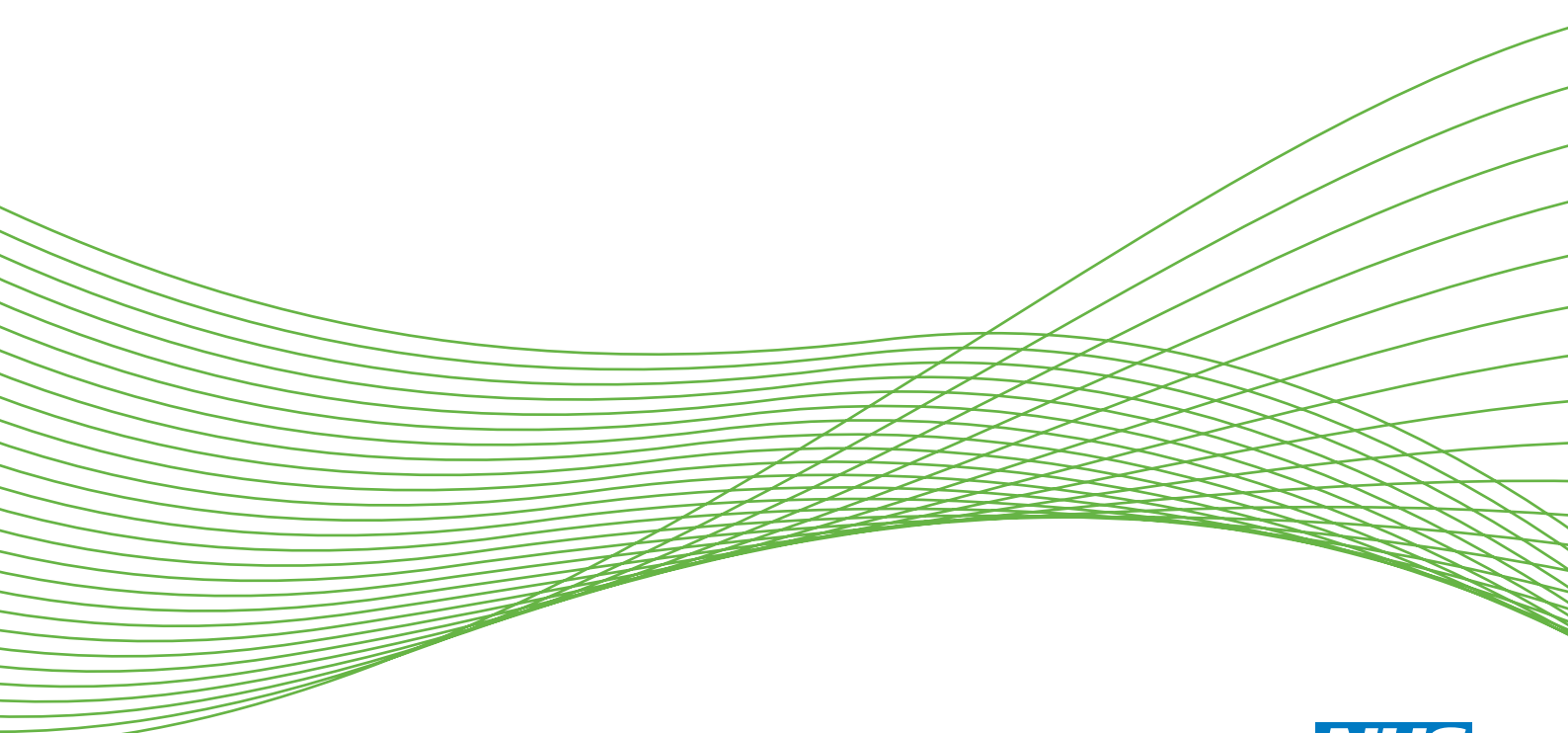


Determining the optimal model for role substitution in NHS dental services in the UK: a mixed-methods study

Paul Brocklehurst, Stephen Birch, Ruth McDonald, Harry Hill, Lucy O'Malley, Richard Macey and Martin Tickle



***National Institute for
Health Research***

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Abstract

Determining the optimal model for role substitution in NHS dental services in the UK: a mixed-methods study

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Background: Maximising health gain for a given level and mix of resources is an ethical imperative for health-service planners. Approximately half of all patients who attend a regular NHS dental check-up do not require any further treatment, whereas many in the population do not regularly attend. Thus, the most expensive resource (the dentist) is seeing healthy patients at a time when many of those with disease do not access care. Role substitution in NHS dentistry, where other members of the dental team undertake the clinical tasks previously provided by dentists, has the potential to increase efficiency and the capacity to care and lower costs. However, no studies have empirically investigated the efficiency of NHS dental provision that makes use of role substitution.

Research questions: This programme of research sought to address three research questions: (1) what is the efficiency of NHS dental teams that make use of role substitution?; (2) what are the barriers to, and facilitators of, role substitution in NHS dental practices?; and (3) how do incentives in the remuneration systems influence the organisation of these inputs and production of outputs in the NHS?

Design: Data envelopment analysis was used to develop a productive efficiency frontier for participating NHS practices, which were then compared on a relative basis, after controlling for patient and practice characteristics. External validity was tested using stochastic frontier modelling, while semistructured interviews explored the views of participating dental teams and their patients to role substitution.

Setting: NHS 'high-street' general dental practices.

Participants: 121 practices across the north of England.

Interventions: No active interventions were undertaken.

Main outcome measures: Relative efficiency of participating NHS practices, alongside a detailed narrative of their views about role substitution dentistry. Social acceptability for patients.

Results: The utilisation of non-dentist roles in NHS practices was relatively low, the most common role type being the dental hygienist. Increasing the number of non-dentist team members reduced efficiency. However, it was not possible to determine the relative efficiency of individual team members, as the NHS contracts only with dentists. Financial incentives in the NHS dental contract and the views of practice principals (i.e. senior staff members) were equally important. Bespoke payment and referral systems were required to make role substitution economically viable. Many non-dentist team members were not being used to their full scope of practice and constraints on their ability to prescribe reduced efficiency further. Many non-dentist team members experienced a precarious existence, commonly being employed at multiple practices. Patients had a low level of awareness of the different non-dentist roles in a dental team. Many exhibited an inherent trust in the professional 'system', but prior experience of role substitution was important for social acceptability.

Conclusions: Better alignment between the financial incentives within the NHS dental contract and the use of role substitution is required, although professional acceptability remains critical.

Study limitations: Output data collected did not reflect the quality of care provided by the dental team and the input data were self-reported.

Future work: Further work is required to improve the evidence base for the use of role substitution in NHS dentistry, exploring the effects and costs of provision.

Funding: The National Institute for Health Research Health Services and Delivery Research programme.

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Glossary

Data envelopment analysis and stochastic frontier modelling The two principal methods in health economics of measuring technical efficiency.

High-street dentists Also known as general dental practitioners, the only clinicians who can contract directly with the NHS. In England, general dental practitioners are provided with a target for their clinical activity, known as the Annual Contract Value. Three bands of treatment activity exist in England (band 1, band 2 and band 3) to reflect differing degrees of treatment complexity. Band 1 relates to examinations and preventative treatments, while bands 2 and 3 relate to invasive and irreversible dental procedures. Band 1 attracts one Unit of Dental Activity, whereas bands 2 and 3 attract three and 12 Units of Dental Activity, respectively. The Annual Contract Value is the annual target of Units of Dental Activity that a dental team must provide.

Non-dentist members of the dental team Team members that can substitute the role of the general dental practitioner, such as the dental hygienist, the dental hygiene therapist and the dental therapist, collectively known as dental care professionals. Although, technically, dental nurses and dental technicians are also classed as dental care professionals, their activity supplements the role of the general dental practitioner. As such, the term dental care professional in this report refers to those non-dentist members of the dental team who can engage in role substitution.

List of abbreviations

ACV	Annual Contract Value	NIHR	National Institute for Health Research
BSDHT	British Society of Dental Hygiene and Therapy	OLS	ordinary least squares
DCP	dental care professional	PCT	primary care trust
DEA	data envelopment analysis	PDS	personal dental service
DH	dental hygienist	PP	practice principal
DHT	dental hygiene therapist	PPI	patient and public involvement
DT	dental therapist	RESET	Ramsey regression equation specification error test
FFS	fee for service	RQ	research question
GDC	General Dental Council	SFM	stochastic frontier modelling
GDP	general dental practitioner	UDA	Unit of Dental Activity
GDS	General Dental Services		

Plain English summary

Improving productivity in the NHS is a key consideration for policy-makers and is becoming increasingly important, given budgetary pressures on public expenditure. Across England, approximately half of the patients who attend for a regular NHS dental check-up do not require any further treatment, whereas half of the population does not regularly attend the dentist. In other words, the most expensive resource (the dentist) is seeing healthy patients at a time when many of those with the most dental health problems do not access care. One way to address this issue is to improve the productivity of the dental team. Role substitution, when non-dentist members of the dental team take on tasks previously limited to dentists, has the potential to do this. The aims of this study were to examine how productive dental teams are that make use of non-dentists and to explore the barriers to, and enablers of, change.

A multimethod approach was adopted using questionnaires, health-economic models specifically designed to measure productivity and interviews with dentists, their teams and patients. The extent of role substitution in NHS dentistry was limited; the most common non-dentist team member was the dental hygienist. As the number of non-dentist team members increased, the productivity of the NHS practice dropped. Financial incentives played a major role in this, but the views of practice principals were also important. Patients had a low level of awareness of the different roles of the dental team, but many had been seen and were happy to be treated by non-dentists.

Scientific summary

Background

Maximising health gain for a given level and mix of resources is an ethical imperative for health-service planners. The independent review of NHS dentistry in 2009 (Department of Health. *NHS Dental Services In England: An Independent Review Led by Professor Jimmy Steele*. London: Department of Health; 2009) concluded that there was an overwhelming need to make the best use of the whole dental workforce. Across England, approximately 55% of patients who attend for a regular dental check-up do not require any further treatment. By contrast, half of the population does not attend a general dental practitioner (GDP) on a regular basis and this group tends to be the most disadvantaged and experiences the majority of dental disease. As a result, patients with the least need are being seen and treated by the most expensive resource, the GDP, whereas patients with high levels of need can have problems accessing NHS dental services.

Role substitution occurs when appropriately qualified non-dentist team members undertake the clinical activity previously provided by GDPs. In primary dental care, role substitution is provided principally by dental hygienists (DHs), dental hygiene therapists (DHTs) and dental therapists (DTs). This contrasts with dental nurses, who augment the activity of the GDP in the form of role supplementation. Unlike role supplementation, role substitution has the potential to improve efficiency and the capacity to care and lower costs. In addition, it has the potential to reduce inequalities in service delivery as resources can be diverted to the population with the greatest need. Technical efficiency is defined as the production of the maximum amount of output from a given amount of input so that a service operates at the production frontier. Academic research into technical efficiency is being used increasingly in health-care evaluation, although no studies have empirically investigated the efficiency of NHS dentistry or role substitution in dental practices. By contrast, NHS dental service provision has developed historically, with levels of future service provision being determined by extrapolating trends from past activity into the future, at a time when disease levels are actually reducing.

Aims and objectives

This programme of research sought to address three research questions (RQs):

1. What is the technical efficiency of NHS dental teams that make use of role substitution?
2. What are the barriers to, and facilitators of, role substitution in NHS dental practices?
3. How do incentives in the remuneration systems influence the organisation of these inputs and production of outputs in the NHS?

The following were the objectives of the programme:

- to conduct a cross-sectional study to determine the current working patterns of non-dentist team members capable of role substitution in NHS dental practices (DHs, DHTs and DTs)
- to collect input data (NHS hours worked) and output data (clinical activity) from participating practices
- to identify the most technically efficient provider mix among the different provider configurations observed
- to assess the external validity of the methods used for efficiency analysis
- to explore barriers/enablers to increased use of role substitution
- to examine how the technical efficiency of the different provider models varied across different remuneration systems (England, Northern Ireland and Scotland)
- to examine how financial incentives in remuneration systems influence the organisation of inputs and the production of outputs in NHS dentistry.

Methods

A multimethod approach was adopted, integrating both qualitative and quantitative methodologies. Following NHS ethical approval (12/WA/0403), the membership of the British Society of Dental Hygiene and Therapy (BSDHT) were contacted and asked to complete a screening questionnaire in 2013 to determine the current working patterns of DHs, DHTs and DTs in NHS dental practices. Questionnaires were distributed to all of the 3100 members of the BSDHT (saturation sampling) after being reviewed by the research team's patient and public involvement (PPI) group.

Based on the results of this initial screening questionnaire, NHS practices that utilised role substitution were identified in England, Scotland and Northern Ireland. Once these were identified, a second detailed questionnaire was distributed to capture input data (number of NHS hours worked by the whole dental team and number of surgeries) and important practice demographics. Practices were also asked to consent to its output data being obtained (measures of clinical activity recorded by their relevant NHS payment agency). The input and output data were then linked and anonymised by a third party.

Data envelopment analysis (DEA) was then used to identify the most technically efficient provider mix in participating practices and stochastic frontier modelling (SFM) followed to assess the external validity of the DEA approach. Prior to DEA, the linked data sets were compared with the national average, using data provided by the relevant NHS payment agency. A production possibility frontier was then created using DEA and the relative distance of each practice from the frontier was measured to determine their technical efficiency. A sensitivity analysis was conducted with alternative specifications for different input and output variables to explore if the findings were sensitive to the choice of these variables. Efficiency scores were then regressed onto a range of practice variables to identify correlates of inefficiency. As DEA provides only a relative measure of efficiency, SFM was used in parallel with estimate the frontier, using regression (Cobb–Douglas function) to test the robustness of the DEA findings.

For the qualitative workstream, practices were recruited using the information generated from the screening questionnaire. Technically efficient and inefficient practices were also identified from the quantitative workstream. This was augmented by invitations to DHs, DHTs and DTs via social networks. Semistructured interviews were then conducted to explore the potential barriers to, and facilitators of, role substitution in NHS practices, using interview schedules that had been developed iteratively with the help of the research team's PPI group.

Data collection and analysis were run concurrently between October 2013 and May 2015, using a framework informed by the literature and the PPI group. This was then developed further as the findings emerged. All interviews were audiorecorded and transcribed verbatim. Thematic analysis was carried out by group, so practice principals (PPs), non-dentist team members and patients were coded separately. Interpretations were then pooled and edited in the presence of all three researchers to produce the final version of the coding frame, with disputes being resolved using a majority voting system. Data analysis was undertaken concomitantly with the interviews, which continued until saturation.

To examine the third RQ, data relating to a natural experiment in NHS service provision in Northern Ireland were collected and analysed. Thirteen practices that were remunerated via capitation were compared with 57 matched controls. The latter were selected according to practice location and were paid on a fee-for-service (FFS) basis within the NHS. The data from claim forms were pooled by the Business Service Organisation over 43 months (April 2011 to October 2014) and underwent ordinary least squares regression, using a long panel form. The Ramsey regression equation specification error test was then used to test for model misspecification.

Results

Two hundred and eighty-seven of the 1859 screening questionnaires (15.4%) were returned from 432 NHS practices. The most common non-dentist team member capable of role substitution was the DH (64.1%), followed by DHTs (33.8%) and DTs (1.0%). Their mean age was 42.1 years and the mean time since qualification was 16.5 years. Almost all were female and the mean time in post was 8.4 years. More than half worked in one practice, but a substantial majority worked in more than one practice. The mean number of additional non-dentist team members that the respondents worked with was 1.7.

One hundred and twenty-one practices provided input data that could be linked to the Business Services Authority in England. When Units of Dental Activity (UDAs) were used as the output measure in England, NHS dental practices operated at a mean level of efficiency of 64%. This changed very little when the outputs were measured in terms of number of patients seen or the number of treatment plans generated. NHS dental practices that did not use any form of role substitution had a higher mean level of efficiency (68%; $n = 39$). Any use of non-dentist team members was found to be associated with statistically significant lower efficiency scores (14% lower for UDAs, 11% lower for treatment plans or patients seen) than practices that used no role substitution.

No significant interactions with patient population characteristics were found. Correlations between efficiency scores estimated by SFM and DEA were > 0.6 , which supported the robustness of estimated DEA efficiency scores and the internal validity of the approach. Efficiency in NHS dental practices in Northern Ireland and Scotland was consistently higher (94% and 80%, respectively), although it was difficult to make robust comparisons across the two countries because of their smaller sample sizes ($n = 20$ and $n = 29$, respectively).

Sixteen PPs and 17 non-dentist team members were interviewed. The use of role substitution in the NHS across the practices was highly varied. Some practices used DHs, DHTs and DTs to their full scope of practice and were enabling them to undergo further training; whereas in other practices, they were limited in the duties they could carry out and were used primarily to complete routine scale and polishing.

The PPs interviewed felt that the greater use of role substitution did not result in financial gain. Instead, the current NHS dental contract appeared to disincentivise its use. In addition, the attitudes and beliefs of PPs towards non-dentist team members appeared to be highly influential in terms of how the practice was organised and whether or not the practice culture supported role substitution. Practices with low levels of role substitution appeared to be led by PPs who were concerned about the abilities of DHs, DHTs and DTs, in particular how much longer it might take to carry out treatment when compared with a GDP. PPs who used non-dentist team members tended to have confidence in the ability of their own staff, but were less confident in the use of role substitution more generally.

Among non-dentist team members themselves, a number of day-to-day barriers were found to reduce the efficiency of working in the practice environment. These included not being able to prescribe fluoride varnish and the inability to prescribe local analgesia or radiographs. Notably, a substantial proportion of DHs, DHTs and DTs worked across a number of practices (between two and eight).

The majority of patients had a low level of awareness of the roles of different members of the dental team. Most patients interviewed were familiar with GDPs and DHs, but they were not aware that DHTs and DTs could undertake restorations or extractions. Restorations, crowns and bridges were identified as activities undertaken by GDPs, whereas periodontal treatment ('hygiene work') fell within the expertise of DHs. Most patients interviewed were not interested in the debate within the profession about who could treat them. Instead, they reported that they just wanted to know that any treatment being carried out was undertaken by a suitably qualified clinician. They all appeared to place a great deal of trust in the NHS, the regulatory system and in the opinion of their GDP.

The results from the natural experiment in Northern Ireland showed that the mean number of monthly treatment items delivered by FFS practices was higher than the number remunerated by capitation (922 and 811 treatment items, respectively). The mean monthly number of treatment plans delivered to patients was higher in the capitation practices than in the FFS practices (463 and 392, respectively). The mean monetary value of the treatment plans delivered was lower in capitation practices (by £10.83). These differences were statistically significant at a 5% level.

There was no evidence of differences in patient selection between the two types of practices, although practices paid by capitation provided, on average, 9.7 fewer examinations, 17.2 fewer fillings and 11.5 fewer scale and polish services per 100 unique patients per month ($p < 0.00$). They also provided an average of 6.3 more extractions per 100 unique patients per month ($p < 0.00$). The volume of fluoride varnish applications per patient and per 100 child registrations was not significantly different between practice groups.

Conclusions

The extent of role substitution in NHS dental practices appears to be relatively low and mainly limited to the use of DHs for routine periodontal treatment. NHS dental practices that utilised fewer non-dentist team members were associated with higher levels of technical efficiency, that is as role substitution in NHS practices increased, their relative efficiency dropped. The efficiency of role substitution in NHS dental practices appeared to be heavily influenced by the remuneration system. The inability of non-dentist team members to contract directly with the NHS meant that it was not possible to determine the technical efficiency of individual DHs, DHTs and DTs. They were also subject to the prevailing organisational culture within each practice, restrictions on their ability to prescribe and the views of the individual PPs that employed them.

The scope for addressing the recommendations of the Independent Review of NHS dentistry (Department of Health 2009) to make best use of the whole dental workforce appears limited, as the traditional model of care using GPs predominates. Aligning financial incentives to encourage the greater use of role substitution would be an important intermediate step, although the development of a NHS contract with DHs, DHTs and DTs would offer greater flexibility for commissioners of services. As oral health continues to improve, this is important if maximising health gain for a given level and mix of resources remains an ethical imperative for the NHS. Failure to do so will increasingly mean that the most expensive resource treats those with the least need.

Further research is needed to:

1. explore new models of NHS dental care that are efficient and make best use of increasingly scarce resources (identifying and assessing different approaches to organising the delivery of dental health care in the NHS)
2. determine the cost-effectiveness of new models of dental care based on role substitution in NHS dentistry
3. examine the quality of the care provided by non-dentist team members and understand how they compare with GPs
4. develop a needs-based workforce plan for NHS dentistry that makes best use of the whole dental team
5. explore the impact of traditional and new models of care on the health inequalities of NHS dental service provision, including equity, service coverage and access to care.

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Chapter 1 Overview of the report

Outline of the report

This report is composed of seven chapters. *Chapter 1* provides an introduction to the project and sets the scene.

Introduction

Maximising health gain for a given level and mix of resources is an ethical imperative for health-service planners.¹ An independent review of NHS dentistry in 2009² concluded that there was an overwhelming need to make best use of the whole dental workforce. Across England, approximately 55% of patients who attend for a regular dental check-up do not require any further treatment.³ This costs the NHS over £1B per annum and represents around one-quarter of the total NHS expenditure on dental care.³ By contrast, half of the population does not attend a general dental practitioner (GDP) on a regular basis, and this group tends to be the most disadvantaged and experiences the majority of dental disease.^{4,5} As a result, patients with the least need are being seen and treated by the most expensive resource, the GDP, whereas patients with high levels of need can have problems accessing NHS dental services.⁵

Role substitution occurs when appropriately qualified non-dentist team members undertake the clinical activity previously provided by GDPs.⁶ In primary dental care, role substitution is provided principally by dental hygienists (DHs), dental hygiene therapists (DHTs) and dental therapists (DTs). For the remainder of this report, non-dentist team members capable of role substitution are referred to as dental care professionals (DCPs). This is in contrast to dental nurses, who augment the activity of the GDP in the form of role supplementation. Unlike role supplementation, role substitution has the potential to improve efficiency and the capacity to care and to lower costs. In addition, it has the potential to reduce inequalities in service delivery as resources can be diverted to the population with the greatest need. DCPs cover many different categories of dental professions. The scope of this programme of research was to examine DCP roles that could be used in role substitution, specifically DT, DHT and DH. For concision, this subcategory of roles (where role substitution may be expected to take place) is referred to as DCPs in the remainder of this report.

Technical efficiency is defined as the production of the maximum amount of output from a given amount of input so that a service operates at the production frontier.⁷ Academic research into technical efficiency is being used increasingly in health-care evaluation,⁸ although no studies have investigated the efficiency of NHS dentistry or examined the impact of role substitution in dental practices. By contrast, NHS dental service provision has developed historically, with levels of future service provision being determined by past levels of provision, at a time when disease levels are actually reducing.⁹⁻¹¹

General dental practitioners are acutely sensitive to financial incentives within the dental contract,¹²⁻¹⁴ although intrinsic motivation and professional standards can also be important moderators.¹⁵ Retrospective fee-for-service (FFS) remuneration systems can lead to overtreatment in order to maximise profit.^{13,16,17} Prospective per capita remuneration systems reduce the financial risk for the third-party payer, at the potential cost of patient selection (skimping and dumping) and undertreatment.¹⁸⁻²⁰

Empirical research in medical settings suggests that appropriately trained nurses can deliver high-quality care that matches doctors' performance in preventative health care, routine follow-up of patients with long-term conditions and as the first contact for people with minor illness.^{21,22} However, efficiency gains are possible only if the doctor stops carrying out the tasks delegated to nurses.²³ In addition, role substitution may challenge the professional identity of both professional groups, leading to opposition as clinicians struggle to maintain traditional boundaries.^{24,25}

Given the hitherto ad hoc approach to service design, it is important to determine the most technically efficient model for role substitution a priori. As outlined above, in dentistry this has the potential to increase efficiency and effectiveness in service provision.²⁶ It also has the potential to release resources and increase the capacity to care.^{27–30} Harris and Sun^{31,32} found that role substitution may be effective in improving efficiency, but this may be limited to particular situations when conditions are conducive. Therefore, not only is it critical to determine the most technically efficient role-substitutive models, but it is equally important to explore the values of policy-makers and clinicians to determine the factors affecting the implementation of such innovative designs and how patients would view such a change in service design.

This programme of research sought to address three research questions (RQs):

1. What is the technical efficiency of NHS dental teams that make use of GDPs and DCPs, that is, what is the relationship between clinical inputs and outputs across different role-substitutive models used in the UK?
2. What are the barriers to, and facilitators of, role substitution in NHS dental practices?
3. How do incentives in the remuneration systems in the UK influence the organisation of these inputs and production of outputs in the NHS?

Aims and objectives

The aim of this programme of research was to undertake a mixed-methods study to determine the technical efficiency of role substitution between GDPs and DCPs in NHS dental practices and ascertain if this is influenced by the incentives within the NHS remuneration system. Role substitution is defined as DCPs undertaking the clinical tasks previously provided by GDPs. Barriers of, and enablers to, the greater use of role substitution in a NHS dental practice were also examined, from the perspective of policy-makers, GDPs, DCPs and patients.

The objectives of the programme of research were to:

- conduct a cross-sectional study to determine the current working patterns of DCPs in NHS dental practices
- collect input data (NHS hours worked) and output data (clinical activity) from participating practices
- identify the most technically efficient provider mix among the different provider configurations observed in the study practices
- assess the external validity of the methods used for efficiency analysis
- explore barriers/enablers to the greater use of role substitution; and develop an understanding of the configuration of the dental team, collect the input data (NHS hours worked) and gain consent to collect the output data
- examine how the technical efficiency of the different provider models varies across different retrospective and prospective payment systems for adults in the UK
- explore how financial incentives in remuneration systems influence the organisation of inputs and the production of outputs in NHS dentistry.

Research design and project overview

A multimethod approach was adopted, integrating both qualitative and quantitative methodologies.

Data envelopment analysis (DEA) and stochastic frontier modelling (SFM) were used to determine the technical efficiency of different role substitution models.³³ Technical efficiency is the effectiveness with which a given set of inputs is used to produce an output. A dental practice is said to be technically efficient if it is producing the maximum output from the minimum quantity of inputs, such as labour, capital and technology.³³

Data envelopment analysis accommodates multiple inputs and multiple outputs in a single measure of technical efficiency and has become the dominant approach to efficiency measurement in health care and other sectors of the economy.³⁴ The most efficient practices/sites form a frontier of productive efficiency and those that lie below this frontier are allocated proportionally smaller efficiency values, which correspond to their distance from the frontier. Optimal service design is then relative to service design observed in other dental practices, after differences between practices in workplace and environmental characteristics are controlled for.

Stochastic frontier modelling is a regression approach to estimating the frontier of productive efficiency. The level of variation in health-care output that is not explained by variation in the level of inputs (i.e. the regression residuals) forms a measure of relative efficiency compared with average practices. The method divides the regression residuals into a 'noise' or 'measurement error' component and an efficiency component. The last component is used to make an assessment of how far each role substitutive model differs from the most efficient use of role substitution.

Estimates of differences between practices in efficiency of production were analysed and interpreted using DEA and validated using SFM. Factors that influenced the efficiency of different models of role substitution were explored and sensitivity analyses were also undertaken to determine the extent to which efficiency was affected by changes in other variables. Both DEA and SFM investigate units of production and do not account for the quality of dental health care delivered by practices.

Efficiency is understood in terms of the level of inputs used to achieve the outputs produced ('technical efficiency'). Technical efficiency, the effectiveness with which a given set of inputs is used to produce an output, was determined using two principal measures of activity: total clinical activity and patient throughput. In England, the former is constrained as a result of the capped nature of the NHS dental contract. Dental practices face penalties if the contract value falls below 4% of its Annual Contract Value (ACV) or exceeds its ACV by 2% or more. This means that outputs are constrained in the DEA computation for dental practices from England.

The qualitative component of the programme was undertaken in parallel with the quantitative element. Interviews were undertaken with policy-makers, GPs who made use of role substitution, GPs who did not, DCPs and patients. The final number of interviews was determined by saturation (i.e. no new themes were emerging). The semistructured interviews were recorded and transcribed verbatim. Field notes were also undertaken as appropriate. The transcripts then underwent thematic analysis using the constant comparative method.³⁵ Initial coding focused primarily on the barriers to, and facilitators of, to role substitution in line with our RQ. In addition, inductive coding of data alongside the field notes was undertaken to produce a 'thick description' of the social processes involved.³⁶

Structure of the report

This report is arranged as follows.

Chapter 2 describes the historical context of NHS dentistry, the use of role substitution in NHS dentistry and the role of financial incentives in how services are organised.

Chapter 3 presents a descriptive study that was undertaken across the UK to understand the current levels of DCP utilisation.

Chapter 4 describes an economic analysis of the technical efficiency of DCP utilisation in England, using DEA and SFM. Supplementary analyses were performed for Northern Ireland, Scotland and the community dental services. These were based on much smaller samples of practices and could not be combined with the English analysis because of differences in the way these services are managed and funded. The results of these supplementary analyses are provided in *Appendix 1*.

Chapter 5 examines role substitution using the qualitative paradigm, exploring the barriers to, and facilitators of, role substitution in NHS dental practices (thereby addressing RQ2).

Chapter 6 then uses data from a large, 3-year project in Northern Ireland to look at how incentives in the remuneration systems in the UK influence the organisation of inputs and production of outputs in the NHS.

Finally, *Chapter 7* integrates the findings from the empirical work and provides an overview and assessment of the contribution of role substitution and financial incentives to the technical efficiency of practices in NHS dentistry.

Chapter 2 Organisation of NHS dentistry in primary care

Introduction

This chapter provides the context for the programme of research undertaken. It describes the organisation of NHS dentistry in primary care in England, Northern Ireland and Scotland. It then goes on to describe role substitution in NHS dentistry in primary care and describes the role of financial incentives in NHS dentistry.

Organisation of NHS dentistry in primary care in England and Wales

NHS dentistry began in 1948. The National Health Service Act (1946)³⁷ had three key principles: (1) no one would ever have to fear not getting care they needed because they could not afford it; (2) care would be free at the point of delivery; and (3) care would be based on clinical need. As a result, NHS dental services were provided free of charge for the entire population. GDPs were considered to be independent contractors under the NHS [General Dental Services (GDS) contracts] regulations and so could establish their practice anywhere in the UK. GDPs' GDS remuneration was based on a FFS basis (i.e. the volume and type of work undertaken) and, although they were self-employed, dentists were eligible for a NHS pension. By 1950, the government became concerned about the affordability of the new service, given the volume of work being undertaken by NHS GDPs (mostly extractions and fillings). This resulted in the introduction of the Patient Charge Regulations (1952),³⁸ which required patients to contribute to the bulk of the cost of treatment according to a Statement of Dental Remuneration (a list of available treatments under the NHS).

Other than minor changes to the Statement of Dental Remuneration, the shape of GDS provision remained relatively static until the introduction of a new contract in 1990.³⁹ For the first time, the NHS dental contract contained an element of prospective payment. The remuneration arrangements for adults and children were split, with adults still treated under FFS arrangements (plus additional continuing care payments) but children treated on a wholly capitation basis. As a result, approximately 20% of the income for NHS GDPs was based on the number of dental patients registered (on a per capita basis), rather than simply being based on the volume of activity on a FFS basis. The policy intention of the 1990 contract was to encourage registration and promote prevention and continuity of care, moving service provision away from treating disease to maintaining oral health.³⁹ However, higher-than-expected expenditure in the following year led to the government making substantive cuts to NHS fees in 1991. Those in the dental profession felt that they were unfairly penalised by this 'claw-back' and many GDPs felt unhappy with the new NHS system of payment. This triggered a progressive shift towards the provision of privately funded dentistry within the profession, with a reduction in the availability of NHS services. By the mid-1990s, access to dental services for NHS patients was becoming a political issue and it was increasingly recognised that reform of the NHS contract was necessary. As highlighted by the Bloomfield report⁴⁰ the 'system of remuneration for dentists seems to have an inherent leaning towards instability which threatens to undermine the commitment of dental practitioners to the NHS'.

