.11 Scenarios considering the effect of VTs and therapists
Given the apparent gap in numbers of GDPs required to provide the level of utilisation suggested by the model when compared with the supply model (section 4.10), some scenarios that assess how this gap might be reduced are considered.

The first scenario considers an increase in VT joining rates such that 70% of VTs join the GDS within 1 year of completion of their training (as presented in Section 3.9). This is an adjustment to the supply model output.

The second scenario considers the impact of an additional 25 PCD per year contributing to dental service provision. This is not an unrealistic increase in future PCD numbers, given that 40 PCD per year are expected to be trained in Scotland (section 3.4). This is an adjustment to the utilisation model output, since the presence of PCD in the workforce means that fewer GDPs are required.

Finally, a combination of the above two scenarios is presented.

In all cases, the scenario adjustments have been made to the medium model outputs. The results are presented in Figure 4.18. For reference the medium utilisation minus medium supply output from Figure 4.17 is also shown.

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
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<tr>
<td>2010</td>
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<td>-87</td>
<td>75</td>
<td>164</td>
<td>305</td>
<td>544</td>
<td>686</td>
</tr>
<tr>
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<td>-147</td>
<td>139</td>
<td>361</td>
<td>561</td>
<td>783</td>
<td></td>
</tr>
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<td>-144</td>
<td>176</td>
<td>460</td>
<td>635</td>
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<td>535</td>
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<td>-286</td>
<td>137</td>
<td>527</td>
<td>688</td>
<td>1078</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.3: Difference between utilisation and supply model outputs (utilisation GDP requirements minus supply GDP numbers)
It can be seen that both the increase in VT joining rates and the addition of 25 PCD per year have similar effects on the difference between the projected GDP numbers and projected GDP requirements. The difference is expected to reduce to zero by 2014 and 2017 respectively. Combining the two scenarios results in a faster decrease in the differences, such that the difference disappears by 2010.

A further scenario which can be considered is the effect of the service contribution of 120 VTs. If the contribution of a VT is assumed to be 40% of that of a non-salaried GDP, this would add the equivalent of 48 GDPs to the workforce and the effect of this 'additional' workforce is shown in Figure 4.19.
This Chapter has described how a model has been developed to estimate the future number of GDPs required for the utilisation of dental services. The model has relied on data from the ADHS and MIDAS, together with population projections. The model makes the assumption that the characteristics of dental provision in the future remain constant. The structure of the model is made up of sub-models as follows:

- **Population;** uses projections from GAD
- **Participation;** rates are generally higher amongst males than females. The rates have been adjusted for projected reducing edentulous rates
- **Attendance;** rates are highest amongst children, lowest amongst young adults, and increase for older ages
- **Treatment;** the correlation between treatment cost and clinical time has been exploited to measure treatment amounts in terms of cost. Complex treatment rates tend to increase for older ages; all other treatment rates decrease with adult age
- **Dentist Activity;** surveys and MIDAS data illustrate how non-salaried GDP output tends to reduce with age amongst male GDPs, whilst female GDPs provide relatively fewer treatments between the ages of 30 and 50. A salaried GDP provides on average 40% of treatments compared to a non-salaried GDP.

Outputs from the model indicate that future numbers of GDPs required are expected to increase. This increase is from 2,223 GDPs in year 2003 to 2,592 GDPs in year 2036 for the Medium output. A selection of outputs is presented to reflect the uncertainty of these results. The figures suggest that the numbers required could be 420 fewer than or 550 more than the Medium output.

Comparison of utilisation model outputs with supply model outputs (Chapter 3) provides information on how the projected supply is expected to change, relative to utilisation requirements. Should the supply increase at a greater rate than the utilisation requirements, this would suggest an improvement in the level of service being provided.

Results suggest that the utilisation model’s projected rate of increase in GDP requirements is at least matched by the supply model’s projected rate of increase in GDP numbers for the next 12 years. The principal model outputs suggest a shortage of 215 GDPs in 2003, which would reduce to 140 by 2014. However, the range of outputs suggest that at present as many as 530 extra GDPs may be required to provide a level of service equivalent to that derived from the historical data.

Scenarios which consider the effect of increased VT joining rates, and the contribution of an additional 25 PCD per year were examined. They showed that, were these two factors to occur simultaneously, the shortage of GDPs required to provide the historically derived level of service would be eliminated as early as 2010. A further scenario which considered the service contribution of 120 VTs shows that the ‘gap’ would be closed by 2008.
Sensitivity analysis of the utilisation model output highlights that one of the main drivers behind the projected increase in dentist number requirements is reducing edentulous rates. The greater maintenance burden of increasing tooth retention is clearly a significant issue in workforce planning for dentistry. Correspondingly, this increase in tooth retention may, due to lack of information, result in changes not able to be considered in the modelling presented. For example, future patterns of attendance and/or treatment may change as a result of the country’s improving oral health.

It is important to bear in mind the limitations in making any prediction of workforce requirements. The inherent unknowns in such work emphasise the importance of continued data collection to provide additional evidence towards workforce planning. This should be both through continued updating of existing datasets, and also expansion to collect new data, such as tooth specific treatment information.

4.13 REFERENCES


The utilisation forecasts described in Part II represent an estimate of the trend in aggregate utilisation of dental services over time. In contrast, Part III considers the demand for dental services by individuals. The purpose of this part of the report is to identify and estimate the effect of factors that determine an individual patient's utilisation of dental services. These factors have not been explicitly included in the aggregate utilisation forecasts of Part II.

Part III provides a framework for analysing the demand for dental services (Chapter 5), reports the key results from the existing literature (Chapter 6), and estimates the utilisation of dental services in Scotland using two good quality data sources (Chapter 7).

