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The INCENTIVE Study: a mixed methods evaluation of an innovation in commissioning and delivery of primary dental care compared to traditional dental contracting.

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ABSTRACT (500 Words)

Background

Over the past decade commissioning of primary care dentistry has seen contract currency evolving from payment for units of dental activity towards blended contracts that include key performance indicators such as access, quality and improved health outcome.

Objectives

The aim of this study was to evaluate a blended/incentive-driven model of dental service provision. To:

1. Explore stakeholder perspectives of the new service delivery model
2. Assess the effectiveness of the new service delivery model in reducing the risk of and amount of dental disease and enhancing oral health related quality of life in patients
3. Assess cost effectiveness of the new service delivery model

Methods

Using a mixed methods approach the study included three dental practices working under the blended/incentive-driven (INCENTIVE) contract and three working under the units of dental activity (TRADITONAL) contract. All were based in West Yorkshire. The qualitative study reports on the meaning of key aspects of the model for three stakeholder groups (lay people (patients and individuals without a dentist), commissioners and the primary care dental teams), with framework analysis of focus group and semi-structured interview data. A non-randomised study compared effectiveness and cost effectiveness of treatment under the two contracts. The primary outcome was gingivitis measured using bleeding on probing. Secondary outcomes included oral health related quality of life and cost effectiveness.

Results

Participants in the qualitative study associated the INCENTIVE contract with more access, greater use of skill mix and improved health outcomes. In the quantitative analyses, of 550 participants recruited, 291 attended baseline and follow up. Given missing data and following quality assurance, 188 were included in the bleeding on probing analysis, 187 in the caries assessment and 210 in the economic analysis. The results were mixed. The primary outcome favoured the INCENTIVE practices whilst the assessment of caries favoured the TRADITIONAL practices. INCENTIVE practices attracted a higher cost for the service

commissioner but were financially attractive for the dental provider at the practice level. Differences in generic health related quality of life were negligible. Positive changes over time in oral health related quality of life in both groups were statistically significant.

Limitations

The results of the quantitative analysis should be treated with caution given small sample numbers, reservations about the validity of pooling, differential drop out results and data quality issues.

Conclusions

A large proportion of people in this study who had access to a dentist did not follow up on oral care. These individuals are more likely to be younger males and have poorer oral health. Whilst access to dental services was increased this did not appear to facilitate continued use of services.

Future Work

Further research is required to understand how best to promote and encourage appropriate dental service attendance especially amongst those with high level of need to avoid increasing health inequalities; and to assess the financial impact of the contract. For dental practitioners, there are challenges around perceptions about preventive dentistry and use of the risk assessments and care pathways. Changes in skill mix pose further challenges.

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Abbreviations

ACRONYM	DEFINITION
ANCOVA	Analysis of Covariance
BoP	Bleeding on probing
CEAC	Cost Effectiveness Acceptability Curve
CPR	Cardiopulmonary Resuscitation
DQOF	Dental Quality and Outcomes Framework
CCEMG-EPPI	Campbell & Cochrane Economics Methods Group - Evidence for Policy and Practice Information and Co-ordinating Centre
E&F	Extractions and Fillings
FDI	World Dentist Federation
GDP	General Dental Practitioner
ICDAS	International Caries Detection and Assessment System
ICER	Incremental Cost Effectiveness Ratio
INCENTIVE Study	Improving the organisation and delivery of dental health care to patients - innovation in commissioning primary dental care delivery
MAR	Missing at Random
MID	Minimal Important Difference
nGDS	New General Dental Services Contracts
NHS	National Health Service
NHSE	National Health Service Executive
NIHR	National Institute of Health Research
NRES	National Research Ethics Service
PPI	Patient Public Involvement
OHA	Oral Health Assessment
OHImp	Oral Health Improvement
OHIP	Oral Health Impact Profile
OHQoL	Oral Health Related Quality of Life
OHR	Oral Health Review
OLS	Ordinary least Squares
QALY	Quality Adjusted Life Year
QOF	Quality and Outcomes Framework
PCT	Primary Care Trust
PDS	Personal Dental Service
PROMS	Patient Reported Outcome Measures
RAG	Red, Amber, Green
REC	Research Ethics Committee
SD	Standard Deviation
TPM	Two Part Model
TVC	Total Contract Value
UDA	Unit of Dental Activity

SCIENTIFIC SUMMARY (2395 WORDS)

Background

Commissioning of primary care dentistry in the NHS has seen contract currency evolving from payment for units of dental activity towards incentive-driven or blended contracts that include incentives linked with key performance indicators such as access, quality and improved health outcome. There is limited evidence on the impact of these changes in dental oral health outcomes and patient, commissioner and workforce acceptability.

Objectives

The aim of this study was to evaluate a blended/incentive-driven model of dental service provision. To:

1. Explore stakeholder perspectives of the new service delivery model
2. Assess the effectiveness of the new service delivery model in reducing the risk of and amount of dental disease and enhancing oral health related quality of life in patients
3. Assess cost effectiveness of the new service delivery model

The intervention

In the UK, current dental contracts are based on payment for units of dental activity. The new blended/incentive-driven contract and service delivery model evaluated here is based on contracts incentivising quality and oral health improvement in addition to units of dental activity. Sixty per cent of the contract value is apportioned to delivery of a set number of units of dental activity. The remaining 40% is dependent on the delivery of quality (systems, processes, infrastructure 20% and oral health improvement 20%). The blended/incentive-driven contracts are aimed at: ensuring evidence-based preventive interventions are delivered in line with identified needs for a defined population; increased access to dentistry; that care is provided by the most appropriate team member to encourage skill mix. The new contract was designed to encourage a care pathway approach in which all patients have an Oral Health Assessment on joining the practice and at each subsequent recall. Four sets of information (age group, medical history, social history (self-care, habits/diet) and clinical assessment) are used to inform a traffic-light system for patients with high (red), medium (amber) or low (green) risk of oral disease.

Methods

Using a mixed methods approach the study included three dental practices working under the blended/incentive-driven (INCENTIVE) contract and three working under the units of dental activity (TRADITONAL) contract. TRADITIONAL practices, included in the study as comparators, were matched with INCENTIVE practices by deprivation index, age profile, size of practice and ethnicity. All practices were based in West Yorkshire.

Qualitative study

Objective 1 uses focus groups and semi-structured interviews, supplemented with observations of dental appointments of the delivery of dental care in the INCENTIVE practices and TRADITIONAL practices. Purposive sampling via a sampling matrix supported recruitment of participants with different experiences of the model. The three stakeholders groups were lay people (patients and individuals without a dentist), dental teams and service commissioners. Interviews and focus groups followed a topic guide, partly informed by Andersen's Behavioural model of access but supplemented with themes that emerged from the observations and previous interviews. Interviews with dental team members took place at the dental surgery, those with patients took place in patients' homes. All were recorded and transcribed verbatim.

Effectiveness study

A non-randomised study design compares effectiveness (Objective 2) and cost effectiveness (Objective 3) of INCENTIVE practices compared with the TRADITIONAL practices. The primary outcome was the percentage of points bleeding on probing (BoP). Secondary outcomes were: percentage of sound surfaces, percentage of extracted and filled teeth and oral health related quality of life (OHIP-14 total score). Exploratory analysis was undertaken of the traffic-light risk assessment system.

Sample size was powered using BoP. We estimated the standard deviation in percentage sites BoP across a UK cohort to be 27.5%, assuming a within-patient correlation in baseline to follow percentage sites BoP of 0.5 and a common variance in practices. We assumed a clinically meaningful mean difference in percentage sites BoP baseline to follow up in INCENTIVE practices of 10%, versus a mean difference in percentage sites BoP baseline to follow up in TRADITIONAL practices of 0%. We fixed a Type I error rate of 0.05 and a power of 0.8. A design effect was included to account for clustering of patients within

INCENTIVE and TRADITIONAL practices, assuming an intra-cluster correlation of 0.2. A two-sided two independent samples t-test identified a total of 550 patients to be recruited (allowing for a 10% loss to follow up).

Multiple linear regression was used to model the primary and secondary outcome measures. Given the reduced sample size due to loss to follow up, to improve power, we use an analysis of covariance approach with follow up measurement as the outcome and baseline measurement as a covariate. We first analyse the matched pairs separately before combining in a single analysis. Due to reduced sample size and staff turnover, we have not been able to include practitioner level variables in our analyses.

Cost effectiveness study

Within Objective 3, primary analyses take the perspective of the commissioners of the service (contractual payments). Secondary analysis takes the perspective of the service provider including the cost of dental practitioners' time and treatment materials. The price year is 2012. A discounting rate of 3.5% was used for costs and outcomes.

The analyses used the incremental cost per unit change in OHIP-14 score and the cost per quality adjusted life year (QALY) (derived from the EQ-5D-3L). Incremental cost effectiveness ratios are presented together with cost-effectiveness plane scatterplots showing the uncertainty surrounding the estimates and cost-effectiveness acceptability curves to illustrate the probability that each treatment would be cost-effective given a range of acceptable threshold values. Sensitivity analyses were further carried out to account for uncertainty in the cost values.

For the quantitative studies missing data for the OHIP-14 was imputed use median imputation if 2 or less OHIP-14 item scores are missing. Participants who had more than 2 components of the OHIP-14 missing or missing EQ-5D-3L at baseline and follow-up are excluded from the analysis.

Inclusion criteria and timing of assessments

The inclusion criteria for the quantitative studies were: patients aged 16 years and over, willing to be followed up for 24 months and give informed consent, a *new* patient to the dental practice and able to complete the patient questionnaires. All new patients attending the practice for the first time were invited to participate. Patients were asked to complete the OHIP-14 and EQ-5D-3L at their first visits and at the follow-up visit 24 months later. The dentist undertook the clinical assessment of teeth and gingivae using the International Caries Detection and Assessment System instrument (ICDAS) and BoP at both visits. Family/social history was taken at the first visit only. The oral health assessment, using the traffic light system was completed at baseline and 24 months by INCENTIVE practices. Appointment and treatment history were collected retrospectively using patients' dental records held at the practices.

Patients were contacted by the dental practice 6-8 weeks prior to their 24 months follow up date to arrange an appointment by way of telephone, SMS and letter in order to optimise follow up. Patients were contacted a minimum of three times to arrange the appointment.

Ethical approval

Ethical approval was received from Bromley REC reference number 12/LO/0205 on 5th April 2012. The study was sponsored by the University of Leeds.

Results

Qualitative study

Observations were made of 30 dental appointments. Eighteen lay people, 15 dental team staff and a member of the commissioning team took part in the interviews and focus groups. Data were collected between August 2012 and February 2014.

We found perceptions that the blended/incentive-driven contract increased access to dental care, with the contract determining dentists' and patients' perceptions of need, their behaviours, evaluated and subjective health outcomes and patient satisfaction. These outcomes were then seen to feed back to shape people's predispositions to visit the dentist.

The data hint at appreciable challenges related to a general refocussing of care and especially to perceptions about preventive dentistry and use of the risk assessments and care pathways. There are also obstacles to overcome to realise any benefits of the greater deployment of skill mix.

The ratings from the oral health assessments were seen to influence patients' perceptions of need, which led to changes in preventive behaviour. There was evidence that dentists' behaviours had responded to the contract in the desired direction with greater emphasis on prevention, use of the ratings in treatment planning, adherence to the pathways and the utilisation of skill-mix. Participants identified increases in the capacity of practices to deliver more care as a result. These changes were seen to improve evaluated and perceived health and patient satisfaction.

Effectiveness study

Within the quantitative studies recruitment started on 1st June 2012 (the first patient entered the study on 14th June 2012). Recruitment finished on 31st January 2013. 550 participants were recruited to the study at baseline. However, only 291 participants attended a follow up appointment at 24 months. Although there are no statistically significant differences in age, gender or ethnicity between those who included in these analyses and those lost to follow up, those who are lost to follow up are generally younger and more likely to be male. Additionally those lost to follow up have worse oral health although this is more variable (a higher mean and standard deviation).

Of the 550 recruited, 529 had a BoP measure at baseline but only 270 had a BoP at both time periods. Following quality assurance 188 were included in the BoP analysis (n=90 INCENTIVE, n=98 TRADITIONAL practice). For BoP pooled across practices, a 95% CI for the effect size was (3.23%, 17.25%) indicating a positive effect for INCENTIVE but with considerable uncertainty in magnitude. For Sound Surfaces (n=187) (defined as caries-free and initial caries ICDAS codes 1 and 2), TRADITIONAL practices had a higher proportion of Sound Surfaces at follow up (4.68%) – although two of the pairings had a non-significant difference between Sound Surfaces. Overall TRADITIONAL practices had a higher follow up OHIP-14 score (n=176) by 3.5 indicating worse oral health related quality of life. Again for two of the three pairings there was no significant difference. For the oral health

assessment (INCENTIVE practices only), for those who attended both baseline and follow up (n=111) there was an improvement with 68% red at baseline and 44% red at follow up.

Cost effectiveness

Two hundred and ten of those patients were included in the analyses. Patients in INCENTIVE practices had more appointments on average than those in TRADITIONAL practices (8.89 vs. 6.63). This is slightly higher than patients who were lost to follow (and for who we had appointment data). For the loss to follow up group the average number of dental appointments per person was 7.97 (SD 5.34; n=152) for the INCENTIVE practices and 4.99 (SD 3.53; n=131) for the TRADITIONAL practices.

The INCENTIVE arm attracted a higher cost for the service commissioner (mean per person cost of £459.77 vs. £281.57). INCENTIVE contracts were financially attractive for the dental provider at the practice level (costs less contractual payments equated to a mean per person cost of £-209.26 vs. £-116.21). The mean OHIP-14 scores were 7.11 vs. 8.00 for the INCENTIVE and TRADITIONAL practices respectively. The incremental cost effectiveness ratio using the OHIP-14 from the commissioner's perspective was £199.22 (indicating a cost of £199.22 for an increase of one in the OHIP-14 score); from the service provider perspective INCENTIVE dominates TRADITIONAL (less costly, better mean outcomes). The incremental cost effectiveness ratios using the QALYs from the commissioner's perspective show INCENTIVE to be dominated (more costly, lower mean QALY) and for the service providers perspective incremental cost effectiveness ratio=£122,089.48 (indicating a cost of £122,089.48 for an increase of 1 QALY).