The NHS (Primary Care) Act 1997⁴¹ enabled the voluntary establishment of personal dental services (PDSs) pilot schemes to explore alternative ways of delivering NHS dental services. A key feature of these new contracts was how they were tied to local issues around need and access to care through contracting arrangements with primary care trusts (PCTs). For NHS GDPs, the new PDS contracts offered greater flexibility for the provision of services, with less emphasis on the volume of activity provided. Instead, NHS GDPs were paid on a per capita basis and rewarded for improving access to care and maintaining oral

health for those patients who were already registered. The net effect of paying the PDS schemes was a dramatic reduction in NHS service activity, a fall in the provision of complex treatments and loss of Patient Charge Revenue.⁴² The last was particularly worrying for the government as patient charges had become an important component of funding for NHS dentistry. However, many viewed the PDS pilots as a success, given the focus on local needs.^{42,43}

In 2000, *Modernising NHS Dentistry – Implementing the NHS Plan*⁴⁴ was introduced in England. Again, improving access was considered to be the most important policy objective for the government and the new proposals gave PCTs powerful new commissioning tools to improve access to NHS dentistry, the provision of preventative services and to monitor the performance of GDPs. This was further emphasised in *Options for Change* in 2002.⁴³ However, a question that remained for the government was how to concomitantly improve access to care and the provision of prevention, while maintaining Patient Charge Revenue (i.e. the income generated from patient charges, which accounts for approximately 25% of the payment to the NHS GDP).

In 2006, a new NHS dental contract was introduced in England,⁴⁵ organised around a local commissioning model. NHS GDPs were paid according to activity categorised in one of three bands of treatment, rather than the 400 individual treatment items in the Statement of Dental Remuneration. Band 1 attracted one Unit of Dental Activity (UDA) and included an examination, radiographs as appropriate, and a simple scale and polish. Band 2 attracted three UDAs and included restorations, extractions and root canal treatments, while more complex crowns, bridges and dentures attracted 12 UDAs as a band 3 treatment. Patient Charge Revenues were also simplified so that there were only three levels of payment tied to each band. To reflect individual variation among NHS GDPs, the value of the UDA was based on individual earnings in a reference period, although for most, this meant that a UDA was worth between £20 and £25. One feature of the new NHS contract was that NHS GDPs would receive three UDAs for one band 2 treatment (i.e. they would be paid the same amount), whether they did one restoration in a single visit or multiple restorations over a number of visits. In a similar manner, NHS GDPs were also allocated 12 UDAs for one band 3 treatment irrespective of whether they provided one crown or multiple crowns within one course of treatment.

A key feature of the 2006 contract was cost containment, that is, GDPs' NHS activity and revenue was capped at an agreed number of UDAs per year, known as an ACV. NHS GDPs were then paid one-twelfth of their ACV on a monthly basis, less than the anticipated Patient Charge Revenue. As a result, NHS GDPs' outputs under the new contract in England were constrained and they were penalised if they underperformed (< 96% of their ACV) or overperformed (> 102% of their ACV). Patient registration in the 2006 contract also ceased to exist, along with the contractual responsibility for NHS GDPs to provide emergency care for their patients. Instead, this responsibility was devolved to PCTs along with the planning and securing of NHS dental services for their locality.

The effect of this NHS contract change in England in 2006 was investigated by an earlier National Institute for Health Research (NIHR) Service Delivery and Organisation programme funded study (reference number 08/1618/158).^{13,14} Large and abrupt changes in the provision of a number of treatments coincided with the introduction of the 2006 contract.¹³ The number of complex treatments provided (root canal treatments, crowns and bridges) fell dramatically, whereas the number of extractions rose. This appeared to reflect an increase in those activities that were easier and less costly to perform at the expense of those treatments that were more time intensive or that incurred laboratory costs for crowns and bridges. The authors concluded that 'the change in treatment patterns suggests that significant numbers of dentists [were] attempting to hit their UDA contract targets in the most efficient way possible, i.e. shifting towards treatments where rewards are high relative to costs, as opposed to selecting on the basis of clinical factors'.¹³ In addition, McDonald *et al.*¹⁴ remarked 'it is the interests of dentists, as opposed to patients, which [were] being prioritised'.

Given this change to activity following the 2006 contract and mounting dissatisfaction among NHS GDPs and patients, the House of Commons Health Select Committee undertook a review in 2008.⁴⁶ The review identified key problems with the NHS contract, including failure to improve patient access, higher patient

charges, problems caused by removing the patient registration process, lack of incentives to promote prevention, incentives to provide treatment which may not best align with a patient's needs (e.g. extraction over a root canal treatment) and a highly unpopular UDA payment system. This was followed by an independent review of NHS service provision in England by Steele in 2009.² Again, this found that the incentives for NHS GPs were not aligned with the goal of securing oral health. The independent review highlighted a number of substantive inefficiencies in the system and recommended that a new NHS contract that had clearer incentives for improving health, access and quality be developed in England.²

In 2011, 70 NHS dental pilots were established in England to explore how NHS dentistry could shift its focus from primarily treatment and repair to prevention and oral health.⁴⁷ This process was built around a new oral health assessment that aimed to assess the risk of the patient, enabling them to be assigned to new clinical care pathways to create a healthy oral environment based on their level of need. This was supported by three different types of remuneration models to test different ways of remunerating NHS GPs. All three models were based on a prospective payment system (per capita), in which dental practices would be remunerated based on the number of patients they cared for and their quality of care (not FFS).

Four years on, the information generated from these pilots remains unclear. Although the dental pilots presented an ideal opportunity to address the issues raised by the Steele review,² the findings reported were mainly descriptive in nature. The evaluation of the oral health assessment (and associated risk algorithms) was also limited to professional and social acceptability and its predictive validity remains untested.

In 2015, new dental 'prototypes' were introduced, which appeared to build on the limited information generated from the pilots.⁴⁸ The principles of the 'prototypes' were again based on an initial assessment and a care pathway approach to prevention and care. In aligning to the *Building the NHS of the Five Year Forward View*,⁴⁹ emphasis was placed on prevention, empowering patients to take control of their own oral health and making the most efficient use of NHS resources. Although they still included capitation payments and remuneration for quality, an important difference with the 2011 pilots was an emphasis on activity, through a blend of both capitation and FFS.⁴⁸

In terms of the dental workforce, the latest information from the Health and Social Care Information Centre reveals that 23,723 NHS GPs were undertaking activity within the NHS during the period April 2013 to April 2014.³ This is an increase of 17.7% ($n = 3563$) compared with 2006, when the existing contract in England started. Approximately half of the workforce was female (46.1%). A total of 29.9 million patients were seen in the 24-month period ending June 2014 (55.9% of the total population). In 2014, 54.5% of all NHS activity was related to band 1 payments, 29.7% related to band 2 and 5.6% related to band 3. The remaining UDAs (10.2%) were allocated to emergency and other payments.

Organisation of NHS dentistry in primary care in Northern Ireland and Scotland

The provision of NHS dentistry in Northern Ireland and Scotland followed a similar trajectory to NHS dentistry in England up until the 2006 contract. Instead of moving towards a banded system of retrospective payment (the UDA system), both Northern Ireland and Scotland remained with the existing Statement of Dental Remuneration and FFS payment system. As such, although a few minor changes were made at a national level, the shape of the NHS contract in both countries is very similar to the 1990 contract in England and is primarily based on FFS for adults and capitation for children.

In Northern Ireland, approximately 1100 NHS GPs work in 380 dental practices. Unlike England's current NHS contract (the UDA system), there is no local commissioning model and so outputs remain unconstrained. This means that there is no limit on the amount of FFS NHS activity that can be produced. This has led to costs for NHS dentistry doubling in the last 5 years. In 2013–14, the total cost was estimated to be £124M, of

which £20M came from Patient Charge Revenue. There are also no limitations on where new NHS practices can be established or the number of new NHS GDPs that can enter the market. As highlighted above, this is in contrast to England, where, under the local commissioning model, new NHS GDPs have to obtain agreement before setting up any new service. The number of NHS GDPs in Northern Ireland in 2014 was twice the level recorded in 1989.

As a result of this dramatic rise in activity, costs and the number of NHS GDPs, Northern Ireland began piloting a new dental contract in 2015. This is based on per capita payments and is the subject of a new NIHR Health Services and Delivery Research programme study by the authors (reference number 14/19/12). The technical efficiency of NHS GDPs working under a capitation arrangement in an earlier 3-year pilot aimed at improving access to care in 2010 is reported in *Chapter 6*.

In Scotland, the number of NHS GDPs rose from 2848 in 2011 to 3035 in 2014.⁵⁰ Over 4.6 million people were registered with a NHS GDP in 2014 (87% of the population) and over 74% had seen their NHS GDP in the previous 2 years.³ The proportion of both children and adults registered with a NHS GDP continued to increase during the last 2 years, with more than 91% of children and 83% of adults registered at the end of March 2014.³

Role substitution in NHS dentistry in primary care

Designing the most appropriate dental workforce for NHS dentistry is critical to ensure ‘the right number of people with the right skills are in the right place at the right time to provide the right services to the right people’.^{50,51} At its inception in 1948, the only type of clinician working within NHS dentistry was the GDP. In 1921, the Dentists Act 1921⁵² created the UK Dental Board, whose role was to be the professional body for dentistry and oversee its practice, regulating who could practise as a GDP. In 1946, the Teviot Report⁵³ argued that the dental profession had become sufficiently mature to self-govern and, by 1956, the new Dentists Act 1956⁵⁴ had enshrined this principle in law. To discharge this Act, the functions of the board were taken over by the General Dental Council (GDC).

The Dentists Act 1956⁵⁴ also allowed the training of ‘dental auxiliaries’ for the first time and, in 1960, the first ‘auxiliary’ school was opened at New Cross Hospital in London, UK. The newly formed GDC subsequently developed the regulated titles of ‘DH’ and ‘DT’, but restricted the types of clinical activities that they could legally undertake. The duties of the former role related to the provision of prevention and periodontal treatment, while the latter role was permitted to provide a range of direct restorative procedures and extract deciduous teeth. DHs were allowed to practice in the NHS, but it was not until 2002 that a new Dentists Act 2002⁵⁵ allowed DTs to work in NHS dental practices (their role before this had been limited to the provision of care in NHS community dental services settings only). Since 1983, UK dental schools also offered ‘dual’ integrated training over a period of 2 years. The new ‘DHT’ was able to offer the full range of clinical activities that both DHs and DTs could legally undertake.⁵⁶

Common to all these roles, however, was the inability of patients to directly access their services. All patients had to be seen by a GDP first and then referred on to a DH, DT or DHT. A further factor in the provision of care within the NHS that had kept GDPs as the ‘gate-keeper’ was the inability of DCPs to directly contract with the NHS. Under both the current GDS and PDS agreements of 2005, only GDPs can legally establish a NHS contract and be entered onto a Performers List to provide NHS care. In 2013, a contested landmark decision by the GDC⁵⁷ allowed patients for the first time to access the care of DHs, DTs and DHTs without a referral from a GDP. This was known as ‘direct access’ and led to the expansion of DCPs’ scope of practice.⁵⁸ However, DHs, DTs and DHTs remain unable to contract directly with the NHS and so the majority are employed by NHS GDPs on a sessional, salary or activity basis.

The Nuffield inquiry on the education and training of personnel auxiliary to dentistry was published in the UK in 1993.⁵⁹ It focused on a redefinition of the dental team through which dental care would be delivered and also examined if, and how far, the role of auxiliaries could be expanded. Since the publication of the Nuffield report,⁵⁹ much has been written in the dental literature about the need to adopt a model of care in the NHS that makes greater use of 'skill mix'.⁶ Skill mix is a term that is used to describe a model of care in which the whole of the clinical team is utilised in delivering service activity.⁶⁰ The use of skill mix in medicine is relatively developed, but dentistry has always appeared to lag behind.⁶ Skill mix can be further subdivided into role substitution and role supplementation. The former is when DCPs undertake clinical tasks instead of a GDP, whereas the latter is when other team members augment the activity of a GDP (e.g. dental nurses or dental technicians). It is argued that both should play a substantive role in shifting dentistry from a 'cure' to a 'care' culture in the future.⁶¹

Population health needs are changing. From the most recent epidemiological survey undertaken in the UK, 90% of young adults are expected to have more than 20 teeth in 10 years' time and the levels of dental caries and periodontal disease have fallen dramatically.^{2,9,11} However, social inequalities have remained relatively static, disease in young children remains intransigent (although geographical variations are evident) and there is a burgeoning group of older people who are now keeping their teeth for longer.^{10,62-64} In addition, approximately 45% of the adult population in England do not use NHS dental services routinely and much of the activity that is undertaken by NHS GDPs relates to band 1 (primarily check-ups without treatment) activity.³

As population needs continue to change, there are increasing calls for the development of a NHS dental workforce that can best meet the emerging needs of these strata: maintaining the health of routine attenders, while freeing up resources to increase the capacity to care and reduce social inequalities in oral health.⁶⁵ These calls reflect a growing international debate on the subject.^{27,28,60} In a review of the international literature, Nash *et al.*⁶⁶ conclude that 'access to basic dental care will not be available without the utilisation of dental therapists in the workforce', while Johnson⁶⁷ argues for a paradigm shift using DCPs to shift the culture 'from treatment to prevention, wellness and self-care'.

Role substitution by DHs, DTs and DHTs is long established in a number of countries and there are varying models of independent practice.^{66,68} Sweden and the Netherlands were among the first countries to allow DHs to practise independently, and this was legalised in 1964 and 1978, respectively.⁶⁹ Finland, Denmark and Norway have allowed independent practice since 1994, 1996 and 2001, respectively. Similar practices are found in Switzerland, which started in 1997, and in Italy, where DHs have been able to work as independent practitioners since 1999.⁶⁹ In the USA and Canada, DHs are part of a growing profession; they can practise with varying degrees of independence in a number of US states, such as California, Colorado, Montana, Nebraska, New Mexico, Oregon and Washington, and Canadian provinces such as British Columbia, Alberta, Saskatchewan and Manitoba, although some restrictions remain in terms of settings.⁷⁰ Tasmania has a liberal regulatory model where DHs and DTs practise independently and can own private practices.⁶⁹ DTs are also considered to be independent in New Zealand, although they are not able to treat adults. In Samoa and Singapore, DTs must work under the supervision of a GDP. Fiji has allowed DTs to assume independent responsibility for managing clinics since 1985 and DTs have been allowed to practise independently in South Africa since 1994.⁶⁹

The research evidence for the greater use of DHs, DTs and DHTs is emerging. In Galloway *et al.*'s⁷¹ systematic review, DCPs were found to be better than GDPs at oral health promotion, and in the most recent Cochrane systematic review⁷² survival rates of resin fissure sealants were similar over various time periods. Previous studies have found that DCPs are able to screen for oral diseases.⁷³⁻⁷⁹ Treatment outcomes for atraumatic restorative techniques were also similar across a number of criteria for single-surface (small) and multisurface (large) restorations for DCPs and GDPs.⁷² In a review of the literature on direct access,⁸⁰ DCPs were again found to perform to a similar standard as GDPs, although the evidence base found by Dyer *et al.*⁷² and Brocklehurst *et al.*⁸⁰ was mainly descriptive with only a few experimental studies.

Although DHs appear to be well-accepted members of the dental team in the UK,^{81,82} financial considerations appear to play a significant part in the decision to use a DT in the NHS.^{56,83–90} Of the few studies that have examined DTs' profitability, patient charges generated did not cover the cost associated with their use.⁹¹ As a result, many DTs have been employed by the NHS as DHs in England, limiting their ability to use the full range of their skills.⁹² Although the social acceptability of DTs appears to be positive,^{93–95} public awareness of DTs as a professional group is not widespread.⁹³ Despite this, it does appear that adults are willing to receive treatment from DCPs under the NHS and there is evidence of increased patient satisfaction.⁹⁵ However, some patients expect to pay less for treatment provided by a DCP and are reticent about care provided by a DCP for young children or when anxious.⁹³

The NHS GDPs run their practices as businesses to offset the cost of the capital risk of the premises and the equipment that they own, while ensuring liquidity to cover their overheads.⁴⁶ This means that the use of role substitution must be profitable and is sensitive to the remuneration system.⁹⁶ In medicine, transaction costs can be offset by economies of scale, which enable a broader range of services to be made available.⁹⁷ However, historically the size of dental practices has been limited to a small number of surgeries, with approximately one-third run single-handedly.⁹⁸ It also requires all GDPs in the dental team to refer patients to DCPs and there is evidence that not all do this because of the GDP effectively losing income to the DCP.³¹

One study that examined the efficiency of using DTs in the NHS found that this was described by NHS GDPs as the optimum use of surgery time to manage patient flow, provide patient satisfaction and maintain activity levels.³² However, some efficiency gains were noted in the nine practices examined. Harris and Sun⁹⁹ concluded that role substitution 'may be limited to particular situations where conditions are conducive'. For example, the type of patient care was found to be relevant to whether or not referrals to DTs were deemed efficient. Patients with high levels of disease (many restorations) were thought less suitable for referral because GDPs would undertake care in fewer visits and there was a risk of complications necessitating referral back to a GDP.

Management of change is also a potential problem with role substitution, as professionals seek to protect their clinical roles and maintain traditional boundaries.⁷⁰ Managing a transition to role substitution takes time and good human resource skills.¹⁰⁰ As highlighted by Watt *et al.*,¹⁰¹ the most important factors influencing change in dentistry include concerns about financial risk, progressive practice environment, supportive organisational structure, supportive professional networks and opportunity for training. McDonald *et al.*¹⁰² found that the key factors that determined the acceptability of changes to role boundaries included the clarity around roles and responsibilities as well as personal relationships with colleagues, which raise issues of mutual trust and respect. The importance of financial incentives has also been identified.^{14,102,103}

Financial incentives in NHS dentistry in primary care

As highlighted above (see *Organisation of NHS Dentistry in primary care in England and Wales*), NHS GDPs are part of an altruistic profession, yet much of their activity in primary care is driven by the 'profit principle' to maintain the viability of their practices. NHS GDPs are acutely sensitive to incentives within the remuneration system.^{13,15,16,104} Retrospective payment systems like FFS commonly lead to overtreatment,^{17,18,104} whereas prospective systems or 'per capita' payments often lead to undertreatment.¹⁸ When incentives promote preventative activity, NHS GDPs tend to actively engage and shape their dental team accordingly, greatly increasing the use of role supplementation and substitution.¹⁰⁵ Little is known about how the efficiency of NHS dental services is affected by role substitution. The only study in the UK (at the time of writing) used only nine practices.⁹⁹

Oral health follows a social gradient, with the poorest experiencing the majority of the disease.¹⁰⁶ However, prevention and treatment of oral diseases are determined by an individual's ability to pay for services.¹⁰⁷ As a result, access to services tends to be greatest in those groups with the fewest needs.^{108,109} Public funding of health and social care provides a means of overcoming the divergence between the ability to pay for care and need for care. It offers the opportunity for improving both efficiency (increasing health gains produced from available health-care resources) and equity (removing barriers to access to services associated with individuals' income or wealth). In an evaluation of the previous contract reform in England, Whittaker and Birch¹¹⁰ found that the dental reforms impacted on access. Copayments via Patient Charge Revenue have also been a fundamental component of the NHS dental contract since the 1950s. In the USA, Manning *et al.*¹¹¹ found that dental service use increased as copayments decreased in a randomised trial of alternative insurance plans, whereas Parkin and Yule¹¹² found a negative relationship between price and dental care use in Scotland. Little is known about the impact of remuneration systems on the efficiency of NHS practices and how they might influence outputs such as access.

Concluding remarks

The preceding sections have highlighted a range of issues relating to the NHS dental contract in England, Northern Ireland and Wales. It has also highlighted the factors that can impact on the use of role substitution in NHS dentistry and how in turn, this may impact on key areas of quality, including access, efficiency, efficacy, inequalities and social acceptability. *Chapter 3* explores the distribution of DCPs across the UK, if role substitution is associated with efficiency in NHS dentistry in England, the types of barriers to and enablers of the greater use of role substitution in NHS practices across the UK and the role that financial incentives have on the organisation and efficiency of NHS dental teams.

Chapter 3 Preliminary screening of NHS dental care professionals

Introduction

The publication of the Nuffield Report led many in the dental profession to articulate the importance and potential of using skill mix in NHS dentistry.⁵⁹ Although the GDC provided oversight on the range of clinical duties that DCPs could perform, it was not until 2008 that it required DHS, DTs and DHTs to be registered with the dental regulator. Prior to this point, the 'stock and flow' of DCPs in the dental marketplace could be estimated only from the number of training places available in the UK dental schools. By 2008 there were over 5000 DHs and DHTs registered with the GDC and approximately 250 dually qualified DHTs were being trained each year across 10 dental schools.¹¹³

Despite the potential for using DCPs as part of the NHS dental team, there is evidence that some DCPs are not being fully utilised in the NHS.^{92,114–118} The oldest studies found that one-fifth of DH students who graduated from Liverpool in 1989 and one-tenth in 2000 did not stay in the dental profession.^{117,118} In 2002, a survey undertaken in the south of England found that only one-fifth of DHs worked within the NHS, spending their remaining time undertaking private activity.¹¹⁶ In the north of England, this proportion was slightly higher, at one-third, and in Scotland just over half (54%) of all DH activity was undertaken on NHS patients (in those NHS practices that utilised DCPs).¹¹⁵ The most recent survey across the UK found again that just over one-fifth of practising DHs undertook activity on NHS patients.¹¹⁴ The proportion of DCPs who work with NHS and private patients was not examined in these surveys, although they are capable of treating both.

There is also evidence from Godson *et al.*⁹² that many DTs are not working to their full scope of practice (i.e. the range of clinical tasks that they are trained to perform) in the NHS in England.⁹² Many DTs surveyed, who went on to record their views via free-text box (46.6%), stated that they practised exclusively or nearly exclusively as a DH. Approximately one-third (36%) worked wholly under NHS regulations, whereas a further 32% spent the majority of their time (50–99%) on NHS work.

Given this range of utilisation, the objective for this part of the research programme was to conduct a cross-sectional study to determine the current working patterns of DCPs in NHS dental practices across the UK. This was then used as part of the sampling strategy for the studies reported in *Chapters 4 and 5*.

Methods

Following NHS ethical approval (12/WA/0403), the membership of the British Society of Dental Hygiene and Therapy (BSDHT) was contacted and asked to complete a questionnaire in 2013. Questionnaires were distributed to all of the 3100 members of the BSDHT (saturation sampling) using a letter of invitation that was cowritten by the research team and the president of the BSDHT. The questionnaires were mailed out using the BSDHT database that was used to distribute their newsletter. The BSDHT is the predominant professional organisation for DHs, DTs and DHTs.

The questionnaire recorded the type of DCP and the address of the practice where they worked. It also asked participants to record the time in their current NHS post, the number of clinically active hours worked per week on NHS patients, the proportion of time working with children and adult NHS patients and the number and type of DCPs that they worked alongside.

The distribution process was managed by the BSDHT. Reminder letters and repeat questionnaires were mailed out twice, so that each of the 3100 members of the BSDHT was approached a maximum of three times.

The results of these questionnaires were then compiled and the addresses were used to geographically locate the practices where they worked, using ArcGIS (Esri, Redlands, CA, USA). Maps were created to record the distribution of NHS provision (see *Figure 1*).

Results

A total of 1859 responses were returned (60.0%), of which 287 (15.4%) were from DHs, DTs and DHTs working in 432 NHS practices. The remaining responses either related to DCPs working in private practice or had been left blank or were unusable.

Based on the responses, the most common DCP type working in the NHS was the DH (64.1%) (*Table 1*) followed by DHTs (33.8%) and DTs (1.0%).

TABLE 1 Demographics of the DCP sample

Variable	Detail
<i>Type of DCP</i>	
DH	64.1%
DHT	33.8%
DT	1.0%
Other	1.1%
Mean (SD) hours worked	12.6 (11.4)
Mean (SD) age (years)	42.1 (10.9)
Years (SD) qualified	16.5 (12.4)
Proportion (%) female	97.9
Mean (SD) time in post (years)	8.4 (8.7)
<i>Number of NHS practices DCP works across</i>	
1	59.9%
2	27.5%
3	12.5%
≥ 4	0.1%
Mean (SD) number of additional DCPs at the practice	1.7 (1.8)
SD, standard deviation.	

The mean age of the DCPs was 42.1 years and the mean number of years qualified was 16.5. Almost all of the DCPs were female and the mean time in post was 8.4 years. More than half of the DCPs worked in one practice, but a substantial majority worked in more than one practice. The mean number of additional DCPs that the respondents worked with was 1.7.

The geographical spread of DCPs that work in the NHS is provided in *Figure 1* and *Table 2* highlights the distribution of the 10 most common models in use in the NHS across the UK.



FIGURE 1 Distribution of DHs, DTs and DHTs in NHS practices across the UK.

TABLE 2 Common models of role substitution in sampled NHS practices in the UK

Model	Detail of the model used	England	Wales	Scotland	Northern Ireland	Total
1	DH with no additional DCP	93	11	7	3	114
2	DH with one other DH	39	1	6	0	46
3	DH with one DHT	23	1	2	0	26
4	DH with two other DHs	17	3	7	0	27
5	DH with one DH and one DHT	12	0	2	0	14
6	DHT with no additional DCP	48	2	5	0	55
7	DHT with one DH	22	0	3	0	25
8	DHT with one other DHT	22	2	1	0	25
9	DHT with two DHs	11	0	1	0	12
10	DT with one DH	11	0	0	0	11
Total		298	20	34	3	355

Discussion

The most common type of DCP seeing NHS patients in the group investigated was the DH (64.1%), suggesting that role substitution for periodontal treatment was more common than for DCPs who undertake direct restorations (DHTs and DTs). These results are consistent with Godson *et al.*,⁹² who found that, even where DHTs are employed, they are commonly used to undertake periodontal treatment. This may reflect a difference in the availability of work within the NHS or it may equally reflect a reluctance in GDPs to allow DHs, DTs and DHTs to encroach over traditional role boundaries. The role of DT in NHS practices was permitted only in 2002 and there appears to be evidence that both GDPs and dental students are either not aware of the expanded scope of practice for DTs and DHTs, or that they choose not to support this expansion of their role.¹¹³

Over half of the NHS practices employed DCPs, with the most common additional DCP type being the DH. The mean number of additional DCPs employed at a practice was 1.7 (see *Table 1*). This suggests that the practice culture and ethos is an important determining factor, that is, if skill mix is perceived to be important for the practice, it is common for multiple DCP roles to be employed.

The mean number of hours worked per week by NHS DHs, DTs and DHTs was 12.6, which means that most only worked for three or four sessions at any one practice. This is consistent with the finding that over one-third of these DCP roles worked in more than one practice. Eaton *et al.*¹¹⁴ found that the mean number of clinical hours worked per week was 24.6 hours. This propensity for part-time working among DCPs is consistent with findings from other studies.^{92,119,120} Eaton *et al.*¹¹⁴ reported that 62.7% of DCPs worked in more than one practice. However, they did not distinguish between NHS activity and private activity, so this may explain some of the differences with this study.

Concluding remarks

The objective of this component of the research programme was to provide a snapshot of DCP utilisation in the NHS and contribute towards the development of a sampling frame for the studies highlighted in *Chapters 4* and *5*. It is clear from the results that not all NHS high-street dental practices use DHs, DTs and DHTs and those that do are not employing them full time. Instead, it appears that it is common for DCPs to work across multiple practices.

Chapter 4 Technical efficiency of NHS teams that use role substitution

Introduction

The independent review of NHS dentistry in 2009² concluded that there was an overwhelming need to make best use of the whole dental workforce. The greater use of DCPs and role substitution provides a potential strategy for increasing the efficiency of NHS dentistry. Technical efficiency is defined as the production of the maximum amount of output from a given amount of input so that a service operates at the production frontier.⁷ In NHS dentistry, this could be achieved by either increasing the amount of NHS activity produced (including the capacity to care) with the same level of input or producing the same level of activity (output) with a reduced input.

Role substitution is already established in medicine.^{21,22} However, practice efficiency is improved only when (1) physician time is released from the tasks delegated to nurses (i.e. nurse time replaces physician time in these activities, as opposed to supplementing it) and (2) that released physician time is used for tasks that only physicians can perform.²³

Harris and Sun³² found that role substitution may improve efficiency in NHS dental service provision, but that this may be limited to particular situations or contexts. Therefore, it is important to determine (1) whether or not the way role substitution is used is associated with higher levels of technical efficiency and (2) whether or not the potential efficiency gains of role substitution are constrained by structural constraints. There is little evidence on the economic consequences of role substitution in NHS dental practices,² even though such evidence is important for commissioning NHS services across the UK.

In the UK, GDPs who work in the NHS are either practice principals (PPs) or associate GDPs. PPs own the NHS dental practice and are responsible for paying estate, staff and consumables associated with the delivery of a NHS dental contract. Associate GDPs are self-employed NHS GDPs who have their own subcontract with the NHS and who rent facilities and support staff time from the PP.

As highlighted in *Chapter 2*, PPs and associate GDPs in England do not receive any additional remuneration for NHS care delivered in excess of 102% of their ACV and are penalised through a pro rata 'claw-back' of remuneration if their activity falls below 96% of their ACV. As such, practices in England are output constrained and PPs organise their practices to operate within these constraints.

Dental care professionals are a heterogeneous group including DHs, DTs or DHTs. DCPs also include dental nurses and dental technicians, but these roles are predominantly supplementary in nature and so the term DCPs in this report collectively describes those non-GDP clinicians able to perform a range of clinical tasks as defined by their legislated scope of practice (regulated by the GDC).⁵⁸ One method of making efficiency improvements in NHS GDP practices is to substitute lower cost time of these DCPs for higher cost GDP time, as any output is constrained by the ACV threshold. However, as DHs, DTs and DHTs cannot contract with the NHS, the predominant model in NHS dentistry in England is to add the number of UDAs that these DCPs produce to the PP's NHS contract. As a result, there is an incentive for PPs to encourage role substitution and a disincentive for associate GDPs to support role substitution.

Aims and objectives

The aim of this chapter is to determine if the use of these DCPs in NHS practices is associated with higher levels of efficiency of production in service delivery. In particular, the following RQs were addressed:

1. Are practices that employ DCPs significantly more technically efficient than those that do not employ DCPs after controlling for other practice/site and patient population characteristics?
2. Among practices that employ DCPs, was the level of technical efficiency significantly associated with the level of DCP use after controlling for other practice/site and patient population characteristics?

Although the first two RQs evaluate the efficiency implications of the presence and level of use of DCPs, they do not identify role substitution (i.e. DCPs contributing a higher proportion of total provider time in a practice). To explore the notion of role substitution a third RQ was:

3. Among practices that employ DCPs, is the level of technical efficiency significantly associated with the proportion of total clinical time provided by DCPs?

In order to consider whether or not the efficiency of using DCPs is specific to particular practice circumstances and settings (in particular the patient mix served by the practice), a fourth RQ to be addressed was:

4. Among practices that employ DCPs, was the association between technical efficiency and DCP use dependent on (1) the proportion of adult (non-elderly) patients treated (subgroup of patients with relatively low need compared with children or elderly patients) and (2) the proportion of exempt patients (subgroup of patients with relatively high need)?

Finally, in order to test whether or not role substitution was associated with the mix of services delivered, two further RQs to be addressed were:

5. Among practices that employ DCPs, was the proportion of UDAs received for provision of routine services significantly associated with the level of DCP use after controlling for other practice/site and patient population characteristics?
6. Among practices that employ DCPs, was the proportion of UDAs received for provision of routine services significantly associated with the proportion of clinical time provided by DCPs after controlling for other practice/site and patient population characteristics?