The results from Part III should be used in combination with the aggregate utilisation model in Part II to compile a picture of the utilisation of dental services in Scotland. In the future, the results from Part III will be integrated into the aggregate utilisation model of Part II and the combined data will form the basis of future forecasting models.
5. THE DEMAND FOR DENTAL SERVICES: AN ANALYTICAL FRAMEWORK

5.1 Background
The demand for dental services in Scotland is significant. According to the Scottish Dental Practice Board (2003) in 2002-2003 just over 4.1 million forms were authorised in the non-salaried GDS. Approximately 715,000 children and about 2 million adults were registered with a GDS dentist. Total item of service fees amounted to £133m. The average cost of a course of NHS dental treatment was £40 for both adults and children and over 2.2 million dental examinations were provided.

5.2 A framework for analysis of demand
The purpose of this chapter is to develop a framework on which to analyse the demand for dental services and its determinants.

5.2.1 The determinants of demand
The conventional framework within which economists evaluate the demand-side of markets for goods and services is that consumers (patients) determine the amount of services they will consume by comparing the costs and benefits of consumption. The benefits of dental treatment might include the arrest of pain, a reduction in the probability of pain in the future, or an improvement in aesthetics. The costs could include absence from work, travel costs, and patient charges.

Within this framework patients will attend a dentist when the benefits are greater than the costs. Furthermore, once at the dental surgery, a patient will only willingly pay for treatment when benefits exceed the costs. Thus, this framework predicts that the determinants of the demand for dental services are those factors that increase (marginal) benefits or reduce (marginal) costs. These factors include the individual’s oral health state and preferences for oral health, the relative level of patient charges and income.

5.2.2 An example: patient charges
Consider the impact of an increase in the patient charge. This may reduce the utilisation of NHS dental services in two ways. Firstly, patients who choose to attend a dental practice for treatment may choose to receive less on account of patient charges, henceforth, this is referred to as a reduction in the amount of dental services used per attendance. Secondly, some patients may no longer attend at all, may attend less frequently or may seek private treatment, a reduction in the frequency of attendance at NHS dental practices.\(^1\) In both cases the reduction in use occurs because the cost of treatment to the patient increases with the increase in patient charges.

Figure 5.1 illustrates the impact of an increase in patient charges on the frequency of attendance. The horizontal axis measures the frequency of attendance (per time period) and the vertical axis measures the cost of attendance. The demand function (D) is downward sloping because as the cost of attendance rises the patient prefers to attend less frequently. The cost function is considered constant at the level of the patient charge (C) but it could also include other costs of attendance.

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\(^1\)A change in the use of dental services per attendance and the frequency of attendance are also sometimes referred to as changes in the utilisation of dental services at the intensive and extensive margins, respectively.
Increasing the patient charge increases the cost schedule from $C$ to $C_1$ and reduces the frequency with which patients attend from $Q$ to $Q_1$: after an increase in the patient charge, patients use fewer dental services. The precise magnitude of the response, $Q - Q_1$, to the increase in the patient charge is an empirical matter, i.e. can only be estimated using data.\(^2\),\(^3\) Thus, in theory the effect of eliminating patient charges for dental examinations – as announced in the recent Partnership Agreement between the Scottish Labour Party and the Scottish Liberal Democrats – is likely to lead to an increase in the frequency of attendance.

5.2.3 Other demand factors

The demand functions in Figure 5.1 are drawn under the assumption that all other determinants of demand such as income, preferences and oral health state, are constant. Changes in these factors are represented by shifts in the demand function. Figure 5.2 illustrates the impact of different preferences for dental services.

The two demand functions relate to two individuals who, apart from their preferences for dental services, are otherwise identical. Individual A has a stronger preference for dental services than individual B. In Figure 5.2 this stronger preference is reflected in individual A’s demand function being a right-shifted version of individual B’s. This shift reflects that individual A is prepared to pay more to access dental services than individual B at all frequencies of utilisation.

The effects of different levels of income and oral health on utilisation can also be illustrated by shifts in the demand function. However, while we may have some expectation of the direction and magnitude of these shifts, their net effect on the frequency of attendance is an empirical matter.

\(^2\) In the absence of patient charges patients face a very low or zero overall cost for the services they use and thus have an incentive to ‘over-consume’ health care resources. In the economics literature this increased consumption is termed ex post moral hazard (Zweifel & Manning, 2000).

\(^3\) Blomqvist (1997) analyses how patient charges might optimally be structured in such a way as to induce the ‘right’ amount of utilisation.
5.3 Physician agency

5.3.1 Introduction

The conventional analytical framework discussed in section 5.2 treats the demand side of the market in isolation from the supply side. Recently, the emerging view is that characteristics of the supply side also play an important role in the utilisation of health services. There are reasons for suggesting that the supply side and, in particular, the incentives inherent in providers’ employment contracts are an important determinant of the variation in health care utilisation. If so, variations in patient charges and the other determinants of demand may have little impact upon the amount of dental services used per attendance or the frequency of attendance.

5.3.2 Physician agency and the amount of dental services used per attendance

The demand for oral health care is different from the demand for other non-health goods and services. In particular, patients are unlikely to be perfectly informed about either the cost or the benefit of dental treatment. Indeed, once at a dental surgery many patients are likely to be guided by the advice of the dentist. The situation in which providers of services have more information than the purchaser is termed ‘asymmetric information’. The prevalence of asymmetric information in health care markets gives rise to concerns about the extent to which the discretion of providers may be exercised in ways that are against the interests of the recipients of health services or private or public purchasing agencies. This discretion may be exercised in terms of the extent of treatment offered, inputs that affect cost, the quality of treatment and the price of health care. McGuire (2000) refers to these related issues as ‘Physician Agency’. The physician agency literature considers how incentives may be structured in order to align physicians’ incentives with those of the purchaser. Therefore, in terms of the amount of dental services used per attendance, patients are viewed as relatively passive.