Patient Public Involvement (PPI)

Patient contributors were integral members of the research team from conception of the research through input in: the research and design questions, the ethics application including patient information sheets and as members of our advisory group, They ensured our research was of relevance to patients and the NHS and would contribute to shape and improve reform of the dental contract to maximise a service designed to address patient needs in terms of improved oral health outcome through a paradigm shift from restorative to preventative oral health care and access to NHS services.

Conclusions

The blended/incentive driven contracts were perceived to increase access to dental care, with the contract determining dentists' and patients' perceptions of need, their behaviours, evaluated and subjective health outcomes and patient satisfaction. Whilst the results of the quantitative analysis were mixed and should be treated with caution given the high loss to follow up, the study findings have implications for both practice and future work in assessing these types of contract.

A large proportion of people in the study who had access to a dentist did not follow up on oral care. These individuals are more likely to be younger males and have poorer oral health. The evidence suggests further work is required to understand how best to promote and encourage appropriate dental service attendance especially amongst those with high level of need to avoid increasing health inequalities; and to consider from a policy perspective the care pathway approach recommended in the Steele Report, which legitimises irregular dental attendance for those who choose it.

For dental practitioners, there are challenges within the blended/incentive driven contracts related to a general refocussing of care around preventative dentistry, risk assessment and a care pathway approach rather than the focus on treatment inherent in the UDA based contract. There are also obstacles to overcome to realise the benefits of the greater deployment of skill mix. Intuitively, the delegation of treatment to staff specialised in only a specific range of treatments could reduce costs and increase access to care but that there may be financial barriers that prevent the profitability and effective use of skill mix. Further work is required to validate the RAG assessment as a risk assessment, communication aid, and contract monitoring tool and as a tool for evaluation; and to further assess the financial impact of the contract and particularly the increase of skill mix on the individual practitioner in order to support the model.

Data quality and dentist data recording, particularly dentition charting, was challenging. This supports the view that here should be a strong driver in the contract for it to be collected accurately and appropriate training and support for practices. Further work is required to explore further the utility of bleeding on probing as a surrogate for other oral health outcomes and both the utility and validity of recording dental caries and treatment experience with an indicator such as ICDAS as a contract outcome.

Funding

National Institute of Health Research, Health Service and Delivery Research programme.

Plain English summary

In 2006 a new contract was introduced for NHS system dentists. The contracts incentivise dental treatment through payment of an annual sum in return for delivering an agreed number of 'courses of treatment' weighted for complexity. An alternative to this contract is one which provides an incentive to shift from treatment and repair to prevention and oral health by introducing a new clinical pathway and new remuneration models. However, there is limited evidence on the impact of this type of contract.

The aim of this project was to evaluate a new blended/incentive-driven model of dental service provision implemented in West Yorkshire. The project compares three dental practices under the 2006 contract with three under the new contract. A qualitative study reports on the meaning of key aspects of the model for patients and non-patients (individuals without a dentist), commissioners and the dental teams using data from observations, focus groups and interviews. The clinical effectiveness (does it improved health outcomes?) and cost effectiveness (is it value for money?) of treatment under the two contracts is assessed.

The results favoured the new contract which was associated with improved health outcomes, but for commissioners was more expensive. However, the results should be treated with caution as a large proportion of people who had access to a dentist did not follow up on oral care. These individuals are more likely to be younger males and have poorer oral health. Further work is required to understand how best to promote and encourage appropriate dental service attendance especially amongst those with high level of need to avoid increasing health inequalities.

Chapter 1: Background

Use of incentives in dental care

There is an increasing trend in the use of incentives in National Health Service (NHS) primary care including dentistry[1]. Whilst dentistry has long been incentivised; over the past decade commissioning of primary care dentistry has seen the introduction of refinements with contract currency evolving from payment for units of dental activity (UDA) towards incentive-driven or blended contracts that include incentives linked with key performance indicators such as access, quality and improved health outcome[2]. This has included (as part of the Department of Health dental contract reform programme) a series of national NHS dental contract pilots which opened in 2011 with the aim of exploring how focus can shift from treatment and repair to prevention and oral health by introducing of a new clinical pathway and new remuneration models[2]. Whilst there is a burgeoning field looking at impact of these blended contracts on process there remains limited evidence on the impact of changes in dental oral health outcomes and patient, commissioner and workforce acceptability.

The policy context

In 2003 the Department of Health set out changes in governance as part of the Modernisation Agenda in order to create the right context, incentives and operational environment for their staff and front line teams to transform patient services[3]. The changes transformed the NHS from a centrally directed service to a more complex system with devolved local commissioners [notably, Primary Care Trusts] and a delivery structure comprised of diverse providers[4]. In 2002 Shifting the Balance of Power[5] and its subsequent delivery document gave greater authority and decision making power to patients and frontline staff and changed organisational roles and relationships giving Primary Care Trusts (PCTs) new commissioning powers. This was then followed in 2005 by Commissioning a Patient Led NHS[6] which further strengthened the PCT lead role as commissioners of services to meet the needs of their local communities.

Options for Change[7] set out a vision for dentistry with prevention at its heart which was widely supported by the profession. Personal Dental Service (PDS) pilots tested these new ways of working between 1998 and 2006. In 2006 a new dental contract emerged, essentially devolving the commissioning of dental services locally to PCTs to meet the needs of their local population. The currency of the new General Dental Services contracts (nGDS) was UDAs divided into three levels of treatment bands with the total number of UDAs in each contract based on historic activity and agreed between PCTs and dental practices. The nGDS contracts meant that the payment mechanism changed from one-off fee per item of service to a system whereby providers were paid an annual sum in return for delivering an agreed number of 'courses of treatment' weighted for complexity (UDAs). PCTs became the local commissioners of dental services and were charged with demonstrating their competencies as 'World Class Commissioners'.

The PDS pilots (1998-2006) encompassed a wide variety of configurations and were widely evaluated[8-12]. Whilst the evaluations were largely positive there were concerns about whether PDS met local needs, the absence of measures of success or appropriate goals for commissioning and missed opportunities to harness skill-mix[9,12]. More recently the health committee implicitly rejected PDS as a precursor of nGDS when it criticised the lack of piloting of the new contract[13]. There has been little research to date on the implementation of nGDS contracts. There were concerns amongst dental practitioners[14,15], particularly whether the nGDS contracts would allow more time for prevention[16] and restrict access to new patients and those requiring complex treatment[17].

The Steele Report[2] examined how dental services in England could be developed over the next five years. The Review advocated a commissioning approach to align dentistry with the rest of NHS services and to commission for health outcomes; to develop blended contracts rewarding not only activity but quality and oral health improvement. It recommended that payments explicitly recognise prevention and reward the contribution of the dental team to improvements to oral health, reflected in patient progression along the pathway, adherence to nationally agreed clinical guidelines and the achievement of expected outcomes[2]. Commissioners were asked to support dentists to make best and most cost effective use of the available dental workforce[2].

Following the Review proposals were set out to pilot different types of dental contract[18]. Alongside these proposals sat the Dental Quality Outcomes Framework (DQOF) which advocated quality as a necessary part of future dental contracts[19]. Within the framework quality consisted of three domains: clinical effectiveness, patient experience and safety[19].

A series of NHS national dental contract pilots began in 2011. The aim was to shift focus from treatment and repair to prevention and oral health through the introduction of a new clinical pathway, supported by new remuneration models[20]. The new pathway begins with an oral health assessment (OHA) from which the patients is advised of their oral risk status using a red/amber/green rating (RAG) rating and given advice on maintaining or improving their oral health. A follow up appointment or review is then set based on their risk status.

The needs assessment tool (RAG) was underpinned by the Salford and Oldham primary dental care service redesign project who found that the RAG scores:

- Enabled the capture of oral health improvement as patients move RAG status. The project has learnt that, as some risk/modifying factors do not change, only the clinical components should be used as outcome measure
- Incentivised dentists to perform detailed assessments and to value all patients the same through completing the same consistent, comprehensive assessment
- Aided communication with patients through the use of the RAG status
- Motivated dentists to deliver clinical care appropriate to need through robust, consistent clinical and risk assessment.

Three remuneration models were proposed in the pilot sites to identify the optimal single remuneration model. Dentists were not required to carry out a given number of UDAs but were required to adhere to the DQOF[18]. The three pilot contract types were based on (i) time spent on providing care for NHS patients as measured by the appointment time; (ii) capitation payments weighted for individual patients (age, gender, deprivation) based on all care (preventative, routine and complex); and (iii) capitation payments weighted for individual patients based on preventive and routine care only[18]. However, whilst a small element of remuneration with the models was weighted based on DQOF, remuneration adjustments were not applied as the indicators required testing and refinements before they could be used[18].

Evidence of the effectiveness of incentive-driven contracting

Overall the evidence of the effectiveness of use of contracting and incentives in health providers is still emerging. Christianson and colleagues[21] review found mixed results of the effect of payer initiatives that reward healthcare providers for quality improvements. O'Donnell and colleagues[22] found the Quality and Outcomes Framework (QOF) within the new General Medical Services contracts in primary care incentivised performance, motivating staff towards QOF targets. Similarly, McDonald and colleagues[1] found incentives to be powerful motivators on the primary care workforce. A more granular view suggests that their process-based nature may limit their long-term effects on health outcomes[23]. There is also a danger that important activities that lack a target may be underemphasised[23,24].

Within dentistry, Tickle and colleagues[25] analysis of longitudinal data of English adults explored the impact of the nGDS contracts and found that changes to incentive structures had had a substantial impact on dentists' behaviour with respect to their treatment prescribing patterns. Significant numbers of dentists were attempting to hit their UDA contract targets in the most efficient (to them) way possible, by shifting towards treatments with high rewards relative to costs, as opposed to selecting on the basis of clinical factors alone. This echoed the results of Chalkley[26] who found the introduction of the nGDS contract in England generated a large and significant increase in activity. However, these results are tempered by a recent Cochrane Review[27] that found generally low level evidence from the two randomised controlled studies included[28,29] (both UK studies). Brocklehurst and colleagues[27] concluded that changes to remuneration may change clinical activity in primary care dentistry but further experimental research is needed – specifically the impact on patient outcomes.

Early findings from the most recent dental contract pilots introduced following the Steele Report have focused on patient and practitioners views of the new clinical pathway, reporting them to be strongly supportive[30]. More recent findings focus on adaptation to the new system but also report positive indications about clinical benefits in terms of a reduction of risk and health improvement (measured through the RAG and a basic periodontal examination). However, the authors have quite rightly added the caveat that there are few comparable data from outside the pilot sites[20].

Structure of the project report

This study was funded by the National Institute of Health Research, Service Delivery and Organisation programme (now Health Service & Delivery Research programme) (09/1004/04 INCENTIVE). The project aims to evaluate a blended/incentive-driven contract model compared to traditional nGDS contracts on dental service delivery in practices in West Yorkshire, England. Whilst the blended/incentive-driven dentist contract pre-dates the most recent national dental contract pilots, and the Steele Report[2] its specification was innovative and contributed to the ethos and recommendations of the report (the model was cited within the report as an example of good practice) with regard to an emphasis on quality of care, achieving health outcomes and patient reported outcome measures (PROMS)[31] whilst improving access to NHS dentistry. It thus widens the evidence base underpinning the proposed introduction of blended contracts in NHS primary care dentistry.

In the National Institute of Health Research (NIHR) funded INCENTIVE study we used a mixed methods approach with three interlinked projects to evaluate a blended/incentive-driven model of NHS dental service delivery compared to contemporaneous traditional contracting. These three projects addressed questions of acceptability, dental efficacy and cost effectiveness. Included in the study were three new dental practices with a blended/incentive-driven contract and three matched practices under the traditional nGDS contracts (Chapter 2).

Our qualitative work (Chapter 3) addresses questions of acceptability using focus groups, semi structured interviews and observations with stakeholders. Qualitative exploration is useful where there is little pre-existing knowledge, in this case where it is important to find out what changes to services mean to participants. The number of stakeholder groups and budget constraints necessitate a broad, policy focused, 'Framework' approach; useful for a structured exploration of participants' perspectives and provides an advantage because findings are induced from their original accounts[32,33]. This approach enabled us to cover the broad tapestry of experiences emerging from this intervention.

Our quantitative work (Chapter 4) includes an assessment of the clinical effectiveness of the blended/incentive-driven contract comparing three newly commissioned dental practices with three existing TRADITIONAL practices. Additionally an exploratory study assesses the traffic-light risk assessment (RAG) within the model for fitness for purpose.

Of key importance within the is whether the blended/incentive-driven model of service delivery shows value for money and our third project (Chapter 5) assesses the cost-effectiveness of the new model compared with the TRADITIONAL contract. The report concludes with a synthesis of our main findings (Chapter 6) and a timely discussion of the implications for designing and commissioning future NHS dental services in light of the planned dental contract reform and further national testing of prototype models.

Chapter 2: Research Objectives & Intervention

Aim and research objectives

The overall aim of the INCENTIVE research study is to evaluate a blended/incentive driven model of dental service provision implemented in West Yorkshire in the North of England. An ideal commissioning model will complement population based health improvement measures with sufficient capacity to meet population needs using effective and efficient prevention and treatment to enhance the clinical status and patient reported outcomes in the patient base. The model evaluated here uses a blended/incentive-driven approach to commission improved health outcomes through the incentivised delivery of evidence-based prevention, care pathways, skill mix and increasing access to dentistry in response to identified needs. The implementation of this novel contract provided an opportunity to evaluate an innovation in healthcare delivery that was already being piloted and applied ideas from other settings offering substantial potential benefit for patients and the future commissioning and delivery of dental services throughout England.

Our primary objectives in the INCENTIVE study were:

- To explore stakeholder perspectives of the new service delivery model
- To assess the effectiveness of the new service delivery model in reducing the risk of and amount of dental disease and enhancing oral health related quality of life in patients
- To assess cost-effectiveness of the new service delivery model in relation to oral health related quality of life

Over the course of this study whilst our objectives have remained true to our original intent there has been a substantial move towards the introduction of blended, incentivised contracts in NHS primary care dentistry subsequent to the Steele Report[2]; specifically the introduction of the national dental contract pilots and more recently prototypes. It is important to note that

the blended/incentive driven contract evaluated here pre-dates the national dental contract pilots, and the Steele Report[2]. However, the specification was innovative and reflected the ethos and recommendations of that report with regard to an emphasis on quality of care, achieving health outcomes and PROMS[31]. This evaluation therefore complements the national pilots and recent prototypes providing insight not only of the acceptability of blended/incentive driven contracts for all stakeholders but also adds the important perspective of clinical and cost effectiveness.