Methods

Data collection

This was a multicentre study of NHS dental practices based in the north of England. Contact details of NHS GDPs practising in the north of England were collected from a range of sources. These included the screening questionnaire in *Chapter 3*, Health Education England and the NIHR Clinical Research Networks. Two hundred and one NHS practices in the north-west of England and 143 NHS practices in the north-east were invited to participate. Further data were collected from sites in Northern Ireland and Scotland via the Health and Social Care Board and the Scottish Practice Based Research Network, respectively. The results of analyses using data from Northern Ireland and Scotland are provided in *Appendix 1*.

Each NHS practice was asked to complete a short research questionnaire about the inputs used in the practice's dental health-care production. As a rule of thumb, Dyson *et al.*¹²¹ argues that the selected inputs and outputs for an efficiency analysis should cover the full range of resources used and outputs produced. The selection of inputs and outputs for the questionnaire was decided following a review of the existing economic literature on productive efficiency in dental health care and discussions with local NHS GDPs (Greater Manchester Local Professional Network). The questionnaire was then piloted and further refined after post-pilot interviews with local PPs from Greater Manchester.

The final questionnaire (see *Appendix 2*) was distributed to the identified NHS practices by a third party, who held the database for Health Education England and who anonymised the data. All the PPs were asked to provide consent for the research team to link the information in the questionnaire to data recording the extent of NHS clinical activity undertaken by the practice held by the Business Services Authority (the Information Services Division in Scotland and the Business Services Organisation in Northern Ireland provided the corresponding data for those jurisdictions). The types of input and output data collected in England are provided in *Table 3*. Data were provided for the period 2013–14 and excluded any orthodontic activity (some variables in the questionnaires for Scotland and Northern Ireland were amended to reflect the difference in their remuneration systems; see *Appendix 2*).

Tables 4 and *5* highlight the variables captured by the questionnaire or via the Business Services Authority that were used to capture patient population characteristics and measures of the service mix delivered to patients.

To test the representativeness of the sample from England, data were also collected from the Business Services Authority for the following variables:

- annual number of UDAs
- annual number of patients seen
- annual number of treatment plans (claims)
- percentage of UDAs from adults
- percentage of UDAs from patients aged 40 years and over
- percentage of UDAs from patients exempt from payment charges
- percentage of claims that are band 1
- percentage of claims that are band 2
- percentage of claims that are band 3
- percentage of claims that are urgent
- active NHS GDPs at the practice.

TABLE 3 Input and output variables for the oral health-care production

Variable name	Variable description	Data source
UDAs	Units of dental activity	Business Services Authority
Income	Revenue accrued	Business Services Authority
Patients seen	Number of adults and children seen	Business Services Authority
Treatment plans	Number of individual claims made	Business Services Authority
Weekly DCP sessions with NHS patients	Number of sessions (half days) worked by DHs, DHTs, DTs seeing NHS patients in a typical week	Questionnaire
Weekly GDP sessions with NHS patients	The number of sessions (half days) worked by GDPs (PPs and associate GDPs) seeing NHS patients in a typical week	Questionnaire
Weekly nurse sessions	Number of sessions (half days) worked by dental nurses in a typical week	Questionnaire
Weekly administration staff sessions	The number of sessions (half days) worked by practice managers and administrative staff in a typical week	Questionnaire
Number of surgeries	The number of surgeries that are typically in operation (for at least 3 days per week)	Questionnaire

TABLE 4 Practice characteristics recorded (via questionnaire)

Variable name	Variable description
Corporation	Practice is a dental body corporate
Good Practice Award	Practice has been awarded the British Dental Association's Good Practice Award
Material costs	The approximate percentage of expenditure from total practice revenue spent on consumables
Laboratory costs	The approximate percentage of expenditure from total practice revenue spent on laboratory fees
Treatment time	How long the practice tends to book for regular and new patient examinations (minutes)
Proportion of DCP to GDP sessions seeing NHS patients	The percentage of DCP sessions seeing NHS patients to GDP sessions seeing NHS patients
Weekly PP sessions with NHS patients	The number of sessions worked by PPs seeing NHS patients in a typical week
Weekly associate GDP sessions with NHS patients	The number of sessions worked by associate GDPs seeing NHS patients in a typical week
Weekly DH sessions with NHS patients	The number of sessions worked by DHs seeing NHS patients in a typical week
Weekly DHT sessions with NHS patients	The number of sessions worked by DHTs seeing NHS patients in a typical week
Weekly DT sessions with NHS patients	The number of sessions worked by DTs seeing NHS patients in a typical week
Any use of DCPs with NHS patients	Practice/site employs DCPs for use on NHS patients
Any use of DCPs (with either NHS or private patients)	Practice/site employs DCPs
Number of FTE DCPs employed (to work with NHS or private patients)	FTE number of DCPs the practice employs
Weekly support staff sessions	The weekly number of administration staff sessions for GDS practices

FTE, full-time equivalent.

TABLE 5 Patient population and service mix characteristics (via Business Services Authority)

Variable name	Variable description
Percentage of child patients	Percentage of patients treated that are children (aged 0–18 years)
Proportion of adult non-elderly patients	Proportion of total patients treated aged 19–59 years
Proportion of exempt patients	The percentage of patients treated when a patient was exempt
Proportion of patients with non-age related exemption from NHS charges status	The proportion of patients treated when a patient was exempt from NHS charges status for the following reasons: expectant or nursing mothers, income support, job seeker's allowance, working family tax credits and certificates for full or partial help with health-care costs
Proportion of band 1 treatments	The proportion of annual NHS claims for routine treatment (band 1)
Proportion of band 2 treatments	The proportion of annual NHS claims for routine treatment (band 2)
Proportion of band 3 treatments	The proportion of annual NHS claims for complex treatment (band 3)
Proportion of urgent treatments	The proportion of annual NHS claims for urgent treatment
Proportion of preventative treatments	The proportion of annual NHS claims that include preventative treatments
Proportion of examinations	The proportion of annual NHS claims for examinations
Proportion of fillings and restorations	The proportion of annual NHS claims for routine restorations

Data envelopment analysis and the analysis of efficiency scores

The data were analysed in a two-stage process. In stage 1, DEA was used to compute the technical efficiency scores of each practice. Efficiency estimates were bootstrapped to improve statistical accuracy in stage 2, where practice characteristics were regressed on the technical efficiency scores obtained in stage 1 using ordinary least squares (OLS) regression to determine whether or not practice efficiency was significantly associated with DCP use and role substitution after controlling for other practice characteristics. What follows is an overview of the methods for the first and second stages. This includes the approach taken to account for scale inefficiencies, how we arrived at a decision to choose an input-orientated model, the methods taken to overcome problems of correlation among the DEA estimates and correlation of the inputs and outputs used in the first stage with second-stage 'environmental' factors.

Data envelopment analysis is a linear programming technique that estimates the relative efficiency of a particular decision unit (i.e. GDS practice) is identified by comparing it to the performance of another decision unit rather than trying to associate performance with statistical averages that may not be applicable. DEA constructs a convex hull around a set of outlying observations based on best observable practice. The approach is non-parametric because the location and shape of the efficiency frontier is anchored to observations rather than estimated from parameters such as the level of inputs practices have used. The distance of a practice unit from the frontier is a measure of technical inefficiency.¹²² Technical efficiency is a comparative measure of how well a decision-making unit deploys inputs to produce outputs, as opposed to the production possibility frontier, which is the maximum output that can be achieved for a particular level and mix of inputs. As the DEA efficiency frontier is based on best observable practice, it is only an approximation of the true unobserved efficiency frontier. In other words, it can tell how efficient a practice is compared with its peers but not compared with a theoretical maximum.

The advantage of DEA is that it can accommodate the multiple inputs and multiple outputs of dental health-care production more easily than regression analysis,³³ where non-biased estimation requires parameters to have specific distributional forms (usually normally distributed) and there is the potential for correlation-based problems such as multicollinearity.¹²²

Inputs used for GDS practices were the number of surgeries and staff time worked (GDP sessions with NHS patients, DCP sessions with NHS patients, dental nurse sessions, administrative and managerial staff sessions). Sensitivity analysis was used to test alternative specifications that (1) include consumable materials and laboratory fees as a percentage of total practice revenue as inputs and (2) exclude staff groups that are not involved directly in patient care (administrative staff and nurses).

The output of the practice was measured by UDAs. Two other health-care outcomes were used to assess the sensitivity of results to the choice of the outcome measure. These were the number of treatment plans and the number of unique patients seen. Standard economic techniques were used to calculate missing values of input variables for GDS practices with a missing value (six GDS practices from all samples) with the predicted mean calculated from the values of all other input variables.

The sample efficiency estimates are bootstrapped to correct for bias that exaggerates the level of efficiency within a sample.¹²³ The bootstrapped DEA is a common approach in the research literature and enables consistent inference within the models explaining the efficiency estimates, while simultaneously producing standard errors and confidence intervals for these estimates.

In the second stage of the analysis, the efficiency scores were regressed onto practice variables. If efficiently operating practices have common characteristics, this allows for identification of possible correlates of inefficiency.

To answer the first three RQs, the variation in dental practice/site use of DCPs was measured in terms of whether or not a practice employs any DCPs for use on NHS patients, the number of sessions worked on

NHS patients in a typical week and, to understand how established DCPs are within the dental team, the relative frequency of DCP sessions on NHS patients compared with GDP sessions on NHS patients.

The following practice characteristics served as control variables in the model: number of sessions per week worked by GDPs on NHS patients (this variable is not present in the model specification when the percentage of DCP sessions to GDP sessions variable is included, to avoid correlation between the terms), the number of support staff sessions per week (managerial and administration staff for GDS practices), the number of surgeries in each practice, the proportion of adult (non-elderly) patients treated (aged 19–59 years) and the proportion of patients who are exempt from NHS payment charges (i.e. exemption for expectant or nursing mothers, income support, job seeker's allowance, working family tax credits and certificates for full or partial help with health-care costs).

Sensitivity analysis

Sensitivity analysis was conducted with alternative specifications for different input and output variables to explore if findings are sensitive to the choice of these variables.

Alternative outputs of dental health production were considered because the output of health care, which practices focus attention on and arrange their services to achieve (e.g. NHS remuneration), might differ from what patients use to select a dental practice, or what a trust uses to assess practice performance. Other stakeholders (such as the Department of Health) may have other performance indicators, for example patient access to treatment where needed. Patient access per se cannot be measured, but the reach of a practice to patient groups could be proxied by the number of unique patients seen. In comparison to a measure of the number of UDAs or NHS income received, the number of treatment plans (claims) might be a more accurate measure of the volume of care delivered to patient populations because the distribution of efficiency scores will not be skewed by practices that deliver a relatively small (large) number of treatments of relatively high (low) complexity and remuneration.

Sensitivity analysis was also conducted with consumable materials and laboratory fees included as non-labour inputs in production.¹²⁴ The sensitivity analysis contributes to understanding whether or not findings are robust to the inclusion of a greater range of inputs. Consumable materials and laboratory fees are measured as a percentage of total practice revenue, with an increase in this ratio resulting in a decrease in efficiency. This was included in the model as part of a sensitivity analysis because the questionnaire asked respondents for approximate values of these ratios, which might have introduced measurement error. However, the ratio of materials or laboratory costs to total revenue can rise or fall without a change in the quantity or cost of materials and laboratory fees when the practice income of delivering a treatment changes independently of material usage. This could have occurred if greater income was received from delivering identical treatments to private rather than NHS patients, with private patients benefiting from a reduction in waiting time in their treatments rather than a change in quality or quantity of the materials or laboratory equipment used. This means that the results from estimation with capital stock variables should be interpreted with care as it is not known whether a change in results is the result of an improvement in information (i.e. using the full range of resources used) or a loss of information from the use of imprecisely measured variables.

Following Scheffler and Kushman,¹²⁴ essential inputs are those where output would be zero if they are not present (i.e. surgeries and dental staff); the two non-essential inputs excluded from the analysis were the weekly number of dental nurse sessions and administration and managerial sessions worked. DCP sessions worked on NHS patients are considered an essential input because unlike nurses and administrators, they deliver care that accrues UDAs/income to a practice.

Stochastic frontier model approach to estimating efficiency

A limitation of DEA is that it assumes that if a NHS dental practice can produce a certain level of output using specific input levels, another NHS dental practice of equal scale should be capable of doing the same. This might not be the case if, for example, the frontier of most efficient practices is reached because

of unique local contextual circumstances (e.g. a practice has established itself as being able to employ or refer to one of a limited number of specialist GPs) or because of measurement error in the values of input or output variables.

Stochastic frontier modelling helps overcome this limitation by estimating the frontier with statistical regression methods rather than fixing the frontier from extreme point observations. However, the SFM approach has limitations. In particular, efficiency scores (as measured by regression residuals) reflect a combination of relative efficiency, measurement error in the dependent variable, and statistical noise.³³ Moreover, it does not calculate a productive frontier that corresponds to the theoretical notion of a production function, but instead estimates a fitted 'average' function that provides no direct quantitative information on productive inefficiency in the sample.³³ Nevertheless, SFM was used in this study to test the robustness of the DEA findings for RQ1 and RQ2. A Cobb–Douglas function form was used for the SFM after a more flexible functional form (Translog) was rejected in a joint chi-square test of the coefficients on the additional Translog variables.³³

Sample size

The most important sample consideration is the selection of homogeneous sample observations that would achieve a level of efficiency of those practices on the frontier if they adopted the same level and combination of inputs and techniques (e.g. organisational or technological processes of production) for transforming inputs into outputs.¹²⁵ For this reason, we limit the main analysis to practices in England operating under the same NHS remuneration arrangements and do not combine samples from different jurisdictions and service types.

The relative nature of DEA (i.e. estimating technical efficiency relative to the best-performing practice on the 'frontier') makes it vulnerable to problems with degrees of freedom. The number of degrees of freedom increases with the number of NHS dental practices in the data set and decreases with the number of input and output variables. Banker *et al.*¹²⁶ suggest a rough rule of thumb for acceptable sample size: (1) it should be larger than the product of the number of inputs and number of outputs and (2) it should be at least three times as large as the sum of the number of inputs and the number of outputs. Dyson *et al.*¹²¹ suggested a sample of at least twice the total number of input and output variables. Brown¹²⁷ suggested the sample should exceed three times the sum of the number of inputs and the number of outputs. The sample size of DEA models in all jurisdictions and service types estimated in this study comfortably meets all of these criteria.

In this study, conclusions were drawn from the analysis of NHS dental practices located in England (with the remaining analyses for Scotland and Northern Ireland being described in *Appendix 1*). The England sample has over four times as many observations as practices in other jurisdictions. A large number of observations enables a sharper identification of typical relations between inputs and outputs so that more inputs and more outputs can be incorporated into a DEA.¹²⁴

Results

Sample of NHS dental practices in England

Table 6 compares the sample of 121 practices with data collected from the Business Services Authority for all of England to test how generalisable the study sample was. The mean practice output of UDAs was higher among sample practices than for England (15,444 compared with 10,494), as was the mean number of patients seen (5597 compared with 3670) and treatment plans (7286 compared with 4701). This may be explained by the sample practices being larger (on average 5.7 active GPs compared with 3.9 in England). Despite this difference in scale, the distribution of claims across pay bands and the percentage of UDAs claimed from treating patients exempt from payment charges in sample practices were both similar to all practices in England. However, the adult share of practice patients was greater for sample practices (mean of 73.6%) than all England practices (mean of 65%).

TABLE 6 Sample practices in England compared with national data

Practice characteristics	England, mean ($n = 8788$)	Sample, mean ($n = 121$)
Annual number of UDAs	10,494	15,444
Annual number of patients seen	3670	5597
Annual number of treatment plans (claims)	4701	7286
Percentage of UDAs from adults	65	73.6
Percentage of UDAs from patients aged 40 years and over	41	52.7
Percentage of UDA from patients exempt from patient charges	41	37.3
Percentage of claims that are band 1	54	57.3
Percentage of claims that are band 2	30	28.4
Percentage of claims that are band 3	6	4.7
Percentage of claims that are urgent	9	9.6
Active performers at the practice	3.9	5.7

Table 7 presents descriptive statistics of practice characteristics for practices that used DCPs on NHS patients and practices that did not use DCPs. The larger size of practices with DCPs (3.82 dental surgeries compared with 2.8 for practices without DCPs) suggests that DCPs may have been used to increase practice capacity (i.e. to supplement capacity rather than substitute for dentists while maintaining capacity). For all other practice characteristics there is no statistically significant difference between the two practice groups.

Tables 8–10 present the mean values of the variables that were collected from the sample of NHS dental practices in England (corresponding data for Scotland and Northern Ireland practice samples are provided in Appendix 1).

Data envelopment analysis

Table 11 presents the estimated mean level of practice performance from the sample in England for the main outcome measure (UDAs) and secondary output measures (treatment plans, patients seen). NHS dental practices that perform with full technical efficiency (i.e. producing on the frontier) have an efficiency score of 100. Efficiency scores were estimated after bootstrapping with 1000 replications. The corresponding estimates for Scotland and Northern Ireland are provided in Appendix 1.

Practices were operating at a mean level of efficiency of 64%. Practices without role substitution (no DCPs employed) had a mean level of efficiency of 68% ($n = 39$) and 62% ($n = 82$) for those with role substitution. The mean efficiency score changes little when practice performance is measured in terms of number of patients or treatment plans. The variation in practice scores around this mean is small, with 95% of scores lying within 5 percentage points of the mean. Subgroup analysis of the efficiency scores revealed the greatest variation in efficiency scores to be among those practices that did not use role substitution (95% of scores lying within 12 percentage points of the mean). This may be an indication of greater variation in operating procedures among practices that do not use role substitution or it could be that operating procedures become more similar by the use of DCPs (e.g. those practices may shift their service mix towards the smaller range of treatments that DCPs are able to perform).

The technical inefficiencies can arise from the ineffective operation of the production process in organising inputs and/or transforming inputs to outputs after controlling for scale effects. Efficiency scores were estimated after bootstrapping with 1000 replications.

TABLE 7 Descriptive statistics of practices that did and did not use DCPs

Practice characteristics	Mean number of practices		p-value of difference in means
	With no DCPs (n = 39)	With DCPs (n = 82)	
Dental health-care outputs			
Annual number of UDAs	15,769	15,289	0.83
Annual number of courses of treatments (claims)	7168	7342	0.86
Annual number of patients seen	5513	5637	0.90
Staff sessions			
Weekly number of GDP sessions with NHS patients	17.7	18.7	0.72
Weekly number of PP sessions with NHS patients	4.7	6.7	0.10
Weekly number of associate GDPs sessions with NHS patients	12.6	10.7	0.42
Weekly number of administrative staff sessions	19.3	23.2	0.19
Practice characteristics			
Number of surgeries	2.8	3.82	< 0.00
Consumable materials as a percentage of practice revenue	12.3	11.5	0.63
Laboratory expenditure as a percentage of practice revenue	9.0	10.0	0.51
Treatment mix			
Percentage of band 1 treatments	57.7	57.1	0.77
Percentage of band 2 treatments	29.8	27.8	0.16
Percentage of band 3 treatments	5.1	4.5	0.38
Percentage of urgent treatments	7.4	10.6	0.12
Patient case mix			
Percentage of adult patients treated	76.2	72.4	0.34
Percentage of copayment exempt patients	42.3	34.9	0.12
Percentage of patients with non-age-related exemption from NHS charges status	25.4	24.2	0.64

TABLE 8 Sample statistics of NHS dental health-care output measures

Measure	Detail	England, mean (95% CI)
UDAs	UDAs accrued in 2013/14 for general dentistry	15,444 (13,433 to 17,455)
Treatment plans	Number of submitted claim forms in 2013/14 for general dentistry	7286 (6367 to 8205)
Patients seen	Number of unique patients seen in 2013/14 for general dentistry	5597 (4905 to 6288)

CI, confidence interval.

TABLE 9 Sample statistics of staffing variables

Measure	Detail	England, mean (95% CI)
Weekly GDP sessions with NHS patients	Number of sessions worked by GDPs seeing NHS patients in a typical week	19.4 (17 to 21.9)
Weekly PP sessions with NHS patients	The number of sessions worked by PPs seeing NHS patients in a typical week	6.1 (4.9 to 7.1)
Weekly associate GDP sessions with NHS patients	The number of sessions worked by associate GDPs seeing NHS patients in a typical week	11.3 (9.1 to 13.4)
The percentage of DCP to GDP sessions seeing NHS patients	The percentage of DCP to GDP sessions seeing NHS patients	16.6 (12.6 to 34.6)
Any use of DCPs with NHS patients	Percentage of the whole sample that uses DCPs with NHS patients	68
Number of FTE DCPs employed	The number of WTE DCPs employed (NHS and private work)	1.1 (0.8 to 1.5)
Weekly DCP sessions with NHS patients	Number of sessions worked by DCPs seeing NHS patients in a typical week	3.0 (2.1 to 3.8)
Weekly DH sessions with NHS patients	Number of sessions worked by DHs seeing NHS patients in a typical week	0.6 (0.3 to 0.8)
Weekly DHTs sessions with NHS patients	Number of sessions worked by DHTs seeing NHS patients in a typical week	1.7 (0.9 to 2.5)
Weekly DTs sessions with NHS patients	Number of sessions worked DTs seeing NHS patients in a typical week	0.7 (0.3 to 1.0)
Weekly nurse sessions	Number dental nurse sessions worked in a typical week	47.0 (42.1 to 52.0)
Weekly administration staff sessions	The number of sessions worked by managers and administrative staff in a typical week	20.8 (18.3 to 23.3)

CI, confidence interval; FTE, full-time equivalent.

TABLE 10 Sample statistics of practice/site variables

Measure	Detail	England, mean (95% CI)
Surgeries	The number of surgeries that are typically in operation (for at least 3 days per week)	3.5 (3.2 to 3.8)
Percentage of child patients	Percentage of patients treated that are children	26.4 (22.7 to 30.1)
Percentage of exempt patients	Percentage of patients that are exempt from patient charges	37.3 (32.9 to 41.7)
Percentage of band 1 treatments	Percentage of UDAs that are band 1	57.3 (55.1 to 59.5)
Percentage of band 2 treatments	Percentage of UDAs that are band 2	28.4 (27.1 to 29.7)
Percentage of band 3 treatments	Percentage of UDAs that are band 3	4.7 (4.1 to 5.3)
Percentage of urgent treatments	Percentage of UDAs that are urgent	9.6 (7.7 to 11.6)
Good Practice Award	Percentage of practices that have been awarded the British Dental Association's Good Practice Award	33
Material costs	Percentage of total practice revenue spent on consumables in 2013/14	11.7 (10.2 to 13.2)
Laboratory costs	Percentage of total practice revenue spent on laboratory fees in 2013/14	9.7 (8.3 to 11.1)

CI, confidence interval.

TABLE 11 Mean practice efficiency score when health-care output is measured by UDAs, treatment plans and patients seen

Output measure	Mean ^a	95% CI
Annual number of UDAs	0.64	0.60 to 0.69
Annual number of treatment plans (claims)	0.63	0.58 to 0.67
Annual number of patients seen	0.62	0.57 to 0.67

CI, confidence interval.

a DEA requires the selection of the 'orientation' to be adopted for estimating technical efficiency scores. An input-orientated model estimates the amount by which inputs can be proportionally reduced, without loss of outputs. Output orientation is an estimation of the amount by which outputs can be proportionally expanded, without additional inputs (Thanassoulis¹²²). Selection of orientation depends on the precise RQ. In this analysis, outputs were constrained.

Research question 1: are NHS dental practices that employ DCPs significantly more technically efficient than practices that do not employ DCPs after controlling for other practice and patient population characteristics?

Table 12 describes the association with efficiency scores of any use of DCPs for different output measures. Any use of DCPs with NHS patients is found to be associated with statistically significant lower efficiency (14 percentage points lower for UDAs, 11 percentage points lower for treatment plans or patients seen) than practices with no DCPs.

Research question 2: among NHS dental practices that employ DCPs, is the level of technical efficiency significantly associated with the level of DCP use after controlling for other practice and patient population characteristics?

The association between efficiency score and the level of use of DCPs with NHS patients among those practices that employ DCPs is presented in Table 13. There is no significant association between efficiency and the number of DCP weekly sessions worked with NHS patients after controlling for patient and practice characteristics.

TABLE 12 Association with efficiency scores of any use of DCPs with NHS patients for different health-care output measures

Variable	UDAs		Treatment plans (claims)		Patients seen	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Any use of DCPs with NHS patients	-0.14	< 0.00	-0.11	< 0.00	-0.11	< 0.00
Weekly GDP sessions with NHS patients	-0.001	0.76	-0.001	0.54	-0.002	0.21
Weekly support staff sessions	-0.005	< 0.00	-0.006	< 0.00	-0.006	< 0.00
Number of surgeries	-0.04	0.02	-0.05	< 0.00	-0.05	< 0.00
Proportion of adult non-elderly patients	-0.19	0.09	-0.15	0.11	-0.16	0.09
Proportion with non-age-related exemption	-0.13	0.34	-0.38	0.01	-0.29	0.04

TABLE 13 Association with efficiency scores of the level of use of DCPs with NHS patients for different health-care output measures

Variable	UDAs		Treatment plans (claims)		Patients seen	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Weekly DCP sessions with NHS patients	-0.004	0.51	-0.005	0.35	-0.0009	0.85
Weekly GDP sessions with NHS patients	0.001	0.73	0.001	0.79	-0.0008	0.68
Weekly support staff sessions	-0.005	< 0.00	-0.006	< 0.00	-0.006	< 0.00
Number of surgeries	-0.04	0.05	-0.04	0.03	-0.05	< 0.00
Proportion of adult non-elderly patients	-0.21	0.11	-0.16	0.16	-0.17	0.12
Proportion with non-age-related exemption	-0.09	0.58	-0.32	0.08	-0.26	0.15

Research question 3: among NHS dental practices that employ DCPs, is the level of technical efficiency significantly associated with the proportion of clinical time provided by DCPs?

The association between efficiency score and the proportion of clinical time provided by DCPs is presented in *Table 14*. The ratio of DCP weekly sessions worked with NHS patients to GDP sessions worked with NHS patients is not significantly associated with any of the three output measures after controlling for patient and practice characteristics.

Research question 4: among NHS dental practices that employ DCPs, is the association between technical efficiency and DCP use dependent on (a) the proportion of the practice population that is made up of adult non-elderly patients (who on average are more likely to have routine dental care needs) and (b) the proportion of the practice population made up of patients with non-age-related exemption from NHS charges status (who on average are more likely to have non-routine dental care needs)?

Table 15 presents the estimated coefficients on the interaction term between the level of DCP use and the characteristics of the patient population. No significant interactions with patient population characteristics were found indicating that the association between DCP use and efficiency is not related to the characteristics of the practice population being served.

TABLE 14 Associations with efficiency scores of the proportion of clinical time provided for different health-care output measures

Variable	UDAs		Treatment plans (claims)		Patients seen	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
The percentage of DCP to GDP sessions seeing NHS patients	0.0005	0.09	0.0005	0.07	0.001	0.06
Weekly GDP sessions with NHS patients	-0.005	< 0.00	-0.006	< 0.00	-0.006	< 0.00
Weekly support staff sessions	-0.04	< 0.00	-0.04	< 0.00	-0.05	< 0.00
Number of surgeries	-0.17	0.10	-0.12	0.15	-0.17	0.04
Proportion of adult non-elderly patients	-0.14	0.35	-0.40	0.02	-0.30	0.06
Proportion with non-age-related exemption	0.0005	0.09	0.0005	0.07	0.001	0.06

TABLE 15 Mediating associations with efficiency scores between the level of DCP use and patient case-mix variables

Mediating variable (interaction term)	UDAs		Treatment plans (claims)		Patients seen	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Proportion of adult non-elderly patients	0.08	0.10	0.05	0.24	0.06	0.06
Proportion with non-age-related exemption	0.03	0.21	0.05	0.08	0.05	0.05

Each row is a separate regression that includes the following control variables: weekly NHS GDP sessions, weekly administration staff sessions, number of surgeries, proportion of adult non-elderly patients and proportion of patients with non-age-related exemption from NHS charges status.

Research question 5: among NHS dental practices that employ DCPs, is the proportion of claims for routine services significantly associated with the level of DCP use after controlling for other practice and patient population characteristics? Among practices that employ DCPs, is the proportion of claims for routine services significantly associated with the proportion of clinical time provided by DCPs after controlling for other practice and patient population characteristics?

The association between routine services and the level of use of DCPs and the association between routine services and the proportion of clinical time provided by DCPs are presented in *Table 16*. The only significant association found was between the proportion of preventative treatment and the proportion of clinical time provided by DCPs. One more weekly session of DCP activity for NHS patients per GDP session with NHS patients is associated with a 0.36 percentage point higher proportion of preventative treatments delivered after controlling for practice and patient characteristics. Therefore, practices that employed more DCPs as a proportion of total labour inputs delivered a greater proportion of preventative treatments.

Sensitivity checks on the estimation of efficiency scores

Table 17 describes the associations of DCP use and efficiency scores with alternative specifications of inputs into the production function. The findings were robust to (1) the exclusion of nurses and administrative staff time and/or (2) the inclusion of material and laboratory expenditure as a percentage of practice revenue. As with the findings reported above, any use of DCPs was negatively associated with efficiency scores.

TABLE 16 Associations between the numbers of routine services delivered in the NHS and the level of DCP use on NHS patients

Outcome variable (routine services)	Coefficient on the level of DCP use on NHS patients	p-value	Coefficient on the proportion of DCP's clinical time relative to GDP's clinical time working with NHS patients	p-value
Proportion of band 1 treatments	-0.0001	0.99	-0.00003	0.86
Proportion of band 2 treatments	0.001	0.51	-0.00001	0.90
Proportion of preventative treatments	2.46	0.10	0.36	0.00

Each row is a separate regression that includes control variables: weekly NHS GDP sessions, weekly administration staff sessions, number of surgeries, proportion of adult non-elderly patients and proportion of patients with non-age-related exemption from NHS charges status.

TABLE 17 Alternative specifications of inputs into the productive efficiency frontier

DCP utilisation variable	Without nurses and administration as a production input		With material and laboratory expenditure as a percentage of practice revenue as an input		Without nurses and administration as a production input and with material and laboratory expenditure as a percentage of practice revenue as an input	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
<i>In the sample of practices that employ and do not employ DCPs</i>						
Any use of DCPs with NHS patients	-0.12	< 0.00	-0.13	< 0.00	-0.13	< 0.00
Any use of DCPs (on either NHS or private patients)	-0.10	0.03	-0.13	< 0.00	-0.11	0.02
Number of FTE DCPs employed (to work with NHS or private patients)	0.02	0.06	0.001	0.85	0.002	0.84
<i>In the sample of practices that employ DCPs with NHS patients</i>						
Weekly DCP NHS sessions	0.0001	0.97	-0.005	0.37	-0.006	0.30
The percentage of DCP to GDP sessions seeing NHS patients	0.001	0.06	0.0002	0.58	0.0004	0.21

FTE, full-time equivalent.

Sample is GDS practices located in England. Efficiency scores were calculated with an input-orientated approach and with UDAs as the outcome measure. Each row is a separate regression. Each regression includes as control variables the number of NHS GDP sessions, number of support staff sessions, number of surgeries, proportion of the case mix that are adults and proportion of exempt patients. The regression examining the percentage of DCP to GDP sessions seeing NHS patients does not include the number of GDP sessions variable as that is incorporated as part of the percentage of DCP to GDP sessions seeing NHS patients measure.