5.3.3 Physician agency and the frequency of attendance

Whilst the presence of asymmetric information may influence the impact of demand side factors on the amount of dental services used per attendance, the patient has much more discretion over the frequency of their attendance. That discretion may be exercised within the conceptual framework described in section 5.2. Thus, although providers and policy makers may attempt to influence the frequency of attendance through recall frequencies and appointment reminders, patients have the ultimate discretion over whether to seek treatment or not. This suggests that the determinants of demand may have a greater impact upon the frequency of attendance, relative to the amount of dental services used per attendance.

5.4 Summary

A conventional economic framework can be applied to dental services but the framework has to be augmented in light of the asymmetric information between purchasers and providers. In light of this augmented framework, this chapter suggests that a useful empirical measure of demand for dental services is the frequency of attendance. A number of points have emerged:
The demand for dental services can be considered within a conventional economic framework in which the determinants of demand are prices (patient charges), income, oral health status and preferences.

The impact of the determinants of demand may be attenuated by supply side arrangements.

The determinants of demand may impact upon both the frequency of attendance and the amount of dental services used per attendance but the existence of asymmetric information between the patient and the provider suggests that demand side factors will have their largest impact on the frequency of attendance.

The impact of both supply side and demand side factors on the utilisation of dental services may be informed by the framework of this chapter. Estimates of the precise impact of these factors are provided in the next two chapters.

5.5 References


6. AN OVERVIEW OF RESEARCH EVIDENCE

6.1 Introduction
The purpose of this chapter is to review the existing literature on the demand for dental services. It has not been possible to conduct a full systematic review of the available literature and this chapter draws heavily on the research reported by Chalkley and Tilley (2002a). Four key areas which impinge upon demand have been identified. They are:

• Patient charges
• The socio-economic characteristics of the patient
• The number and type of available insurance contracts
• The number, and proximity to patients, of dentists.

6.2 Patient charges

6.2.1 Patient charges have a greater impact upon the frequency of attendance than the amount of dental services used per attendance
Newhouse et al (1993) report that, whilst patient charges impact upon both the frequency of attendance and the amount of dental services used per attendance, the majority of the effects of patient charges operate through the reduction in the probability of use (two-thirds) and the number of visits per patient (three quarters), that is the frequency of attendance, rather than the expenses per user (the amount of services used per attendance).

The magnitude of the effect of patient charges on the frequency of attendance varies across studies. For example, Newhouse et al (1993) and Manning et al (1985) estimate that the effect of increasing the patient charge from 0 to 25% of the cost of treatment reduces visits by about 30%. Mattei and Simon (2000) report that the introduction of some degree of patient charges reduces the number of visits by 33%, and Jung (1998) reports that the introduction of an access charge in Korea reduced patient visits by 25%. Olsson (1999) shows that patients with insurance are 20% more likely to attend than uninsured patients, while Milgrom et al (1998) report that insurance increases the attendance of children by about 10%.

There is less evidence in terms of the amount of dental services used per attendance. Using data from the GDS in Scotland, Parkin and Yule (1988) estimate that a 10% increase in the cost of dental services reduces total expenditure by 2.4%, while Chalkley and Tilley (2002b), also using Scottish data, estimate that exemption from patient charges increases the cost of a dental claim by 22%. Importantly, however, they show that the magnitude of this effect depends crucially upon the method of provider payment. In particular, they find that self-employed dentists provide more treatment to patients who are exempt from payment than their employed counterparts. These results imply that changes in remuneration can have a large effect on the distribution of treatments. More generally, these results provide support for economic models that view financial incentives as important determinants of dentist behaviour and, therefore, have implications for the review of dental services in Scotland (SEHD 2003).

The international evidence of the effect of patient charges on the amount of dental services used per attendance is mixed, with some studies finding significant effects (Manning & Phelps, 1979) and (Mueller & Monheit, 1988) and others finding none (Conrad et al, 1987) and (Kington et al, 1995) which suggests that the precise impact of patient charges is context specific.
6.2.2 The effect of patient charges on the utilisation of specific treatments varies across treatments

Newhouse et al (1993) find that, relative to individuals who paid 95% of the cost of their treatment, individuals who paid no patient charges were 31% more likely to use diagnostic services, 30% more likely to use restorative services, 63% more likely to use prosthetic services, and 47% more likely to use endodontic services. In addition, Manning and Phelps (1979) find that the use of examinations is less responsive to patient charges than other services and Matee and Simon (2000), Zammit (1993) and Parkin and Yule (1988) report that prosthetic services are amongst the most responsive treatments to patient charges.

6.3 The demand for dental services is a function of a patient’s socio-economic characteristics

Newhouse et al (1993) report that, relative to patients who paid 95% of the cost of treatment, individuals who paid no patient charges and were in the lower third of the income distribution were 45% more likely to use any dental services, made 45% more visits, and had 47% greater dental expenses. In contrast, individuals who faced no patient charges and were in the upper third of the income distribution were 22% more likely to use any dental services, made 26% more visits, and had 44% greater dental expenses. Newhouse et al (1993) also report that income has significantly different effects on the frequency of attendance but not on the amount of dental services used per attendance.

Propper (2000) reports that the demand for dental services in the UK, using the British Household Panel Survey (BHPS), is a function of the income, employment, and educational qualifications of the individual.

6.4 The demand for dental services is a function of the number, and type, of other available insurance contracts

Godfried et al (2001) analysed the demand for dental services when patients may choose from a menu of insurance contracts. When dental services were excluded from compulsory health insurance cover in Holland, patients who expected to use dental services more frequently or more intensively opted for more generous insurance cover. Since the premiums for those policies were not adjusted for the risk characteristics of the individuals they insured, high cost individuals systematically self-selected into the most generous plans. Cutler and Zeckhauser (1998) discuss the effects of this ‘adverse selection’ in detail. Propper (2000) analysed the demand for public and private sector dental services using data from the BHPS. Her findings show that the frequency of attendance is significantly affected by individuals’ previous use of public and private dental services.