The intervention

In 2007 NHS Bradford and Airedale commenced a dental service delivery procurement for three new dental practices. Providers were sought through a national procurement exercise. There was considerable interest from a wide range of providers. Nineteen pre-qualification questionnaires were submitted, of these 12 were invited to tender with seven subsequently interviewed. The PCT was actively seeking bidders who both understood the principles of the Bradford and Airedale service delivery model with its focus on the delivery of oral health improvement, quality and activity, and who also had a robust business case and operational plan for delivery. The successful bidders came from a variety of provider models, an independent contractor, a dental body corporate and a not for profit corporate.

Currently 493,100 people live in Bradford and Airedale, population projections expect the population to increase at a much higher than average rate to approximately 600,000 by 2030. The three new dental practices were carefully sited to address both oral health needs and demands for NHS dental care. The largest practice is located in an area with a predominantly white population with high levels of material deprivation; the second is again located in an area of material deprivation however with an ethnically diverse population. However the last practice is located in an affluent area (the ward is within the 10% least deprived in the country) that is predominantly white but lacks access to NHS dental care. These communities represented a rich diversity in terms of ethnicity, material deprivation and age profile allowing the service delivery model to be tested with a variety of practice populations and a range of providers allowing the findings to have a wider generalisability and applicability.

The Bradford & Airedale service delivery model instigated in 2007 was based on blended/incentive driven contract to address local NHS dental access needs and deliver quality and oral health improvement in addition to UDAs. The procurement remained timely and in line with subsequent recommendations of the review of NHS dentistry and Equity and Excellence[34] - that commissioning should be focused on health outcomes. This delivery system enables quality to be rewarded with payment linked to evidence-based management and monitoring of oral health outcomes. It also allows for continuous improvement through thresholds for payments and emphasis on outcomes by weighting payments. The service was, additionally, implementing quality and outcome measures which allowed us to evaluate their implementation and use.

The three practices operating a blended/incentive-driven contract were matched with three TRADITIONAL practices, operating under the traditional UDA based contracts, by demographics, list size and number of dentists. Table 1 details differences between contracts and reimbursement as a result of the new commissioning together with the incentives and levers and how these were anticipated to impact on process and service delivery (practice).

In detail, within the new practices, 60% of the contract value is apportioned to delivery of a set number of UDAs. The remaining 40% is dependent on the delivery of quality – 20% systems, processes, infrastructure (e.g. cross infection, policies, Standards for Better Health latterly becoming Care Quality Commission domains) and 20% oral health improvement (OHImp). The blended/incentive-driven contracts were aimed at: ensuring evidence-based preventive interventions (based on Delivering Better Oral Health – An evidence based Toolkit for Prevention[35]) are delivered in line with identified needs for a defined population; increased access to NHS dentistry; that care is provided by the most appropriate team member to encourage skill mix. It was intended that all the incentive-driven practices would fully utilise skill mix including for example, dental therapists and hygienists and extended duty dental nurses.

Table 1: Key characteristics of the practices using TRADITIONAL or incentive-driven contracts under evaluation in the INCENTIVE study

	TRADITIONAL practices	INCENTIVE practices
Contract type	**General Dental Services Contract (nGDS)**	**A blended/incentive-driven contract**
Mode of reimbursement	**Activity based, weighted bands of dental activity** **Contract currency units of dental activity (UDAs)**	**Activity: 60% of contract value – UDAs** **Incentives: 40% of contract value (1) 20%, quality systems, processes and infrastructure; (2) 20% oral health improvement**
Incentives and levers	**Driven by delivery of UDAs, with no incentives for preventive approach**	**Allocation of payment allows commissioners to incentivise key structures, processes and outcomes for quality and oral health improvement**
Health professional responsible for delivery of care	**Dentist (with no incentives for therapist and hygienist support)**	**Blended contract incentivises use of skill mix to deliver preventive focussed care**
Care pathway and recall	**Prescribed by individual performers**	**Risk assessed (traffic light system) evidence based preventive care pathway** **Risk assessed recall interval variations recorded**
Stakeholder feedback on delivery and impact of care	**Standard complaints/comments**	**Patient forum**

Skill mix

One area of potential advantage in the blended incentive-driven model of delivery is more effective use of the dental team. For example, dental hygienists/therapists can carry out courses of treatments recommended by the dentist who has examined the patient. Dental hygienists can carry out treatments such as scaling and polishing, oral health promotion and fissure sealants. A dental therapist can perform additional treatments such as fillings, pulp

treatment/stainless steel crowns and extractions on children. Additional skills dental nurses may be trained and competent to give preventive advice and apply preventive fluoride varnishes to teeth. Intuitively, the delegation of treatment to staff specialised in only a specific range of treatments could reduce costs and increase access to care but this hypothesis needs testing[36].

Skill-mix is advocated in several current proposals that continue a trend seen in UK dentistry over the last twenty years[2,7,37,38]. For example, dental therapists may now work in general dental practice[7] and their clinical remit has expanded[39,40]. The number of training places increased and several educational establishments opened programmes. The potential contribution of dental therapy is considerable. Evans and colleagues[41] found that within their current remit, therapists could undertake the treatment provided in 35% of dental visits and in 43% of clinical time. Yet dentistry has not harnessed this potential. Dentists may need models to help them employ dental hygienists/therapists profitably and fully use their skills and there have been calls to develop a system which encourages dentists to use dental hygienists/therapists differently[42,43]. The PDS pilots failed to fully involve the wider skill mix available i.e. dental care professionals (DCPs) or improve their conditions to recruit and retain them[9].

Whilst there are few hard data to support skill-mix in dentistry[36] some data are beginning to emerge. A recent practice-based study found the success of fissure sealants placed by dentists, hygienists and therapists to be comparable[44].

There is a trend towards greater professional acceptance of therapists[43,45-49] with approximately 60 – 70% of dentists prepared to consider employing a therapist in the more recent studies[50,51]. Despite this, some dentists remain unclear of their roles[51,52].

There is also some uncertainty about public acceptance of dental therapists. Two recent surveys and a qualitative study suggest few lay people are aware of dental therapists as a professional group. Furthermore, even after the training of dental therapists was explained to them, only 61% of adults were willing to receive simple restorative treatment from a therapist[53,54]. The provision of dental care is influenced by the NHS contract for dentists. The existing UDA contract does not make any allowance for treatment provided by dental therapists. In addition since 2013 dental hygienists and therapists can carry out their full

scope of practice without the prescription or the need to first see a dentist, this is known as direct access and the impact of this on dental team delivery is yet to be realised. Research is therefore needed to assess whether new models of delivery and service design will encourage their use and whether they are acceptable to dentists and patients.

Care pathways

The Bradford and Airedale new service delivery model (INCENTIVE) was designed to encourage a care pathway approach in which all patients have an OHA on joining the practice and at each subsequent recall. Four sets of information (age group, medical history, social history (self-care, habits/diet) and clinical assessment) are used to inform a traffic-light risk assessment (RAG) for patients with high (red), medium (amber) or low (green) risk of oral disease (Table 2).

Table 2: Traffic light (RAG) risk assessment

Risk	Descriptor	Example indicators
RED: High	High Risk of disease identified through clinical assessment and social history	Clinical: active decay in more than one tooth, Basic Peridontal Examination (BPE) Social history: Never rushes teeth
AMBER: Moderate	Medium Risk of disease identified through clinical assessment and social history	Clinical: Active decay in one tooth, BPE score of >2 in 2 sexants Social history: brushes once per day
GREEN: Low	Low risk of disease identified through clinical assessment and social history	Clinical: No active decay, BPE score ≤2 confined to 1 sextant Social history: brushes twice a day

Within the model, each patient follows a care pathway according to the protocol. The care pathway includes evidence based preventive treatment and advice, appropriate recall interval and restorative care as appropriate (for example, the red risk category limits patients to stabilisation and lowering their risk status). The care pathway's evidence base was based on the Department of Health's 'Delivering Better Oral Health – an evidence based toolkit for prevention'[35]. On each patient's next OHA their status is reviewed. Patients may therefore move between risk categories. Within practice monitoring ensures evidence-based preventive

interventions are delivered in line with identified needs and monitored access to dentistry. Oral health improvement is assessed through the delivery of a performance framework. This framework is based upon the transfer of ideas from the GP contract QOF. (It is of note that this contract pre-dated the DQOF[19].)

There is little literature regarding care pathways in primary dental care, though the concept has been around for a number of years. The concepts and benefits of the care pathway approach in dental primary care were described by Hally and Pitts[55]. As a result of recommendations within Options for Change[7] the first widely disseminated care pathway in UK dental primary care was the OHA within the National Institute for Health and Clinical Excellence guidance on dental recall intervals[56]. The OHA care pathway was designed to enable more prevention within personalised care plans taking into account their social and dental histories as well as clinical findings.

The type of risk assessment traffic-light system (RAG) included in the blended incentive-driven contract in our study has hitherto not been fully evaluated. Examination of different RAG models in other dental settings is on-going in the North West of England[57]. Early findings from the national dental contract pilots, suggest small improvements in risk reduction over the short-term[20].

In summary, the blended incentive-driven (INCENTIVE) dental contracts are aimed at: ensuring that evidence-based preventive interventions are delivered in line with identified needs for a defined population; ensuring increased access to dentistry; and ensuring that care is provided by the most appropriate team member to encourage skill mix. Quality indicators linked to contracts and payments have been used widely in other branches of healthcare, and the results are complex. The indicators can drive organisational change towards best practice, but may also be a disincentive to important but non-rewarded activities[24]. Used alongside demographic data, the indicators can measure practice performance, identify areas for development and assist sharing of best practice[58]. The indicators often increase the quantity of service provision, but not always the quality[59]. Furthermore, the indicators can affect the dynamic of professional relations and the doctor-patient interaction[60]. Whilst offering great potential, DQOF with embedded quality indicators have not been comprehensively evaluated in dentistry. A recent systematic review was only able to provide a framework for how such

indicators might work[61]. The blended/incentive driven contract in West Yorkshire provides opportunity for a comprehensive evaluation to inform the next dental contract reform.

Chapter 3: Stakeholder Perspectives of the Blended/Incentive-Driven Service Delivery Model

Introduction

As outlined in Chapter 2, in 2007 the Primary Care Trust in Bradford and Airedale commenced procurement for three new dental practices to address access to NHS dentistry and which would pilot a new service delivery model. The model was based on a blended/incentive-driven contract and whilst it pre-dated the Steel Report[2] and the national dental contract pilots, its specification whilst innovative actually reflected the ethos and recommendations of the report placing an emphasis on quality of care and achieving oral health improvement in accordance with the report[2] and *Equity and Excellence*[34] that followed. The successful bidders represented three provider models: an independent contractor, a dental body corporate and a social enterprise organisation.

The contract blends novel incentives to demonstrate quality and oral health improvements as well as volume of service (measured in UDAs) and therefore shares features with the reformed dental contract piloted by the Department of Health. Most of its value (60%) arises from the delivery of UDAs. The remainder is equally divided between delivery of quality including systems, processes and infrastructure (e.g. infection control and initially standards for better health and then domain evidence for Care Quality Commission and 20% on oral health improvement (implementation of Delivering Better Oral Health[62]). Thus the contract is intended to promote evidence-based preventive interventions, widen access to dentistry and encourage the use of skill mix.

A central feature of the contract is a 'care pathway', whereby an initial OHA for each patient joining a practice determines the risk of poor oral health and guides treatment and the frequency of recall appointments. These decisions are informed by the patient's age; medical history; social history (self-care, habits/diet) and the clinical assessment. Patients are categorised according to a traffic-light risk assessment (RAG), with high risk of oral disease (red), medium (amber) or low (green). The treatment protocols consist of evidence-based preventive care and advice, restorative care and designated recall intervals. Patients considered 'red' are limited to stabilisation and lowering risk status. Statuses are reviewed at

future appointments with the potential for patients to move between groups, for example, moving from ‘red’ to ‘amber’ (see Chapter 2, Table 2).

The three newly commissioned dental practices were in areas of high oral health need and with high demand for NHS dental care. The largest practice (practice 2) is located in an area of Bradford with a predominantly white population with high levels of deprivation. Practice 1 is in a neighbouring town in an area of material deprivation, but with an ethnically diverse population (over 50% of Pakistani/Bangladeshi origin). Practice 3 is the smallest practice with only two surgeries. It is located in a predominantly white affluent area (within the 10% least deprived wards in the country), yet lacked access to NHS dental care.

In this chapter we report on the qualitative research to explore stakeholder perspectives of the new service delivery model We describe meanings of key aspects of the model across three stakeholder groups: lay people (that is both patients and non-patients (non-patient are defined as individuals not having a dentist)), commissioners and the primary care dental teams, with framework analysis of focus group and semi-structured interview data.

Methods

Our focus lies on the three newly commissioned dental practices working under the blended/incentive-driven contracts (INCENTIVE practices) and three dental practices working under TRADITIONAL nGDS contracts (TRADITIONAL practices). The TRADITIONAL practices were included in the study as comparators; matched with the INCENTIVE practices by deprivation index, age profile, size of practice and ethnicity. Details of all six practices are given in Table 3.

The qualitative study uses focus groups and semi-structured interviews, supplemented with observations of dental appointments of the delivery of dental care in the INCENTIVE practices and three TRADITIONAL practices.

Purposive sampling via a sampling matrix supported recruitment of participants with different experiences of the model. The three stakeholders groups were lay people (patients and non-patients), dental teams (dental practitioners, dental care professionals and practice managers) and service commissioners.

Table 3: Characteristics of three INCENTIVE and three TRADITIONAL practices

Demographics	INCENTIVE Practices			TRADITIONAL Practices		
Type of Contract	Blended contract– UDA and Incentives for Health promotion/prevention activity			Working to 2006 NHS dental contract. (nGPS Contract)		
Practice	Practice 3	Practice 2	Practice 1	Practice 6	Practice 5	Practice 4
Established	2009	2009	2008	>10 years	>10 years	>10 years
Operated as:	Part of a social enterprise organisation	Independent provider	Part of a large corporate provider	Independent provider	Independent provider	Part of a large corporate provider
Location	In an affluent market town	SE Bradford	Centre of large town	SW Bradford	NW Bradford	Centre of large town
Deprivation Ward Located in % of households with at least one dimension of deprivation (employment, education, health & disability, housing)*	42.1%	71%	74.6%	53.9%	51%	74.6%
Number of General Dental Practitioners (GDP)	2	5	4	2	7	6
Multidisciplinary Team e.g. Hygienist therapists**	1 therapist	2 therapists	1 therapist	0	1 hygienist	2 hygienists
Number of Surgeries	2	5	5	2	6	7
Ethnicity of population*	94% white British	79.4% white British	51.3% Pakistani / Bangladeshi	89.2% white British	92.8% white British	51.3% Pakistani / Bangladeshi

*Taken from 2011 Census

** The composition changed over the course of the project as staff changed. For example practice 1 included a hygienist, therapist and oral health educator over the study lifetime.