Stochastic frontier modelling

Table 18 describes the results of the SFM. Only the number of GDP sessions on NHS patients is statistically significant at a 5% level, with a 10 percentage point increase in the number of GDP sessions on NHS patients being associated with a 7.5 percentage point increase in the level of annual UDAs. The SFM efficiency scores had a lower mean than DEA efficiency scores by 0.06, which is expected because measurement error/statistical noise in the dependent variable is excluded from SFM values.³³ Correlations between efficiency scores estimated by SFM and DEA were greater than 0.6, which supports the robustness of estimated DEA efficiency scores and the internal validity of the approach.¹²⁴

Impact of different remuneration systems on the technical efficiency of role substitution models

The number of input questionnaires returned from Northern Ireland ($n = 29$) and Scotland ($n = 20$) was limited (when compared with England) and so it is difficult to make robust comparisons across the different countries. As a result, the DEA analyses for Northern Ireland and Scotland are presented in Appendix 1. NHS practices in Northern Ireland and Scotland operate within a FFS remuneration system and so, unlike England, there are no constraints on the level of clinical activity (outputs) that can be produced by any one dental team. Although direct comparisons are problematic given the smaller sample sizes, the results suggest that English NHS dental practices operate at a lower level of efficiency (64%) than practices in Northern Ireland (80%) and Scotland (94%). The efficiency scores changed little when practice performance was measured by the effectiveness of the practices in reducing health-care inputs to see a fixed number of patients or treatment plans (output orientation).

TABLE 18 Stochastic frontier modelling approach to estimating efficiency scores

Input variables	Output measures					
	Logarithm of annual number of UDAs		Logarithm of annual number of treatment courses		Logarithm of annual number of patients seen	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Logarithm of weekly DCP sessions with NHS patients	-0.007	0.36	-0.002	0.76	-0.005	0.54
Logarithm of weekly GDP sessions with NHS patients	0.75	<0.00	0.67	<0.00	0.67	<0.00
Logarithm of weekly nurse sessions	0.03	0.57	0.014	0.75	0.008	0.85
Logarithm of weekly administration staff sessions	0.04	0.26	0.03	0.33	0.03	0.37
Logarithm of number of surgeries	0.06	0.75	0.13	0.44	0.19	0.28
Observations	121					

The variation in practice efficiency was also greater in FFS remuneration systems, with 95% of scores lying within 12 (Scotland) and 6 (Northern Ireland) percentage points of the mean, compared with 5 percentage points for practices in England. This difference might have been caused artificially by the unitary measure used for health-care output in Scotland and Northern Ireland, compared with England (pounds sterling vs. UDAs). If pounds are a more sensitive metric of NHS income received, this could explain the greater variation in estimated efficiency. However, the higher mean efficiency scores and greater dispersion of efficiency scores in Northern Ireland and Scotland might be explained by the absence of an ACV (no output constraint). This allows those NHS practices with a given set of inputs to maximise their technical efficiency, expanding their production until their inputs are fully utilised. This may be a particularly effective way to improve efficiency in dental health care in a FFS remuneration system when inputs are relatively fixed or difficult to vary in the short term (e.g. number of surgeries, number of staff). Of note, the number of surgeries was not statistically associated at a 5% level with efficiency scores in Northern Ireland and Scotland, whereas in England it had a negative association (at a 5% level). This suggests that economies of scale are not present in NHS primary dental care in Northern Ireland and Scotland, whereas diseconomies of scale are present in England.

There was no statistically significant association between the use of DCPs and efficiency scores in Northern Ireland and Scotland, whereas in England the association was negative (see *Table 28, Appendix 1*). This might be because practices in Northern Ireland and Scotland are using the full scope of practice of their DCPs. However, the small sample sizes in Northern Ireland and Scotland and the limited use of DCPs (0.2 and 0.3 full-time equivalent DCPs, respectively), compared with 1.1 DCPs per practice in England (see *Table 24, Appendix 1*), would suggest that this is unlikely. The small sample size may also explain why efficiency scores in Scottish practices are not significantly associated with any practice environment characteristics or staffing variables regardless of the model specification of the role substitution measure used (see *Tables 28–38, in Appendix 1*).

Discussion

Main findings

The number of studies that have examined technical efficiency in primary dental care is limited.^{124,128,129} Gutacker *et al.*¹²⁸ found that there were no diseconomies of scale related to capital or labour inputs into the production of efficiency in Australia. A consistent finding from Gutacker *et al.*,¹²⁸ Gray¹²⁹ and Scheffler and Kushman¹²⁴ was that GDPs' own labour input was the most important determinant of their output.

The results from this study show that many NHS dental practices in England were not performing as efficiently as they might (relative to the most efficient practice in the sample). This finding may be influenced by the cost-containment mechanism within the 2006 NHS dental contract in England.⁴⁵ Output constraints within this contract place a ceiling on the number of UDAs that can be generated within any one financial year. Given that the number of surgeries and GDPs working in NHS dental practices are relatively inflexible inputs, the inability of PPs to adjust the team size and composition as the contracted deadline for the target output is approached might explain the inefficiency in production. The analyses for the smaller sample from Northern Ireland who were paid on a FFS basis (see *Appendix 1*), and hence faced no output constraints, showed that practice efficiency was higher than for England.

This is the first study to examine the impact of role substitution in primary dental care. Practices with a lower use of DCPs were found to operate at higher levels of technical efficiency, after controlling for staff, practice environment and patient variables. This suggests, that where practices employ DCPs, they do not appear to contribute to higher volumes of NHS dental activity. This finding did not vary with any of the sensitivity tests undertaken. The correlation between the DEA- and the SFM-estimated levels of efficiency was greater than 0.6, which supports the robustness of the estimated DEA efficiency scores and the internal validity of the methodological approach.

The cross-sectional basis of the analysis cannot determine the precise mechanisms underlying the findings or infer causality. Caution should be exercised in the interpretation of these results as the lower efficiency scores among NHS dental practices that utilise DCPs could be caused by the way the DCPs were deployed and structural constraints of the remuneration system. In the current NHS dental contract in England, there is a disincentive to refer work in practices that employ associate GDPs, because the GDP loses income for activities referred on to other providers. This may lead to DCPs not being used to their full scope of practice and being used in ways that do not substitute for more expensive dentist time. As a result, they may represent a relatively costly input for the practice. These factors are explored in *Chapter 5*.

The findings could also be caused by the limited scope of the efficiency measure. This study has examined the efficiency of NHS dental practices, not individual DCPs (as DCPs do not directly contract with the NHS). It could be that DCPs are being used efficiently and in accordance with their full scope of practice, but their use is associated with a reduction in efficiency of GDP time. For example, GDPs may not use the time freed up by DCPs in ways that accrue UDAs for the practice (as noted above, this may be the result of the output targets inherent in the NHS contract). They might instead undertake more private dentistry, such that efficiency gains in the NHS are lost to the private sector. Alternatively, they may increase the length of appointment times, take on new managerial or administrative duties or reduce the effort and intensity of their own work within the NHS.

Ideally, efficiency would incorporate considerations of the quality of products and services in terms of impact on patient outcomes (e.g. oral health). Lower efficiency may be a reflection of higher-quality care that produces better patient outcomes by, for example, taking more time with patients. Further exploration of this line of enquiry would require data on quality of care.

Finally, lower efficiency scores might be explained by other variables that were not measured in the analysis, such as lower skills and experience of dental staff.

Study limitations

This study was based on a sample of 121 general dental practices located in the north of England (with corresponding analyses on smaller samples of dental practices in Scotland and Northern Ireland; see *Appendix 1*). The sample was selected from practices that replied to a postal questionnaire. Although the economic model included control variables for characteristics of the practices and their patient populations, this is not adequate to control for practice site self-selection to the study. Therefore, it is not possible to draw conclusions on the associations between DCP utilisation and technical efficiency in other service settings, especially as the DEA measures efficiency relative to the best practice observed within a study sample.

A limitation of the economic model is that inputs were considered only in terms of hours of work. Low response rates to the initial pilot survey prevented the research team from including many non-labour operating expenditures (establishment costs, marketing expenses, administration and general expenses), rent and interest payments and expenditure on physical capital. The model does not include expenditures on materials, consumables and laboratory supplies among the inputs in the estimation of the production frontier, therefore it is not possible to estimate cost efficiency. However, consumable materials and laboratory costs were included as a proportion of total practice revenue as an input variable to estimate production functions of health-care outputs. We found that there was no change in previously observed associations with efficiency scores. Another limitation is that the model assumes that practices have staff with the same levels of qualifications and experience, etc. However, the quality of labour input may vary depending on individual skills, professional experience within each type of staff. Finally, we observe only the quantity of DCP use, not how DCP time is used in the practice (i.e. according to their full scope of practice or not).

A shortcoming of the DEA approach used is that it assumes that there is no measurement error and, therefore, practices with 'noise' may end up being identified as technically efficient. For example, if one practice understated inputs or overstated outputs, it might be an outlier and hence significantly reduce the estimated (relative) efficiency of other practices. Each unit of data was screened for outliers. Missing data or outliers in data were addressed through a manual check of original records. When a participant had left a question blank, or answered with an uninterpretable, illegible or unlikely (i.e. an 'outlier') answer on the original record of the questionnaire, the practice was contacted to amend or clarify their answer. However, all judgements of what might be measurement error or an outlying observation in the data are necessarily arbitrary and imprecise. For example, a unit value might be within a normal range on a measurement instrument and not be flagged with having measurement error when its true value is very different from the one recorded. We had no opportunity to check the dental practices' output data against the actual claim forms that were submitted.

Finally, quantitative analyses cannot determine what factors lead practices to hire DCPs and delegate activities to them. The potential for practices to meet their NHS remuneration target using fewer resources by delegating more work to DCPs does not appear to have occurred. Reasons for this are explored in the following chapter.

Concluding remarks

The technical efficiency of practices was found to be associated with many factors, including the practice's staffing capacity and ownership structure. We found no evidence of positive efficiency gains from the use of DCPs. However, this might reflect limitations in the way DCPs are currently being used in the NHS, as well as constraints imposed by the use of historically based UDA targets as the basis for contracted activity and a lack of incentive for associate GPs to utilise DCP skills.

Chapter 5 Attitudes of patients and the NHS dental team to role substitution

Introduction

Role substitution in dentistry has traditionally lagged behind its use in medicine.⁶ This may reflect struggles between NHS GPs and DCPs regarding role boundaries and jurisdictions.⁷⁰ McDonald *et al.*¹⁰² found that the acceptability of role substitution in the medical workforce relies on a number of factors, including distribution of rewards in relation to effort across the team, clarity around roles and responsibilities and personal relationships with colleagues, which raise issues of trust and respect. As highlighted in previous chapters in this report, many DCPs are not being used to their full scope of practice within NHS dentistry. It may also reflect the concerns of NHS dental teams about patients' attitudes to role substitution, although the evidence in the literature is mixed.^{93–95} Taken together, there is a need to explore the views of patients and the different members of the dental team on role substitution to examine the formal and informal aspects of organisational life.

The objectives for this part of the research programme were:

- to undertake semistructured interviews with GPs, DCPs and patients to explore barriers/enablers to the greater use of role substitution
- to undertake semistructured interviews with key policy-makers to determine their perspective on the greater use of role substitution in NHS dentistry.

Methods

Qualitative methods were used to explore these issues, as we needed to obtain an understanding of relationships and activities within practices and the ways in which these relate to skill mix patterns.

Recruitment

The initial stage of recruitment targeted practices that had completed the screening questionnaire (see *Chapter 3*). In addition, NHS GPs and DCPs were approached via professional networks (e.g. the BSDHT). The second stage recruited participants from England, Scotland and Northern Ireland that had taken part in the first workstream (reported in *Chapter 4*). These were augmented by invitations to DCPs sent via social networks. The third stage used the efficiency data analysed in *Chapter 4* to target those practices that were considered to be the most and least efficient.

Interview structure and context

The interview questions were designed to explore the potential barriers to, and facilitators of, role substitution in practice and were developed by the research team iteratively. Separate interview schedules were designed a priori for each of the groups (PPs, DCPs, patients). Input was sought from the patient representative with regard to the patient interview schedule.

All face-to-face interviews were held in private rooms within the dental practice, either a staff room or office, or an empty surgery. The interviews varied in length: those with the PPs ranged from 20 to 50 minutes and those with the DCPs ranged from 20 to 40 minutes. Interviews with patients were generally much shorter, lasting around 10–15 minutes each. This short interview time seemed to be caused by the generally low level of awareness patients had regarding the roles and duties of different members of the dental team.

Data analysis

All data were collected between October 2013 and May 2015. Data collection and analysis were run concurrently. We collected and analysed data using a framework informed by the literature and sought to develop this framework as the findings emerged. This framework was designed to develop an understanding of the practice of role substitution, which was grounded in local and national contexts; to go beyond the particulars of local cases to generate and test theory in order to draw lessons for the NHS more generally; and to inform the international literature on role substitution in dentistry.

All interviews were audiorecorded and transcribed verbatim. Thematic analysis was carried out by group, that is, PPs, DCPs and patients were coded separately. A thematic analysis was undertaken.¹³⁰ The transcripts were read by the researchers who undertook the interviews and two of the research team separately. Interpretations were then pooled and edited in the presence of all three researchers to produce the final version of the coding frame, with disputes being resolved using a majority voting system. Data analysis was undertaken concomitantly with the interviews.

Results

Overview of sample

The practices in the north-west of England that were visited by the research team were heterogeneous. Consistent with the findings from *Chapters 3 and 4*, the utilisation of DCPs across the practices was highly varied. Some practices used DCPs to their full scope of practice and were enabling DCPs to undergo further training, whereas, in other practices, DCPs were more limited in the duties they carried out and were used primarily to complete routine scale and polishing.

The patients interviewed ranged in age from ≥ 30 to 75 years and were a broadly equal mix in terms of gender. All patients were attending the NHS dental practice for routine appointments either with a GDP or a DCP and were interviewed following their appointment in a private room within the dental practice. Further details of the interviews conducted are provided below (*Table 19*).

TABLE 19 Numbers of participants by type, country, mode of interview and recruitment

Participant type	PP	DCP	Patient
Total (<i>n</i>)	16	17	18
Gender (female : male)	5 : 11	15 : 2	–
Site			
England	12	16	18
Scotland	4	1	0
Mode			
Face to face	7	6	18
Telephone	9	11	0
Stage			
From questionnaire	7 ^a	6	18
Via professional/social networks	4	11	0
From DEA	7 ^a	0	0

^a Two of the PPs were recruited as participants from the questionnaire and also appeared in the 10 top and bottom efficiency groups.

Quotations attributed to PPs or DCPs are referenced as PP or DCP, respectively, and followed by the interviewee number. When PP_T or DCP_T is referenced, this indicates that the interview was a telephone interview. When PP_S or DCP_S is referenced, this indicates the interview was with a PP or DCP based in Scotland. Patient quotations are referenced by the practice at which they were interviewed as well as interviewee number.

Results: practice principals

Perceptions of patient awareness and acceptability of dental care professionals

A number of PPs, mainly those not utilising DCPs to their full scope of practice, reported that they perceived patients as being less willing to see a DCP than a GDP. Some of the PPs referred to this as a reason for not utilising DCPs more in practice.

We did have a therapist who worked with us, but I don't think we got full use out of the therapist, 'cause I don't think that our patients wanted to see a therapist for having fillings done.

PP3

The reason given by this particular PP for patients not wanting to receive dental treatment from DCPs was that his practice was a fully private one; as a result of this, he explained that he did not think his patients would want to pay the same amount for treatment carried out by a less-qualified member of the dental team. Other PPs who were using DCPs in practice tended to refer to being concerned about patients' reactions to being referred to a DCP initially.

They are not so happy about a therapist doing a filling, because they think, I'm paying all this money, why doesn't the dentist do it?

PP5

When the patients have seen me for years and I go, do you mind if [the DCP] does your filling? Oh, I'm paying £100 for that filling. I want you to do it . . . I know you'll do a good job.

PP6

The last quotation from PP6, where he asks the patients 'do you mind?', shows that treatment by a DCP may be represented as inferior by some GDPs.

However, for some PPs, this perception appeared to change over time. PPs reflected on patients' initial hesitation and felt they had been unnecessarily concerned. This change of mind seemed to come about following a positive patient report about seeing a DCP.

Once they'd seen them and realised that they had this extra time, they had more chance to ask questions, whatever else, they felt more comfortable and then people warm to the idea.

PP1

Practice principals who used DCPs in their practices for hygiene or dental work focused on the benefits to the patient. The extra time that DCPs are able to spend with patients was frequently cited as a positive. This extra time was seen as enabling DCPs to provide a more patient-centred, caring, approach than could reasonably be provided by a GDP. PPs reported this to be a particular advantage for anxious patients and for children, noting that seeing a DCP was less intimidating than seeing a GDP.

It's because it's a soft entry . . . I'm going to see the hygienist, feels much like a more acceptable approach to them, because it's friendly, it's preventative, it's not fixing problems, which, even though it may be a check-up, that's the image I think a lot of people have in their minds.

PP7

Some PPs felt they had to pitch the referral in a positive way and explain why certain treatments would be conducted by a DCP. One way to convince the patient and make the referral acceptable was to describe the benefit to patients, in particular the extra time allocated to patients when seeing DCPs.

The patients say they feel very rushed when they see me, I say that's because you're one of 60. If you want to have proper advice and toothbrush instruction, diet, oral health, a therapist is much better at doing that than I am.

PP5

This contrasts with the quote earlier in which the PP describes asking patients 'do you mind if [the DCP] does your filling?', which might imply that the DCP is inferior. Linked to this, some of the PPs interviewed talked of the significance of the way in which they explained the referral to patients. Positive pitches tended to highlight benefits to the patient such as more timely treatment or more specialist treatment. This may be a potential facilitating factor for patient acceptability of seeing DCPs instead of GDPs.

We're going to book them with the hygienist, we'll let them know that, yes, they can do XYZ, they're really good and we're passing you onto her. And now they have got used to that system.

PP7

Comparison to medicine

When talking about the roles and duties of DCPs in practice, all groups of participants (PPs, DCPs and patients) interviewed tended to liken the model of working to a general medical practice where doctors work alongside nurses and nurse practitioners. This seemed to act as an anchor for understanding how different tasks might be divided among a multiskilled team. This comparison to something that was already working in an 'acceptable way' seemed to add weight to the idea that more role substitution within the dental team could work well.

There'll be less dentists and more therapists and I'm hoping it would become a model like the doctors' where they start off they see the nurse, the nurse does most of the stuff then the therapist does the next step and the dentist does the step after then the endodontist.

PP2

Attitudes towards the scope of practice of dental care professionals

Practice principals seemed to focus on periodontal work as something that DCPs did and dental work as something that GDPs did, as a result of the focus placed on periodontal work during DCPs' training and their skill level in this area. This thinking appeared to impact on referral patterns as well as on the acceptability of DCPs working within their practices.

I've had a hygienist from the word go . . . I think it's very, very important . . . it's because I want them to do perio. I think perio is very important and I can use my time better. I do nervous patients, there's loads . . .

PP_T2

Other PPs admitted that the reason they were happy to refer patients for hygiene work is because scale and polishing is not an appealing or enjoyable task.

They do a good job and they take a dirty job off us that we don't normally like doing.

PP_S3

The scope of practice for DCPs has recently been expanded to include some diagnosis and treatment planning. This seemed to be something that PPs felt unconvinced about and they tended to articulate this as concerns about patient safety. For example, one PP described DCPs as not being able to diagnose, even according to their scope of practice, let alone beyond it.

They're not able to diagnose everything that they're supposed to diagnose.

PP3

If DCPs miss problems that a GDP would have picked up and consequently do not make the appropriate referral, this could lead to worse health outcomes for the patient, although recent evidence confirms that DCPs are able to identify caries, periodontal disease and potentially malignant lesions at a comparable standard to GDPs.^{73,131}

Even PPs who used DCPs extensively within their practice showed some reservation about DCPs performing check-ups, reiterating that, while they could be trained to carry out dental work, diagnosis was something that only a GDP was truly qualified to perform.

The skill is diagnosis, but the actual treatment is the easy part. As long as you're good with the patient and you are competent in skills, you can teach anyone to do dentistry.

PP5

Some PPs argue against role substitution, as they prefer to provide all treatment for patients themselves. They like to be in control of every aspect of care, experience variety in their daily routine and use the full range of skills at their disposal. They also report job satisfaction from seeing diseased patients becoming healthy, which would be lost if they were not involved in the entire care pathway of patients. There is also the opinion that working full time on complex procedures would be tiring; therefore, some PPs prefer to blend complex and straightforward treatments to lighten the workload.

Doing crown and bridge all day or something it just . . . you know, your eyes would get tired. Everything would just . . . yeah, I mean your brain would hurt.

PP_S3

The PPs' experience and approach to dentistry are reported as affecting the organisation of the practice and impacting on the rest of the workforce. PPs can be split into two groups: (1) those who like to perform a full range of treatment and actively seek more routine tasks as recovery time; and (2) those who would rather specialise in more complex treatments and refer routine tasks to others. The latter are more likely to see the benefits in adopting role substitution as it allows them to spend less time completing the routine, more straightforward treatments.

It allowed me to maybe concentrate on some of the more complex stuff, giving them the real bread and butter.

PP_S4

The above PPs run practices that employ therapists and are utilising role substitution wherever possible, whereas the prior set of quotes originates from PPs who either own single-surgery practices or do not employ DCPs for anything more than hygiene work.

In a subgroup of practices, DCPs have been successfully performing hygiene work, but, when PPs attempt to refer patients to DCPs for more complex treatments, such as restorations, they receive a negative response from patients. This seems to be particularly common among private patients, who were reported as expecting restorations to be carried out by the GDP rather than a DCP.

We did have a therapist who worked with us, but I don't think we got full use out of the therapist, because I don't think that our patients wanted to see a therapist for having fillings done . . . It didn't seem to fit in with the, sort of, practice that we are, if you see what I mean . . . Well, they expect to see the dentist, you know. If they're paying private fees.

PP3

Some PPs see role substitution as a threat to their profession. Reasons cited were that DCPs could complete some aspects of the work of GDPs with less training. Another reason given was a concern about oversupply of GDPs and DCPs, particularly in areas with a limited number of patients and a large number of dental practices.

I think the idea was they [DCPs] would be able to do more when there's a shortage of dentists which is great but now there's not a shortage of dentists. So I think it's a worry there's not enough work for a lot of the therapists and the hygienists with all the new dentists coming out . . . Because there are enough dentists about that can treat the population.

PP_S1

Practice principals who embrace role substitution have little concern over reduced workloads; instead, they see an opportunity for their practice to progress to a system which allows more flexibility in managing patient care.

Our patients who see the hygienist will see them on a regular basis. Very often they'll be in a couple of times in between visits with myself and that's been treatment planned by the hygienist himself. He will always be in communication with me if there are any issues or any concerns he has but we have got no issues. Even with patients phoning up, registered patients phoning up and saying I'd like to come in and see the hygienist. Fine.

PP_S4

Financial and payment issues

Financial issues were of key concern to PPs. PPs using DCPs stated that their practices were not necessarily more profitable as a result, which is consistent with the finding from workstream 1.

You look at the profitability of a hygienist compared with a dentist and it made more sense to get another dentist.

PP1

I don't think it's improved the profitability, I'll be honest with you, because there's a lot of down-time . . . and we're still paying the therapist.

PP2

Instead of financial motivations for utilising DCPs in practice, PPs focused on benefits to the practice (e.g. smooth running), to themselves (e.g. more time) and to the patients (e.g. longer appointments with more detailed advice about self-care) as reasons for employing DCPs.

I think part of it is that we'd get a much better job with the patients, it's not just all about the money, we're happy enough that we've got a decent enough UDA value, how many pounds per UDA we get paid, that we don't have to just chase the money and it's about doing good jobs for patients.

PP7

However, it seems that profitability is a complex issue and PPs reported that the use of DCPs can impact on profitability in other ways if used creatively. Some PPs were starting to look at new models of care that expand the role of the DCP towards the top of their scope of practice. In these cases the DCP takes more of a leading role by acting as a triage service prior to a GDP agreeing a treatment plan.

The therapist just has a chat and takes a basic history and then I go in the room, do the charting, tell the therapist what needs doing and then she carries on.

PP2

The current remuneration system was also seen as a barrier to further utilisation by some PPs, who identified the difficulties in claiming UDAs for treatment completed by DCPs.

The entire remuneration system is based on the dentist with the performer number, taking for the UDAs that the treatment incurs in total, and then distributing.

PP7

Some PPs cite the physical space available to the practice to be a limiting factor to utilising more DCPs.

Lack of space. At the end of the day, if I have to do the check-up where do I have the hygienist therapists working? I've got an FD [foundation dentist] 4 days a week. I've got an associate in two days a week and I take a day off. I've got the rooms used to their full extent.

PP4

Referral patterns

The current remuneration system also had an impact on some of the day-to-day issues experienced by DCPs in practice. In the majority of practices, the workload of DCPs depends on what is referred to them by PPs and associate GDPs. Patterns of referrals tend to vary from practice to practice. For example, in some practices, referrals to DCPs are made only by PPs and not by associate GDPs. In other practices, associate GDPs are incentivised to refer to DCPs. One PP explained the thinking behind an associate GDP choosing not to refer work to DCPs.

I can . . . get three UDAs. That's 60 quid. I can do that now while the patient is here, or I'll pass it over to the therapist and I've got to pay for it to them. Hang on! I'm not getting anything.

PP6

Another PP explained the reasons for the difference in referral patterns between associate GDPs and PPs.

If the associates see a patient who wants one filling doing, he'll do that one filling and I'll pay the associate. If they need half a dozen I'll say, refer it to my therapist, but then I get paid for the UDA, because I'm paying the therapist.

PP5

Practice principals in Scotland reported that they are forced to treat periodontal disease privately because the remuneration system does not suitably reimburse the practice for the time taken during a full periodontal treatment. As a result, patients in Scotland will see DCPs only as private patients and those who cannot afford to pay for private treatment may not see a DCP at all.

A way to overcome this would be to create a system in which the DHT could claim for the work that is required for patients.

Some of the practices that used skill mix appeared to have positive workplace cultures that valued the skill levels of all members of staff and supported continued learning and development. These seemed to be the practices that reported role substitution as working well.

We all help each other out. To be honest, we're a training practice so we also have a foundation dentist. That I think helps galvanise people into helping each other. And our associate was one of our ex foundation dentists as well, so they are all used to working together and helping each other.

PP1

Benefits to the practice and general dental practitioners

As outlined above, numerous PPs noted the potential for skill mix to free the GDP's time to concentrate on more complex treatments. This was seen as a benefit that meant patients were able to receive their more complex treatment sooner than they would if the GDP was still carrying out a lot of routine work.

If I had somebody in and they were needing some fillings done if the therapist was doing these fillings for me I would be able to have somebody else in my chair at the same time so it was almost as if I was treating two patients at the same time.

PP_S4

In contrast to this, some PPs were concerned regarding the efficiency of DCPs. Currently, DCPs are often allowed appointment times of around 30 minutes and, therefore, work to a different pace from that of the GDP. So when expanding the roles of DCPs, there may be concerns that DCPs take longer to carry out dental work and that they are not used to working efficiently.

I can do maybe three or four times more patients in an hour than a therapist could do.

PP5

Results: dental care practitioners

Patient awareness and acceptability

Dental care practitioners report that there still exists uncertainty from patients regarding what a DCP is actually allowed to do.

Patients are still a bit unsure of what we can and can't do.

DCP2

Dental care professionals were of the view that patients did not really want or need to know about their scope of practice because the majority of patients do not ask questions about the competence of the person providing treatment. This is because, in part at least, to patients trusting the GDP who made the referral or a belief that the system will ensure that everyone has the appropriate training and experience.

They're not interested in our regulations, are they? They just want to know that they're looked after.

DCP_T3

There is the perception from DCPs that patients prefer seeing them for some of the routine treatments as this is often the impression they get from patients.

I feel a lot more comfortable [with you rather than the dentist], could you do my filling?

DCP_T5

Approachability is one of the reasons why patients are happy to see DCPs and the reason why some patients prefer to see them rather than a GDP. There is also the point that DCPs generally have the

freedom to spend more time with patients and can therefore be more personable. Furthermore, the DCP has historically not performed surgical treatment, so is perceived by the patient to be gentler than a GDP.

Some of the patients prefer to see the hygienist because they like us more because we're nicer . . . think we're softer . . . They think if they see a therapist, oh, it can't be that bad then if a therapist is doing it, so might put my mind at rest a bit.

DCP7

In contrast, there are some DCPs who have experienced the opposite reaction, with patients expecting or demanding to have certain treatments completed by the GDP.

And I suddenly go, I'll give you a filling, you know, they'd be like, hang on a minute are you allowed to do it?

DCP_T5

Dental care professionals emphasised that the way that the PP or GDP pitches the referral to the patient has an impact on patient acceptability. Some GDPs spend time explaining the DCPs' training, qualifications and experience. In contrast, others are described by DCPs as just informing the patient that a colleague will complete the treatment, with very little further explanation. Patients are likely to respond differently to different approaches and it may be that there is not one best way to approach this. According to DCPs, one of the most positive approaches is to explain that DCPs are better at some things.

The therapist is doing restorative care day in day out, this is what she does all the time; and, you know, if I had a choice to go . . . my dentist says if I had a choice the therapist would do my teeth.

DCP1

Some GDPs use a more negative approach and provide less detail to the patient. This can lead to patients perceiving that the GDPs believe the care or treatment is inferior.

Generally the dentists . . . I think they tend to say, I'm just referring you to the therapist because it's just a simple filling and I can do the more difficult stuff.

DCP_T10

Some practices believe that patients and employees of the practice need to be re-educated in terms of their understanding of who completes which part of the patient care pathway. A way to address this is by adopting a proactive and systematic approach, explaining the roles and responsibilities to all stakeholders.

I think when they join the practice it should be explained how we work. You know, you'll see the dentist and then you'll see the therapist for this treatment . . .

DCP_T4

Referral patterns

The issue of which members of the practice actually make referrals to DCPs appeared to be a barrier to, and facilitator of, role substitution. Some practices try to keep the system uncomplicated by allowing only the PPs to make referrals. PPs often have more of a team-working perspective, with the expectation that the practice team rather than individuals can achieve the UDAs target. As their personal targets and salary are not affected, they are happier to make referrals.

At this practice we've got two owners, so they both refer . . . they both know that all the contracts, everything will be coming back to them; so they refer to me and the money is going into their coffers all the time.

DCP1

The referral pattern becomes more of an issue in practices where associate GDPs are allowed or encouraged to refer. It is reported that many seem threatened or do not want to refer work. This can create a culture in which associate GDPs compete for UDAs, striving to achieve personal UDAs targets, but do not have enough patients to fill their own diary. The result is that they do not refer treatments to DCPs because it will affect their own personal income.

We've got two associates . . . they're doing the work and their books are a little bit gappy so, again, there's absolutely no chance and I don't have a nurse.

DCP_T6

The practices that have a team-working approach see the UDAs target as a collective effort and understand that by referring on patients their targets can be achieved more efficiently.

They're happy to refer on to me so that we can get some UDAs sorted out to be honest, because if they're doing the fillings for the three UDAs and I'm doing it then they can be doing a crown prep work and denture work.

DCP_T2

According to some DCPs, PPs see DCPs as part of a pathway to allow them to focus on more private work and maximise the practice's profit that way.

It's just a case of freeing up their time so that they can do more private work or more advanced treatment themselves.

DCP_T5

In addition to the discussion on who makes referrals, the interviewees raised points around the type of patients that were referred. Some saw only children.

I [am] predominantly looking after the children especially because for some of them they've not had any experience before of any hands on clinical dentistry.

DCP6

We have some children, but I have more adult patients there in general.