6.5 Utilisation may be a function of the number, and proximity to patients, of dental providers

Many studies have reported a positive correlation between the number of dental providers in an area and the utilisation of dental services. There are a number of explanations for this correlation and much of the research evidence is directed towards discriminating among these competing hypotheses. One frequently cited explanation is the supplier induced demand hypothesis which supposes that providers exploit their informational advantage over patients by providing more treatment than a fully informed patient would choose. Sintonen & Linnosmaa (2000) conclude that the extent of supplier induced demand in dentistry is uncertain.
Another explanation for this correlation is that some areas may face capacity constraints and the positive correlation between utilisation and the number of providers is just a reflection of more dentists being attracted to areas in greater need of dental services.

6.6 Implications of the research evidence for Scotland

Applying the results of sections 6.2 - 6.5 to dental services in Scotland should be conducted with some caution. All the results reported are a function of the particular environment – the demand and supply-side relationships – in which they are estimated. These environments differ markedly across countries and particularly between Scotland and the US (the predominant source of the results).3

Thus, whilst in the absence of data it is not possible to make any quantitative statements about the impact of various factors on the utilisation of dental services, it is possible to draw some qualitative conclusions based on the foregoing research evidence. In particular, in NHS Scotland: the introduction of free dental examinations is likely to have a positive impact upon the frequency of attendance; individuals in remote and rural locations may face greater costs of dental attendance and thus attend less frequently than their urban counterparts; and relatively deprived socio-economic areas in Scotland are likely to have lower dental attendance rates than more affluent areas.

6.7 Summary

This section has summarised the existing research evidence relating to the demand for dental services in the form of a series of key results. These key results indicate that:

The main determinants of the utilisation of dental services – some of which were also identified by Wanless (2002) – are those factors predicted by the analytical framework: prices, income, preferences, demographic factors, the number and type and of other available insurance contracts, the number of local providers and the method of provider payment.

In order to reflect the specific characteristics of dental services in Scotland a detailed assessment of the demand for dental services in Scotland requires estimates using data from Scotland.

The search for an empirical measure of the demand for dental services can be restricted to measures of the frequency of attendance.

6.8 References


3 The estimates from Newhouse et al.(1993) have been used in a dental simulation model for the United States. The NIDCR microsimulation model is composed of a dental module, DENTSIM, and a population module, CORSIM. DENTSIM estimates the probability that an individual uses dental services and conditional upon use estimates the type of intensive margin services received and variety of transition probabilities between oral health states. All these estimates are made conditional upon various health, demographic and socio-economic characteristics of individuals. The CORSIM module contains the numbers of individuals in the population with each of these characteristics. This enables the combined model to simulate changes in the oral health, demographic and socio-economic status of individuals in the US Brown et al (1995) used the NIDCR model to analyse the impact of fee and insurance changes on dental visits, per capita expenditure on dental services and oral health state.
The demand for dental services


Scottish Executive Health Department (2003), Modernising NHS Dental Services in Scotland Consultation.


7. THE UTILISATION OF DENTAL SERVICES IN SCOTLAND

7.1 Introduction

Chapters 5 and 6 have proposed a number of potential determinants of the demand for dental services but have suggested that the precise relationship between these determinants and demand is a function of the framework within which the relationship is observed.

This chapter explores the demand for dental services in Scotland using two data sets (the BHPS and the MIDAS). This analysis was commissioned by NES specifically for this project and was conducted in collaboration with DHSRU and the Department of Economic Studies at the University of Dundee.

7.2 The demand for dental services - evidence from the BHPS

7.2.1 Introduction

The purpose of this section is to examine the frequency of dental attendance in Scotland and the rest of the UK using data from the BHPS. There are two advantages in using BHPS data. Firstly, the data report both public and private use of dental services by individuals. Specifically, the BHPS asks two important questions relating to individuals’ frequency of attendance:

- Did the respondent have a dental check-up in the last year?
- If the respondent did have a dental check-up, was it provided by the NHS, privately or by both?

Secondly, whilst this data set does not provide much dentistry-specific information it does provide a great deal of socio-economic and demographic background on the respondents which can be used to estimate their demand for dental services.

7.2.2 Data description

The BHPS1 is an annual survey of each adult (16 and over) member of a nationally representative sample of more than 5,000 households in Britain. The BHPS has been conducted since 1991 and data are available from the first 11 waves (years) of these data. From Wave 9, the Scotland and Wales sub-samples have been expanded from around 500 households per year to approximately 1,500 households. The sample used in this report consists of data extracted from the last three waves of data (Waves 9, 10 and 11) which record data from the years 1999-2001.2

7.2.3 Descriptive statistics

The primary purpose for using the BHPS is that it is one of the few sources of information regarding the use of private sector dental services.3 Table 7.1 reports the distribution of examinations in Scotland relative to the rest of the UK.

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1 The data used in this analysis were made available through the ESRC Data Archive (project number 9569). The data were originally collected by the ESRC Research Centre on Micro-social Change at the University of Essex (now incorporated within the Institute for Social and Economic Research). Neither the original collectors of the data nor the Archive bear any responsibility for the analyses or interpretations presented here.

2 For simplicity the final data set only includes individuals who provided a full interview in all three waves: 12,488 individuals. Of these, the use of dental services by 14 individuals was missing or not recorded and was deleted.

3 Only if a respondent claimed to receive a private sector examination were they coded as ‘private’. If the respondent used both services or didn’t know the source of the provider they were coded as receiving NHS care.
Table 7.1 highlights the two dimensions of choice available to individuals: whether to seek care at all (No exam); and, conditional upon choosing to seek care, the type of provider of that care (NHS or Private). Table 7.1 suggests that, relative to the rest of the sample, people who live in Scotland are about 8% less likely to receive a dental exam per annum and they are also 30% less likely to receive a dental exam provided by the private sector.