Encounters were observed in two INCENTIVE and two TRADITIONAL practices. Staff were purposively sampled across the range of skill mix so that similar numbers (15 each) of dentists and dental hygienist/ therapists were observed. All eligible adult patients (18 years or

over) with appointments with the participating staff on the scheduled day of observation were invited to participate. Two weeks before their appointments, patients were sent a letter informing them of the study, a study information leaflet and consent form. Patients who expressed interest in the observations were given the opportunity to ask any questions and give consent on the day of their appointment. The 'non-participant' observer attended appointments passively at a distance close enough to hear the conversion to take comprehensive field notes. A brief analysis of observations was conducted as soon as possible after the observation (the same day or following day).

Observations were followed by interviews with clinicians, resulting in the participation of four dentists and four dental hygienists/therapists that took place on the same day. Staff were asked to comment on the observed encounters and share their views on what had taken place. Questions asked at the post-observation interview were influenced by the nature of the activity in the encounters, the team member's attitude, expectations and impressions and reflections of the experience. Interviews were recorded and transcribed verbatim.

Interviews were also conducted with patients, lay people recruited through community settings, commissioners and dental team members (see Tables 4 and 5).

Lay people were recruited for the interviews in two ways. The research team gave practices information packs to mail to patients. Potential participants indicated interest in the research by returning their contact details in a freepost envelope and were then contacted to arrange an interview. Lay people who were not patients included representatives of community groups in the locality. The researcher contacted the gatekeeper of community organisations to explain the study and provide research information and enlisted their help in recruitment. Focus groups were held with groups attending a community centre, including one aimed at parents with young children and another attended by older residents. In addition, snowball sampling entailed existing participants passing the study information and the researcher's contact details on to acquaintances to invite them to take part. The inclusion criteria for lay people were that they should be aged 16 years and over, be willing to be interviewed. People with no natural teeth were excluded.

Ethical Approval

Ethical approval was obtained from National Research Ethics Service (NRES) Committee London – Bromley. Research Ethics Committee (REC) reference 12/LO/0205 on 5th April

2012. Informed consent was obtained from all participants prior to any qualitative enquiry. The study was sponsored by the University of Leeds.

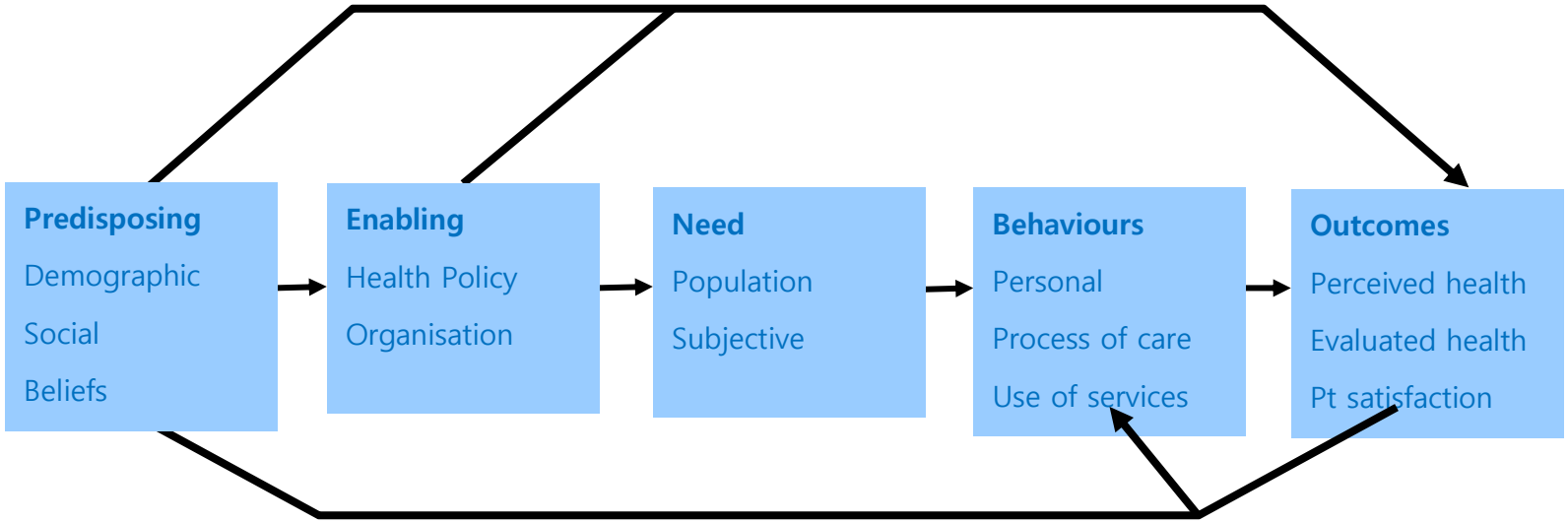
Data were collected between August 2012 and February 2014 by two research associates, who were social scientists rather than dentists. Interviews and focus groups followed a topic guide, partly informed by the theoretical framework (Appendix 1 and Appendix 2) but supplemented with themes that emerged from the observations and previous interviews. Interviews with dental team members took place at the dental surgery, while interviews with patients took place in patient's homes. All were recorded and transcribed verbatim. Interviews lasted between 15 and 70 minutes.

Theoretical framework

The Andersen Behavioural model of access was employed as the theoretical framework for the qualitative analysis (see the simplified depiction in Figure 1). The model sees access as *'the use of personal health services and everything that facilitates or impedes their use'*[64] and distinguishes between 'potential' and 'realized' access. Potential access is measured according to enabling variables such as the availability of care or supply of health care workers. 'Realized access' refers to services actually used or 'utilisation'[64].

Originally developed 40 years ago as a model of healthcare utilisation, the model has evolved in line with advances in understanding that have moved from an individual focus to incorporate the interaction between individual, health care system and external environment[64-66]. The revisions have not altered its basic foundations, but have added components to it. Later versions introduced health and patient satisfaction as desirable outcomes of healthcare, which were said to be determined by predisposing and enabling factors, behaviours and need. Findings from studies in many areas of health care, and dentistry in particular, support its use (e.g.[67,68]).

Figure 1: Andersen Behavioural model of access



Enabling factors relate to the policies, facilities, staff and the organisation of services, which might influence utilisation[66]. It is helpful to consider enabling factors as a spectrum, with different qualities of the same factors either facilitating or challenging service use. Policies, guidelines, rules, practices, contracts, resources and reform define the nature and delivery of care. Financial factors can include the funding and affordability of health care. Organisational factors refer to the structures and processes that influence the availability and the distribution of health services, the personnel and how accommodating they may be to patients' needs.

From this perspective the blended/incentive driven contract being evaluated in this study is an enabling factor with health policy, financial and organisational facets. Government had made policy commitments to oral health and dentistry with focus on: improving the oral health of the population, particularly children; introducing a new NHS primary dental care contract and increasing access to NHS dentistry[18,69]. Other relevant drivers included the recommendations of the Steele Report[2] and the evidence-based prevention of Delivering Better Oral Health[62].

The contract replaces some of the financial emphasis on the volume of treatment with incentives for quality and changed outcomes. These incentives were based on the concept of providing care for a population rather than patients via organisational changes such as the use of care pathways, the provision of evidence-based care and the use of skill mix

Health care need may be seen as the potential to benefit from care and requires both a health problem and an effective intervention[70]. Health needs may include health education, disease prevention, diagnosis, treatment, rehabilitation and palliative care.

Andersen distinguished between evaluated (professionally defined, or normative) and perceived (personally defined or felt) need[71] but recognised that there were social aspects of evaluated need, which could be influenced by technological developments and clinical guidelines.

In some versions of the model predisposing, enabling factors and need are distinguished at the contextual or individual levels. Contextual characteristics operate at a population or

combined level, drawing attention to the environment or the circumstances in which healthcare is delivered. The most recent versions of the model have seen the context and individual levels arranged sequentially with contextual predisposing and enabling factors and need influencing similar factors for individuals.

In turn these components could influence personal and professional health behaviours. Personal behaviours are activities that shape health status, such as oral hygiene, diet and tobacco use. Health service use is treated as behaviour in itself. Professional behaviours relate to the processes of medical care, such as health education, clinician-patient communication and prescribing behaviour. Both personal and professional behaviours may be amenable to changes via enabling factors and will influence the nature and volume of treatment provided

The outcomes are perceived and evaluated health status and patient satisfaction. The maintenance and improvement of health should be the primary outcome of access and is a central target of the Dental Contract Reform Programme[69]. Perceived health status indicates how much an individual can live a *'functional, comfortable and pain free existence'*[66]. This definition is akin to oral health related quality of life, which may be defined as is *the impacts of oral disorders on everyday life that are important to people and of sufficient magnitude to affect perception of their life overall*[72]. However, other patient reported outcomes could be used, such as general health perceptions. Evaluated health status requires a professional assessment of clinical status. Patient satisfaction has a bearing on patient health outcomes, with greater satisfaction being related to health improvement via adherence, involvement with treatment and continued use of services.

An important feature of the model is its recursive nature with feedback loops so that the outcomes of access have the potential to influence future predisposing and enabling factors, population needs and use of services.

Analysis

Data were analysed in two phases. First, pen portraits of the practices are used to give the data context.

The principle approach used framework analysis to induce the results from the variety of original accounts across stakeholder groups within the structured policy focus of the research[32,33]. The focus of the analysis was to explore the effect of the contract as it interacted as an enabling factor with other stages of the model. Analysis adhered to the following process:

i) familiarisation with the data;
ii) identifying the thematic framework;
iii) indexing;
iv) charting and,
v) mapping and interpreting[32].

A member of the research team (MH) studied the field notes and transcripts of the post-observation interviews. This process of *familiarisation* enabled identification of emerging themes in the data set[73]. While Andersen's behavioural model guided the thematic framework in principle, data were not forced into an *a priori* model, instead the framework was refined as required (*Identifying the thematic framework*). Data generated from the post-observation interviews were indexed according to the particular theme to which they corresponded (*Indexing*) and lifted from their original text and placed under subheadings derived from the framework (*Charting*). The themes were flexible and modified as necessary. Data were organised by theme to enable a process of constant comparison across themes and cases. The framework analysis served to either confirm or to challenge the model. A form of deviant case analysis was intended to be used to add new categories or revise the model.

The validity of the findings was supported by discussion of interim and final results for triangulation and corrections with participants in focus groups. The results were also compared against existing knowledge, such as the evaluations of the NHS Dental Contract Pilots[30].

Results

Pen portraits of the practices are presented in Table 3 to set the context of the study. The qualitative results of the principle analysis are presented in two stages. First, the major themes in the data are outlined. Secondly, the interactions between the themes, focussing

particularly on the interactions between enabling (i.e. service organisation) and other factors are described.

Three study practices (1, 2 and 3) were using the blended/incentive driven contract approach referred to as 'INCENTIVE Practices'. These were matched to three control practices (4, 5 and 6) operating nGPS contract referred to as 'TRADITIONAL' according to the number of general dental practitioner (GDP) surgeries, list size and the deprivation index and ethnicity of the local populace.

Practice 1

Practice 1 is situated in the centre a large town several miles from Bradford. The practice is based within the 10% most deprived wards in the country, with associated adverse income, living environment, education, health and employment indicators. The practice estimates that approximately 80% of its patients are eligible for benefits and a similar proportion are white British despite around 50% of the ethnicity of the population in the geographical location being Pakistani/Bangladeshi. The practice was established in 2008 and is operated by a very large national corporate provider. Its team consists of 4 GDPs and 1 dental therapist.

Practice 2

Practice 2 is located at the South East edge of Bradford, adjacent to a large council estate. Bradford ranks 16th in the most deprived local authority areas in England. The area served by the practice originally had a white British population, though has become more ethnically diverse in recent years and has a traveller community. The people of this area had experienced difficulties with access to dental care for many years, with limited care available in the area and a local unwillingness to travel for care.

Established in 2009, the practice is owned by an independent contractor with two other practices (not part blended/incentive-driven contract). The practice has five surgeries, a separate decontamination room and staff training room. It employs five dentists and two dental therapists. Almost all of its treatment is provided under the terms of the NHS (99.5%).

This practice experienced a higher staff turnover than the other study practices, which was attributed anecdotally to the associates being early career dentists eager to take up a post but

not necessarily a commitment to practicing in the locality long term. Lack of opportunities to carry out complex treatments has also been thought to be a factor.

Practice 3

Practice 3 is located in an affluent market town several miles from Bradford, which has lacked NHS dental provision. It was established in 2009 and the provider is part of a social enterprise organisation. It has two surgeries, two dentists and one dental therapist. During the research, one GDP left this practice. The original practice manager was replaced, but later returned.

Three comparison practices (4, 5 and 6) continued to work under the terms of 2006 NHS dental contract and were matched to the blended/incentive-driven practices according to the number of GDP surgeries, list size and the deprivation index and ethnicity of the local populace.

Practice 4

Practice 4 is close to practice 1 and part of a group that operates more than 200 practices in the UK. With more than 10,000 NHS patients the practice is not currently taking on any new patients. Almost all (96%) of the work is provided under the terms of NHS. There are 7 surgeries, staffed by six GDPs. Two dental hygienists are employed.

Practice 5

Practice 5 is an independent practice, on the outskirts of the Bradford and at over 30 years, is the longest serving practice in the study. It has six dental surgeries with seven GDPs and one hygienist who is available on a private basis. One dentist's services include non-surgical procedures such as fillers.

Practice 6

Practice 6 is an independent practice run by two dentists. There are no hygienists or therapists but the practice provides a full range of NHS treatment (except orthodontics) to all members of the public. It also provides private treatment including sedation for anxious patients.