DCP_T3

Some GDPs see children as difficult and time-consuming, and they will happily refer children to the DCP so that they can use their time more effectively elsewhere. Other skills of DCPs were reported as being attractive to children as well, namely the 'softer' approach and opportunity to have longer appointments, which we described in the PP section.

Not in physical skills perhaps, but in the way the communication works with children . . . and I've got smaller hands, and being quite a gentle person, I think they see that, and I think their mums really like the preventative element and the way that I used to do that. So I think it comes from the patients as much as anything.

DCP1

This theme of GDPs referring to the DCP what they perceive to be difficult cases does not apply only to children. Difficulty does not necessarily refer to technical challenge, but instead is concerned with other aspects of care, such as managing patients with anxiety and time-consuming patients more generally. For example, this could be patients with learning difficulties, gag reflexes or other issues that mean a longer appointment will be required. Referral to DCPs can be seen in both a positive and negative way by DCPs. Some see it as flattering that a referring GDP values the DCP's skill to be able to provide a caring, patient-centred approach to patients that their pressing diary commitments and UDA targets do not allow.

Other DCPs seem to see this as GDPs being focused on profit maximisation and as soon as difficult patients come along they refer these patients. This is seen with complex cases; for example, a GDP receives the same UDA value for one or five restorations, yet the time required to complete five restorations is considerably higher, so GDPs will refer these patients on. Although it might be expected that the more highly skilled clinician would complete the more complex cases, the UDA system creates incentives for GDPs to pass these patients on to DCPs.

They are often difficult access, anxious patients, one reason or another complicated in handling the patient ones that won't be a quick earner . . . a complex patient, not the complex dentistry.

DCP1

Lack of control over referrals causes increasing frustration among DCPs. Some are left with large gaps in their diaries, which leads to difficult discussions with PPs. This means that DCPs may find it difficult to demonstrate that they are efficient and covering their costs, because they lack the opportunity to do this in the absence of referrals by GDPs.

I'm sitting around, like, doing absolutely nothing and I thought I've got a review next week which, it'll be brought up that, oh you've got gaps in your book, and it'll be . . . I've been told that I have to go ask the dentist to refer more to me.

DCP_T8

Some DCPs have tried to address this by appealing to GDPs to refer more patients to them, but are met with a lack of interest and obstructive responses.

I go through phases of trying to argue the point and saying, look don't you want me to do this? But they just sort of shrug and fob me off. And, I've said, you know, I can mop up all your band 2 stuff, you can do all your fancy expensive stuff, you can push your private, but they're just not interested.

DCP_T6

Other DCPs see blockages elsewhere in the referral pathway and believe that reception staff could do more to promote DHs and DTs.

We have one receptionist, and I think she's a problem in that she doesn't promote me at the desk and encourage people to book in with me. And then I think the dentist forgets to book them in with me.

DCP_T8

Dental care professional skill level/experience

As with PPs, there are a variety of different sets of beliefs that frame the issue of skill level within the DCP workforce. In part, these may reflect different personalities and experience levels of DCPs, but views are also influenced by their experiences and relationships with their PP.

I do a lot where [the dentists] don't come in, only if it's particularly difficult would I get somebody in. I'd say I'm very confident.

DCP6

This confidence is grounded in the belief that they are the best at what they do and also links to DCPs having greater job satisfaction when they feel they are using their training to its full potential.

The more we can do is always better because it keeps it more interesting, doesn't it?

DCP7

As shown above, some DCPs will challenge a bad situation, whereas others are more willing to accept a poor situation because of a lack of self-confidence or fear of the situation elsewhere being more challenging.

If I went somewhere else, what happens if, because I've de-skilled . . . at the moment I have quite a long . . . I'll have 40 minutes a filling because my book's empty, and so there's no rush for me to do it because my book's quiet and I think I could go somewhere else where the demands are much higher and then it could be a practice that's worse than what I'm in.

DCP_T8

Others are becoming so dissatisfied with both their underutilisation and movement towards more private, cosmetic, work that they are exploring the possibility of leaving general dental practice.

I don't feel I am being utilised really to my capabilities; I don't use any of my extended duties that I'm qualified with . . . I've been trying to look in to either getting in to the hospital environment or trying to change my role slightly because I don't really feel that private practice, you know, is for me.

DCP_T9

Some DCPs show a lack of confidence as a result of what they feel is a lack of experience or opportunity. This often results in DCPs feeling like they are deskilling as a result of not using the skills they were trained in and a lack of trust from their PP. This leads to a lack of job satisfaction and lowering of morale.

They just see me really as a scaling machine, and so I have become deskilled and demotivated because of that.

DCP_T8

Some of those who lack confidence are cautious about taking on more responsibility and see the link between experience and confidence leading to an increase in skill level. A key concept is that of a vocational training scheme, which all GDPs receive (as a foundation year), but this is optional for DCPs and geographically dependent. In addition, DCPs suggest that if PPs were exposed to DCPs during a vocational training year then it may raise awareness of DCPs' skill set.

I think I could have done with the VT [vocational training] just to have someone over my shoulder just saying, yeah, that's fine.

DCP_T1

The erosion of DCPs' confidence and therefore skill level often occurs at the dental practice as a direct response to the behaviour of colleagues, the environment and the culture of the practice.

[I] Came back from there all motivated, like, you know, I want to do some more, my skills are really up, I'm happy with my local . . . and he just laughed at me. He just stood there and he laughed.

DCP_T6

Although external factors can be to blame for a lack of confidence, some study participants believe this is related to the individual's characteristics and that some people prefer to follow the lead of others and do not really want the DCP role to develop beyond their comfort zone.

I'm quite an anxious person anyway, so I think for me I like it in black and white that, yeah, you can do a filling, yeah, you can do this.

DCP2

A similar number of interviewees were highly motivated to see change occur in their practices and determined to be allowed to work to their full scope of practice.

As a therapist I do have to prove myself and constantly remind people that I can do those things and that I'm capable of it.

DCP_T3

Support from nurses

There is concern among the profession that many DCPs are not being fully utilised because they are not given the support of dental nurses in the surgery. Without a dental nurse, many aspects of the role of a DCP are difficult to complete. However, the response from the majority of interviewees was that they have support from nurses.

Of course, always with a nurse, yes. And my nurse would never leave me alone in the surgery.

DCP5

Unfortunately, some DCPs are expected to work without nurses. This often creates major dissatisfaction, and some DCPs raise concerns about the legality of this position. They live under threat of losing their job if they insist on having the support of a dental nurse or by challenging a PP on the issue.

If I give you a nurse just for your hygiene, you know, there might have to be a cut in your pay . . . we don't employ therapists because we don't give you nurses.

DCP_T6

Workplace culture

Dental care professionals who feel valued, have high job satisfaction and report being well utilised often refer to a pleasant supportive environment within the dental practice. This is often driven by the PP but reinforced by all members of the multidisciplinary team within the practice. This facilitates the learning process for all practitioners and provides the opportunity for all to focus on their greatest assets.

If there's anything I'm unsure about I can ask anybody here and there's literally nobody who you think you can't speak to, which is good because that's what you need, especially when you're new. That's how you learn, isn't it, from people with more experience than you, it's what you've got to feed off, isn't it?

DCP2

This sort of culture and integrated workforce often results in people feeling valued because all members of the team understand what everyone does and views all roles as valuable and productive.

A practice like this where you feel like you're nurtured and you're helped, but you're doing it on your own as well, it's just a very good balance between the team here.

DCP2

At the same time, many DCPs report working in a culture of fear, with no opportunity to seek help and support and employees are undervalued. One of the main factors is a lack of understanding on the part of GPs about what the DCP can do.

A genuine lack of knowledge and understanding of what we actually trained to do or how we're trained . . . traditional dentists who are thinking how on earth could they possibly diagnose and we're bound to miss things.

DCP_T3

Dental care professionals report that often the PP does not value the knowledge and skills of the DCP, in terms of what they refer to them and the amount that practices are willing to pay DCPs.

The practice that I work for don't value me as a therapist, they're just valuing me as a, I guess, saving money for themselves.

DCP_T4

This can lead to a culture where the DCP is driven out or, at the very least, sidelined.

Organisation of role substitution

The type of workforce model in place in the dental practices was explored in all DCP interviews. Two main approaches were identified; one is a traditional model in which DCPs are being used to complete hygiene work only (i.e. scale and polishing, oral health advice and root planning). The other group had embraced more of the ethos of role substitution where PPs and associate GPs refer patients for restorations, often referred to as therapy work.

We generally get quite a good mix of treatments; I know some practices I think they're used a bit more as hygienists, but here we have a really good mix of perio and restorative as well, a good mix of adult patients and kid patients.

DCP2

There was very limited use of the direct access approach, although some saw the potential in the system and had explored it tentatively within their practices.

I've seen four or five DA patients a week. I then refer them on to the dentist.

DCP_T1

Many DCPs continue to be limited to a reduced scope of practice in which they concentrate on oral hygiene advice and maintenance.

I trimmed a filling on Thursday and smoothed over an amalgam and put a tiny bit of composite in, and that's the first time I've done that in 2 months.

DCP_T1

Innovative practices

There is an appetite in some practices, usually those described as having a good workplace culture, to use DCPs more creatively. Initial progress is made by offering the DCP more responsibility and moving them towards diagnosis and treatment planning by encouraging them to make their own decisions.

I can make a decision whether it's appropriate to take an X-ray.

DCP1

This increased level of responsibility was described as providing a foundation for a move towards direct access and potentially DCPs being utilised to diagnose and plan treatment.

We can screen the patients and treatment plan and such doesn't mean they have to be direct access patients, it means we can examine them, gather the information. As long as you know when to refer people, that's the important part.

DCP_T3

Beliefs and attitudes: perceived benefits of role substitution

A key part of the interviews was to understand what the DCPs saw as the benefit to the practice and what benefit would be experienced by the PP and patient as a result of role substitution. The most common benefit reported was that DCPs allow the PP's or referring GPs' time to be used more effectively.

It's just a case of freeing up their time so that they can do more private work or more advanced treatment themselves.

DCP_T5

The benefits to patients that we described in the PP section are also echoed here, particularly the accessibility to treatment.

I've got a bit more time, you'd be waiting weeks to get in with [the dentist], I can see now we'll get it done quicker.

DCP6

Payment and its impact

There are different ways of paying DCPs. Many DCPs are self-employed and are paid an hourly rate for the time that they work, irrespective of the number of patients that they see in this time. PPs who run this system generally regard it as their responsibility to ensure that the DCP's time is fully utilised to ensure their employment is profitable and worthwhile. However, as described earlier, this does not always occur and some DCPs are still left with a lack of patients to treat. Another approach is where DCPs are employed by the practice and, therefore, receive a salary. This appears to give the DCP stability and a sense of being valued.

We're salaried, so although we are chasing UDAs, myself and the dentists are on a salary.

DCP_T2

If I was salaried . . . it'd be better because then I'd be happy to carry out everything . . . And it wouldn't be that I'm taking UDAs off the dentist.

DCP_T4

A third way is that DCPs receive payment for the number of patients they treat. One DCP suggested they would expect their rate of pay to be increased if they were to undertake restorative work, referred to here as 'therapy' work. This raises an interesting point about the value of treatments, which would be less of an issue for DCPs paid an hourly rate or fixed salary.

I'm paid a percentage of what the patient pays so, obviously, that would have to change because if I did more therapy.

DCP_T7

Dental care professionals were sceptical about whether or not their services added to the overall profitability of the practice. They reported that the hygiene services generally became more cost-effective if undertaken as part of private treatment rather than within the NHS remuneration system. Furthermore, if they were self-employed and paid a fee for services completed, then they were very much aware that they could maximise earnings by focusing on private patients. In Scotland, in particular, it was very evident that completing hygiene work under the NHS remuneration system was far from profitable; in fact, it was virtually impossible for the practice to cover the costs of the treatment.

Therapists don't do therapy because it doesn't pay as well as if you went and did private hygiene work.

DCP_T7

One repercussion of DCPs not having a NHS performer number is that they are not NHS employees and lack NHS employment benefits such as job security and NHS pension. This leads to significant resentment within the profession and the feeling of being a less valued member of the workforce.

Any work we do under a dentist prescription with their NHS number it's all allocated to them and they pay us. So that goes to their pension but we've not got a pension but yet we're doing the same work on the NHS.

DCP1

Barriers to utilisation of role substitution

Some barriers to greater use of DCPs have been explored elsewhere in this chapter; however, there were many more that DCPs described during the interviews. As with PPs, a common reason for not employing DCPs is a lack of space in the practice and a lack of time.

Just busy with our referrals and the ones that we get in off the dentist. I don't think there'd be time for us to just see people coming in off the streets or anything.

DCP7

A big issue for everyone is the lack of clarity in the legislation around DCPs and whether or not they can perform a more front-line role. Barriers cited are the lack of performer/contract number and (therefore) an inability to make a claim for completed treatment, and the confusion over completing the entire radiographic pathway. DCPs would prefer to be careful in the short term and not broaden their scope until clarity is provided.

You then have to go and do the prescribing radiographs course, which I'm in the middle of but then you still need a dentist to interpret it.

DCP6

I'd need to see in black and white, yes, you can do this; because I wouldn't want to do anything that would jeopardise a patient, or myself.

DCP2

Some DCPs report working in practices where PPs are resistant to change, in a system that works for GDPs and has been successful for years. Even if they can see benefits, there is still not a strong enough reason to make changes while the existing system is working and paying them well. This was reported as being more prevalent in the older generation of GDPs and is linked to concerns that it will result in job losses for GDPs.

[The older generation of dentists] were just not interested, not interested at all. They just saw it as we were trying to steal their jobs.

DCP_T5

This point of the older generation not wanting to adopt new methods can be linked with teaching and the learning experience of GDPs. According to DCPs, dentists should be educated about the DCP role in dental undergraduate courses. This resonates with evidence demonstrating that courses where GDPs and DCPs work and learn alongside each other lead to a greater understanding of each other's roles and abilities.¹³²

They don't fully understand our training, like, they haven't been around for that long so it's like, okay can they actually do it.

DCP_T4

In the whole 3 years we were there we had one lecture that was integrated with them.

DCP_T5

Facilitators of greater utilisation of dental care professionals

Even though the introduction of direct access is yet to have an impact on access to DCPs, there is the expectation that the new dental contract will introduce additional incentives to increase their utilisation. To accompany this, a variety of methods to encourage this process were suggested. The most common suggestions cover the education of GDPs and patients, primarily to raise awareness and understanding. In addition to changes in education at dental school discussed above, DCPs suggested other action was needed.

You are going to have to maybe do like CPD [continuing professional development] events, work it into the contracts particularly when this new contract does come out . . . I think if that can outline and show people how it will work and how the financial benefits for the dentists would be, then maybe that might make them change their mind.

DCP6

I think it's showing a financial gain and how more efficient their appointment book will be and how happier the patients would be. It's just educating them.

DCP_T7

Results: patients

Awareness of the roles of members of the dental team

In general, patients had low levels of awareness of the specific roles and duties of different members of the dental team. When asked about what they knew about the care provided by DHTs, patients tended to be unsure. A patient from a practice without any DCPs referred to hygiene work only.

Basically just a clean and polish. I don't know if there's anything else they do. Is it just called a clean and polish, or something?

Practice 4, patient 5

A patient from a practice using DCPs as DHs and DTs stated they knew nothing at all about the role.

Nothing at all, because I just come here and get my teeth done, so I wouldn't know anything would I?

Practice 5, patient 3

Similarly, when asked if they knew about what therapists did, another patient stated:

No, not really. No, I'm just happy that they do it and it's comfortable what they do and it's good for you, for your teeth.

Practice 6, patient 1

However, there was a broad understanding that GDPs could do everything but were experts in doing dental work and DHs were experts in hygiene work. Therapists did not fit well into this understanding. One patient expressed a little surprise when it was explained to her that a DHT could carry out a filling.

Right, yeah. I don't know, I just thought, you know, it goes with the title. You know, hygienist, just keeping it clean.

Practice 4, patient 5

This statement highlights the importance of the job title itself and how this helps to form patient understandings of the roles of members of the dental team. Another two patients explained their understanding of the work of GDPs and DCPs.

It's the dentist that I need to see for fillings, etc., and they're just mainly for the hygiene, the cleaning of the teeth.

Practice 6, patient 3

General dental practitioners were seen by some as being necessary for more serious treatments. One patient at a practice that utilised a model whereby low-risk patients attended routine hygiene appointments at 3-month intervals stated:

You do see the dentist afterwards; that's for more important things really.

Practice 6, patient 3

Another patient reported the work that GDPs do as being more 'detailed' and 'severe':

Only in so much that when you see the dentist it's more involved and it's more detailed. The work that the dentist has to do is a bit more severe.

Practice 4, patient 3

Patients also thought of dentists' time as limited and saw referrals to DCPs for hygiene work as a way in which the GDP was able to spread the workload:

They just clean, but more thoroughly than the dentist has got time to do.

Practice 6, patient 1

One patient, however, did have a good understanding of DHTs; this was because a daughter of a family friend was currently training as a DHT. She said:

I think there are some hygienists that go through a diploma course, which is 2 years, and I'm aware now that there's a BSc course for oral hygiene . . . I'm aware that they do a 3-year course and that they are qualified to do some fillings – as I understood it, you could correct me if I'm wrong – on minors, on children.

Practice 3, patient 1

Perceived drawbacks

Following some explanation to the patients of role substitution and based on their existing experience of being cared for by DCPs (mostly by DHs rather than by DHTs), some patients expressed concern about the greater utilisation of DHTs. Much of the concern was around DHTs carrying out dental treatments such as fillings. However, there was a number of other perceived drawbacks, including patient preference and convenience.

One such perceived drawback of DCP utilisation was reported by a patient who attended a practice that did not currently employ DCPs. Thinking back to a time when he attended another dental practice, he described the inconvenience of having separate appointments with a GDP and a DH.

They [previous dental practice] had a hygienist which I used to use but I've no need to here because I get it done with my check-up. I didn't have any problems at my check-up and [XXXX] does it all for me. If I have a problem in between I can come and have one [appointment] and so it's much better than booking it separately.

Practice 4, Patient 1

Some patients felt hesitant about seeing someone other than the GDP to whom they had become accustomed. Patients explained that they had good relationships with their GDPs and would not be happy about being cared for on a regular basis by anyone other than their own GDP. This appeared to be regardless of whether the patient was to change from their GDP to a DCP or another GDP. One patient said:

I think I'd prefer to stick with my dentist that I know . . . Just because I don't like trying new dentists. So when you've found one that you really like, I think it's best to stick with them . . . I think it's just that I'm comfortable with what I know.

Practice 6, patient 1

Another patient said that they would reluctantly see someone other than their usual GDP if there was no other choice:

Only if it was OK and there was no choice because my dentist wanted it, you know . . . what's the expression? If it ain't broke, don't . . . you know?

Practice 4, patient 1

Further to these perceived drawbacks, some patients expressed concern over safety issues and the quality of the treatment carried out by DCPs. This tended to relate to thinking along the lines that DHTs' levels of training and skills were lower than those of a GDP. One patient commented on the ability of GDPs to check the health of the whole mouth and spot potentially serious problems.

I'm sure a simple filling is a simple procedure in itself but the dentist isn't just doing a filling, they're looking at other things as well. You know, you might have a bad reaction to a local anaesthetic or it might be another issue. There might be a crack in the tooth that's not been spotted, who knows?

Practice 4, patient 4

Two patients said that they would need a better understanding of the training and the skill levels of DHTs before they would be able to make a decision on whether or not they would accept treatment from a DHT.

I'd be unsure, to be honest. I'd like to know how much they'd done in the past. How many fillings they had done, the training involved, etc. . . . need to understand the level of training and the level of experience that went with it.

Practice 4, patient 4

One patient described that they would not have as much confidence in the abilities of a DHT in comparison to a GDP because of the perceived level of skills and training levels.

I wouldn't have as much faith in a therapist as I do in a dentist because you feel they've got a lot more experience and studied a lot longer.

Practice 6, patient 3

Further to this statement, the patient expressed concern about value for money.

I would think you were getting short changed if you didn't see a dentist really, if you were, you know, being passed on to a hygiene therapist.

Practice 6, patient 3

Another take on this idea of value for money was that some patients might be happier to receive treatment from a DHT if the charge was lower than that of a GDP. One patient at a private practice noted that although this was not the case for her, she could imagine that it might be an attractive prospect for others.

In my case, it wouldn't, but other people might think a lot of it's cheaper for me to have that filling done by a hygienist or somebody with an oral hygiene qualification, and certainly in the economic climate it may be a choice that people feel that they want to make.

Practice 3, patient 1

This patient paid for her dental care privately. She was more aware of the training and qualifications of DHTs than the other patients interviewed; however, she seemed to be sceptical of the quality of the treatment that would be provided by a DHT as opposed to a GDP. She noted that quality was not something she would be prepared to trade off for cost. However, she felt that some people who were more financially restricted than her might be prepared to make this trade-off.

Although this patient was sceptical of the use of DHTs, this seemed to bother her only when thinking about her own treatment. A contrasting view was obtained from another private patient, who expressed concern on a moral level that NHS patients might be 'passed on to a hygiene-therapist'. She felt that the treatment would be of a lesser quality and that this would be a failing of the NHS to patients.

You know, the experience and . . . they've obviously got more qualifications in the long run, the dentist, than the therapist would have, so I would feel, yeah, you'd be a second citizen really. Definitely, it is the dentist that should be doing the actual fillings and the extractions and things like that. It sort of horrifies me to think that you're actually saying this and that they might be considering that for national health patients.

Practice 6, patient 3

Perceived benefits

Although some of the patients interviewed highlighted concerns, a large proportion of the patients were able to see the potential benefits of using DHTs in practice. These principally revolved around freeing up GDPs' time to concentrate on more complex treatments. This was thought to be a benefit by some because it could allow for improved rates of access.

If it helps other people out and gets the jobs done quicker and make it more accessible then yeah.

Practice 5, patient 6

Several patients stated that they would be happy to be treated by a DHT instead of a GDP.

Most patients, even those sceptical of DHTs carrying out dental work, thought that use of DHs was important for freeing up GDPs' time.

For [the hygienist] to be able to do that and save [the dentist] the time it is much better, in my opinion, because she's looking at the hygiene . . . it saves [XXXX] time and gives him a chance to concentrate on more complicated issues.

Practice 3, patient 1

In addition to saving time, some patients thought that visiting a DCP rather than the GDP could be an easier option, especially for those with dental anxieties or fears. One patient described how she used to feel nervous about visiting the GDP and how she found it easier to see the DHT.

Yeah, I'd rather go to [hygienist therapist] about anything to be honest with you. I mean . . . They've been alright, the dentists in here, but I haven't got the same . . . I haven't got the same, what do you call it . . . reassurance as I have with her . . . I used to dread coming, my nerves would be all over the place before [the hygienist] came but now I look forward to coming, you know, because I've got into that routine of coming every 3 or 4 months. And she's always so nice, asks us about the family and my granddaughter and everything.

Practice 5, patient 1

Acceptability

Although there were a number of patients who were unconvinced about the greater utilisation of DCPs in practice, levels of acceptability among the majority of patients were generally high. The majority of the patients were very accepting of DHs, particularly in terms of hygiene work. Some patients even stated that

they would prefer to have hygiene work carried out by a DH than a GDP. This seemed to be because DHs had more time and were experts in hygiene work.

I prefer it because I think that's their field, and they excel at it and she is exceptionally good.

Practice 5, patient 2

Other patients reported that they would be as happy to receive dental treatment from a DHT as they would from a GDP. In some cases, patients used their past experiences to explain their choices.

I trust her, she's been doing it for years and they obviously know everything about it . . . To do my fillings, yeah, fire away. No bother, no. It's my fillings, I can't see any reason why they can't.

Practice 3, patient 2

Across the majority of patients interviewed, it was apparent that there was an implicit trust in health-care professionals and in the health-care system that provided patients with a feeling of safety. Patients trusted that there were sufficient checks and balances within the broad NHS that ensured the appropriate training and vetting of health-care professionals. This trust seemed to reassure patients that standards of care would be maintained.

Patients felt that GDPs would refer only to qualified health-care professionals. In addition, some patients felt satisfied about being treated by a DHT if they could be reassured that they were appropriately qualified to carry out the treatment.

It's not a problem as long as . . . obviously; the person's going to be qualified anyway. They're not going to let an amateur loose on you.

Practice 4, patient 3

Other patients, when asked why they would feel happy to be referred to a DHT for dental treatment, responded with explanations about trusting their GDP or the practice that they attended.

Because I trust them here, they are lovely here.

Practice 5, patient 6

It was apparent that, for some people, their experience of the practice they attended directed their levels of trust in the quality of care provided.

I'd feel fine about it [being referred to a hygienist therapist for a filling] as long as they could do it. Yeah, it doesn't bother me. They've always looked after my teeth well enough here so as long as it gets sorted, it doesn't really matter does it? As long as it's done professionally . . . if they're getting fixed it doesn't really matter. If they are qualified then fair enough.

Practice 5, patient 6

Another patient described how it was important for her to have trust in the individual GDP or DCP treating her on a personal level. She stated that she would prefer her own GDP to carry out even complex treatments rather than be referred to secondary care because she trusted her GDP and knew she would be safe.

[It's more about getting to trust the person rather than] . . . whether it be dentist or a hygienist, basically . . . Yes, I would say that in general. If they trust somebody, you have you have faith in them . . . so I'd rather . . . I'd rather [my dentist] did it than go to the hospital because you know then.

Practice 3, patient 2

Discussion

The PPs interviewed in this study appeared to be in agreement that, within the current NHS contract, the greater use of DCPs did not result in financial gain. These views support the findings from *Chapter 4*. The current system appears to disincentivise the use of role substitution. Although those PPs who did not use DCPs fully did talk about financial ‘disincentives’, this was not the primary reason for their lack of use.^{31,56,83–90} Instead, the attitudes and beliefs of PPs appeared to be highly influential in terms of explaining the organisation of the practice; that is the type and organisation of the practice culture that cascaded down from the practice owner (PP) was key. This concurs with the findings of Watt *et al.*¹⁰¹ and McDonald *et al.*¹⁰²

Practices with low role substitution utilisation appeared to be led by PPs who were concerned about the abilities of DCPs, in particular how much longer it might take a DCP to carry out a treatment than a GDP.³² However, it is worth noting that PPs who used DCPs tended to have confidence in the ability of their own DCPs, but were less confident in the ability of DCPs in general. This suggests that experience of working with DCPs may be a factor that influences GDPs’ attitudes and beliefs about DCPs.^{56,113}

The professional domain of DCPs was also limited by many PPs to the provision of periodontal treatment. This concurs with the work of Godson *et al.*,⁹² who found that many DHTs and DTs in England were employed in the NHS as DHs, rather than being utilised across their full range of skills. Those PPs who supported the greater use of DCPs for more interventional treatment (e.g. preparing teeth for restorations) limited their activity to children and anxious patients, on the basis that these types of patients took up more surgery time. As a result, DCPs appeared to be used by many PPs to improve their own efficiency, at the cost of the efficiency of their own DCPs. This may help explain why there was no net effect across the practice. Periodontal treatments are limited to band 1 payments (and some band 2 payments for complex activity), so the number of UDAs produced by DCPs would be reduced.

Overall, financial incentives remained important for PPs, but so were the beliefs and attitudes of PPs to role substitution and DCPs generally.^{31,83–86,88–90} It may be the case that these attitudes could change over time if there was greater alignment in the system between financial incentives and the greater use of DCPs. This has been shown to increase utilisation in medicine.^{14,102,103}

Among DCPs themselves, a number of day-to-day barriers were found to reduce the efficiency of working in the practice environment. These included not being able to prescribe fluoride varnish and the inability to prescribe local analgesia when they were asked to carry out more interventional treatments. Some practices had developed organisational systems to work around these barriers, such as setting up a ‘patient group directive’ (an agreement overseen by a pharmacist that allows DCPs to prescribe medicines using their own assessment of patient need). However, many practices did not have such agreements in place and this meant that every time a DCP wished to issue fluoride supplements or provide local analgesia prior to treatment, they had to get approval from the GDP.

Another important related restriction is the inability for DCPs to examine patients or to provide a treatment plan under the NHS dental contract regulations. Although the dental regulator recently changed the scope of practice for DCPs,⁵⁸ within the NHS, the GDP still needs to see the patient first. This creates an extra step in the referral pathway and substantial transactional cost, as patients that are seen by GDPs first have to be then ‘booked back in’ with a DCP if they require treatment. In contrast, GDPs have the freedom to conduct the treatment in the same visit, immediately after the examination, if they have time. Both care pathways generate three UDAs, so the efficiency of the latter is far greater than the former and may contribute to the results found in *Chapter 4*. Furthermore, some of the DCPs interviewed reported that they were not referred enough work to keep them busy all day, a factor that would again reduce their efficiency. This was particularly marked for those DCPs that worked in corporate practices, where they were paid on a FFS basis rather than by an hourly rate.

This reliance on referrals from GDPs appeared to reduce the DCP workload in the practice and a substantial proportion of those interviewed worked across a number of practices (between two and eight). This is consistent with the research that has been conducted in England^{92,114} and highlights the precarious nature of professional work for many DCPs.

In general, the majority of patients had a low level of awareness of the roles of different members of the dental team. Most patients interviewed were familiar with GDPs and DHs, but they were not usually aware of DTs. Patients tended to compartmentalise their views on who did what in dental practices; fillings, crowns and bridges were activities undertaken by the GDP, while periodontal treatment ('hygiene work') fell within the expertise of DHs. All patients were happy to have hygiene work carried out by a DH. Although most were open to a DT carrying out simple restorative work, some were adamant that they would only be happy with a GDP carrying out this treatment. These views concur with earlier research.⁹³⁻⁹⁵ However, all patients who had had an experience of being treated by a DT were happy. This may indicate that patients' prior experience of treatment is key. If their only experience was treatment by a GDP, then treatment by a DT may appear daunting. Once they realise that there is no real difference in their management, they appear happy to accept being treated by a DT.

The majority of patients interviewed were simply not interested in the debate about who treated them. Instead, they reported that they just wanted to know that any treatment being carried out was undertaken with a suitably qualified clinician. They all appeared to place a great deal of trust in the NHS, the regulatory system and in the opinion of their GDP. Patients were happy to comply with what was recommended to them. In similarity to the findings by Northcott *et al.*,¹³³ if the GDP was happy to refer them, they were happy too.¹³³ Essentially, they felt that the system/regulator/practice/GDP would look after their best interests.

Concluding remarks

In relation to RQ2, the barriers to, and facilitators of, role substitution in NHS dental practices were varied. Financial implications were important, but the organisational culture at the practice was also critical. PPs views of role substitution were varied and key. As PPs own their practices, their views heavily influenced the culture at a practice. DCPs highlighted the inability to prescribe fluoride, local analgesia and radiographs as important barriers to efficient working practice in the NHS. Patients appeared to have an inherent trust in the 'system' and prior experience of role substitution was influential on its acceptability.

Chapter 6 The role of financial incentives on NHS dental activity

Introduction

Chapters 4 and 5 highlight the variation in efficiency in NHS dental practices and the range of factors that can influence it, including role substitution. This chapter details how the research team used a natural experiment to explore the impact of a change in the remuneration system on the delivery of dental services in a large group of NHS dental practices in Northern Ireland.

In May 2009, the Northern Ireland Health Minister, Michael McGimpsey, announced a plan to improve access across the province to enable 'people to get the health service dental treatment they need'. Rather than paying NHS dental practices via FFS, new contracts were to be based on capitation. Oasis Dental Care was among a number of groups that responded to the tender and, in April 2010, it was successfully awarded funding to provide 38 GDPs working in 14 new practices located in regions where patient access to oral health care was limited. Oasis Dental Care was chosen for their 'extensive expertise and experience in providing dental services to health Trusts across the United Kingdom'.