Figure 7.1 highlights that within Scotland there is a significant amount of variation in the provision of NHS and private care between (BHPS-defined) local authority districts. For example, the percentage of patients who didn’t attend for a check up ranges from 28% in Motherwell to almost 62% in East Kilbride. The percentage of patients who report a private examination ranges from 3% in Angus, Perth and Kinross to 23% in the NW Highlands and the Western Isles.
7.2.4 Further evidence on private sector utilisation: evidence from Denplan

More evidence on the utilisation of private dental services in Scotland has been generously provided by Denplan. Denplan is the largest independent provider of dental services in the UK. These data provide an important supplement to the BHPS as they are collected over a six year period and are thus able to identify trends in private sector utilisation over a longer period than the BHPS data allow.

Figure 7.2 generally supports the geographical distribution of private sector dental services in Scotland reported in Figure 7.1. It highlights that, relative to NHS patients, private sector services are not evenly distributed geographically and, in particular, that a greater proportion of Denplan patients reside in Aberdeen, Edinburgh and Inverness.

The determinants of this distribution may be explained by the factors reported in Chapter 5.

A further virtue of the Denplan data is that it provides some indication of the oral health of its registered patients. Upon registering with Denplan, the dentist conducts a detailed assessment of the patient’s oral health to establish their Denplan Category (a, b, c, d or e). The Denplan Category is mainly determined by the oral health and future dental care needs of the patient: category a corresponds to relatively good oral health and low future dental care needs, while category e corresponds to relatively poor oral health and high future dental care needs. Figure 7.3 reports the number of patients registered by Denplan category between 1998 and 2003. The vast majority of Denplan patients (over 80%) are allocated to categories b and c and all groups have experienced an increase in...
numbers between 1998 and 2003. However, categories a and b (then – in order of increasing growth – e, d and c) have seen the fastest growth in numbers over the 6 years. This suggests that patients not only on higher incomes but also, perhaps as a consequence, those in better oral health are opting for Denplan services.

In summary, these data indicate that the demand for private dental services has been growing relatively quickly over the recent past. Whilst the determinants of this growth are difficult to assess, the results of Chapter 5 and anecdotal evidence suggest that the increasing income of patients and, perhaps, capacity constraints in the NHS are two possible explanations. These determinants and their impact upon utilisation are identified using the BHPS data in the next section of this chapter.

One important question that arises from these data is whether this increase in private sector provision has reduced public sector provision. Table 7.2 – from the full sample of the BHPS – suggests that over 11 years the utilisation of public sector dental services has remained constant at around 48%, while the utilisation of private sector dental services has increased significantly. Consequently, the percentage of people who do not use dental services in any year has fallen considerably.

This increase in the utilisation of dental services may be one reason that, despite the increase in the numbers of trained dentists, there is still evidence of unmet demand for NHS care.
7.3 An analysis of the utilisation of dental services using BHPS\textsuperscript{5} data

7.3.1 Introduction
This section reports the results of an analysis of the utilisation of dental services in Scotland using BHPS data. Following Propper (2000), we estimate the probability that a respondent has no exam, an NHS exam or a private sector exam conditional upon their demographic and socioeconomic characteristics, whether they hold private health insurance and their previous use of dental services in both (NHS and private) sectors.

7.3.2 Demographic variables
Women are more likely to use dental services from both sectors than men. Individuals are more likely to use dental services from both sectors as they get older but at a diminishing rate. The estimates of local area effects suggest that demand varies significantly between different local authority areas.

7.3.3 Socio-economic variables
Educational attainment is positively associated with the use of dental services in both the public and private sectors.

Greater household income is associated with increased frequency of attendance. However, when Scotland and the rest of the UK are compared there is a quantitative difference in effects. An increase in income has approximately twice the impact on NHS use in Scotland than in the rest of the UK. In contrast, income has a much larger effect on private sector use in the rest of the UK than in Scotland.

7.3.4 Health insurance
Individuals who have private health insurance (of some form) are more likely to use private dental care and less likely to use NHS dental services. Again, there is a distinct difference in this effect between Scotland and the rest of the UK. Individuals with private health insurance in the rest of the UK are much more likely to use dental care (public and private) than individuals with private insurance in Scotland.

7.3.5 Previous utilisation
The results demonstrate that one of the largest determinants of the current use of dental services is past, public and private, use. There are some good reasons to expect these determinants to be large. Past use may be correlated with a number of factors that we have not been able to account for, such as the oral health status of the individual, the individual’s preferences for oral health and

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Wave & No exam % & NHS exam % & Private exam % \\
\hline
1991 & 45.25 & 48.46 & 6.29 \\
1992 & 46.25 & 47.36 & 6.39 \\
1993 & 44.18 & 47.37 & 8.46 \\
1994 & 42.91 & 48.14 & 8.95 \\
1995 & 41.84 & 47.63 & 10.54 \\
1996 & 41.23 & 47.19 & 11.58 \\
1997 & 42.44 & 46.80 & 10.75 \\
1998 & 39.73 & 47.98 & 12.29 \\
1999 & 39.82 & 47.44 & 12.73 \\
2000 & 38.96 & 47.74 & 13.29 \\
2001 & 38.53 & 48.05 & 13.42 \\
\hline
\end{tabular}
\caption{Utilisation of public and private dental services in the UK\textsuperscript{4}}
\end{table}

\textsuperscript{4}These results are generated from the first 11 waves of the BHPS. Individuals’ responses are included in the sample if the respondent answered either yes or no to the question about the use of dental services.