Qualitative Results

Observations were made of 30 dental appointments. Eighteen lay people, 15 dental team staff and a member of the commissioning team took part in the interviews and focus groups (Tables 4 and 5).

Table 4: Brief descriptions of 18 lay participants

Pseudonym	Practice	Details
Michael	2	In his early 40's, recently made redundant, former army, cohabiting with partner.
Shazia	2	Community worker, 30's, married with children
Katie	2	Mother of 2, in her 20's, lives with partner, on benefits
Tony	2	Tony & Jeanette are a married couple. He is visually impaired and 66 years old. Jeanette (65) is in a wheelchair following a stroke. Moved to practice 2 because their previous dentist lacked wheelchair access.
Jeanette	2	
Ian	3	Married couple in their mid 40's.
Grace	3	
Martin	3	Married, police officer, in his 40's, two children
Lara	1	Housewife, 30's, married with children
Nanush	1	Married housewife with three children, in her thirties
Alison	Patient at a TRADITIONAL Practice	Working mother of one in her 30's.
Carol	Patient at a TRADITIONAL practice	Stay at home mother of 2 in her forties
Kat	Patient at a TRADITIONAL practice	Stay at home mother of 2 in her twenties. Her children attend and INCENTIVE practice.
Natalie	No dentist	Mother of 2, in her 20's, lone parent, receiving benefits
Johanna	No dentist	Focus group with three women in their 70's and 80's. Each had dentures to varying degrees.
May	No dentist	
Mary	No dentist	
Ann	Discontinued Incentive patient	Housewife in her fifties

Table 5: Participants professionally associated with dentistry

Participants	
TRADITIONAL practice dentists	4
INCENTIVE practice dentists	8
Dental Practice Managers	2
Dental therapist	1
Commissioner	1

The Andersen Framework was sustained in the data, with the only revision being the addition of trust as an outcome of access. During the analysis, the implications of the epistemological position of the model became apparent. A wider debate may be required about enabling the use of social resources for health and the position of health services within that. This debate is introduced in the discussion. The results are described supported by anonymised quotes from the data.

The qualitative results are presented in two sections. The first demonstrates the fit between the data and the Andersen model and the second examines the effect of the new contract as interactions between enabling and other factors in the model.

Predisposing factors

Predisposing factors could be characterised as demographic and social characteristics and beliefs. For example, family commitment could facilitate or hamper service utilisation and one participant (Grace) noted the effect of changing attitudes over time.

I can't remember where I go, I wish I could. My daughter takes me to all my appointments

(Mary, No dentist).

I think the danger is when you're a professional this is what you do for a living, it's a danger as its making an assumption that everybody else thinks it's as important as you, and it is down to education and you know we see ourselves very much as a practice set up to educate and to inform. When you're dealing with the demographic and you know the type of community we are working with, you've got to be very careful not to be patronising, you have to be very careful because you know everybody's need is different and everybody's circumstances, you know we shouldn't just

assume that because we think it's important that they will

(Sarah, INCENTIVE dentist).

I think and it's something that kind of you're very aware for your children as well aren't you? I think when I was younger there was a different kind of attitude towards it and I only went to the dentist if there was a problem and I think attitudes have changed now and I think that its, you know you're much more proactive in making sure that your children go and they get seen and that type of thing

(Grace, INCENTIVE patient)

These data suggest that from the patients' perspectives predisposing factors are things that either hamper or enhance their ability to access care. For the providers it involves fitting the service to what the dentist thinks the patient needs. The last quotation indicates a generational change and changing attitudes to the dentist.

Enabling factors

Compatible with the underlying framework, enabling factors fell into three sub themes of health policy, finance and organisations. The influence of health policy appeared in the data between the extremes of the changes associated with implementation of the blended/incentive-driven contract right through to an apparent lack of policy in some practices.

There's going to be challenges in terms of its new, so you've constantly got perhaps a more demanding type of commissioning process. From a commissioners perspective as I mentioned earlier it takes more time.

(Service commissioner)

We don't have any guidelines or anything

(Dentist at feedback event, TRADITIONAL practice).

A key part of the contract was the remuneration of dentists and thus finance was a rich theme. On the one hand traditional models of service use were problematic for the treatment of complex cases, whereas the problem for INCENTIVE practices became much more focused on the costs of OHAs and building relationships with patients that would enable more prevention.

The current [2006] *contract works to an extent but means treating complex cases is difficult. I'm here to make a profit and a living. There's no point me being here if that's not going to happen. I've trained for a long time, I have laboratory costs to cover, I need to make money. Complex cases are difficult in this contract*

(Adam, TRADITIONAL practice dentist)

The cost of doing that [OHAs] *is far higher than was first anticipated, so if we were to put that as a separate issue we would say that it's the costs prediction. The estimation of what it would cost to run this has been very underestimated, because it does take more time. It takes us away from doing, because we're trying to get patients, encourage them, chase them so much it actually takes an hour for a clinician to build that relationship in the first place and then it's about compliance and so that was collaboration, its maintaining that, it's very hard to do*

(Business Manager, INCENTIVE practice)

Computing problems featured as organisational factors.

Some of the challenges around things like the software I think have been hard and that's been symptomatic because we're using a software system that has to generate, its geared up for payment system as well as a clinical and reception management, patient management system and we're trying to alter it to continue to provide some of the data that the contract demands around UDA generation but also around capturing some of the data that we want and because we're such a small customer, it's hard to influence that.

(Service commissioner)

The only disadvantage is I think in my opinion is the software, there are so many different varieties of software around and they have not prepared themselves to be really in tune or to deliver the type of things which are needed for this pilot, for this kind of service so that is very generic dental software, dental services software. Well in my opinion, the software should have been tweaked much before implementing this contract'.

(Amiya, INCENTIVE dentist)

Need

Evaluated and environmental need and population health indicators were manifest in the data. Two localities in the study are characterised by material deprivation, poor oral health and

long-standing under-supply of care. Unsurprisingly, this influenced dental treatment needs in these areas.

It would add up to perhaps 8 dental visits just for one course of treatment and that will be just to stabilise the patients. There were an awful lot of extractions that were needed. Some patients do struggle obviously with substance misuse, and smoking is quite a major factor as well ...We still do get those new patients who come in more or less the same state who require an awful lot of dental treatment'

(Jennifer, INCENTIVE dentist)

Treatment needs are so high and there's a lot of neglected mouths. Some haven't seen a dentist in years. Some have lost the motivation to maintain their oral health because of this. So there's a lot of preparatory work

(Donna, INCENTIVE therapist)

Health behaviours

Health behaviours involve personal health practices (such as tooth brushing or sugar consumption), the process of care (for example, the delegation of care or other dental team behaviours) or the use of health resources (such as attending or not attending appointments). Personal practices can influence oral health positively or negatively:

There's relationship between what you eat and your teeth and your health…. They told us about what toothpaste to use and gave us some. They told us about drinking fizzy, time of day to brush teeth. I've changed it a bit and drink water now

(Jennifer, INCENTIVE patient)

A novel aspect of the process of care involved the assessing patient's risk of disease. Dental team members commented on the relative imprecision of the traffic light system and its three categories. However, concerns about imprecise systems were not restricted to the risk assessments.

Patients who are amber may be very red because of their diet and because of other things so a couple

of amber should make it red, not amber. The software doesn't pick out some of the differences'

(Suneeta, INCENTIVE dentist)

Focussing on UDAs, the three bands I think can be an issue, some of the dentists have said they think there should be more bands obviously just lumping all restorative work, apart from that needing lab work, into band 2, it could be anything from a simple filing to a very complex molar re-root canal treatment, it does seem a bit wacky.

(Business Manager, INCENTIVE practice)

Attitudes and practices towards prevention varied appreciably among the dental teams:

All the dentists do give advice, you know the preventative advice, to all the patients whether under the contact or not.

(Suneeta, INCENTIVE dentist)

I have been here 12 years and have well established relationships with my patients. I do find it hard to talk about their health – I'm trained to drill and fill

(Ian, TRADITIONAL practice dentist)

The use of health resources might involve attending or not attending appointments and accessing the wider dental team such as a dental hygienist.

I went through like a stage where I didn't go for about 3 years but that was, I went back about 5 years ago, I don't know why I didn't go, I just stopped going and I think then you get thrown off the register'

(Alison, TRADITIONAL patient)

They gave me an appointment because I need a filling and when it came day before I were panicking and worrying, I just cancelled it because at end of day I'm not going through that you know tight chest and I'm not going through all that because at end of day it's not my fault is it? Sweets I've had

(Ann, INCENTIVE patient)

*I've started going to this one I've actually seen an oral hygienist, whilst I was private dental care I was never even offered to see somebody so this is the first time I've actually seen o*ne

(Holly, INCENTIVE patient)

Outcomes

Evaluated or perceived health and satisfaction with care were present in the data, as was the concept of trust. A dentist noticed his patients' improved health and patients trusted and were satisfied with their dentist, although one disliked an interval of two years before they could have another assessment:

I think according to recalls they have improved their brushing, they are using fluoride toothpaste more, they have started smoking less so there is general improvement in their oral health as well and their attitudes towards oral health

(Manish, INCENTIVE dentist)

They're really good. I think they've got more of a modern approach there whereas the other ones still a bit, I don't know seems a bit dated

(Kat, parent of an INCENTIVE patient, patient at a TRADITIONAL practice)

I do trust them here – they treated me, gave me root canal treatment and saved my tooth, without them, I'd have been minus a few teeth and my appearance would not have been good

(Nanush, INCENTIVE patient)

The effects of the blended/incentive-driven contracts: Interactions in the data

The blended/incentive-driven contract changes the finance and organisation of dental practices to implement health policy. Its effects can therefore be seen as interactions between these enabling factors and other stages in the model.

Enabling and predisposing factors and need

The INCENTIVE practices had been located in areas of high need, either associated with deprivation and disease or with the poor availability of NHS care.

We'd carried out quite a robust oral health needs assessment prior to commissioning these practices and we'd looked very closely at equity in terms of access to dental care, so we'd looked for places where there was very poor oral health and also looked at areas where there was limited access to services and we wanted a combination of those. The sites of the practices therefore were chosen on oral health needs, current access to NHS care, transport systems and so on

(Service Commissioner)

For some participants, the INCENTIVE practices marked a shift from *no* dental care, whereas others moved from private to NHS provision. Participants reported the impact of the new services that suited their needs in terms of location, personnel and ease of getting an appointment. Participants referred to the difficulties they had encountered accessing an NHS dentist:

Finding an NHS dentist has been really, really difficult and that's why I have quite strong views on that to be honest with you. We lived somewhere else and we had an NHS dentist and then when we moved, you know what it's like and then you lose your place and then you end up on a waiting list waiting for absolutely ages. Then we heard about this one.

(Jane, INCENTIVE patient)

Enabling and behaviour

The effects of the new contract could be detected on the processes of care, on personal health practices and the use of personal health resources. In turn, the process of care appeared to be affected in three ways, by the use of the care pathway and by increasing the amount of prevention and the use of skill mix.

The care pathways form an important feature of the Steele Report[2], the reformed NHS contract pilots[18] and the blended/incentive-driven model reported here. Initial OHAs for each patient guide treatment and the frequency of recall appointments. Participants reflected on their experiences with the pathways. Benefits included the clear link between the risk assessment and care pathways.

I think some of the people were saying you know if you have a red patient there's only limited treatment options available for that patient until they start moving from red to amber or green, whichever. And I think that was quite a contentious issue, just to leave them in the state and then wait until they got more progressed through from each stage before you can start doing treatments. But I mean the actual process makes sense in the sense that you know there's no point carrying out such complex treatment on someone who can't, who is failing to kind of maintain that level of oral hygiene because it can just make it worse'.

(Amiya, INCENTIVE dentist)

The blended/incentive-driven contract formalised Department of Health guidance[62] from the perspective of clinicians. As treatment plans incorporated preventive treatment, these approaches became standard procedure.

Red, amber or green and then they do get the fluoride varnish, the smoking cessation and alcohol use is being taken automatically. And then obviously depending on the age groups with the fluoride varnish, depending on the categories, while the schedule of the appointments are set then and the recalls so it's kind of, it's part of our contract. We don't do anything else

(David, INCENTIVE dentist)

The blended/incentive-driven contract could be contrasted directly with the TRADITIONAL practices (i.e. those operating the 2006 contract). In this case the focus of care in the incentive contract had penetrated a TRADITIONAL practice, causing them to reflect on their processes of care:

We are pushed towards UDAs rather than improving oral health... The prevention emphasis is an issue – we are expected to talk about perio disease and smoking and diet and have to squeeze that in. We did that before under the old system and it worked to an extent, but we have to do more and more without getting paid anymore. We have to do more in less time

(Sidney, TRADITIONAL practice dentist)

The feeling about the incentive/blended-driven contract as an enabler of preventive approaches was echoed by clinicians in all three Incentive practices. Whilst such systems are not specific to the incentive model and reflect long standing guidance[62], the formalisation of such procedures under this model was valued by service providers. Practitioners felt that it gave them time and space to care for patients.

By contrast communication of the ratings was not always apparent in the observations. Moreover, patients might not be aware of it:

I: Thinking back to your initial assessment as well, I don't know if your dentist, do they use the traffic light system?

K: No, what's that?

I: There's nothing where they kind of rate your oral health or anything like that?

K: No.

(Katie, INCENTIVE patient)

The INCENTIVE practices were not required to use multidisciplinary teams, but the successful bidders employed business models that utilised dental hygienists and dental therapists to deliver preventatively focused care. This wider use of skill-mix has been advocated by repeated policy documents but not widely implemented[7,37,74,75]. One novel approach was for dentists to examine the patients and formulate treatment plans, but the practices did not deduct the value of the delegated treatment from dentists' incomes.

The biggest advantage as well is, is that, it's about mind set as well, if you are working in a normal practice your dentists, your associate will be charged with using the therapist, the hygienist and so therefore your dentist is, your associate is less likely to use your therapist and hygienist because they don't want to pay for them. Here they get it for absolutely free.

(Anna, INCENTIVE practice manager)

They readily work with each other. I mean our therapist and the hygienist are generally busy the whole day, which they say they don't normally get in other practices so, and we pay them on a fixed rate and the therapists are very happy with that because they've got full time work, they're busy, the associates are happy because they're not having to pay for them …, the patients get benefit because they get access to a therapist, … it may cost more for us to do it but it's a more sensible way of running a business because everybody is working together for the same aim

(Claire, INCENTIVE practice manager)

That's definitely an advantage obviously because there's more appointments available now so you can see more patients

(Fiona, Dentist, INCENTIVE practice)

The new contractual arrangements were seen to influence personal health practices and the use of personal health resources. Lara changed her personal routines and attended the dental hygienist.