Contracts were awarded for a period of 3 years and they were to be paid in a block contract payment to register and provide services up to 57,000 patients by 1 August 2012.¹³¹ No additional NHS payments were to be made to Oasis for patient registrations that exceeded this target. Practices were opened at different time points in the first year of this contractual period and each practice was given a target number of registrations to reach within the first year. The Health and Social Care Board in Northern Ireland monitored monthly registrations closely and held regular monitoring meetings with Oasis Dental Care.¹³¹ They considered Oasis to have made 'reasonable efforts' to achieve the target if they operated within a 5% level of the target. Penalties were to be applied if they fell outside this range.

The aim of this study is to examine how specific health-care service indicators differ between the Oasis practices and control practices paid by traditional FFS payments after controlling for other patient and practice characteristics. We addressed the following RQs:

1. Patient selection: do Oasis practices serve a different population of patients from control practices?
 - i. Is the proportion of registered patients who are ≥ 60 years of age greater in Oasis practices than in control practices?
 - ii. Is the proportion of registered patients who are ≤ 18 years of age greater in Oasis practices than in control practices?
 - iii. Is the proportion of registered exempt patients ≤ 18 –60 years of age greater in Oasis practices than in control practices?

2. Receipt of care among registrants: do patients registered to Oasis practices:
 - i. See the GDP less frequently than patients in control practices?
 - ii. Have fewer treatment courses than patients in control practices?
 - iii. Receive less costly treatment than patients in control practices?

3. Type and mix of treatment received: are patients seen in Oasis practices:
 - i. More likely to receive an examination than patients in control practices?
 - ii. More likely to receive an extraction than patients in control practices?
 - iii. More likely to receive a filling than in control practices?
 - iv. More likely to receive a scale and polish than in control practices?
 - v. More likely to receive prevention/topical fluoride than in control practices?

4. Financial viability:
 - i. Is the payment charge revenue generated per registered patient less among Oasis practices than in control practices?
 - ii. Is the payment charge revenue generated per treatment course less among Oasis practices than in control practices?

Methods

Data collection and matching approach

The data used in this study were based on claim forms that GPs are required to submit to the Health and Social Care Board as part of their NHS contractual regulations. Although Oasis practices were not remunerated on the basis of services provided, they were still required to submit the same documentation as GDS practices for auditing purposes.

We compared the 14 Oasis practices with a control group of matched GDS practices paid by FFS. Control practices were selected based on practice location. Postcode data of all registered practices with the Health and Social Care Board for Northern Ireland (that hence provide services under a NHS contract) were used to select the five nearest practices to each Oasis practice. Distance from an Oasis practice was chosen as the matching variable as an attempt to control for the oral health-care needs of populations being served by the practices. This provided a control group of 70 practices. After screening the data, 4 of the 70 control practices were removed from the sample because of incomplete claims data. Practices with fewer than 1000 patients registered at the practice for NHS care in any month were removed from the sample because this could have indicated a new practice was not yet operating at a steady state or that a practice was reducing registrations in advance of practice closure. This resulted in removing one Oasis practice and nine practices from the control group, leaving a study sample of 13 Oasis practices and 57 control practices.

The data from the claim forms were pooled over 43 months (from April 2011 to October 2014). Seventy practices formed an unbalanced panel data set of 2971 monthly practice claims (556 Oasis practices and 2415 control practices). A full description of Oasis and control group practices' sample characteristics can be found in *Appendix 3*.

The analysis covers the period from April 2011 to October 2013, in order to ensure a sufficient number of monthly observations for panel regression. The study period started a year after the Oasis contract was signed to accommodate the different starting dates for the Oasis practices and to ensure the policy change in the extension of the patient registration (from 15 months to 2 years) had taken place.

Variable description

The analysis is based on routinely collected data on a range of study variables and potential confounders. The outcome measures (or dependent variables) in this study were patient selection, receipt of care among registrants, mix of treatments and financial viability.

The study population was divided into subgroups for analysis of patient selection. Patient selection was defined as the proportion of registered patients aged ≤ 18 years, the proportion of registered patients aged ≥ 60 years and the proportion of registered patients exempt from payment charges for one of the following reasons: expectant or nursing mothers, income support, job seeker's allowance, working family tax credits, and certificates for full or partial help with health-care costs. These exemption categories were chosen to capture the proportion of the registered population where there may be oral health need.¹³²

Receipt of care among the registered patient population was defined as the number of unique patients seen (i.e. repeated visits from the same patient was not counted) per 100 patient registrations, the number of treatment courses per 100 registered patients and the monetary value per treatment course. This provided an indication of whether or not patients registered for NHS care received services during a particular month, and the pattern and type of services received.

Treatments provided were categorised into different types to compare the case mix profiles of Oasis and GDS practices. Type and mix of treatment were defined as the prevalence of particular services per 100 unique patients seen. The particular treatments used for this variable were the number of examinations, the number of restorations (fillings), the number of extractions, and the number of scale and polish treatments. As a measure of the prevalence of preventative care, we use the number of fluoride varnishes per 100 children registered at the practice. Routine application of fluoride varnish is recommended for children from the age of 2 years in the NHS in England (*Delivering Better Oral Health*).¹³⁴

Finally, financial viability was defined as the Patient Charge Revenue generated from the NHS services delivered. Reductions in Patient Charge Revenue associated with the frequency and content of services delivered under capitation would increase the net cost of NHS dental care to the board, so is an important consideration for NHS commissioners.

The explanatory variables used in the analysis to control for patient need were the proportion of adult registered patients to registered children, the proportion of exempt patients and the Index of Multiple Deprivation score for the practice location. The capacity of the practice to meet needs was measured by the number of GPs working at the practice.

Analysis

To address the RQs, the mean difference between Oasis and control group practices was estimated after controlling for other explanatory variables using an OLS regression model with robust standard errors.

Ordinary least squares is applied to panel data in long panel form (data on n practices, over t monthly periods, for a total of $n \times t$ observations), with a number of monthly observations for each practice. These repeated observations of an individual practice cause clustering and standard errors to fall as the number of repeated monthly observations increases. These standard errors at practice level were adjusted (robust standard errors) to control for this in a pooled OLS regression. The estimates from the OLS models are presented as associations as there is the possibility that unobservable influences that mediate the relationship between the explanatory variables and the outcome measures invalidate any conclusions of causality.

Panel models provide a way of accounting for unobservable influences, but the data available for this analysis did not favour that approach because of a lack of variation over time.¹³⁵ Panel model specifications were estimated, tested and rejected in favour of pooled OLS. The coefficients and statistical significance of exploratory variables on the OLS model were almost identical to panel specifications and a joint Wald test did not reject the null hypothesis that the coefficients on time-varying explanatory variables were identical. This suggests that there was not enough variation across the months within practices to justify a panel approach and we chose pooled OLS with robust standard errors as our main model specification (see *Appendix 4* for a detailed explanation).

The matching variable measured whether an individual practice is part of the Oasis group or control group. The statistical significance and direction of the estimated coefficient indicates if there is a difference between Oasis practices and the control group after controlling for differences in practice and patient characteristics that were (a) related to the outcome measure and (b) unrelated to whether a practice operates on the Oasis contract. In the patient selection model, the explanatory variables measuring patient mix (aged ≥ 60 years, children and patient need) were not included because they were not independent of the dependent variable (the proportions of registered patients in particular age groups and in particular exemption categories).

The Ramsey regression equation specification error test (RESET) was used to test for model misspecification; that is whether or not there was a statistically significant improvement in fit with non-linear combinations of explanatory variables.

Data analysis used Stata (StataCorp LP, College Station, TX, USA) software version 11.1. A p -value < 0.05 was used as the threshold for statistical significance and highlighted in the results tables.

Results

Descriptive statistics

Table 20 describes practice characteristics and patient selection variables for Oasis practices in comparison with the control practices. Oasis practices had greater staffing capacity to deliver health care than control practices, with, on average, 0.89 more dentists active per practice per month. The mean number of monthly treatment items delivered was larger among control practices (922 treatment items) than in Oasis practices (811 treatment items). The mean monthly number of treatment plans delivered to patients was larger for an Oasis practice (463 treatment plans) than a control practice (392 treatment plans), while the mean monetary value of the treatment plans delivered was lower in an Oasis practice than for a control practice by £10.83. These differences between the two groups were statistically significant at a 5% level.

TABLE 20 Sample comparison of GDS control practices with the Oasis group for practice characteristics and patient selection variables

Variable name	Mean practice value in		Difference in mean practice values	p -value of difference
	GDS control practices (n^a)	Oasis group (n^a)		
Practice characteristics				
Number of dentists	3.21 ($n = 2079$)	4.11 ($n = 478$)	-0.89	< 0.00
Regional deprivation (Index of Multiple Deprivation score)	21.20 ($n = 2415$)	19.80 ($n = 556$)	1.41	< 0.00
Number of monthly treatment items	922 ($n = 2079$)	811 ($n = 478$)	110	< 0.00
Number of monthly treatment plans (claims)	392 ($n = 2079$)	463 ($n = 478$)	-71	< 0.00
Number of monthly registrations	3359 ($n = 2415$)	3850 ($n = 556$)	-490	< 0.00
Number of monthly patients seen	306 ($n = 2415$)	320 ($n = 556$)	-14.40	0.15
Patient selection				
Percentage of registered patients aged ≥ 60 years	15.30 ($n = 2079$)	13.30 ($n = 478$)	2.01	< 0.00
Percentage of registered patients that are children	30.70 ($n = 2415$)	19.90 ($n = 556$)	10.70	< 0.00
Percentage of registered patients exempt from payment charges	43.20 ($n = 2415$)	36.70 ($n = 556$)	6.60	< 0.00

a One observation is one practice observed in 1 month.

Table 21 describes receipt of care among registrants, mix of treatments and financial viability variables for Oasis practices in comparison with the control practices. Oasis practices deliver care over a larger patient population. An Oasis practice had, on average, 490 more registered patients and treats an average of 14 more unique patients per month compared with control group practices. This suggests that, although Oasis practices were purposely set up in locations where the government had identified barriers which prevented access to oral health care in the resident population, the practices nonetheless were facilitating access to health-care services to more patients than neighbouring control group practices.

Main findings

The estimated coefficients are presented in Table 22. Each row in the table is a separate regression, with a different dependent variable to answer a different RQ. Estimated coefficients on the matching variables indicate the difference in the outcome variable between Oasis practices and control practices when the values of other explanatory variables in the equations are held constant. The table shows the matching variable estimate without the use of control variables, with only practice control variables and with practice and case mix control variable. The last is the main model specification. *p*-Values of the matching variable (r^2), the number of practices (n) and the number of practice month observations (N) are described for each regression.

TABLE 21 Sample comparison of national practices with the Oasis group for receipt of care among registrants, mix of treatments and financial viability variables

Variable name	Mean practice value in		Difference in mean practice values	<i>p</i> -value of difference
	GDS control practices (n^a)	Oasis group (n^a)		
Receipt of care among registrants				
Number of monthly patients seen per 100 registrations	8.90 ($n = 2415$)	8.40 ($n = 556$)	0.54	< 0.00
Number of monthly courses per 100 registrations	11.70 ($n = 2079$)	12.50 ($n = 478$)	-0.80	< 0.00
Value of treatment per treatment course (£)	33.80 ($n = 2079$)	22.90 ($n = 478$)	10.80	< 0.00
Mix of treatments				
Number of monthly examinations per 100 patients seen	66.70 ($n = 2079$)	62.40 ($n = 478$)	4.30	< 0.00
Number of monthly extractions per 100 patients seen	16.10 ($n = 2079$)	20.70 ($n = 478$)	-4.60	< 0.00
Number of monthly fillings per 100 patients seen	60.30 ($n = 2079$)	44.30 ($n = 478$)	15.90	< 0.00
Number of monthly scale and polishes per 100 patients seen	48.20 ($n = 2079$)	40 ($n = 478$)	8.10	< 0.00
Number of monthly fluoride varnishes per 100 patients seen	0.023 ($n = 2079$)	0.018 ($n = 478$)	0.005	0.60
Number of monthly fluoride varnishes per 100 child registrations	0.008 ($n = 2079$)	0.007 ($n = 478$)	0.001	0.83
Financial viability				
Patient payment charge revenue per registration (£)	11.50 ($n = 2079$)	15.40 ($n = 478$)	-3.93	< 0.00
Patient payment charge revenue per treatment course (£)	9.10 ($n = 2079$)	10.50 ($n = 478$)	-1.40	< 0.00

a One observation is one practice observed in 1 month.

TABLE 22 Separate regressions showing the difference in the outcome variable between Oasis and comparison practices for each group of RQs

Dependent variable	Matching variable estimate		With practice control variables		With practice and case mix control variables		n, N, r ²
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	
Patient selection							
Percentage of registered patients aged ≥ 60 years	-2.01	0.10	-1.72	0.35	-	-	70, 2557, 0.04
Percentage of registered patient that are children	-10.74	<0.00	-11.2	<0.00	-	-	70, 2557, 0.19
Percentage of registered patients exempt from payment charges for reasons associated with high dental care need	-6.55	0.05	-3.81	0.21	-	-	70, 2557, 0.14
Receipt of care among registrants							
Patients seen per 100 registrations	-0.54	0.07	-0.60	0.04	-1.61	<0.00	70, 2557, 0.11
Treatment courses per 100 registrations	0.78	0.01	0.71	0.02	0.44	0.33	70, 2557, 0.01
Value of treatment per treatment course (£)	-10.83	<0.00	-10.41	<0.00	-14.00	<0.00	70, 2557, 0.29
Mix of treatments							
Examination per 100 patients seen	-4.30	0.02	-3.45	0.07	-9.7	<0.00	70, 2557, 0.05
Extractions per 100 patients seen	4.62	<0.00	5.12	<0.00	6.31	<0.00	70, 2557, 0.18
Fillings per 100 patients seen	-15.97	<0.00	-15.21	<0.00	-17.12	<0.00	70, 2557, 0.22
Scale and polish per 100 patients seen	-8.13	0.01	-9.03	0.01	-11.5	<0.00	70, 2557, 0.07
Fluoride varnish per 100 patients seen	-0.01	0.80	0.002	0.89	0.03	0.41	70, 2557, 0.19
Fluoride varnish per 100 child registrations	-0.001	0.91	0.001	0.85	0.008	0.33	70, 2557, 0.06
Financial viability							
Patient payment charge revenue per registration (£)	3.93	<0.00	3.09	0.01	-0.68	0.63	70, 2557, 77
Patient payment charge revenue per treatment course (£)	1.37	0.17	0.76	0.42	-2.91	<0.00	70, 2989, 0.80

The findings in *Table 22* were robust to model specification. The RESET test was performed for each outcome measure. In each case, the p -value of the test was > 0.05 , indicating that the null hypothesis (that the model is not misspecified) should not be rejected. In addition, there is little difference in the magnitude and statistical significance of the matching variable when it is estimated by random-effects panel model or panel model and Mundlak correction (see *Table 46, Appendix 3*).

Patient selection

There is no evidence of differences in patient selection between Oasis and control practices based on patient need. The proportion of registered patients from payment charge-exempt groups with high-expected health-care need was not significantly different between the two practice types. There was mixed evidence of patient selection based on age. Oasis practices had, on average, 11 fewer children per 100 registrations than control practices ($p < 0.00$), although there was no statistically significant difference in the number of older (aged ≥ 60 years) registrants per 100 practice registrants.

Receipt of care among registrants

An Oasis practice saw on average 1.6 fewer unique patients per 100 patient registrations per month than a control group practice ($p < 0.00$). The average value per treatment course was £14.00 lower in an Oasis practice than in a control practice ($p < 0.00$). This suggests that, over the given time period, Oasis practices saw a smaller proportion of its registered patients and provided courses of a lower monetary value than control practices. There was no statistically significant difference between the practice groups in the average number of monthly claims (a proxy for the number of patient treatment plans) made per registered patient, which suggests that there was no evidence of Oasis practices 'underserving' registered patients in the absence of any treatment plan-based remuneration incentives.

Mix of treatments

There was evidence of a difference in treatment prescribing patterns between the two practice groups. An Oasis practice provided an average of 9.7 fewer examinations, 17.2 fewer fillings and 11.5 fewer scale and polish services per 100 unique patients seen per month than control practices ($p < 0.00$). However, they provided an average of 6.3 more extractions per 100 unique patients per month ($p < 0.00$). The volume of fluoride varnish applications per patient seen and per 100 child registrations was not significantly different between practice groups.

Financial viability

In terms of the financial implications of funding care under capitation (the Oasis contract), an Oasis practice received an average of £2.91 less patient payment charge revenue per treatment course than a control practice ($p < 0.00$). However, this was mitigated by the lower proportion of children in Oasis practices, meaning a greater proportion of the treatment plans delivered by Oasis practices were subject to patient charge payments. Once we adjust for these 'offsetting' patient mix factors, it resulted in no significant difference in the monthly payment charge revenue per registered patient between Oasis and control practices.

Discussion

In similarity to earlier findings, financial incentives in the remuneration system did impact on the clinical activity undertaken in the NHS.^{13,14,135} A major consideration in comparing different practice models was whether the different models attract and/or serve populations with different needs. Our analysis indicated that the proportion of registered patients aged ≤ 18 years was significantly less in Oasis practices, but no differences were found in the proportions of registered patients aged ≥ 60 years, or eligible for exemption from NHS payment charges for reasons associated with higher probability of need. This suggests that there is no evidence of patient selection (or 'cherry picking') associated with need for care among Oasis practices.

After controlling for differences between the two groups in practice and patient characteristics, the number of unique patients seen per 100 patients registered at the practice per month and the average value per treatment course claim were lower in Oasis practices than the control group. This suggests that registered patients at Oasis practices were less likely to visit the GDP than patients in control group practices and received less treatment when they did attend. However, it is important to note that this might be the result of unobserved heterogeneity between practices. As a result, it cannot be concluded that these differences were caused by the different ways the providers were remunerated. For example, Oasis practices were set up where populations were unable to get access to a NHS dentist, hence one could hypothesise that the Oasis practice population might have already had their care needs met by an abundance of provision in the private sector.

It is unlikely that the findings related to the care received among registered patients reflect underlying differences in needs of the patient populations of the two groups of practices. This is because the models included explanatory variables that captured the age mix of the practice population, the prevalence of exemption from NHS payment charges for reasons of higher risks of oral health problems and the level of deprivation in the local community. The findings cannot be explained by Oasis practices having a lower capacity to care for their registered patients because the number of active GDPs in each practice is included as an explanatory variable in the regression model. Although causality is not established by the modelling approach, the findings were consistent with GDPs working under capitation-based remuneration systems seeing patients less frequently and 'doing less' to patients when they do see them.

In terms of the type and mix of services delivered, we found that Oasis practices had higher levels of tooth extractions but lower levels of examinations, scale and polishes and restorations (fillings) than control practices. A factor that is important to consider here is that extractions take less time than other treatment alternatives, that is, clinicians operating within a capitation system could prefer a management option that requires less time.¹³⁶ A 'scale and polish' is a preventative procedure aimed at removing calculus and plaque that can cause oral health problems (gum disease) in the future. Equally, it is a procedure that many patients like, because of its aesthetic value (removal of stained deposits). This suggests that Oasis practices were not any more prevention oriented than control practices. However, the application of fluoride varnish is potentially a better marker of prevention orientation and its use on the registered patient population was no different between Oasis practices and the control group. The lower prevalence of examinations and fillings among Oasis practices suggests that patients registered with these practices were not seen as often and had longer recall periods. Although this might reduce the prevalence of unnecessary interventions among patients, equally it may also lead to some oral health problems being missed and interventions being delayed.

Finally, no evidence was found that patient payment charge revenue differed between Oasis practices and those that operated on a FFS basis. Although Oasis practices received less patient payment charge revenue per course of treatment than control practices (explained by the lower value of treatment per course), the revenue per registered patient was not significantly different. However, Oasis practices had a smaller proportion of children who were exempt from NHS patient charges than control practices, which would offset the reduced revenue per patient income and account for the non-significant findings in overall patient payment charge income.

The main limitation of the study concerned the limited amount of information available on the practices and the populations served by the practices as well as the non-random nature of allocating the provider payment methods and allocation of patients. Receipt of oral health care is conditional on registration, therefore the models used in this study were conditional on registrations and hence subject to selection bias. One approach to correct for sample selection is the Heckman model.¹³⁷ This incorporates the probability of registration within the population, but as this study is confined to *practice* populations, such methods cannot be used. Instead, an OLS regression model with robust standard errors was used. As highlighted above, the study was designed to minimise the impact of patient and practice heterogeneity between Oasis and control practices. As a result, a 'difference in difference' design could not be used

(there was no 'before-intervention' period for the Oasis practices).¹³⁸ Although we were able to identify statistically significant differences in some aspects of patient populations, receipt of care among registrants, service mix and patient payment charge revenue, data were not available on patient outcomes. As such, it is not possible to determine whether the lower prevalence of interventions in the Oasis practices was the result of inappropriate supplier-induced demand among control practices (unnecessary interventions) or the failure to intervene in a timely way among Oasis practices (supervised neglect).

Concluding remarks

The natural experiment described in this chapter explored the change of remuneration in Northern Ireland and enabled the research team to address the third RQ. Capitation influenced the organisation of inputs and outputs in NHS dentistry in Northern Ireland. Practices examined fewer patients and undertook fewer restorations. Capitation remuneration did not improve the level of prevention (fluoride varnish) offered, but did increase the number of extractions performed.

These results must be interpreted with caution. The success of the findings to indicate comparative differences depends on the populations being distinct from each other only in the type of remuneration system. Oasis practices were set up in areas of lowest dental health-care access in Northern Ireland, although, to account for the influence that may have had on interpreting the effect of remuneration incentives, a control variable for regional deprivation was included in the regression analysis and the comparison group chosen from nearby practices. Unfortunately, the circumstances of this natural experiment (there was not a group of Oasis practices remunerated in the same way as GDS practices) prevented an analysis of the remuneration incentives that was dissociated from the management systems and culture. Oasis practices were set up and administered by a corporate provider where the organisational environment (e.g. ways of recruiting, supervising and remunerating the work of staff) might not necessarily match that of the GDS practices.

Chapter 7 Conclusions and recommendations

This programme of research sought to address three RQs:

1. What is the most efficient mix of GDPs and DCPs for NHS dental practices to achieve UDA targets?
2. What are the barriers to, and facilitators of, role substitution in high-street NHS dental practices?
3. How do incentives in the remuneration systems in the UK influence the organisation of these inputs and production of outputs in the NHS and population of patients they treat?

From the preceding chapters, it appears that the use of role substitution in NHS dentistry appears to be widespread in some clinical domains (e.g. periodontal treatment), while limited in others (e.g. the provision of restorations) (see *Chapter 3*). The most common form of role substitution found was the use of DHs to undertake hygiene work (see *Chapters 3 to 5*). This may reflect a lack of opportunity for DCPs to exercise their full range of skills within the NHS. Equally, it could reflect some GDPs being unwilling to allow DCPs to encroach on traditional dentist roles. Whether DCPs were hired to replace the clinical activity previously provided by GDPs or simply to meet an increase in demand for routine services is not known. Supporting the latter is the finding (see *Chapter 5*) that not all PPs or associate GDPs were aware of the extended roles of DCPs. Most of the clinical activity that was produced by the practices that had been identified in *Chapter 3* as 'pro'-role substitution was actually generated by more traditional models of service provision, using GDPs rather than DCPs. Overall, the proportion of DCP to GDP sessions seeing NHS patients was relatively low (16.6%) (see *Chapter 4*).

Chapter 4 found that many NHS dental practices in England were not operating at or near the production frontier, when compared with the most efficient group of practices in the sample. This finding may be influenced by the cost-containment mechanism within the 2006 NHS dental contract in England. Output constraints within this contract place a ceiling on the amount of clinical activity that can be generated within any one financial year. Given that the numbers of surgeries and GDPs working in NHS dental practices are relatively inflexible inputs, the inability of PPs to adjust the team size and composition as the contracted deadline for the target output is approached might explain the inefficiency in production. The analyses for the smaller sample from Northern Ireland who were paid on a FFS basis (see *Appendix 1*), and hence faced no output constraints, showed that their practice efficiency was higher than in England.

The key finding from *Chapter 4* was that NHS dental practices that utilise fewer DCPs capable of role substitution operate at higher levels of technical efficiency, after controlling for other staff inputs, practice environment and patient characteristic variables. This finding from the DEA was robust to different specifications of inputs and outputs and was supported by the SFM.

When UDAs were used as the output measure, NHS dental practices in England operated at a mean level of efficiency of 64%. This changed very little when the outputs were measured in terms of the number of patients seen or the number of treatment plans generated. NHS dental practices that did not use any form of role substitution had a higher mean level of efficiency (68%; $n = 39$). The variation seen in the full data set in England was small, with 95% of scores lying within 5 percentage points of the mean.

Efficiency in NHS dental practices in Northern Ireland and Scotland was consistently higher (80% and 94%, respectively). Although it is difficult to make robust comparisons across the different countries because of their smaller sample sizes ($n = 29$ and $n = 20$, respectively), the results suggest that English NHS dental practices operate at a lower level of efficiency and variance. This may be influenced by the remuneration system employed in England and the limits that are placed on clinical activity (i.e. the output constraint caused by the ACV and the need to keep within a fixed range of UDAs). Without this output constraint (Northern Ireland and Scotland), it appears that many NHS practices maximise their technical efficiency, expanding their production until their inputs are fully utilised.

Caution should be exercised in the interpretation of the efficiency measure. This study examined the efficiency of NHS dental practices, not DCPs (as DCPs do not directly contract with the NHS). It could be that DCPs are being used efficiently but their use is associated with a reduction in efficiency for the practice overall. Equally, efficiency gains in the NHS may be lost to the private sector, if the GDP uses freed-up capacity (by the DCP) to undertake private dentistry. The output measures used, UDAs and number of patient visits, may not reflect the quality of care provided. NHS dental practices may be more efficient in terms of health outcomes, but less efficient in terms of NHS activity, patient throughput and remuneration. Such considerations would require data collection on the quality of the services produced by GDPs and DCPs, which was beyond the scope of this study.

The finding that a greater number of DHs, DTs and DHTs was associated with lower productivity might appear surprising. However, our qualitative investigation highlighted a number of factors which explain why this might be the case. These included attitudes, incentives, structural factors, systems of remuneration and the lack of direct access to DCPs. *Chapter 5* found that there was a disincentive for associate GDPs within practices to refer on to DCPs. Many PPs were also concerned about the financial implications of employing DCPs for activity other than periodontal treatment (hygiene work). The current remuneration system in NHS dentistry does not appear to reward practices for the use of role substitution and a number of PPs were concerned with the perception that DCPs took longer to carry out treatment than a GDP.

General dental practitioners' attitudes and beliefs about DHs', DTs' and DHTs' skill levels also acted as a barrier to them practising to their full scope of practice. GDPs expressed doubts about DCP skills and also reported that in the context of an expansion of supply into the dental market (via an increase in the number of dental schools and the number of overseas GDPs), DCPs capable of role substitution were perceived as a threat to GDPs. Another influential factor in the utilisation of DCPs was the organisation of the practice, (i.e. the type and organisation of the practice culture that cascaded down from the PP; see *Chapter 5*). Some PPs expressed a lack of confidence in the abilities of DCPs generally, although were very happy with the performance of their own DCP. The lack of a contractual relationship between the NHS and DCPs meant that their financial independence was limited and so they were subject to the views of the individual PPs that employed them. This meant that many DCPs had a precarious existence, with multiple jobs at different practices (see *Chapters 3 and 5*).

The need for better alignment between the financial incentives within the NHS dental contract and the use of DCPs is key if the NHS is to address the recommendations of the Independent Review² and make best use of the whole dental workforce. Aligning financial incentives to encourage the greater use of role substitution would be an important intermediate step, although the development of a direct DCP NHS contract would offer greater flexibility for commissioners. This is important as oral health continues to improve, if maximising health gain for a given level and mix of resources is an ethical imperative for the NHS. Failure to do so will increasingly mean that the most expensive resource treats those with the least need.

A number of regulatory barriers were also identified by the DCPs that were interviewed. The inability to prescribe fluoride, local analgesia and radiographs (X-rays) were identified as the key barriers to efficient working practice in the NHS (see *Chapter 5*). Some practices had developed organisational systems to work around some of these barriers, such as setting up patient group directives to allow prescription-only medicines to be prescribed. However, many practices did not have such agreements in place and this meant that every time a DCP wished to issue fluoride supplements or provide local analgesia prior to treatment, they had to get approval from the GDP.

Another important, related, restriction is the inability for DCPs to examine patients or to provide a treatment plan under the NHS dental contract regulations. Although the dental regulator recently changed the scope of practice for DCPs, within the NHS, the GDP still needs to see the patient first. This creates an extra step in the referral pathway and substantial transactional cost, as patients that are seen by GDPs first

have to then be 'booked back in' with a DCP if they require treatment. In contrast, GDPs have the freedom to conduct the treatment in the same visit, immediately after the examination, if they have time. Both care pathways generate three UDAs, so the efficiency of the latter is far greater than that of the former.

The majority of patients had a low level of awareness of the roles of different members of the dental team and were not interested in the debate around role substitution within the NHS (see *Chapter 5*). Many exhibited an inherent trust in the system, although prior experience of role substitution was influential in social acceptability.

Drawing conclusions about the relationship between role substitution and efficiency requires an appreciation; therefore, the way in which role substitution is currently being implemented in practice makes it difficult for many practices to reap potential benefits of role substitution. The factors outlined in *Chapter 5* act as powerful barriers to more efficient ways of working, with the result that many DCPs capable of undertaking role substitution feel demotivated and underutilised.

Chapter 6 found that remuneration systems based on capitation did influence the organisation of inputs and outputs in NHS dentistry in Northern Ireland. Practices examined fewer patients and undertook fewer restorations, a finding that was not explained by a difference in patient mix. Lower levels of activity remained when patient selection (for a population with lower levels of dental health-care need) was analysed. Capitation remuneration did not increase the level of prevention offered, but did increase the number of extractions performed.

Considerations for future policy

The growing demand for health care in the UK, recent rises in NHS expenditures and decreasing health-care budgets highlight the importance of paying attention to the organisation and performance of the dental health-care system and of providing policy-makers and practice owners with evidence-based information to better inform their decisions. On account of this background, efficiency analysis and benchmarking has an important role in enabling health policy-makers, practice managers and dental professionals to identify and assess different approaches to organising the delivery of dental health care, including the success of different dental team structures in terms of processes and outcomes. We found a comprehensive analysis of dental health-care efficiency in the UK a challenging task, primarily because data were more readily available on units of health-care output than service quality or patients' oral health gains from treatment. We also found that dental practices were reluctant to provide cost information that could be used to estimate the profitability of their service. In these circumstances, in which data collection is limited, it is possible that findings have been influenced by unobserved determinants of practices' choice of inputs that also determine output, for example past investment in equipment or the attitudes of dentists towards DCPs.

Strengths and limitations of the research

This was the first study of its kind to empirically examine the efficiency of dental teams in the NHS that make use of role substitution. It was also of methodological interest, given that both models for determining efficiency in health care were utilised and the results were found to be robust and independent of the method of analysis, that there was consistency across both the non-parametric and parametric methods that were utilised. The study was also the first to compare the efficiency of NHS dental teams across different remuneration systems, although the limited sample sizes in Northern Ireland and Scotland prevented a fully robust comparison.

We examined a range of environmental and organisational influences, both internal and external to the dental practice, to establish associations with more efficient production. Ideally we would have applied longitudinal data with frequent waves to account for changes in the dental practice team and changes in care patterns over time. Without longitudinal data it was not possible to identify the extent of change in the efficiency of dental services or determinants of improvements in service performance.