\textsuperscript{5}Results of the econometric analysis for both Scotland and the rest of the UK are available from Dr C. J. Tilley (DHSRU) upon request.
the type of treatment the patient received. These factors and their relative importance will be analysed in greater detail in the next section. For now, though, consider previous use as a proxy for these unobserved influences.

The results suggest that if an individual in Scotland had an NHS exam in the previous year, there is a 50% (52% in the rest of the UK) chance that they will have an NHS exam this year. Similarly if an individual in Scotland had a private exam last year, there is a 30% (33% in the rest of the UK) chance that they will have a private exam this year. These own-sector effects are relatively large and almost identical between the two areas.

In contrast, cross-sector use is very small, relative to these own-sector effects. In Scotland, if an individual had an NHS (private) exam last year there is a 0.7% (7%) chance that they will have private (NHS) exam this year, indicating a large degree of persistence in the choice of dental service provider. Moreover, there seem to be large differences in the degree of persistence between Scotland and the rest of the UK. For example, if an individual had a private examination last year there is a much greater chance that they will have an NHS exam this year in Scotland (7%) compared with the rest of the UK (0.1%). The size of these own- and cross-sector effects may indicate the strength of patients’ preference for private and NHS dental care.

7.3.6 Implications of the BHPS analysis
This analysis has provided empirical support for the determinants of demand using UK data. The implications for forecasting the frequency of attendance from this section are:

- The utilisation of dental services is increasing over time.
- The demand for dental services is a function of the demographic and socio-economic characteristics of an individual.
- An important determinant of the demand for dental services in the public and private sectors is the past use of dental services in that sector.
- The extent of movement between the public and private sectors is relatively small.

The presence of the private sector is an important determinant of the demand for dental services. However, the third bullet point suggests that, conditional upon the provision of dental services within an area, the demand for NHS dental services may be treated in isolation from the demand for private dental services. This is a useful implication of the analysis as it provides support for the use of routinely-collected NHS data to investigate the impact of a number of factors not observed in the BHPS data set.

7.4 The demand for dental services in Scotland: evidence from the GDS

7.4.1 Introduction
MIDAS is an administrative database primarily used for paying dentists. There are a number of advantages in using MIDAS data to analyse the utilisation of dental services in Scotland:

- MIDAS contains dental data that are unavailable in the BHPS
• The measure of the frequency of attendance from MIDAS is conformable with the amount of dental services used per attendance.

• MIDAS contains an enormous amount of longitudinal data that can be used to estimate demand relationships.

This section examines the frequency of attendance in the GDS in Scotland using a random sample of claims data from MIDAS@DHSRU.6

In order to facilitate comparison with the BHPS data, the empirical analogue of the demand for dental services adopted in this section is the ‘participation’ of patients in the GDS (Chiappori et al 1998). An individual is said to have participated in the GDS if at least one claim is made on their behalf in a year.

7.4.2 Data description

For the purposes of this analysis we obtained a simple random sample from the MIDAS@DHSRU database. Specifically, the following results are based on a 1% random sample of (anonymised) patients drawn from MIDAS@DHSRU between 1997 and 2002. The sample consisted of almost 44,000 patients and about 205,000 claims for treatment.

The accuracy of the inferences drawn is dependent upon the representative nature of this 1% sample. To assess the relationship between the sample and the Scottish population, Figure 7.4 illustrates the age distribution of patients from the sample and the age distribution reported by the General Register Office for Scotland, GRO(S), for the year 2000.7

Figure 7.4: The age distribution by sample source

---

6 MIDAS@DHSRU is an anonymised version of the MIDAS data set.
7 The MIDAS estimates of the number of patients by age group may be larger than the GRO(S) estimates as a result of sample variation. The unique patient identifier in MIDAS is reported to be accurate.
Figure 7.4 shows a close correspondence between our sample and the GRO(S) data. However, there are clearly two ranges of the age distribution that the GDS data do not capture very well, children below 12 and adults above 60. This may be because patients in these age groups access other types of NHS and private dental services or because they simply access all dental services less frequently.8

7.4.3 Descriptive statistics
Table 7.3 reports the participation rates of individuals over the duration of the sample. Of the 43,781 patients in the sample, about 48% participated in 1997 and about 46% participated in 2002.

Table 7.3: Participation rates in the GDS

<table>
<thead>
<tr>
<th>Year</th>
<th>Participation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>47.99</td>
</tr>
<tr>
<td>1998</td>
<td>48.42</td>
</tr>
<tr>
<td>1999</td>
<td>47.77</td>
</tr>
<tr>
<td>2000</td>
<td>47.31</td>
</tr>
<tr>
<td>2001</td>
<td>47.31</td>
</tr>
<tr>
<td>2002</td>
<td>46.32</td>
</tr>
</tbody>
</table>

This table supports one of the key results often reported in relation to dental service utilisation; that about 50% of the population are registered, treated or attend each year. However, this aggregate cross sectional approach is unable to discern whether the 50% participation rates are a result of the same 50% of patients participating annually or the whole population participating every other year. Clearly, policy decisions should recognise this distinction (Ben-Porath, 1973).

In contrast, consider Table 7.4 which shows the seven most frequent patterns of participation in the GDS in Scotland over the duration of the sample. A ‘1’ in the ‘Pattern’ column indicates that a patient participated in that year. A ‘0’ in the column indicates that they did not participate. For example, Table 7.4 shows that 8.52% of the sample participated in 1997 only, while 6.41% participated in 1998 only, and so on.