I've been prescribed Duraphat fluoride toothpaste, I use interdental brushes and see the hygienist. I take advice on board and I don't want to get told off. So I've changed my routine. I didn't know you could go to a hygienist until I came here

(Lara, INCENTIVE patient)

Enabling and Outcomes

The blended/incentive-driven contract also influenced outcomes of perceived and evaluated health and patient satisfaction.

They managed to sort my mouth so that I can actually smile now and feel confident about my smile, I don't feel like it's, or people are looking at my teeth anymore which, I mean it's a massive improvement, it makes you confidence so much more, it makes you feel better about yourself when you know that someone is helping you sort something that you know is a big problem. You feel self-confident about it'

(Shazia, INCENTIVE patient)

I have been working here for 2 years plus so I can see that the patients from the deprived area, yes, I think according to recalls they have improved their brushing, they are using fluoride toothpaste more, they have started smoking less so there is general improvement in their oral health as well and their attitudes towards oral health.

(Jane, INCENTIVE dentist)

Generally making you feel better at going, I feel much happier going to the dentist now than I did a year ago.

(Carol, INCENTIVE patient)

That's really good because I don't know maybe the hygienists have got a bit more time and if it's something they're trained to do that's fine rather than taking up the dentist time which is more specialist work. I mean I know my daughters been to see the hygienist, you know about brushing her teeth and they gave her some Duraphat cream

(Grace, INCENTIVE patient).

Far reaching effects

The interactions could ripple throughout the model to have far-reaching effects. For example the RAG ratings could influence patients' perceptions of their own needs, leading to personal behaviour changes and satisfaction (an outcome).

I think it's good because if you know, if someone says to you, you know on this rating you are more at risk, you're more likely to do something about it aren't you, as opposed to someone not saying anything to you, you know, I think you are likely to be more active. I would be more active but I think it gives people that, again it's about having that bit more choice and a bit more involvement in your own kind of care which I think is a good thing.

(Grace, INCENTIVE patient)

Using the ratings to determine recall intervals liberated more time for the process of care and allowed observation of increased health but influenced patient satisfaction both positively and negatively:

The recall intervals will be according to the risk assessments that we are doing and the risk assessment is based on their medical, their social and their clinical domains and patient to understand it and they are really happy, the majority of them 99% are very happy to have the recall intervals as dictated by their risk assessment… The recall intervals of 2 years and a year for the green and the amber patients so we are definitely seeing more patients and as the amber ones move towards green or the reds move towards green so we would be having more appointments for the patients to be seen

(Manish, INCENTIVE dentist)

2 years seemed a long time to wait . . . I sort of think umm would I be prepared to pay a premium price and go back to private care as a result of that and that's something that I'll have to consider really

(Martin, INCENTIVE patient)

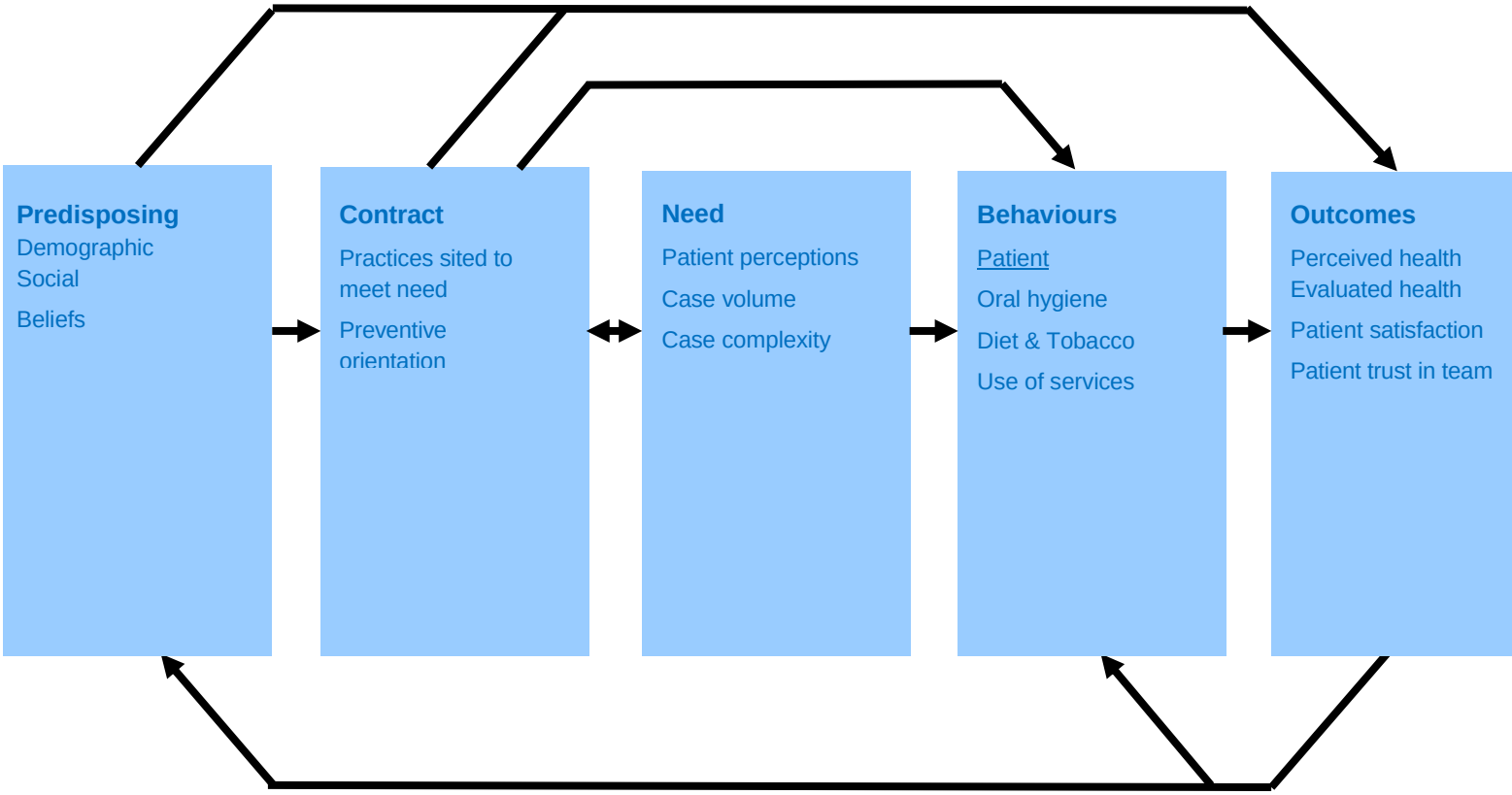
These data suggest a need to reconcile contrasting views. From the dentist's perspective there is the ability to see more patients and hence increase access. At its best, the incentive model seems to enable greater access because it prioritises those who need treatment and rebalances appointments around need. However, the patient was not happy with waiting two years for another assessment and may consider seeking alternative or additional care.

In a wholly positive example, a patient satisfied with her own care encouraged her partner to attend so that professional behaviour enhanced satisfaction to change predisposing factors to increase access to care.

> *. . fantastic and the dentist themselves are really friendly. They're really understanding, I mean for me I'm not somewhat scared of the dentist as my partner and it's made a real improvement for my partner because he's terrified of them so, and we've actually managed to get him there and he's having work done there which is an improvement, usually trying to get him through the door of the dentist was a real effort, it took a day to get him there, get him sorted and get him home again. So I mean from that point of view they've just been absolutely fantastic with both him and me.*
>
> (Holly, INCENTIVE patient)

In summary, participants' observations are compatible with existing knowledge of access to care, but highlight possible effects of the INCENTIVE contract (Figure 2). In particular, patients' needs were seen to influence the siting of practices. The contract had a number of direct effects on practice orientation and costs. However, participants related these effects to better health-related behaviours on the part of patients and changes in dental practice behaviours regarding assessments, prevention, patient communication, the use of skill mix, the number of patients seen and recall intervals. In turn, these changes were related to improvements in perceived and evaluated health, patient satisfaction and trust.

Figure 2: Summary of stakeholders' perspectives on the INCENTIVE contract



Discussion

This Chapter has reported the exploration of stakeholders' views of the new contracting arrangements. There were perceptions that the blended/incentive-driven contract increased access to dental care, with the contract determining dentists' and patients' perceptions of need, their behaviours, evaluated and subjective health outcomes and patient satisfaction. These outcomes were then seen to feed back to shape people's predispositions to visit the dentist. The data hint at appreciable challenges related to a general refocussing of care and especially to perceptions about preventive dentistry and use of the risk assessments and care pathways. There are also obstacles to overcome to realise any benefits of the greater deployment of skill mix. Dentists may need support in these areas and to recognise the differences between caring for individual patients and caring for segments of the population, such as that formed by the patient-base of a practice.

The impact of the contract is evident as interactions with other stages in the model. There was ample evidence of such interactions.

The ratings from OHAs were seen to influence patients' perceptions of need, which led to changes in preventive behaviour. There was also ample evidence that dentists' behaviours had responded to the contract in the desired direction with greater emphasis on prevention, use of the ratings in treatment planning, adherence to the pathways and the utilisation of skill-mix. Participants identified increases in the capacity of practices to deliver more care as a result. These changes were seen to improve evaluated and perceived health and patient satisfaction. These findings are compatible with the patient and staff feedback on the first year of the NHS dental contract pilots where almost three quarters of patients said they had a better understanding of their oral health and had changed their behaviour[30]. Furthermore, the Department of Health has analysed matched pairs of OHAs and Oral Health Reviews (OHRs) between 2011 and 2013 that suggest improved RAG ratings for small numbers of patients, even within this relatively short time span[20].

Moreover, better health and satisfaction fed back with explicit examples where people were more predisposed to visit the dentist. These findings demonstrate the potential for the new contract to increase access to high quality services and to improve health and provide support for the continued use of contract reform in the forthcoming prototypes[76]. However, dentists may need support and training to maximise this potential.

Several areas of the contract were also identified as requiring more careful consideration, where NHS England, dental teams and the public may need more support if this potential is to be realised.

The practices had been placed in areas of high need, in some cases related to social deprivation, although in the case of one practice unmet need had been associated with low levels of NHS dental provision in an affluent area. As well as meeting immediate needs, the *perception* of low availability of care may also be a barrier to access in areas that have been underserved in the past. Evidence of new services is therefore needed to break this cycle.

The geographical location of the practices was based on addressing both unmet need and local NHS demand for dental care. The commissioning process described the blended/incentive-driven contract and asked bidders to describe their business model to deliver the contract requirements. The results demonstrate direct benefits of the needs-led service commissioning that has been in place since the inception of the 2006 dental contract and which allows for local commissioning arrangements[7,77]. The forthcoming Prototypes, which represent the next stage in the evolution of the NHS Dental Contract reform programme[76] will lack these local flexibilities. Although these local flexibilities remain with regard to dental commissioning by the National Health Service Executive (NHSE), they are utilised less in the current commissioning arrangements. This may be a result of commissioning using a single operating model with less local knowledge applied to practice commissioning. In addition, the new system is expected to use standardised national values for capitation and activity, with weightings based on patient characteristics of age and deprivation status. The level of these weightings will be important in influencing the commissioning of new practices in areas of high need.

Successes in prevention were prominent in the data, with participants adopting a variety of preventive professional and lay preventive behaviours leading to better evaluated and perceived health. This refocus of care had also penetrated into TRADITIONAL practices where one dentist acknowledged that they were pushed towards volume of treatment rather than improving health. However, there were concerns over offering preventive advice, the complexities of accounting for the patient's context, the time this took and the difficulties of effective prevention, especially in areas with high levels of disease.

It is interesting that these aspects of dentistry are so often presented as problems, sometimes beyond the scope of practitioners, rather than part of their job. Unlike the challenges of (say)

a difficult restoration, some dentists regard them as beyond their remit. One dentist declared "*I do find it hard to talk about their health – I'm trained to drill and fill".* Earlier research has indicated that some dentists regard prevention as 'not their job' and so there is still case for a refocussing of care towards prevention[50]. This is a key issue if dentistry is to achieve the change needed in the Five Year Forward View[78]. These and other data indicate that change is possible if it is encouraged by the right contractual model. Educational interventions may also be required to support contractual drivers. Neither one alone is likely to be sufficient. A Cochrane Review[79] concluded that educational meetings had a small effect on professional practice and health outcomes but the effects were likely to be smaller still for complex behaviours. Both a systematic review of incentives to follow best practice in health care and a Cochrane review of the effect of remuneration on primary care dentists' behaviour cited within it[27,80] concluded that financial incentives can have a 'modest' effect on improving the quality of healthcare.

The emphasis on OHAs and pathways was a key feature of the blended/incentive-driven contract and the NHS contract pilots[30]. Some patients were not aware of the traffic light (RAG) ratings, others perceived them to alert them to their preventive needs and to be a motivator. Others perceived them to be potentially disempowering. Interested to find out how the dental teams were using the RAG rating, we specifically enquired about them when triangulating the data in focus groups with dental staff. There was near universal use of the ratings as a decision aid (as evident in the data), but their use in patient communication was said to have decreased over time. The use of RAG ratings in communication therefore remains an opportunity that might be, or should not be exploited. Dental teams will clearly benefit from clarification of whether and how the ratings are supposed to be communicated to patients.

The small number of categories within the rating system was a concern among dentists, especially for patients who had risk factors such as general health problems, which would not change. Some participants erroneously attributed this to the software rather than to the purpose of the OHA. Dentists' concerns might be alleviated by the addition of new categories. Alternatively, they may become used to this system and gain confidence in over-riding the rules of the pathway. Their reluctance to do this may stem from the requirement to justify doing so. Dentists who engaged in the NHS contract reform requested reassurance about exercising clinical judgement so that 'there would be no medico-legal repercussions arising from deviating from software recommendations provided there was evidence of

clinical justification'[81]. Respondents wanted to be reassured on 2 points: first, that there would be no medico-legal repercussions arising from deviating from software recommendations provided there was evidence of clinical justification; and second, that "overriding" software recommendations would not subsequently be used to penalise dentists. An additional category of 'light green' was added to the national contract pilots for instance, but dentists may need more training in working with the pathways.