Efficiency studies in NHS dental service provision to date have not adopted a robust empirical design and have used a limited range of input and output measures. A strength of our findings is that they are presented with both activity-based measures (patients seen and treatment plans) and price-based measures (NHS remuneration income). These measures allowed us to explore technical inefficiency (inefficiency caused by the wasteful use of inputs) although limitations in the availability of price and cost data prevented us from exploring allocative inefficiency (inefficiency caused by selection of an inappropriate input mix).

A major limitation of the programme of study was that it was not possible to observe inputs or outputs produced independently by DCPs who were capable of role substitution. Given that the current contractual relationship is between the NHS and the GDP alone, it was not possible to determine the efficiency of DCPs independently. Study findings therefore require careful interpretation, as we only estimate the effect of role substitution on the output of the whole dental team rather than the individual DCPs' output. In addition, we relied on practice-reported input measures recorded via a questionnaire. The pilot questionnaire was tested in depth and a balance had to be found between the inclusion of variables that were considered to be important in the production function and the likelihood of practices participating and returning the questionnaire. Any more detailed analysis would have required a prospective study. The research team also found that many dental practices were wary of sharing too much financial information and had to be reassured that the linkage between input data and the output data kept by the NHS would be anonymised at the source.

Another limitation is that random selection of practices did not take place. This would influence findings if there were factors unobserved to researchers that were related to the incidence of role substitution (e.g. dentists' choice to work with DCPs or limited dentist awareness of DCPs full scope of practice), as this may influence both the choice to hire a DCP and the supervision they receive to produce output. However, a broad range of covariates was entered into the analysis and the results remained robust.

Recommendations for further research

Further research is needed to fill the gaps in some areas of our productive efficiency model, such as a greater range of capital resources. Use of a health-related quality-of-life measure would provide a measure of the effect that dental health care has on patients' oral health. However, there are difficulties with this approach. Routine dental patients are largely non-symptomatic, so quality-of-life measures in this population would not identify subtle variations in effect and appropriately discriminate.^{139,140}

To better inform future planning decisions, it is recommended that future research integrate efficiency analysis with other relevant factors of overall performance in NHS dentistry such as equity, service coverage and access to care, responsiveness to changes in population needs and preferences for services, and accurate alignment at a national level of supply (e.g. the size of the workforce and health-care budget) with population needs for care (driven by, for example, population demographics and oral epidemiology). However, there are challenges to accessing the level of detail required for a full analysis of efficiency at a NHS practice. Prospective studies could offer potential, but do require the full co-operation of the NHS dental practice and our experience to date is that not all appreciate the extent of information required.

Concluding remarks

The use of DCPs capable of role substitution in NHS dental teams is not associated with higher levels of efficiency at the practice level. More attention needs to be paid to identifying the conditions under which DCP use improves practice efficiency and how NHS contracts could be developed in the future to support the efficient use of role substitution within NHS dentistry.

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Contributions of authors

Professor Paul Brocklehurst (Director of NWOORTH Clinical Trials Unit, Professor of Health Services Research and Honorary Consultant in Dental Public Health, Bangor University) led the research team and provided oversight on both main workstreams. He also oversaw the preparation and writing of the report.

Professor Stephen Birch (Professor in the Department of Clinical Epidemiology & Biostatistics, McMaster University and Professor of Health Economics, University of Manchester) led the development of the RQs and study objectives for workstream 1. He also oversaw the design of the workstream, the interpretation of the results and the preparation and writing of the report.

Professor Ruth McDonald (Professor of Health Services Research and Policy, University of Manchester) led the development of the RQs and study objectives for workstream 2. She also oversaw the design of the workstream, the interpretation of the results and the preparation and writing of the report.

Dr Harry Hill (Post-doctoral Research Associate, University of Manchester) undertook the research and analysis for workstream 1. He also wrote the section of the report on the use of technical efficiency (see *Chapter 4*).

Dr Lucy O'Malley (Lecturer in Oral Health Research, University of Manchester) undertook the research and analysis for workstream 2. She also wrote the section of the report that examined the experience of DCPs in the workplace (see *Chapter 5*).

Mr Richard Macey (Doctoral student, University of Manchester) also undertook the research and analysis for workstream 2. He also wrote the section of the report that examined the experience of DCPs in the workplace (see *Chapter 5*).

Professor Martin Tickle (Director of the Institute of Population Health, Professor and Honorary Consultant in Dental Public Health) helped to interpret the findings of both main workstreams and contributed to the writing of the report.

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Publications

Brocklehurst PR, Birch S, McDonald R, Tickle M. Determining the optimal model for role substitution in NHS dental services in the United Kingdom. *BMC Oral Health* 2013;**13**:46.

Data sharing statement

Data can be obtained from the corresponding author.

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Appendix 1 Analysis of additional sites

Sites from Scotland, Northern Ireland and from the community dental services were collected to understand the differences that different remuneration systems made to efficiency. Owing to the relatively low numbers collected, the results of the analysis are presented in this appendix, rather than in the main body of the report.

Tables 23 and 24 describe the sample statistics of NHS dental health-care output and input measures to the production of health care. A GDS practice in England had, on average, the most dentist hours on NHS patients (19.4 weekly sessions) followed by Scotland (17.2 weekly sessions), Northern Ireland (13.8 weekly sessions) and community dental services sites (13.3 weekly sessions). Community dental services sites are, however, the most likely to employ DCPs (80% of sample sites) followed by practices in England (68% of sample practices), Scotland (48% of sample practices) and Northern Ireland (34% of sample practices).

Table 25 describes the sample statistics for practice/site characteristics that may influence the production of health care. The number of surgeries is a direct input into the production of health care and is a measure of the capacity/size of each production unit. A community dental services site has on average the largest number of surgeries (3.7), followed by GDS practices in England (3.5), Scotland (2.9) and Northern Ireland (2.5). Patients who are exempt from payment charges are most likely to be found in community dental services sites (75.2% of the patient case mix), followed by Northern Ireland practices (59.9%), Scotland practices (46.4%) and England practices (37.3%). Children are a greater proportion of the patient case mix in community dental services sites (31.1%) than in practices in England (26.4%), Northern Ireland (13.7%) and Scotland (13.1%).

Table 26 presents efficiency scores estimated by an input orientation model and Table 27 describes efficiency scores estimated by output orientation.

TABLE 23 Sample statistics of NHS dental health-care output measures

Measure	Sample			
	England	Northern Ireland	Scotland	Community dental services sites
UDAs, <i>n</i> (95% CI)	15,444 (13,433 to 17,455)	N/A	N/A	2336 (1761 to 2910)
Income, £ (95% CI)	N/A	153,224 (102,808 to 203,639)	170,801 (105,848 to 235,754)	N/A
Treatment plans, <i>n</i> (95% CI)	7286 (6367 to 8205)	3351 (2366 to 4337)	3724 (2516 to 4931)	1278 (975 to 1581)
Patients seen, <i>n</i> (95% CI)	5597 (4905 to 6288)	2104 (1506 to 2704)	2811 (1992 to 3631)	1211 (827 to 1595)

CI, confidence interval; N/A, not applicable for this jurisdiction.

TABLE 24 Sample statistics of staffing measures

Measure	Sample, mean (95% CI)			Community dental services sites
	England	Northern Ireland	Scotland	
Number of weekly GDP sessions with NHS patients	19.4 (17 to 21.9)	13.8 (10.4 to 17.2)	17.2 (12.9 to 21.5)	13.3 (9.9 to 16.7)
Number of weekly PP sessions with NHS patients	6.1 (4.9 to 7.1)	6.5 (4.9 to 8.2)	5.6 (3.8 to 7.4)	N/A
Number of weekly associate GDP sessions with NHS patients	11.3 (9.1 to 13.4)	6.2 (3.1 to 9.3)	9.55 (5.2 to 13.8)	N/A
The percentage of DCP to GDP sessions seeing NHS patients	16.6 (12.6 to 34.6)	3.7 (0.3 to 7.1)	3.9 (0.7 to 7.2)	52.1 (34.1 to 70.2)
Any use of DCPs with NHS patients (%)	68	34	48	80
Number of FTE DCPs employed (to work with NHS or private patients)	1.1 (0.8 to 1.5)	0.2 (0.9 to 0.3)	0.3 (0.1 to 0.4)	5.2 (3.7 to 6.7)
Number of weekly DCP sessions with NHS patients	3.0 (2.1 to 3.8)	0.4 (0.02 to 0.9)	0.6 (0.03 to 1.2)	5.2 (3.7 to 6.7)
Number of weekly DH sessions with NHS patients	0.6 (0.3 to 0.8)	0.1 (0.03 to 0.2)	0.4 (0.04 to 0.7)	0.3 (0.01 to 0.62)
Number of weekly DHT sessions with NHS patients	1.7 (0.9 to 2.5)	0.3 (0.02 to 0.7)	0.01 (0.01 to 0.02)	0
Number of weekly DT sessions with NHS patients	0.7 (0.3 to 1.0)	0	0.3 (0.03 to 0.8)	3.6 (2.5 to 4.6)
Number of weekly nurse sessions	47.0 (42.1 to 52.0)	29.8 (23.2 to 36.5)	39.6 (29.8 to 49.4)	40.1 (30.5 to 49.7)
Number of weekly administration staff sessions	20.8 (18.3 to 23.3)	14.1 (10.8 to 17.5)	15.7 (11.0 to 20.3)	26.5 (20.8 to 32.3)

CI, confidence interval; FTE, full-time equivalent; N/A, not applicable for this programme.

TABLE 25 Sample statistics of practice/site measures

Measure	Sample, mean (95% CI)			
	England	Northern Ireland	Scotland	Community dental services sites
Surgeries (<i>n</i>)	3.5 (3.2 to 3.8)	2.5 (1.9 to 3.0)	2.9 (2.2 to 3.5)	3.7 (2.9 to 4.6)
Percentage of child patients	26.4 (22.7 to 30.1)	13.7 (7.1 to 20.2)	13.1 (8.7 to 17.6)	31.1 (20.3 to 41.1)
Percentage of payment-exempt patients	37.3 (32.9 to 41.7)	59.9 (50.6 to 69.2)	46.4 (37.7 to 54.9)	75.2 (71.1 to 79.3)
Percentage of band 1 treatments	57.3 (55.1 to 59.5)	N/A	N/A	33.2 (29.1 to 38.0)
Percentage of band 2 treatments	28.4 (27.1 to 29.7)	N/A	N/A	43.2 (39.1 to 47.4)
Percentage of band 3 treatments	4.7 (4.1 to 5.3)	N/A	N/A	16.1 (12.2 to 20.2)
Percentage of urgent treatments	9.6 (7.7 to 11.6)	N/A	N/A	7.5 (3.1 to 11.4)
Good Practice Award (<i>n</i>)	33	3.4	8.7	N/A
Material costs (£)	11.7 (10.2 to 13.2)	12.9 (9.7 to 16.0)	16.4 (10.7 to 22.1)	N/A
Laboratory costs (£)	9.7 (8.3 to 11.1)	12.1 (9.4 to 14.9)	11.9 (10.0 to 13.8)	N/A

CI, confidence interval; N/A, not applicable for this jurisdiction/programme.

TABLE 26 Summary of efficiency scores estimated by input orientation

Output measure	Sample, mean efficiency score (range: minimum–maximum)			
	England (<i>n</i> = 121)	Northern Ireland (<i>n</i> = 29)	Scotland (<i>n</i> = 20)	Community dental services sites (<i>n</i> = 40)
Annual number of UDAs	0.64 (0.19–1.00)	N/A	N/A	0.85 (0.35–1.00)
Annual gross NHS income	N/A	0.80 (0.34–1.00)	0.94 (0.65–1.00)	N/A
Annual number of treatment plans (claims)	0.63 (0.19–1.00)	0.81 (0.40–1.00)	0.91 (0.51–1.00)	0.82 (0.36–1.00)
Annual number of patients seen	0.62 (0.19–1.00)	0.82 (0.40–1.00)	0.91 (0.59–1.00)	0.73 (0.21–1.00)

N/A, not applicable for this jurisdiction/programme.

TABLE 27 Summary of efficiency scores estimated by output orientation

Output measure	Sample, mean efficiency score (range: minimum–maximum)			
	England (<i>n</i> = 121)	Northern Ireland (<i>n</i> = 29)	Scotland (<i>n</i> = 20)	Community dental services sites (<i>n</i> = 40)
Annual number of UDAs	0.48 (0.08–1.00)	N/A	N/A	0.82 (0.32–1.00)
Annual gross NHS income	N/A	0.68 (0.22–1.00)	0.90 (0.46–1.00)	N/A
Annual number of treatment plans (claims)	0.46 (0.09–1.00)	0.71 (0.21–1.00)	0.88 (0.51–1.00)	0.81 (0.43–1.00)
Annual number of patients seen	0.45 (0.10–1.00)	0.74 (0.22–1.00)	0.89 (0.54–1.00)	0.68 (0.22–1.00)

N/A, not applicable for this jurisdiction/programme.

Practices are operating at a mean level of efficiency of 64% (England), 80% (Northern Ireland), 94% (Scotland) and 85% (community dental services sites) with input orientation. The mean efficiency score changes little when practice performance is measured by the effectiveness of the practices in reducing health-care inputs to see a fixed number of patients or treatment plans (output orientation).

The associations with efficiency scores of any use of DCPs with NHS patients are calculated for the sample of practices in each jurisdiction and service type in *Table 28* (UDAs as the health-care output), *Table 29* (treatment plans as the health-care output) and *Table 30* (patients seen as the health-care output). *Table 31* describes the findings for the sample of practices in each jurisdiction and service type when the measure is use of DCPs including sessions worked with all patients (NHS or private). This broadening of the measure of DCP use does not change the direction of the statistical associations identified above and the estimated coefficients on the use of DCPs remain similar. Any use of DCPs with NHS patients was found to be associated with 14% lower efficiency when the output measure was UDAs and 11% lower efficiency when the output measure was treatment plans or patients seen. All of these associations are statistically significant. The only other statistically significant association between efficiency and use of DCPs with NHS patients is found in the sample of community dental services sites in which use of DCPs is associated with a 21% lower efficiency score when health-care output is measured by the number of patients seen.

TABLE 28 Association with efficiency scores of any use of DCPs with NHS patients when the health-care output was UDAs/gross NHS income

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Any use of DCPs with NHS patients	-0.140	< 0.00	-0.07	0.38	-0.0500	0.32	-0.130	0.16
Weekly GDP sessions with NHS patients	-0.001	0.76	-0.01	< 0.00	0.0040	0.26	0.008	0.26
Weekly support staff sessions	-0.005	< 0.00	-0.02	< 0.00	0.0050	0.13	-0.004	0.09
Number of surgeries	-0.040	0.02	0.06	0.07	-0.0500	0.10	-0.020	0.51
Proportion of adult non-elderly patients	-0.190	0.09	-0.68	0.02	-0.2800	0.11	-0.230	0.12
Proportion with non-age-related exemption from NHS charges status	-0.130	0.34	0.22	0.31	-0.0001	0.97	0.150	0.64

Note

Efficiency scores are calculated from an input orientation.

TABLE 29 Association with efficiency scores of any use of DCPs with NHS patients when the health-care output was treatment plans (claims)

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Any use of DCPs with NHS patients	-0.110	<0.00	-0.04	0.65	-0.020	0.83	-0.110	0.21
Weekly GDP sessions with NHS patients	-0.001	0.54	-0.02	<0.00	-0.001	0.79	0.007	0.33
Weekly support staff sessions	-0.006	<0.00	-0.02	0.01	-0.004	0.47	-0.005	<0.02
Number of surgeries	-0.050	<0.00	0.07	0.05	-0.020	0.72	-0.010	0.63
Proportion of adult non-elderly patients	-0.150	0.11	1.10	0.09	0.180	0.49	-0.180	0.20
Proportion with non-age-related exemption from NHS charges status	-0.380	0.01	0.20	0.27	-0.510	0.38	-0.110	0.70

Note
Efficiency scores are calculated from an input orientation.

TABLE 30 Association with efficiency scores of any use of DCPs with NHS patients when the health-care output was patients seen

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Any use of DCPs with NHS patients	-0.110	<0.00	-0.03	0.70	-0.030	0.69	-0.210	0.02
Weekly GDP sessions with NHS patients	-0.002	0.21	-0.02	0.01	-0.001	0.77	-0.010	0.13
Weekly support staff sessions	-0.006	<0.00	-0.01	0.02	-0.004	0.42	-0.001	0.50
Number of surgeries	-0.050	<0.00	0.09	0.02	0.004	0.93	-0.007	0.78
Proportion of adult non-elderly patients	-0.160	0.09	0.50	0.12	0.090	0.70	0.180	0.22
Proportion with non-age-related exemption from NHS charges status	-0.290	0.04	0.10	0.66	-0.260	0.62	-0.090	0.76

Note
Efficiency scores are calculated from an input orientation.

TABLE 31 Associations with efficiency scores of the utilisation of DCPs with either NHS or private patients

Health-care output	Utilisation of DCPs with either NHS or private patients	Sample						
		England		Northern Ireland		Scotland		
		Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	
UDAs/income	Any use of DCPs (on either NHS or private patients)	-0.14	<0.00	-0.080	0.30	-0.03	0.66	N/A
Treatment plans	Any use of DCPs (on either NHS or private patients)	-0.12	<0.00	-0.070	0.38	-0.02	0.82	N/A
Patients seen	Any use of DCPs (on either NHS or private patients)	-0.13	<0.00	-0.080	0.31	-0.08	0.39	N/A
UDAs/income	Number of FTE DCPs employed (to work with NHS or private patients)	0.02	0.10	-0.007	0.58	-0.11	0.49	N/A
Treatment plans	Number of FTE DCPs employed (to work with NHS or private patients)	0.01	0.43	-0.010	0.30	-0.08	0.73	N/A
Patients seen	Number of FTE DCPs employed (to work with NHS or private patients)	0.01	0.32	-0.010	0.25	-0.33	0.15	N/A

FTE, full-time equivalent; N/A, not applicable for community dental services sites as DCP use is with NHS patients only.

Note

Each row is a separate regression that includes control variables: weekly NHS GDP sessions, weekly administration staff sessions, Number of surgeries, proportion of adult non-elderly patients and proportion of patients with non-age-related exemption from NHS charges status.

The associations with efficiency scores of the level of use of DCPs with NHS patients is calculated for the sample of practices in each jurisdiction and service type in *Table 32* (UDAs as the health-care output), *Table 33* (treatment plans as the health-care output) and *Table 34* (patients seen as the health-care output).

There is no difference in the associations identified for the England sample except in the sample case study of community dental services sites. A site with an additional weekly session of DCP use in community dental services sites is associated with a 5% lower efficiency score ($p < 0.05$) when UDAs is the output measure and a 4% lower efficiency score ($p < 0.05$) when the number of treatment plans is the output measure, although there is no significant difference in efficiency scores among community dental services sites when the output measure is patients seen.

The association between efficiency scores and the proportion of clinical time provided by DCPs in practices/sites that employ DCPs is presented for each jurisdiction and service type in *Table 35* (UDAs as the health-care output), *Table 36* (treatment plans as the health-care output) and *Table 37* (patients seen as the health-care output). There is no difference in the case study samples in the non-statistically significant difference identified in the England sample. In all jurisdictions and service types (practices or community dental services sites), the ratio of DCP weekly sessions worked with NHS patients to GPs' weekly sessions worked with NHS patients is not significantly associated with any measure of output after controlling for patient and practice characteristics.

TABLE 32 Association with efficiency scores of the level of use of DCPs with NHS patients when the health-care output was UDAs/gross NHS income

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Weekly DCP sessions with NHS patients	-0.004	0.51	0.020	0.43	-0.020	0.63	-0.05	<0.00
Weekly GDP sessions with NHS patients	0.001	0.73	-0.010	0.56	0.007	0.35	0.02	0.04
Weekly support staff sessions	-0.005	<0.00	-0.010	0.17	0.007	0.50	-0.005	0.01
Number of surgeries	-0.040	0.05	-0.002	0.98	-0.080	0.34	0.03	0.16
Proportion of adult non-elderly patients	-0.210	0.11	-2.030	0.12	-0.620	0.31	-0.38	0.01
Proportion with non-age-related exemption from NHS charges status	-0.090	0.58	0.710	0.11	0.005	0.53	0.24	0.43

Note

Efficiency scores are calculated from an input orientation.

TABLE 33 Association with efficiency scores of the level of use of DCPs with NHS patients when the health-care output was treatment plans (claims)

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Weekly DCP sessions with NHS patients	-0.005	0.35	0.008	0.89	0.010	0.81	-0.040	<0.00
Weekly GDP sessions with NHS patients	0.001	0.79	-0.020	0.16	0.004	0.52	0.010	0.11
Weekly support staff sessions	-0.006	<0.00	-0.010	0.53	-0.006	0.58	-0.006	0.01
Number of surgeries	-0.040	0.03	-0.010	0.95	-0.100	0.23	0.040	0.17
Proportion of adult non-elderly patients	-0.160	0.16	2.500	0.36	0.470	0.46	-0.300	0.04
Proportion with non-age-related exemption from NHS charges status	-0.320	0.08	0.670	0.30	-0.780	0.50	-0.090	0.77

Note
Efficiency scores are calculated from an input orientation.

TABLE 34 Association with efficiency scores of the level of use of DCPs with NHS patients when the health-care output was patients seen

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Weekly DCP sessions with NHS patients	-0.0009	0.85	-0.020	0.77	-0.020	0.77	-0.020	0.10
Weekly GDP sessions with NHS patients	-0.0008	0.68	-0.010	0.68	0.002	0.79	-0.008	0.39
Weekly support staff sessions	-0.0060	<0.00	-0.020	0.35	-0.001	0.91	-0.003	0.30
Number of surgeries	-0.0500	<0.00	0.140	0.45	-0.020	0.80	0.020	0.54
Proportion of adult non-elderly patients	-0.1700	0.12	-0.400	0.86	0.080	0.92	0.120	0.49
Proportion with non-age-related exemption from NHS charges status	-0.2600	0.15	0.310	0.76	-0.140	0.91	0.010	0.98

Notes
Efficiency scores are calculated from an input orientation.
Regression was with GDS practices/community dental services sites that employed some level of use of DCPs with NHS patients.

TABLE 35 Association with efficiency scores of the proportion of clinical time provided by DCPs when the health-care output was UDAs/gross income

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
The percentage of DCP to GDP sessions seeing NHS patients	0.0005	0.09	-0.003	0.54	-0.003	0.72	-0.0500	0.67
Weekly support staff sessions	-0.0050	<0.00	-0.020	0.11	0.006	0.58	-0.0030	0.27
Number of surgeries	-0.0400	<0.00	0.060	0.47	-0.050	0.47	0.0002	0.99
Proportion of adult non-elderly patients	-0.1700	0.10	-2.690	0.01	-0.500	0.37	-0.1900	0.32
Proportion with non-age-related exemption from NHS charges status	-0.1400	0.35	0.560	0.10	0.004	0.64	-0.0400	0.91

Notes

Efficiency scores are calculated from an input orientation.

Regression was with GDS practices/community dental services sites that employed some level of use of DCPs with NHS patients.

TABLE 36 Association with efficiency scores of the proportion of clinical time provided by DCPs when the health-care output was treatment courses (claims)

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
The percentage of DCP to GDP sessions seeing NHS patients	0.001	0.07	0.02	0.46	0.003	0.69	-0.060	0.62
Weekly support staff sessions	-0.006	<0.00	0.02	0.64	-0.006	0.55	-0.005	0.08
Number of surgeries	-0.040	<0.00	-0.30	0.44	-0.070	0.25	0.010	0.78
Proportion of adult non-elderly patients	-0.120	0.15	2.85	0.51	0.510	0.35	-0.170	0.36
Proportion with non-age-related exemption from NHS charges status	-0.400	0.02	1.05	0.20	-0.990	0.42	-0.320	0.36

Notes

Efficiency scores are calculated from an input orientation.

Regression was with GDS practices/community dental services sites that employed some level of use of DCPs with NHS patients.

TABLE 37 Association with efficiency scores of the proportion of clinical time provided by DCPs when the health-care output was patients seen

Variable	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
The percentage of DCP to GDP sessions seeing NHS patients	0.001	0.06	-0.03	0.14	0.0001	0.99	0.200	0.12
Weekly support staff sessions	-0.006	< 0.00	-0.06	0.08	-0.002	0.89	-0.001	0.81
Number of surgeries	-0.050	< 0.00	0.41	0.11	-0.010	0.89	-0.060	0.10
Proportion of adult non-elderly patients	-0.170	0.04	-3.34	0.07	0.240	0.71	0.270	0.15
Proportion with non-age-related exemption from NHS charges status	-0.300	0.06	0.02	0.98	-0.160	0.90	0.160	0.64

Notes

Efficiency scores are calculated from an input orientation.

Regression was with GDS practices/community dental services sites that employed some level of use of DCPs with NHS patients.

Table 38 presents the estimated coefficients on the interaction term between the level of DCP use and the characteristics of the patient population for all jurisdictions and service types. There is no difference in the case study samples in the non-statistically significant interaction terms identified in the England sample. No significant interactions with patient population characteristics were found, indicating that the association between DCP use and efficiency is not related to the type of population being served.

The associations between routine services and the level of use of DCPs, and the associations between routine services and the proportion of clinical time provided by DCPs are presented in Tables 39 and 40, respectively.

Among the case study samples, the only significant association between routine services and the level of use of DCPs was found in the community dental services sample, in which the proportion of band 2 treatments was larger ($p < 0.05$). One more weekly session of DCP use for NHS patients is associated with a 1% higher proportion of band 2 treatments delivered after controlling for practice and/or patient characteristics.

TABLE 38 Mediating associations with efficiency scores between the level of DCP use and patient case-mix variables

Output measure	Mediating variable	Sample							
		England		Northern Ireland		Scotland		Community dental services sites	
		Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
UDA/income	Proportion of adult non-elderly patients	0.08	0.10	-2.46	0.31	-0.33	0.80	0.02	0.57
	Proportion with non-age-related exemption from NHS charges status	0.03	0.21	-0.58	0.49	0.02	0.25	-0.04	0.66
Claims	Proportion of adult non-elderly patients	0.05	0.24	0.04	0.99	0.02	0.98	0.04	0.31
	Proportion with non-age-related exemption from NHS charges status	0.05	0.08	-4.30	0.06	2.64	0.29	-0.12	0.21
Patients seen	Proportion of adult non-elderly patients	0.06	0.09	4.52	0.67	-0.43	0.59	0.004	0.93
	Proportion with non-age-related exemption from NHS charges status (95% CI)	0.05 (-0.01 to 0.10)	0.08	-3.44 (-6.72 to -0.16)	0.05	5.09	0.18	0.042	0.72

CI, confidence interval.

TABLE 39 Associations between the numbers of routine services delivered in the NHS and the level of DCP use on NHS patients

Outcome variable (routine services)	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient: number of DCP NHS sessions	p-value	Coefficient: number of DCP NHS sessions	p-value	Coefficient: number of DCP NHS sessions	p-value	Coefficient: number of DCP NHS sessions	p-value
Proportion of band 1 treatments	-0.0001	0.99	N/A	N/A	N/A	N/A	0.004	0.67
Proportion of band 2 treatments	0.0010	0.51	N/A	N/A	N/A	N/A	0.01	0.01
Percentage of preventative treatments (scale and polish, fluoride varnish)	2.46	0.10	-0.31	0.86	0.54	0.78	0.67	0.61
Proportion of examinations	N/A	N/A	0.69	0.64	-1.10	0.06	1.32	0.42
Proportion of fillings	N/A	N/A	-3.75	0.61	-3.24	0.07	0.04	0.93

N/A, not applicable for this jurisdiction/programme.

Note
Each row is a separate regression that includes control variables: weekly NHS GDP sessions, weekly administration staff sessions, number of surgeries, proportion of adult non-elderly patients and proportion of patients with non-age-related exemption from NHS charges status.

TABLE 40 Associations between routine services delivered in the NHS and the proportion of DCPs' clinical time relative to GDPs' clinical time working with NHS patients

Outcome variable (routine services)	Sample							
	England		Northern Ireland		Scotland		Community dental services sites	
	Coefficient: number of DCP NHS sessions	p-value	Coefficient: number of DCP NHS sessions	p-value	Coefficient: number of DCP NHS sessions	p-value	Coefficient: number of DCP NHS sessions	p-value
Proportion of band 1 treatments	-0.00003	0.86	N/A	N/A	N/A	N/A	0.05	0.50
Proportion of band 2 treatments	-0.00001	0.90	N/A	N/A	N/A	N/A	-0.09	0.06
Percentage of preventative treatments (scale and polish, fluoride varnish)	0.36	0.00	0.11	0.65	-0.02	0.96	2.37	0.84
Proportion of examinations	N/A	N/A	-0.31	0.06	-0.19	0.11	0.63	0.96
Proportion of fillings	N/A	N/A	-0.50	0.15	-0.52	0.18	-1.36	0.70

N/A, not applicable for this jurisdiction/programme.

Note
Each row is a separate regression that includes control variables: weekly NHS GDP sessions, weekly administration staff sessions, number of surgeries, proportion of adult non-elderly patients and proportion of patients with non-age-related exemption from NHS charges status.

Appendix 2 Dental team questionnaire

ID:

DENTAL TEAM QUESTIONNAIRE

This is a questionnaire that has been designed to help us understand how dental teams work and the types of activity that they undertake. The questionnaire has been piloted with fellow practitioners to ensure that it is fit-for-purpose, whilst being sensitive to the commercial interests of the practice. It has received full ethics approval (University of Manchester Research Ethics Committee reference number 14028). *Given the type of questions that are asked, either the practice owner or the practice manager should complete the questionnaire.*

It will not be possible for the research team to identify persons who complete this questionnaire. All the data recorded on the form will be *anonymised independently* from the research team so it will not be possible to identify the practice to which the data belongs:

- The answers to the questionnaire will be entered onto a password protected Excel file, totally independent to the research team. Upon receipt of the questionnaire you will be sent a £75 voucher to thank you for your participation;
- Your contact details will then be sent to the relevant NHS Information Centre to link the Excel file to your activity data, again independent to the research team;
- Your contact details will then be removed from the Excel file and destroyed, before the NHS Information Centre sends the linked, anonymised data to the research team;
- All of the data collected in the questionnaire will be held in compliance with the Data Protection Act 1998 and will be processed in accordance with the rights under this Act;
- The data will only be used for the analyses that have been approved by the Ethics Committee;

Please complete the questionnaire and return it in the envelope provided. You will be sent a £75 voucher for your practice *when the fully completed* questionnaire is returned (this includes the full completion of the consent form).

SECTION 1

Please answer all of the following questions:

1. Is your practice a dental body corporate? **Y** / **N** (please circle)

2. How many surgeries are typically in operation (for at least 3 days / week)?

3. Has your practice been awarded the British Dental Association's Good Practice Award? **Y** / **N** (please circle)
 - If yes, what is your most recent award status: gold, silver, bronze?

4. Please describe your practice by detailing the number of *full time equivalent* staff that you have (you'll get to describe the number of clinicians in Section 2):
 - Nurses
 - Practice managers
 - Other administrative staff

5. How long (in minutes) do you tend to book for a routine examination?
 - For a regular patient:
 - For a new patient (non-emergency):

6. As a proportion of total annual income, what do you typically spend on:

- Consumables and materials per year?%
- Laboratory fees per year?%

7. What would be a typical remuneration rate for a session for the following members of staff (either that you actually pay or what you'd be prepared to pay)?