Table 7.4 Patterns of participation in the GDS

<table>
<thead>
<tr>
<th>No. of individuals</th>
<th>%</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>6201</td>
<td>14.16</td>
<td>111111</td>
</tr>
<tr>
<td>3732</td>
<td>8.52</td>
<td>100000</td>
</tr>
<tr>
<td>2805</td>
<td>6.41</td>
<td>010000</td>
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<tr>
<td>2594</td>
<td>5.92</td>
<td>000001</td>
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<tr>
<td>2132</td>
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<td>001000</td>
</tr>
<tr>
<td>1979</td>
<td>4.52</td>
<td>000010</td>
</tr>
<tr>
<td>1959</td>
<td>4.47</td>
<td>000100</td>
</tr>
</tbody>
</table>

Hence, the most frequent pattern of participation, accounting for about 14% of all patients, is for patients to participate in every year of the sample. In stark contrast, the next six most frequent patterns of claims, accounting for almost 35% of patients, comprise those patients who participate only once in the six-year period.

Because our sample is a snapshot from the lifetime participation patterns of patients the 3,732 individuals reported in row two of Table 7.4, for example, may not consist solely of individuals who participate once every six years. Rather, some of the 3,732 could also comprise individuals who attend once every seven, eight, nine (and so on).

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8Children using the GDS without generating a claim for treatment are not included in thissample.
years. Using data for adults, Chalkley and Tilley (2004) analyse these patterns in greater detail and estimate the relative proportions of the population who participate at different frequencies under specific assumptions. They find that approximately 30% of Scottish adults participate every year while, in contrast, 16% participate only once every six years.

Given that the 44,000 patients represent only a 1% random sample of all patients in the database, the total number of patients in the database over the six years of data is approximately 4.4 million. In comparison, the total number of individuals who, in principle, could have been treated in the GDS between 1997 and 2002 is approximately 5.8 million. This is the sum of the population of Scotland in 1997 (5,083,340), the cumulative number of births since 1997 (about 300,000), and the cumulative number of immigrants since 1997 (about 420,000). Therefore these data represent approximately 76% of the population of Scotland over six years. Thus, the percentage of people who do not access GDS in Scotland is very much lower than commonly thought.

A comparison of Tables 7.3 and 7.4 suggests that aggregate, cross sectional data are much less informative than individual-level dynamic data. Therefore, it is the determinants of these dynamic, individual-level data, rather than the aggregate, cross sectional data, that this analysis aims to identify.

7.5 An analysis of the utilisation of dental services using MIDAS

7.5.1 Introduction
This section reports the results of an analysis of the utilisation of dental services in Scotland. We estimate the probability of participation conditional upon a patient’s demographic and socio-economic characteristics, a proxy for the supply of dental services, and variables that account for the persistence in participation rates over time.

7.5.2 Demographic variables
Men are much less likely to participate than women. The estimates imply that age increases participation rates until age 49 and reduces participation thereafter. The estimates of NHS Board effects suggest that participation rates vary between different NHS Board areas.

7.5.3 Socio-economic variables
Individuals who attend dental practices in areas with high DEPCAT scores (low socioeconomic scores) are less likely to participate than patients who attend practices in areas with low DEPCAT scores (high socioeconomic scores).

Exemption from NHS costs on grounds of health (for example, pregnant women and nursing mothers) and income reduces the probability of participation. Exemption on grounds of income confounds two effects. The first is a price effect: patients exempt from payment face a lower (zero) price for treatment which one would expect to increase participation. The second is an income differential: patients who are exempt on grounds of income have lower income (by definition) than non-exempt individuals.

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9The preliminary results are available from Dr C. J. Tilley (DHSRU) upon request. Whilst the following results should be treated with some caution, the qualitative consistency in the results across different methods of estimation suggests that some very tentative conclusions may be drawn at this stage.
This income differential is likely to reduce exempt individuals’ participation rates. The net negative effect implies that the income differential effect outweighs the price effect.

7.5.4 The supply of dental services
The supply of NHS dental services has a positive and significant effect on participation rates suggesting that participation rates are higher in areas with a greater concentration of dental services.

7.5.5 Sources of persistence in participation
These data enable us to decompose the persistence in participation rates observed in Table 7.3 into two parts: state dependence and individual heterogeneity. These components have very natural interpretations in health care. State dependence measures the relationship between previous and current health service use: preventive treatment today may make treatment tomorrow less likely. Individual heterogeneity measures the extent to which an individual’s participation depends upon their individual-specific characteristics, such as their preferences for oral health.

The results provide support for the presence of both state dependence and individual heterogeneity. In particular, the results find that participation and the type of treatment patients receive influences future participation rates. In addition, individual-specific effects play a large role in explaining the variation in utilisation between individuals.

7.6 Predicted participation patterns
Table 7.5 reports the actual and predicted frequencies of participation for two different methods of predicting participation: one that includes state dependence and individual heterogeneity and one that excludes these sources of persistence. For example, row five shows that 18.43% of the individuals participated in each of the last five years of the sample.
claim that cross-sectional data are much less informative than longitudinal data and may be misleading.

7.7 Implications of the MIDAS analysis
This section has estimated the determinants of participation in the GDS and has assessed the performance of two different estimation methods in terms of their ability to predict the actual patterns of attendance observed in the sample. In particular the section has shown that:

- MIDAS data are broadly representative of the age distribution of adults aged less than 60 in the population.
- Approximately 76% of individuals in Scotland have accessed NHS GDS during the six years of the sample.
- Cross sectional data are much less informative than longitudinal data and may be misleading.
- The determinants of participation in the GDS include those variables identified in previous sections and two sources of persistence: state dependence and individual heterogeneity.
- The estimation method that accounts for sources of persistence in the participation rates of individuals accurately predicts the in-sample patterns of attendance within the GDS. Models that do not account for these sources are severely mis-specified.

7.8 Summary
All the available evidence suggests that the demand for dental care is rising. There are a number of factors which are likely to be contributing to this rise in demand:

- Increased oral health
- Increased affluence
- Increasing numbers of GDPs
- Societal changes
- Consumer preferences
- Demographic changes.

The results generated using the two data sets described in this chapter are sufficiently consistent with the existing research evidence that we can be reasonably confident in our conclusions regarding the impact of various determinants on the utilisation of dental services in Scotland. Therefore, these results should be viewed as complementary to the results in Chapter 4.