A prominent feature in the data was adherence to guidance on recall intervals. There was evidence that both dentists and patients could be unhappy with longer recall intervals although some both groups were able to adapt to it, which created more space increasing access to other patients. One view saw the extended recall intervals as too long. A dentist in a focus group acknowledged that he tended to adopt a maximum interval of annual recall, and this view was echoed by a Local Dental Committee in the recent contract reform engagement exercise[81]. Our dentist could distinguish between the stakes and the probability of missing new disease with a longer recall period but did not recognise that missed diagnosis was less likely at a time of lower disease incidence. Neither the review leading to the NICE guidance, nor a Cochrane review on recall intervals could find any evidence in favour of a particular time, thus the guidance was based on assessment of the risks associated with different intervals[56,82]. Whilst there is weight of history behind the six month dental check up its risks in terms of the chances of over-diagnosis and reducing capacity may not be visible to practitioners. Dentists may require a better understanding of these population effects to help them adapt to the new system. The World Dental Federation (FDI) has proposed dental education emphasise these types of public health perspectives[83].

To some extent these problems may reflect the difficulties of any organisational change. Furthermore, dentists may be grieving for their loss of individuality and clinical freedom. Once again, they may need support on the nature of working with a system based on clinical guidelines and care pathways and on how to deviate from the pathways including over-coming the medico-legal implications of doing so.

One aspect of working within a framework of care pathways involves incorporating the wishes of patients with relatively strict guidelines. Participants were able to do this and indeed one patient referred to it as 'modern'. This task is illuminated by the work of Timmermans[84] who described how the interventions used to resuscitate people created new identities for them. For example, the passive victim receiving cardiopulmonary resuscitation

(CPR) with his shirt ripped open for defibrillator pads has essentially no identity, but with luck becomes a recovering middle-aged man with modesty and personal worries about family, work and recovery. These identities are primarily defined by the 'scripts' or protocols of resuscitation that specify the relationships between the participants (passive victim, passer-by, rescuer, paramedic etc). Paramedics and patients become tightly coupled to the technology, rendering the man's more social identities less relevant, to the point where they 'disappear into the margin of the script'.

Timmermans[84] describes two key categories of marginality to the script. Some people may deliberately try to set themselves aside from the script, by not wishing to be resuscitated. Secondly, there are those people (typically already in hospital) who do not get fully enrolled into the script because the medical staff determine that they are not eligible.

Of course, dental treatment is rarely so dramatic as resuscitation, yet the script can be likened to the pathways, and from this perspective an understanding of the effects of the script are helpful. First, people may exercise a legitimate right not to engage with the pathway and may choose simply to have treatment for the relief of pain, as was recognised in the Steele Report[2]. Secondly, as patients must be active participants in their own care, dentists must reconcile the competing needs of adhering to the script without marginalising the wishes of their patients.

Dental team members in this research talked of the need to listen to and understand their patients, and there were clear signs that patients appreciated that. Patient satisfaction and feeling sufficiently involved in decisions about their care will be indicators of patient experience in the dental prototypes[76]. There is therefore a need to train dental professionals to reconcile the tensions of integrating patients' wishes into evidence-based pathways. This will involve them acquiring a stronger understanding of evidence-based care and the communications skills to listen and negotiate with patients.

Dental therapists increased the availability of care and patient satisfaction. However, the use of skill-mix is exquisitely sensitive to contracting and practice finance[85]. Practices had increased the utilisation of dental therapists by not reducing the payments to individual dentists who referred their patients to them. Whilst seemingly paying two staff members for the same treatments, this approach incentivised referral, so liberating dentists' time for patient OHAs and more remunerative complex treatments. This might be further explored and evaluated in the evaluations of the forthcoming contract prototypes[76].

The impact of funding arrangements on dental practice is well known, and dentists must reconcile the business and other elements of their practices[86]. Revenue was a key factor in these data. Dentists could see how the new contract carried the potential for greater value for money and the reduction of unnecessary treatment. By contrast, there were concerns that the time spent with patients and therefore the costs had been under-estimated. In part these additional costs were associated with longer patient OHAs, high levels of treatment needs and the need to work more quickly to maintain activity. The time taken for the OHAs was also perceived as a problem in the NHS national dental contract pilot sites and was evident as reduced patient access[76,81]. Other factors were also thought to be associated with decreases in patient access in the pilots, including initial learning curves, culture change, the new pathway approaches, IT issues and the inability of providers to monitor access. Some of this reduction in access was also attributed to the lack of financial risk carried by the practices, which will be overcome in the forthcoming prototypes by placing up to 10% of contract value at risk if there is under delivery.

This financial risk may be particularly relevant to new practices. The NHS dental contract pilots were conducted in existing practices and experienced falls in access. However, the challenges may be even more severe in new practices (such as the incentive-blended practices here), where all the patients required comprehensive initial assessments and were more likely to have high treatment needs necessitating more visits. This consideration goes further than dentists' incomes as concerns about costs were seen to influence practitioner behaviour.

These concerns support the notion of assigning contract values according to patient needs, which in the contract prototypes will be achieved by weighting the capitation element by patient characteristics of age and deprivation status[76].

Software problems loomed large in the data as they have in the national pilots. To some extent, these observations are not specific to this incentive-blended contract, but reflect the difficulties of piloting any new way of working. In this case, the software had been developed for a relatively small number of practices and may have needed further development. These comments echo those in the Dental Contract Reform Engagement Exercise where many participants commented on software that needed to be simpler and less 'click-heavy'[81]. Our participants also wanted systems and software that were easier, more flexible and responsive than the current ones. The software used in the national pilots was refined in response to feedback like this.

The Andersen Model provided a useful taxonomy for the data and allowed identification of the effects of the new contract. This fit is unsurprising as the model was developed over a forty year period and remains amongst the most widely cited models of access to health care[65.66.87.88].

Theoretical models may be tested empirically or by looking for logical coherence[89]. The Andersen model is somewhat general with overlapping dimensions (need and perceived health) and others (social capital, culture, trust and social resources) not explicitly incorporated[87]. Very little is said about demographic variables gender, age and marital status other than a particular community might have greater proportions of older people that will affect their access to health services[88], with little detail on how this might work and why. A new factor present in these data ('Trust') is not explicit in the model but could be regarded as both a belief and an outcome of care[90]. Dimensions also overlap in the model where dissimilar concepts are grouped together (personal health practices and health service use, perceived and evaluated health and satisfaction). This is important because empirical testing demands careful specification of inclusive relationships and to a certain extent this confounded testing of this model[87]. One consequence of this might be that the model yields very different results when cross national comparisons are made[91].

The basic taxonomic relationships in the later versions of the model place contextual before individual characteristics (Figure 3)[88]. However, the variables within the demographic characteristics (socioeconomic status, ethnicity, migrant status, and educational attainment) could also be properties of individuals, so questioning the distinction between them. An alternative approach might be to collapse this distinction and emphasise the predisposing factors and enabling resources. Figure 4 adopts this approach and allows conceptualisation of both predisposing factors and resources as proximal, mesial and distal to individuals[68]. Adding this dimension allows qualitative distinctions between broad demographic variables that are characteristics of populations and those that act at in individual level. It also enables us to place wider social and environmental predisposing factors such as the levels of inequality in particular societies including broader social policy into the model[92]. Predisposing characteristics can also take the form of social factors that are mesial to individuals, including social capital and individual deprivation and social support networks[93-96].

Figure 3: Andersen's revised behavioural model of access

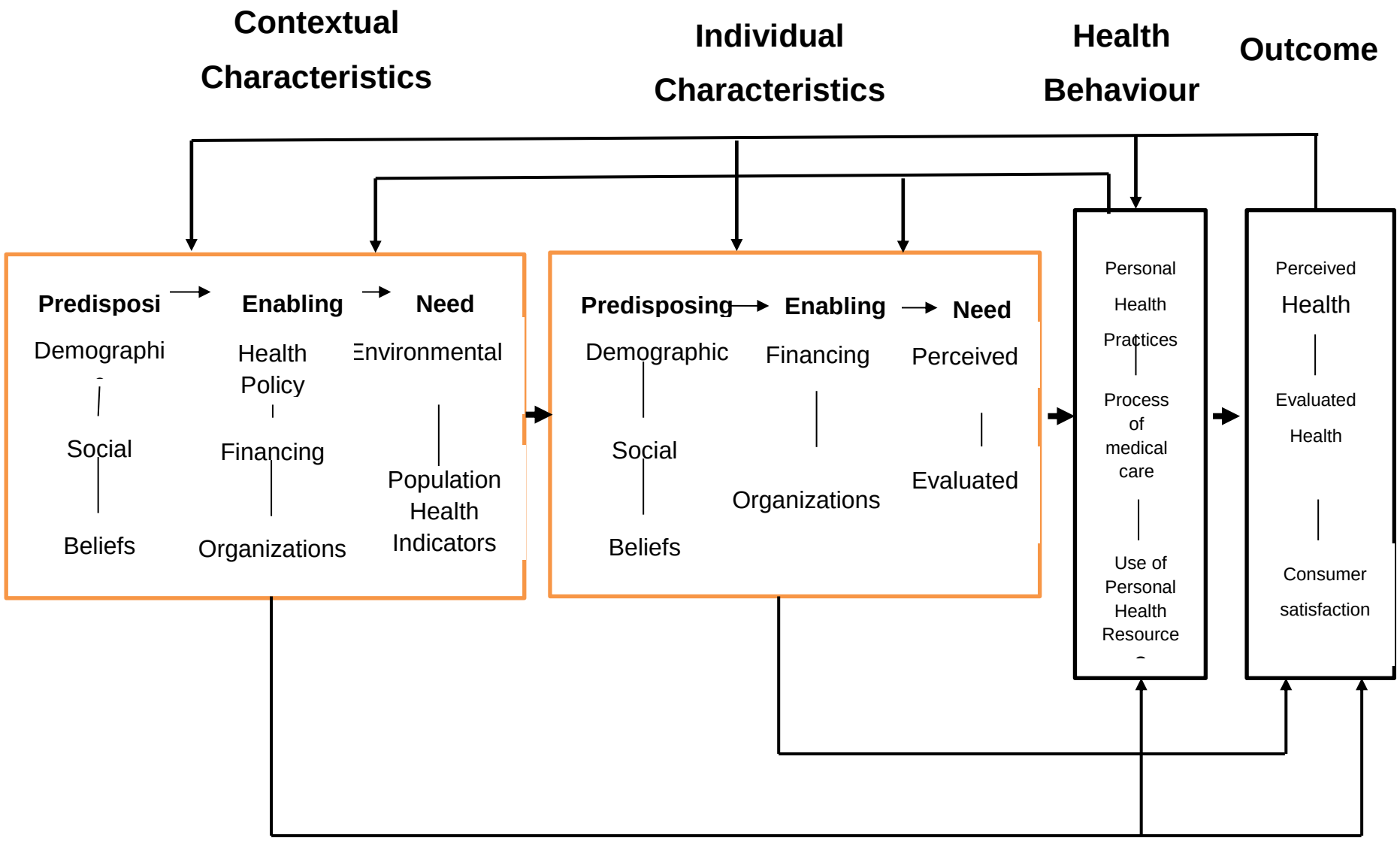
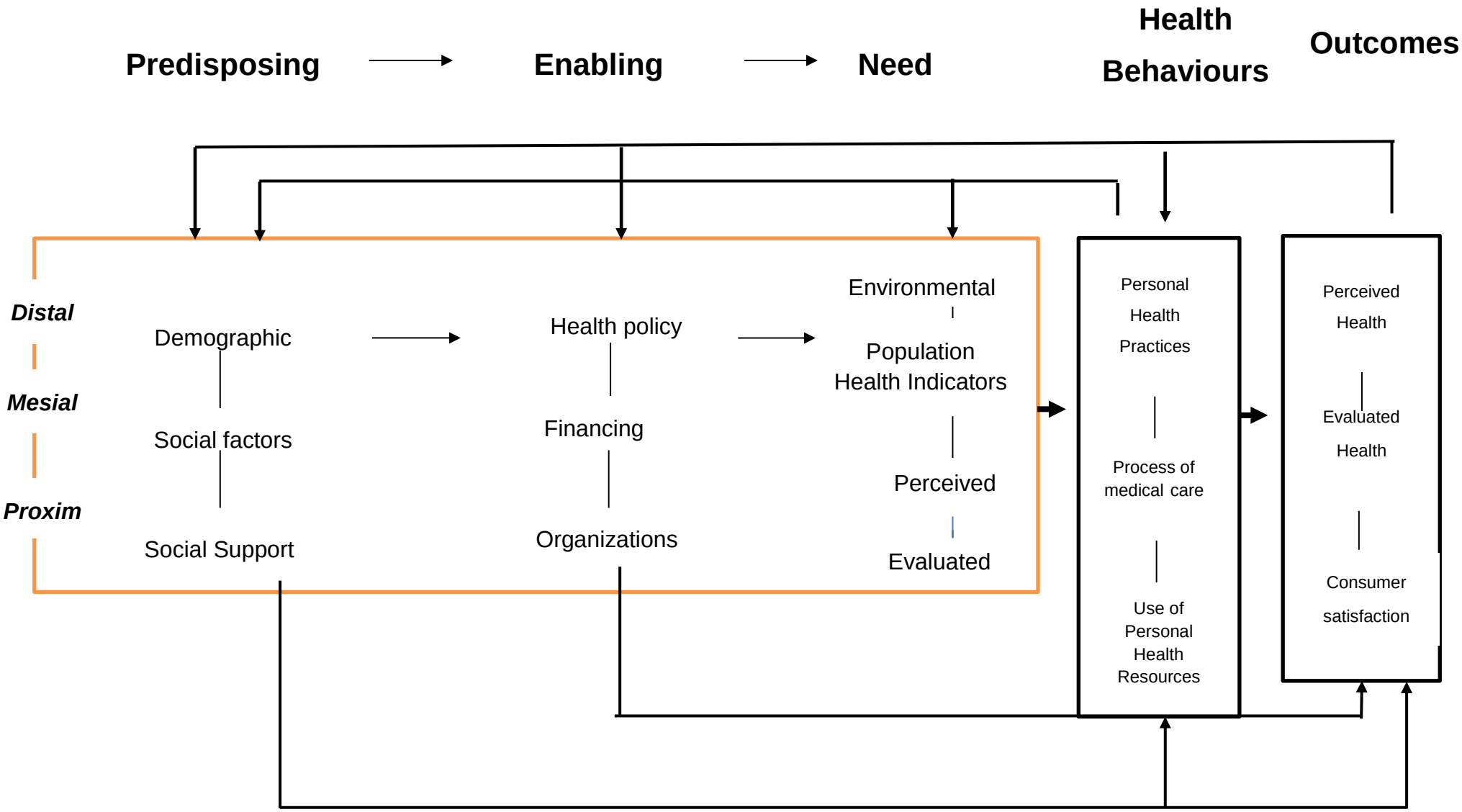


Figure 4: Revising Andersen's behavioural model of access



In a similar vein, collapsing the distinction between contextual and individual characteristics allows us to focus on what aspects make up enabling resources and how they impact on access to services. Health policy includes the distribution and availability of resources. Thus, one strength of the Andersen model is that forces us to think about how social resources are configured and places their configuration and use as central to population health outcomes. In this regard it can be characterised as a model of access that focuses on the success and failure of social resources for health[97]. With respect to oral health however, it also includes the methods and techniques for delivering optimum levels of fluoride to the whole population. This might be achieved through public programmes of water fluoridation or through consumerism.