- Hygienist £ per session
- Hygiene-therapist £ per session
- Therapist £ per session

SECTION 2

Please complete the table below, with each row representing a separate **dentist** at your practice:

Dentist number	Please indicate whether each dentist is a principal (P), an associate (A), a salaried dentist (S), assistant (As) or Dental Foundation Trainee (DF)?	Please indicate the dentist's UDA target for the year 2013/14?	Please indicate how many sessions* the dentist works in the practice in a typical week?	Please indicate the approximate proportion of this time that is spent on treating NHS patients?
1				%
2				%
3				%
4				%
5				%
6				%
7				%
8				%

*session = half-day

Please complete the table below, with each row representing either a hygienist, hygiene-therapist or therapist that you employ in your practice (**we do not require information on dental nurses**). Please leave the table blank if you employ none of these types of staff.

DCP number	Please indicate the type of DCP that works at your practice: hygienist (H), hygiene-therapist (H-T) and therapist (T)?	Please indicate how many sessions* the DCP works in the practice in a typical week?	Please indicate the approximate proportion of this time that is spent on treating NHS patients?
1			%
2			%
3			%
4			%
5			%
6			%
7			%
8			%
9			%
10			%

*session = half-day

THANK YOU FOR YOUR TIME, IT IS VERY MUCH APPRECIATED

PLEASE RETURN THIS QUESTIONNAIRE IN THE ENCLOSED ENVELOPE

THE DATA RECORDED ABOVE REPRESENTS IMPORTANT INFORMATION THAT
WILL BE TREATED ANONYMOUSLY AND WILL HELP US UNDERSTAND HOW
DIFFERENT DENTAL TEAMS ARE UTILISED.

**WE'D ALSO LIKE TO COLLECT RELEVANT AND ANONYMISED ACTIVITY
DATA FOR THE PRACTICE. THIS WILL BE SOURCED FROM THE RELEVANT
NHS INFORMATION CENTRE FOR A SINGLE ANNUAL PERIOD.**

**ON RECEIPT OF THE FULLY COMPLETED QUESTIONNAIRE (including the
consent form), YOU WILL RECEIVE YOUR £75 VOUCHER BY POST**

Appendix 3 Analysis of Oasis data

This appendix contains the descriptive statistics of the Oasis and control group.

Table 41 describes practice characteristics and patient selection variables for Oasis practices in comparison with the control practices. Oasis practices had greater staffing capacity to deliver health care than control practices, with, on average, 0.89 more GPs active per practice per month. The mean number of monthly treatment items delivered was larger among control practices (922 treatment items) than among Oasis practices (811 treatment items) and this difference between the two groups was statistically significant at a 5% level. The mean monthly number of treatment plans delivered to patients was larger for an Oasis practice (463 treatment plans) than a control practice (392 treatment plans), whereas the mean value of the treatment plans delivered was lower in Oasis practices than in control practices by £10.83.

On average, in control group practices, 2.01% more of the practice population was made up of patients aged ≥ 60 years; in Oasis practices, 6.55% more of patients seen were exempt from payment charges for reasons associated with high dental care need. However, Oasis practices are, on average, located in areas of lower deprivation than control practices.

TABLE 41 Sample comparison of Oasis practices with control practices for practice characteristics and patient selection variables

Variable name	Average for practice				Difference	
	Control		Oasis		Mean	<i>p</i> -value
	Mean (<i>n</i>)	95% CI	Mean (<i>n</i>)	95% CI		
Practice characteristics						
Number of GPs	3.21 (2079)	3.15 to 3.27	4.11 (478)	3.91 to 4.31	-0.89	<0.00
Regional deprivation	21.2 (2415)	21 to 21.47	19.8 (556)	19.4 to 20.3	1.41	<0.00
Monthly number of treatment items	922 (2079)	895 to 948	811 (478)	766 to 857	110	<0.00
Monthly number of treatment plans (claims)	392 (2079)	381 to 402	463 (478)	435 to 492	-71.41	<0.00
Monthly number of registrations	3359 (2415)	3282 to 3437	3850 (556)	3665 to 4034	-490	<0.00
Monthly number of patients seen	306 (2415)	297 to 314	320 (556)	302 to 339	-14.4	0.15
Patient selection						
Percentage of registered patients aged ≥ 60 years	15.3 (2079)	15.1 to 15.6	13.3 (478)	13 to 13.6	2.01	<0.00
Percentage of registered patients that are children	30.7 (2415)	30.3 to 31.1	19.9 (556)	19.7 to 20.2	10.7	<0.00
Percentage of registered patients exempt from payment charges	43.2 (2415)	42.4 to 44.0	36.7 (556)	35.9 to 37.3	6.6	<0.00

CI, confidence interval.

Table 42 describes receipt of care among registrants, mix of treatments and financial viability variables for Oasis practices in comparison with the control practices. Oasis practices deliver care over a larger patient population. An Oasis practice has, on average, 490 more registered patients and treats an average of 14 more unique patients per month than control group practices. This suggests that, although Oasis practices were purposely set up in locations where the government had identified barriers which prevented access to oral health care in the resident population, the practices nonetheless facilitated access to health-care services to more patients than neighbouring control group practices.

TABLE 42 Sample comparison of Oasis practices with control practices for receipt of care among registrants, mix of treatments and financial viability variables

Variable name	Average for practice				Difference	
	Control		Control		Mean difference	p-value
	Mean (n ^a)	95% CI	Mean (n ^a)	95% CI		
Receipt of care among registrants						
Monthly number of patients seen per 100 registrations	8.9 (2415)	8.8 to 9	8.4 (556)	8.1 to 8.6	0.54	<0.00
Monthly number of courses per 100 registrations	11.7 (2079)	11.6 to 11.9	12.5 (478)	12.1 to 12.9	-0.8	<0.00
Value of treatment per treatment course (£)	33.8 (2079)	33.4 to 34.2	22.9 (478)	22.4 to 23.5	10.8	<0.00
Mix of treatments						
Monthly number of examinations per 100 patients seen	66.7 (2079)	66.2 to 67.1	62.4 (478)	61.6 to 63.2	4.30	<0.00
Monthly number of extractions per 100 patients seen	16.1 (2079)	15.8 to 16.4	20.7 (478)	20 to 21.4	-4.6	<0.00
Monthly number of fillings per 100 patients seen	60.3 (2079)	59.6 to 60.9	44.3 (478)	43.3 to 45.4	15.9	<0.00
Monthly number of scale and polishes per 100 patients seen	48.2 (2079)	47.6 to 48.7	40 (478)	39 to 41.1	8.1	<0.00
Monthly number of fluoride varnishes per 100 patients seen	0.023 (2079)	0.015 to 0.032	0.018 (478)	0.008 to 0.029	0.005	0.60
Monthly number of fluoride varnishes per 100 child registrations	0.008 (2079)	0.005 to 0.01	0.007 (478)	0.003 to 0.01	0.0007	0.83
Financial viability						
Patient payment charge revenue per registration (£)	11.5 (2079)	11.1 to 11.8	15.4 (478)	15.1 to 15.7	-3.93	<0.00
Patient payment charge revenue treatment course (£)	9.1 (2079)	8.8 to 9.41	10.5 (478)	10.2 to 10.8	-1.4	<0.00
CI, confidence interval.						
a One observation is one practice observed in 1 month.						

The revenues accrued to the practice from patient payment charges per registration and per patient seen are both higher for an Oasis practice by £3.93 and £1.37, respectively. Oasis practices deliver an average of 4.6 more extractions per 100 patients seen than control practices. Other types of treatments are less frequently delivered in Oasis practices. These differences are statistically significant, which indicates different service mixes between Oasis and control practices.

A limitation of the pooled OLS approach is the potential bias for unobserved individual heterogeneity on estimators. Each dental practice has its own unique individual characteristics, not all of which are observed in the data but may influence or bias the explanatory variables. For example, the tenure of GPs could influence the amount of health care they provide, the number of nearby dental practices could influence the amount of patient registrations, business expertise may influence the size of the practice; use of DCPs could influence the treatment service mix. Not controlling for unobserved practice specific effects leads to potential bias in the resulting estimates. In panel estimation, the influence of time-invariant practice characteristics is assumed to be captured by the correlation between the error term for the practice and explanatory variables.

Fixed- and random-effects estimators are alternative estimators for the panel model. Each has advantages and disadvantages. However, in this study random effects is appropriate because calculating an estimate of the matching variable (the estimated coefficient of matching variable indicates the effect on an outcome of belonging to either the Oasis or control group) is not possible with a fixed-effects estimator as that variable is time invariant. We use the Hausman test¹⁴¹ to test the null hypothesis that the coefficients estimated by a more efficient model (random effects) are the same as the ones estimated by a less efficient but consistent model (fixed effects). At a 5% significance level the null hypothesis was accepted, which means that random effects are preferable to fixed effects.

A problem with the random-effects model is that it assumes that the practice-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, current and future time periods of the same practice. This assumption is false if, for example, the ability of a practice to deliver oral health care is learnt from their experience delivering care to patients. Then the practice-specific effect would not be random but related to types of patients they have seen (patient case-mix explanatory variables). The assumption would also be false if the ability of a practice to deliver health care arises from its management structure, organisational culture and workplace environment. Those are in part constituted by the number and type of staff members that the practice has employed, so the practice-specific effect would be correlated with the explanatory variables measuring staffing levels.

To relax this assumption, we estimate the random-effects model with a Mundlak correction. This approach is often used with random-effects models and is conducted by adding group means of the time-varying explanatory variables to the model. The results of the estimators are now divided between the current effect and the long-term effect of the explanatory variables on the outcome variable. The coefficient on the group means of the time-varying explanatory variables is the longer-term effect of those variables on the current outcome, while the coefficient on the time-varying explanatory variables is the current effect of those variables on current outcome. The current effect of the time-varying explanatory variables should be less than the 'total' (current and long-term) effect if the model holds true. Hence, if the correct specification is the Mundlak-corrected random-effects model, the coefficients on its time-varying explanatory variables (current effect) should be of smaller magnitude than the coefficients in the OLS model and random-effects model on the time-varying explanatory variables ('total' effect). *Table 43* shows the coefficients and statistical significance of explanatory variables to be almost identical across the three model specifications. A joint Wald test did not reject the null hypothesis that the coefficients on time-varying explanatory variables are identical. This suggests that there is not enough variation across the months within practices to justify a panel approach and we chose pooled OLS with robust standard errors as our main model specification.

TABLE 43 Separate regressions showing the differences in the outcome variables between Oasis and control practices for each group of RQs when estimated using OLS with robust standard errors, random effects and random effects with the Mundlak correction

Dependent variable (i.e. outcome measure)	OLS		Random effects		Random effects with Mundlak correction	
	Matching variable estimate	p-value	Matching variable estimate	p-value	Matching variable estimate	p-value
Patient selection						
Percentage of registered patients aged ≥ 60 years	-1.72	0.35	-2.28	0.20	-1.73	0.35
Percentage of registered patient that are children	-11.2	<0.00	-11.04	<0.00	-11.16	<0.00
Percentage of registered patients exempt from payment charges for reasons associated with high dental care need	-3.81	0.21	-3.78	0.50	-3.56	0.53
Receipt of care among registrants						
Patients seen per 100 registrations	-1.61	<0.00	-1.85	<0.00	-1.51	<0.00
Treatment courses per 100 registrations	0.69	0.25	-0.22	0.70	0.69	0.25
Value of treatment per claim (£)	-14.29	<0.00	-14.44	<0.00	-14.29	<0.00
Mix of treatments						
Examination per 100 patients seen	-9.76	<0.00	-9.50	<0.00	-9.76	<0.00
Extractions per 100 patients seen	6.20	<0.00	7.18	<0.00	6.20	<0.00
Fillings per 100 patients seen	-17.89	<0.00	-16.90	<0.00	-17.89	<0.00
Scale and polish per 100 patients seen	-11.47	<0.00	-14.45	<0.00	-11.47	<0.00
Fluoride varnish per 100 patients seen	0.034	0.41	0.017	0.66	0.034	0.41
Fluoride varnish per 100 child registrations	0.008	0.53	0.005	0.65	0.008	0.53
Financial viability						
Patient payment charge revenue per registration (£)	-0.53	0.63	-1.42	0.14	-0.53	0.63
Patient payment charge revenue per treatment course (£)	-2.85	<0.00	-3.02	<0.00	-2.85	<0.00

Appendix 4 Topic guide and coding frame

Theoretical frameworks are increasingly used for process evaluation and to determine the barriers to, and enablers of, implementation.^{142–144} As a result, normalisation process theory was used as a means of framing the development of the topic guides to understand the barriers to, and enablers of, role substitution and how such practices could become normalised.

The following domains were considered:¹⁴⁴

1. Coherence (i.e. meaning and sense-making by participants)
 - Is the intervention easy to describe?
 - Is it clearly distinct from other interventions?
 - Does it have a clear purpose for all relevant participants?
 - Do participants have a shared sense of its purpose?
 - What benefits will the intervention bring and to whom?
 - Are these benefits likely to be valued by potential participants?
 - Will it fit with the overall goals and activity of the organisation?
2. Cognitive participation (i.e. commitment and engagement by participants)
 - Are target user groups likely to think it is a good idea?
 - Will they see the point of the intervention easily?
 - Will they be prepared to invest time, energy and work in it?
3. Collective action (i.e. the work participants do to make the intervention function)
 - How compatible is it with existing work practices?
 - What impact will it have on division of labour, resources, power and responsibility between different professional groups?
 - Will it fit with the overall goals and activity of the organisation?
4. Reflexive monitoring (i.e. participants reflect on or appraise the intervention)
 - How are users likely to perceive the intervention once it has been in use for a while?
 - Is it likely to be perceived as advantageous for patients or staff?
 - Can users/staff contribute feedback about the intervention once it is in use?
 - Can the intervention be adapted or improved on the basis of experience?

Topic guide: general dental practitioners

1. What do you see as the advantages and disadvantages of using DCPs at the practice?
2. What model of DCPs and dentists do you currently have in your practice?
 - Why is this?
 - How well do you think this model works?

3. What do you perceive to be the optimal combination of DCPs and dentists in your practice?
4. Could DCPs be utilised more in practice?
 - In what way?
 - What are the potential barriers?
5. Have your views on the use of DCPs in the practice team changed over time?
 - How?
 - Why do you think this is?
 - Have the views of your colleagues changed?
 - What about new associates?
6. What do you think about the duties that DCPs can carry out under their current scope of practice?
 - Should they be doing more/less?
 - Does it work well in practice?
7. What do you think about the recent expansion in the scope of practice of DCPs?
 - Has it changed the way you have chosen to utilise DCPs at this practice?
 - What are your dentist colleagues' views about the change?
 - What are your DCPs' views about the change?
 - What are your views about direct access?
8. How do patients respond when you refer them to DCPs?
 - For treatment and for hygiene/advice?
 - Are patients aware of the role of DCPs?
 - Which way is best to communicate this to patients?
 - What about for more complex treatments?
9. How does the way that dentists get paid in the NHS affect the dental team?
 - Does it affect the types of tasks that you refer to DCPs?
10. Has using DCPs freed up your time to concentrate on more complex cases?
 - Does this happen often at the practice?
 - If so, how often?
 - What kind of tasks?
 - Are you happy with seeing more complex cases rather than the routine care?
11. What would prompt you to use DCPs more at the practice?
12. How do you think that your use of DCPs over the last few years has affected the profitability of this practice?
13. Where do you think we will be in ten years' time in respect to the DCPs' role in delivering dental health care?
14. How do you think the changing oral health needs of the population will affect the way you organise your practice in the future?

Topic guide: dental care professionals

1. How are DCPs used in your practice at the moment?
 - Who completes which tasks?
 - How do you refer to the dentist?
 - How do they refer to you?
 - Associates? Do they refer to you?
2. What do you think about the recent expansion in the scope of practice of DCPs?
 - Has it changed your practice?
 - What are your colleague's views about the change?
3. Could DCPs be utilised more in practice?
 - Could you do more?
 - Would you want to do more?
4. What are your views about direct access?
 - How successful has this been in your practice?
 - Do you think it has changed the way that care is delivered?
 - What are your colleagues' views about the change?
 - Do you think this will change over time?
5. What response do you get from patients that come to see you?
 - Do they accept receiving care from the whole dental team, rather than just the dentist?
6. Do you think they are aware of the different types of roles that DCPs can undertake?
 - How does your practice communicate this to patients?
7. Would changes to the way that the NHS pays the dental team affect the types of tasks that you undertake?
8. How happy are you with the level of support you have in the surgery?
 - Dental nurse?
9. Does using DCPs help to free up time for dentists to concentrate on more complex cases?
 - Does this happen in practice?
10. How confident are you about performing dental procedures without oversight from a dentist?
 - Which tasks?
11. What would prompt dentists to use DCPs more at the practice?
12. Where do you think we will be in ten years' time in terms of the role of DCPs?

Topic guide: patients

To open: how long have you been coming to this practice?

1. When you last saw or were treated by a DHT what treatment did you receive?
 - How did you feel about receiving this treatment from your DHT rather than from your dentist?
 - Was it different seeing a DHT rather than a dentist?
 - Were you happy with the service you received?
2. How much do you know about the roles and duties of a DHT?
 - Are there any tasks that only a dentist can do?
3. If, in the future, your dentist referred you to a DHT for a filling how would you feel?
4. How do you think other patients at this practice would feel about seeing DHTs instead of dentists?
5. What things could your practice do to help patients manage the change from seeing the dentist regularly to seeing the DHT?
6. How much information do you think patients would want or need about the role of DHTs?
7. What do you think is the best way to communicate this type of information to patients?

TABLE 44 Coding frame: GDPs

Theme	Codes	Example quote	
Attitudes and beliefs	Benefits to the practice and GDPs	<i>The biggest advantage is it frees up more of my time to more involved treatments, you know, endos, crowns, cosmetic treatment</i>	PP2
	Perceptions of patient awareness	<i>We actually had more people come to us via the direct access hygiene route, than we did via the traditional check-up and referral route</i>	PPT_7
	Perceptions of patient acceptability	<i>Yes, I mean they seem absolutely fine to see the therapist or hygienist for hygiene treatment because it seems fine, you say, oh, I want you to see the hygienist, absolutely fine. You say I want you to see a therapist for fillings, oh no, I want you to do it. So there's some sort of block that patients have got but they do understand the value of the hygienist for some reason</i>	PP2
	GDP pitch of referral	<i>We tend to say, I think your teeth need cleaning and at the same time of being cleaned the therapist can do the filling for you. They say, well I need to come back one more time for a clean up and a filling. That's how I sell it</i>	PP5
	Leadership	<i>I think it's both. I think basically we tried to explain to patients why we had the therapist here, for what reason, and I think once they'd seen them and realised that they had this extra time, they had more chance to ask questions, whatever else, they felt more comfortable and then people warm to the idea</i>	PP1
	Low awareness of DCP roles and skills	<i>I don't know how it works. Are they limited to NHS? How does it all work? I know like they're not allowed to do a check up. A dentist has to do a check up</i>	PP4
	Value of DCPs	<i>Only benefit for us might be that we could reduce the prices for patients a bit, because the hourly rate would be different. But otherwise, we just change them an hourly rate anyway, so as long as patients are prepared to pay us our hourly rate, we'll do the fillings for them</i>	PP3

TABLE 44 Coding frame: GDPs (continued)

Theme	Codes	Example quote
	Patient safety – DCPs may miss something	<i>The skill is diagnosis, but the actual treatment is the easy part. As long as you're good with the patient and you are competent in skills, you can teach anyone to do dentistry, but diagnosis is the hardest part because that comes with experience</i> PP5
	Professional threat from DCPs	<i>And I think lots of dentists feel threatened</i> PP4
Structural issues	Financial and payment issues	<i>There are problems right now, from what I understand. The entire remuneration system is based on the dentist with the performer number, taking for the UDAs that the treatment incurs in total, and then distributing, in inverted commas, fairly, to the team members as appropriate</i> T7
	Referral patterns	<i>It makes therapists, hygienists, look silly to patients. This way of working makes them look silly. Oh, I can't carry on with your treatment because I have to go and get a prescription to give your local anaesthetic. It hardly flows</i> PPT_7

TABLE 45 Coding frame: DCPs

Theme	Codes	Example quote
Structural/organisational barriers	Facilities and nurse support in clinics	<i>I've always got a dental nurse with me and the dentists are all very happy to (look at referred patients), if one is busy I can look to another</i> DCP1
	Scope of practice – lack of clarity/way it works at present	<i>I was made redundant from a therapy job in a corporate earlier in the year because of the fact that I can't apply fluoride every 3 months without a prescription, and it just didn't create that workflow that we needed</i> DCPT_1
	Financial – payment and patterns of referral	<i>All of them are supposed to refer to me but . . . some are really good at it, some aren't very good at it . . . relying on them to refer patients to me</i> DCPT_4
	Professional culture/identities	<i>Anyone over a certain age would just go in, a dental what? You know, and then they were just not interested, not interested at all. They just saw it as we were trying to steal their jobs and that was it</i> DCPT_5
	Skill level and experience/confidence	<i>And I don't know how . . . hand on heart, how I would feel completely in a practice on my own. I think . . . I'm probably not the right person to be in practice completely on their own</i> DCP3
	Workplace culture/PP leadership	<i>Yeah. So it's the team approach. And I don't know how they do it in many practices and how they keep an accurate check on it, and how they do a lot of monitoring at this practice because we have a deputy manager on reception. Our receptionists have to be – and this is another DCP progression route – our receptionists are all dental nurses, or have been dental nurses, experienced dental nurses, so they know what it's like to be in the surgery and they can have a fair judgement of the performance of each clinician; and they know the treatment times for each clinician as well, so they can measure one against the other</i> DCP1

continued

TABLE 45 Coding frame: DCPs (continued)

Theme	Codes	Example quote
Social/patient acceptability	Compared to general med	<i>Because we have nurse practitioners now in our doctors' surgery that people know they can do some things but they can't do everything doctors do. Most people have to go and see a nurse practitioner. Most people go to the diabetic nurse, they're not bothered about seeing the doctor ... nurse and then there's the practice nurse. Do you know what I mean? As long as people understand and are told where they're going and what they're going for ... to it all</i> DCPT_2
	Patient awareness	<i>I think some of the patients may not be aware of exactly what I can do, and perhaps I need to address that part, I think I've got to sign up that's more clearly ...</i> DCPT_2
	Patient acceptability (trust in GDP/NHS)	<i>And maybe they don't understand what the therapist exactly is, but then you come through and you do the work for them, and they know that [dentist's name] who they trust, has passed you so that's okay. But if you ask somebody on the street what's a dental therapist they think that you put teeth on a couch and talk to them</i> DCP5
	Perceptions of patient awareness/acceptability (GDP pitch)	<i>When the dentist sends them to us, they explain fully who they're going to see, why they're going to see myself or one of the other girls if it is just for hygiene or the oral health educator or the fluoride girls. They know and they understand that and then that's absolutely fine</i> DCP6 <i>I think they're just saying, you can go to my colleagues and have it done, I don't think they're saying what I am</i> DCPT_4
Beliefs and attitudes to role substitution/direct access	Benefits to dentist	<i>Before when you're explaining to some of the patients it's a simple appointment, the dentist can concentrate on more complex treatment, so again it's directing the needs to the appropriate place. If it's a simple occlusal filling, I can do that, the dentist doesn't need to do that, so because I've freed up 20–30 minutes for them, they can then be doing something that's a bit more complex</i> DCP6
	Perceived benefits to patient/practice	<i>And then they know that their work is going to last longer because their oral hygiene is a lot better, so they know overall as well they're not going to have the same problem constantly because we're hopefully dealing with part of the problem</i> DCP2
	Dentists awareness	<i>Education of dentists. Them realising that we are not the enemy. We don't want to be dentists</i> DCP5 <i>Who's read the scope of practice? Probably a third of the room put their hand up, and even then it's only been a brief read probably of their own rather than everybody else's</i> DCPT_1

TABLE 46 Coding frame: patients

Theme	Codes	Example quote
Patient awareness of roles	Good knowledge about roles	<i>I'm aware that they do a three year course and that they are qualified to do some fillings – as I understood it, you could correct me if I'm wrong – on minors, on children</i> <i>Practice 3, patient 1</i>
	Confused about or uninterested in roles	<i>Probably that ... I'm sure it would be, like ... would be qualified to do it, so I don't really understand the difference who's qualified to do a filling and the dentist. What's the difference there?</i> <i>Practice 4, patient 5</i>
Attitudes	Benefit to patients (population access)	<i>The hygienist probably saved time for the dentist and that's why they had probably more patients than what they do in today's</i> <i>Practice 4, patient 5</i>
	Free up GDP time	<i>I personally think if they've seen the dentist and then the next time they say, next time you come in for your check-up it will be a dental hygienist. If there's any problems that they can't deal with, they'll refer you to me. Then that gives the dentist, the dentistry staff, the more professional dentists, time to deal with other more serious items</i> <i>Practice 4, patient 3</i>
	Lower-quality care	<i>I think everybody should see a dentist not a therapist and be a second-class citizen really, even if you're on benefits ... To me a dentist is a dentist, you know; a hygienist therapist will not have the experience or the qualifications of what a dentist will have</i> <i>Practice 6, patient 3</i>
	Continuity of care	<i>It's just you go with ... yeah. I think also seeing the same dentist is ... they're familiar with if you've got problems or</i> <i>Practice 4, patient 5</i>
	GDP pitch	<i>A person I trust trusts somebody else, that's what's important</i> <i>Practice 6, patient 4</i>
Acceptability	GDP-patient relations	<i>Yeah, I've always found that when I've come here they're very, very patient because I'm not the best person in the world</i> <i>Practice 4, patient 3</i>
	Implicate trust in system/qualifications/training	<i>They're obviously qualified otherwise the dentists wouldn't be recommending them. It comes with professional practice and you just automatically know you're going to get professional treatment</i> <i>Practice 4, patient 2</i>
	Untrusting of system/qualifications, etc.	<i>I'd be unsure, to be honest. I'd like to know how much they'd done in the past. How many fillings they had done, the training involved, etc.</i> <i>Practice 4, patient 4</i>
	Preference for status quo	<i>I think I'd prefer to stick with my dentist that I know ... Just because I don't like trying new dentists. So when you've found one that you really like, I think it's best to stick with them ... I think it's just that I'm comfortable with what I know</i> <i>Practice 6, patient 1</i>
	Comparison to general medicine to help understanding	<i>You go to see the practice nurse who ... obviously, you're not going to go to a doctor to have your blood pressure taken. The practising nurse is quite capable of doing that and referring the readings to the doctor if they're not satisfactory, and I expect the same thing of a dental hygienist. If they feel they can't actually carry out the work, they don't want to mess things up or if they've got the confidence or whatever, or the skill, then they refer you to the dentist and you make an appointment to see the dentist for that work to be done</i> <i>Practice 4, patient 3</i>

continued

TABLE 46 Coding frame: patients (continued)

Theme	Codes	Example quote
	Past DCP experience	<i>Yeah, I'd rather go to [hygienist] about anything to be honest with you. I mean . . . They've been alright, the dentists in here, but I haven't got the same . . . I haven't got the same, what do you call it . . . reassurance as I have with her</i> <i>Practice 5, patient 1</i>
	Patient inconvenience	<i>The next one I went to was private and they had a hygienist which I used to use but I've no need to here because I get it done with my check-up. I didn't have any problems at my check-up and [XXXX] does it for me. If I have a problem in between I can come and have one then so it's much better than booking it separately</i> <i>Practice 4, patient 1</i>
	Patient perception of care quality	<i>Yeah, because I think it's the full treatment and I think in the long run it serves a better cause because as you're getting older your gums need a bit more attention. So I think it's saving you from extra dental work really</i> <i>Practice 5, patient 3</i>
	Social acceptability	<i>But I just feel like the more it's publicised, the more people get used to the idea, and then they accept the idea</i> <i>Practice 4, patient 3</i>

Appendix 5 Patient and public involvement

Patient and public involvement (PPI) was an important part of the research process and the research team were keen to have PPI embedded within the main workstreams of the programme.

The grant application had been reviewed by PRIMER (www.population-health.manchester.ac.uk/primer/about/), which is an experienced group of users and user researchers at the University of Manchester. This led to the addition of interviews with patients to the qualitative workstream. The PRIMER group was also invited onto the Research Steering Group, alongside a patient representative (who was also a coapplicant).

The patient representative reviewed the initial screening questionnaire and the main questionnaire to record the inputs for the DEA and SFM. They also reviewed the questions for the qualitative interviews and wrote the interview schedule for the patients.

The intention was to involve the patient representative in the analysis of the qualitative data but, unfortunately, the patient representative secured new employment outside the research programme, which meant that she had little time to be involved further. As a result, a new patient representative was appointed, but this was after the analysis was complete.

However, the research team had also developed a PPI group to get an idea of the types of issues that arise in role substitution. These views were used alongside the analyses for both the quantitative and the qualitative workstreams to ensure that patient perspective remained central. Key themes that arose from engagement with this group were around the awareness of the roles of members of the dental team, perceived drawbacks and benefits. In addition, social acceptability was key. These became the central elements of the analysis for the patient interviews. The PPI group were also recorded to aid recollection and the key views expressed are summarised below.

I don't think there's much difference. She seems to be more, how can I say, logical in the way she expresses what she's doing. She seems to . . . she tells you what's going to happen and what have you. I mean I know Sam does it the same, but she seems to be more, how can I say, knowledgeable in what she was doing.

You don't realise that they're capable to do the same job. But at the end of the day if they can do it then it's taking work off the dentist, obviously they'll see more patients, isn't it, if both of them can do it.

I'm happy to see the therapist as well as the dentist. Because I mean obviously they'll probably have the same ideas, both of them.

But my son, he goes to a different dentist but he sees a therapist and hygienist a lot, so I know how good she was with him. So maybe it's part of that. And I know that he doesn't have the dentist doing the job, he has her because she's small, child friendly, etc., talks to him better.

A bit more relaxed, yes, because you think well, this isn't the dentist who's going to drill. It's a bit more, yeah, at ease but obviously she's fully capable.

I just think two minds are better than one, aren't they? Just teamwork, isn't it, at the end of the day. I saw it as that really rather than oh, she's not capable.

But it's like I shop at Aldi, but I would the same costs for a dentist or therapist. Whereas someone that might not, just wants to pay top dollar for the dentist, they shop at M&S. Different classes, isn't it, really, how people think and what they pay for.

Yes possibly, I think it's more down . . . for me, it's more down to the fact that I think I would probably expect to pay less if I was getting less of a service, not less of a qualified person but if they're deemed to be qualified enough to do the check-ups and make decisions then I don't see any issue with paying any different.

I imagine the whole reason for this is down to the sort of availability of dentist and the fact that people are struggling on waiting list and if you got a therapist that come through that can do the work then it's going to be easing sort of, you know, the backlog of the patients.

I've seen three different people now on all three times I've come. I don't know who I expected to see really today, but no, it doesn't make me any worse or better. Just as soon as I went in I said look, I'm anxious, I'm pregnant, da-da-da, I'm mad and they were fine with me. So it doesn't make me feel uncomfortable.

I think having treatment from the therapist here in the past, I know that the dentist is coming in . . . where there's been more trickier work, the dentist has been in and just double checked and there has never been any issues. I may have had some reservations maybe before I'd seen the therapist, but have been very happy with.

I think I would probably be just as comfortable, which is probably the big thing really because, like you said, they're not the full dentist, they're a therapist, but having had the experience of having work done by them I more than confident to see them instead of the dentist.

Maybe the impression if they were a hygienist then they're just there to do stuff like plaque removal and the deep clean of people's teeth, whereas if you say a therapist then it covers a bit more of broader scope.

The research team intend to use the patient representative and the PPI group in the dissemination of the results. Presentations and papers produced, as outputs from the research programme, will be reviewed prior to submission. This was the process for the presentation of the initial research findings at the International Association for Dental Research meeting in Boston in 2015 and for the submission of the protocol to *BMC Oral Health*.

The *Plain English summary* was also cowritten by the patient representative and patient-facing summaries will be produced.

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