This chapter has demonstrated the feasibility and potential value of using routinely collected data sets to inform the future development of the forecasting model outlined in Chapter 4. In particular, the results are able to identify a number of the key factors reported in Chapter 5 for Scotland, but these are not yet integrated into the aggregate forecasting model.

However, whilst these data sets provide some assistance in compiling a picture of the demand for dental services and its determinants, that picture is still partial. Taken together, the four data sets used in this report – the ADHS, NDIP, the BHPS and MIDAS – include almost all the variables predicted to drive the demand for dental
services but none is complete. Until these data are integrated, our conclusions must remain tentative. This implies that the complex inter-relationships between these factors and the extent to which each affects demand are not clear. Nor is it clear to what extent this will continue, given the uncertainty over the future shape of dental services provision.

Nonetheless, this chapter has clarified the value of collecting individual-level, integrated data to inform policy and important avenues for future research and development include:

• Developing IM&T systems that enable the integration of routine oral health and utilisation data

• Integrating more private sector data

• Developing IM&T systems that enable the integration of data across NHS dental providers (GDS, HDS and CDS).

7.9 References


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APPENDIX IV: BREAKDOWN OF GDS HEADCOUNT

<table>
<thead>
<tr>
<th>Headcount as at 30th September</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2014</td>
<td>2059</td>
<td>2089</td>
<td>2118</td>
</tr>
<tr>
<td>Principals</td>
<td>1865</td>
<td>1905</td>
<td>1935</td>
<td>1967</td>
</tr>
<tr>
<td>Non Salaried principals only</td>
<td>1814</td>
<td>1845</td>
<td>1869</td>
<td>1891</td>
</tr>
<tr>
<td>Salaried Principals only</td>
<td>49</td>
<td>57</td>
<td>63</td>
<td>72</td>
</tr>
<tr>
<td>Joint postholders - salaried and non salaried</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Assistants</td>
<td>48</td>
<td>49</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>Assistants only</td>
<td>40</td>
<td>39</td>
<td>31</td>
<td>28</td>
</tr>
<tr>
<td>Assistant &amp; non salaried</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Assistant &amp; salaried</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of VTs in post</td>
<td>101</td>
<td>105</td>
<td>111</td>
<td>111</td>
</tr>
</tbody>
</table>

Please note the figures given above for each category include those who are exclusively in that category (unless stated otherwise) i.e. the non salaried principals only figure does not include those who hold both a salaried and non salaried list number, or those who hold an assistant list number and non salaried principal list number.

All data pertaining to GDPs is derived from MIDAS. The information on VT numbers is obtained from MIDAS and NES.
APPENDIX V:
MIDAS RESULTS USED IN UTILISATION MODEL

PARTICIPATION

Proportion of male population participating

Proportion of female population participating
ATTENDANCE

Number of claims per male participation

Number of claims per female participation
TREATMENT

Male Assessment & Diagnostic treatment costs

![Graph showing costs per claim for different age groups from 1997 to 2003.](image)

Female Assessment & Diagnostic treatment costs

![Graph showing costs per claim for different age groups from 1997 to 2003.](image)
TREATMENT

Male Core treatment costs

Female Core treatment costs
TREATMENT

Male Complex treatment costs

Female Complex treatment costs
TREATMENT

Male Orthodontic treatment costs

Female Orthodontic treatment costs
DENTIST ACTIVITY

Male non-salaried dentist output

Female non-salaried dentist output
DENTIST ACTIVITY

Salaried dentist output

![Graph showing cost of treatments (2003 £) for male and female dentists from 1997 to 2003. The graph is labeled with the years 1997 to 2003 along the x-axis and the cost of treatments (2003 £) along the y-axis. The data points are represented by blue and red diamonds, indicating male and female costs, respectively. The trend shows that the cost for both males and females generally decreases from 1997 to 2000, with a slight increase in 2001, followed by a decline in 2002 and 2003.]
## APPENDIX VI  SUPPLY AND UTILISATION MODEL OUTPUT

Table VI.1: Supply model output

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>2032</td>
<td>2032</td>
<td>2032</td>
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<td>2005</td>
<td>2035</td>
<td>2064</td>
<td>2082</td>
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<td>2006</td>
<td>2039</td>
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<td>2007</td>
<td>2053</td>
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<td>2182</td>
</tr>
<tr>
<td>2008</td>
<td>2062</td>
<td>2164</td>
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</tr>
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<td>2249</td>
<td>2349</td>
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<td>Low</td>
<td>Medium</td>
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* No data available for missing years because population projections are not supplied for these years.
Table VI.3: Effect on utilisation model output by changing parameters individually.

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<tr>
<th>Output</th>
<th>Participat Rate</th>
<th>Edentulous Rate</th>
<th>Treatment Courses Rate</th>
<th>Treatment Rate</th>
<th>Dentist Activity</th>
<th>Yearly Salaried Dentist Increase</th>
<th>Change in number of GDPs required compared to medium output for year:</th>
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Table VI.4: Number of GDPs required following increases to the level of utilisation.

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<td>Description</td>
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<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
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<td>Government Actuary’s Department</td>
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<tr>
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<tr>
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<td>Management Information and Dental Accounting System</td>
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<tr>
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<tr>
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<td>National Institute of Dental and Craniofacial Research</td>
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</tr>
<tr>
<td>NES</td>
<td>NHS Education for Scotland</td>
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<tr>
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<td>Organisation for Economic Co-operation and Development</td>
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<tr>
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<td>Office of National Statistics</td>
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<td>Vocational Trainee</td>
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\[ \sum \] categories  
Mathematical symbol for summation over a set of categories
Framework for modelling dental workforce and building for the future

Characteristics of the demand dynamics for dental services