The positioning of some variables within the causal chain might also be revised. Need is seen as a function of predisposing characteristics and enabling resources. Need here can refer to the relief of symptoms or a comprehensive service including preventive care[91]. This creates difficulties in accounting for need as its effect was 'suppressed' because of its negative value in relation to predisposing characteristics and enabling resources[68]. Likewise outcomes may overlap with need[87]. Some measures of oral health are applied both as outcomes *and* as indicators of need[98]. Thus the content and meaning of need at different points in the model should be considered. Harris[99] argued that consumption of health services does not always reflect need as those who might benefit most do not access services[100,101].

Conclusions

In conclusion, the blended/incentive-driven contract influenced access to dental care. Participants associated it with more access, greater use of skill mix and improved health outcomes. These outcomes fed back to shape predispositions to visit the dentist.

Contractual drivers to change might be supplemented with educational efforts to support the refocussing of care, perceptions about preventive dentistry, internal practice business models on the use of skill mix, the role of evidence-based dentistry, working with care pathways, communication skills and the need for a greater understanding of the difference between caring for individual patients and a population.

The Andersen model of access was broadly sustained in the data but might be enhanced by greater conceptual clarity, not regarding contextual and individual factors in sequence and by the incorporation of additional factors.

Chapter 4: Effectiveness of the Blended/incentive-driven Service Delivery Model

Introduction

Focus of the blended/incentive-driven contracts introduced in West Yorkshire, and evaluated in this study, lies on delivery of oral health improvement. Whilst there is a burgeoning field looking at impact of these blended contracts on process (e.g.[102,103,1]) there remains limited evidence on the impact of changes in dental oral health outcomes.

The work of Harris and colleagues[102,103] and McDonald[1] provides valuable insights into the processes by which dental teams provide treatment, but evidence is needed on the health outcomes of different ways of incentivising appropriate oral health care. Sequential systematic reviews (e.g. for DH Clinical Effectiveness and Outcomes group) have found no studies that relate methods to implement best practice on oral health outcomes. Yet such evidence is badly needed to support the requirements of all recent NHS strategy documents[34,104]. Indeed Equity and Excellence: Liberating the NHS focuses on improving healthcare outcomes so that 'The NHS will be held to account against clinically credible and evidence-based outcome measures, not process targets'.

One reason why other researchers may have focussed on processes is because the selection of outcomes for oral health care is difficult for both theoretical and practical reasons. This study attempts to overcome these difficulties by using a series of complementary clinical and PROMS, which are linked by a robust and validated theoretical model.

Aim

The aim of this part of the study was to assess the effectiveness of the INCENTIVE model in reducing the risk of and amount of dental disease and enhance oral health related quality of life in patients

In order to assess the clinical effectiveness of the INCENTIVE model a non-randomised study compares the effectiveness of treatment in the three blended/incentive-driven dental practices with three existing (TRADITIONAL) practices working under the nGDS contract.

The TRADITIONAL practices have been matched by deprivation index, age profile, size of practice, ethnicity and taking on new patients. Additionally, the evaluation assesses the new risk assessment model for fitness for purpose.

The effectiveness of the new model is assessed using indicators of gingivitis and an oral health related quality of life measure, the Oral Health Impact Profile (OHIP-14). Data is collected from patients on each on these indicators at their first visits (baseline) and then 24 months later (follow up). A nested exploratory study assessed the dental caries experience in which enamel and dentinal dental caries and its treatment was recorded using the International Caries Detection and Assessment System (ICDAS) coding.

Rationale for choice of outcome measures

Wilson and Cleary[105] link clinical variables to symptoms and functional limitation (analogous to health-related quality of life). Their model is directly applicable to oral health[106,107]. Changes to clinical factors (tooth decay and periodontal diseases) cause symptoms which lead to variations in oral health-related quality of life (OHQoL). However, individual and environmental factors intervene in these relationships by exerting independent effects. For example, the ability to understand one's situation strongly predicted OHQoL[107]. Studying both clinical and OHQoL outcomes provides the potential to not only to identify health benefits, but also to elucidate how the blended/incentive-driven contract might deliver those benefits.

Any clinical measures to assess differences in clinical status between groups must be valid, reproducible and responsive over a relatively short period of time to changes brought about by preventive treatments or improved oral health behaviours. The care pathways in this study are for up to 2-years we therefore matched our outcome measures onto this time frame, using measures chosen which are capable of demonstrating changes in dental and gingival health within a number of months rather than years. The health outcomes selected for this study were: gingivitis (bleeding on probing), dental caries experience, oral symptoms and OHQoL.

Gingivitis was selected as the primary outcome because it affects over 90% of the population is readily measured in a clinical examination, summarises the participant's personal oral

hygiene behaviour over the preceding days, is responsive to interventions (such as oral hygiene advice or using a new toothbrush) within two weeks, is a proxy for other self-care behaviours (such as the use of fluoride toothpaste) and is an interim outcome for periodontitis (which is a significant public health problem)[108-112] and changes are readily demonstrated over a period of two years. For these reasons, gingivitis was the primary outcome in this study and was recorded as the proportion of sites with bleeding on probing (BoP) at baseline and 24 months follow up.

Other periodontal outcomes were not suitable for use in this study. For example, periodontal attachment loss occurs so slowly that changes cannot be reliably detected within two years[110,113]. The basic periodontal examination records the worst periodontal condition in each of the six sextants of the mouth. However, this measure (and CPITN, its precursor) is not sufficiently precise for use in evaluative research, is not responsive to treatment of severe disease and there is the added complexity that changes in one part of a sextant can be masked by changes in other parts of the same sextant[114].

Assessment of gingivitis by way of BoP was supported by process outcome data from the INCENTIVE practices taken from the RAG. As described in Chapter 2, the blended/incentive-driven contract was designed to encourage a care pathway approach in which all patients have an OHA on joining the practice and at each subsequent recall. Four sets of information (age group, medical history, social history (self-care, habits/diet) and clinical assessment) are used to inform a traffic-light (RAG) system for patients with high (red), medium (amber) or low (green) risk of oral disease.

Secondary outcomes included assessment of dental caries experience in which enamel and dentinal dental caries and its treatment was recorded. In order to do this in a standardised way the ICDAS coding system was used to chart the number and condition of all teeth present with regard to their caries status and treatment history at baseline and follow-up. The inclusion of enamel caries allows recording of early carious lesions that may develop and heal as a result of changes in behaviour and the application of fluoride[115-117]. Whilst the work of Chesters and colleagues[115] suggest that changes in dental caries status can readily be measured within an abbreviated (24 month) clinical trial design by including enamel caries the measure was included as an exploratory element of the research since little is known about the prevalence and behaviour of enamel lesions in the UK population of adults

attending General Dental Practice. However, this is an important measure in terms of oral health improvement and the findings of this study will help to inform future research and the suitability of enamel caries as an outcome measure in clinical dental practice. Training was provided to all practices on use of ICDAS following the 2009 Dental Adult Survey criteria. This was supplemented with training via e-learning.

Oral health related quality of life was recorded using the 14 item version of the OHIP (OHIP-14)[118,119]. OHIP14 has good reliability, content and discriminative validity for use in UK dental patients[120] and is responsive to the changes brought about by general dental treatments, periodontal treatment and the provision of dentures[121-123].

Methods

Design and setting

The study uses a non-randomised comparative study design. The three INCENTIVE practices were matched with three existing (TRADITIONAL) practices working under the nGDS contract in West Yorkshire. The matching at practice level considered the practice in terms of deprivation index, age profile, size of practice, ethnicity and taking on new patients. Details of the practices are reported in Chapter 3. Patient demographics across the six practices are summarised in Table 6.

Table 6: Demographics of INCENTIVE and TRADITIONAL practices

	INCENTIVE Practices			TRADITIONAL Practices		
Type of Contract	**Blended contract– UDA and incentives for Health promotion/prevention activity**			**Working to 2006 NHS dental contract (nGPS Contract)**		
Practice	**Practice 3**	**Practice 2**	**Practice 1**	**Practice 6**	**Practice 5**	**Practice 4**
Age	47.60 (17.55)	40.30 (13.16)	34.64 (12.08)	40.78 (16.05)	38.48 (13.99)	40.99 (15.29)
Gender: Male/Female	19/21 (47.50/52.50)	77/75* (47.83/46.58)	36/40 (47.37/52.63)	15/22 (40.54/59.46)	49/42 (53.85/46.15)	61/55* (49.19/44.35)
Ethnicity: White/Other	37/3 (92.50/7.50)	105/51* (65.22/31.68)	49/27 (64.47/35.53)	35/2 (94.59/5.41)	59/32 (64.83/35.16)	59/17* (47.58/13.71)
Recruitment n	40	161	76	37	91	124
Loss to follow up n (%)	14 (35.00)	79 (49.07)	56 (73.68)	21 (56.76)	35 (38.46)	54 (43.55)

mean (SD) for continuous variables, n (%) for categorical variables, patient recruitment and loss to follow up referenced to completion of BoP at baseline and follow up, respectively, *=counts do not add to recruitment total due to missing data)

From Table 6 we can see that the ethnicity balance in the 3-6 pairing differs from the other pairings in as much as the proportion of those who classify themselves 'white' is much higher than the other pairings (~90/10 in 3-6 compared to ~65/35 in 1-4 and 2-5). The loss to follow up differs across practices, the lowest is 35% practice 3 and the highest 74% in practice 1. Differences in recruitment between practices are expected and reflects the number of GDPs/size of the practices.

Sample

Sample size was estimated based on powering the primary outcome measure. Based on data from the Clarkson study[124], we estimated the standard deviation in percentage sites BoP across a UK cohort to be 27.5%. We assumed a within-patient correlation in baseline to follow percentage sites BoP of 0.5 and a common variance in INCENTIVE and TRADITIONAL practices. We assumed a clinically meaningful mean difference in percentage sites BoP baseline to follow up in INCENTIVE practices of 10%, versus a mean difference in percentage sites BoP baseline to follow up in TRADITIONAL practices of 0%. We fixed a Type I error rate of 0.05 and a power of 0.8. A design effect was included to account for clustering of patients within the three INCENTIVE and three TRADITIONAL practices, assuming an intra-cluster correlation of 0.2. A two-sided two independent samples t-test identified a total of 550 patients to be recruited (allowing for a 10% loss to follow up).

Recruitment and inclusion and exclusion criteria

To achieve a recruitment of 550 new patients in the study project, recruitment was initially planned to take place over a six month period, although this was subsequently increased to eight months. This figure was based on: i) six dental practices included in the study; ii) an average list size of 1000 adult patients per dentist; iii) 10% of which per year will be new patients to the practice (estimated from the Dental Public Health audit figures of practices in Bradford and Airedale); iv) of these we estimated a minimum of 50% will agree to participate in the study over the recruitment period. Thus at a practice level the three INCENTIVE practices were matched with three existing TRADITIONAL practices of similar size, deprivation index, age profile, ethnicity and that the practice is taking on new patients.

At the patient level inclusion criteria was that patients must be:

- Aged 16 years and over (all the patient information leaflets were reviewed by a teenager as suitable to be easily understood for use with a broad age group in the study)
- Willing to be followed up for 24 months and give informed consent
- A *new* patient to the dental practice
- Able to complete the patient completed questionnaires

If a translator was needed, the availability of provision of translation service in the spoken language of the participant was via the normal dental practice access routes to such services. Study materials were not translated as the dental practices reported that those accessing the translator services are typically not literate in their mother language. Given questionnaires were only to be completed at baseline and 24 months, after taking advice, we concluded that the provision of a translator was sufficient and indeed the best option to maximise inclusion. All other data collected on the participants was from routine collected data and was not affected by the language of the participant.

With regard to exclusion criteria and the specific handling of those who are edentulous, they were not excluded from the sample however they would be considered supplementary to the core sample of 550 patients and would provide additional specific data. Postcode, age and ethnicity of all patients included within the sample was be recorded and profiled during the analysis.

The practices purposefully opened their lists to recruit new patients for our study. All new patients attending the practice for the first time were invited to participate. Prior to their scheduled appointment they were sent a letter of invite and information sheet and provided informed consent to be part of the study. Informed consent was taken by members of the dental surgery staff who received training in taking informed consent. Patients were asked to complete the following questionnaires at their first visits and at the follow-up visit 24 months later: EQ-5D-3L, OHIP-14 (details of the EQ-5D-3L are presented in the cost-effectiveness methods and results in Chapter 5). The dentist undertook the clinical assessment of teeth and gingivae using ICDAS and BoP at both visits. Family/social history was taken at the first visit only. The OHA, using the RAG was completed at baseline and 24 months by the INCENTIVE practices.

Patients were contacted by the dental practice around 6-8 weeks prior to their 24 months follow up date to arrange an appointment. Contact assumed a variety of mediums including telephone, SMS and letter in order to optimise follow up. Patients were contacted a minimum of three times to arrange the appointment.

Ethical approval and archiving

Ethical approval was obtained from National Research Ethics Service (NRES) Committee London – Bromley. Research Ethics Committee (REC) reference 12/LO/0205 on 5th April 2012. The study was sponsored by the University of Leeds. At the end of the study, data will be securely archived in line with the Sponsor's procedures for a minimum of 6 years. Data held by the research teams, will be locally archived or as instructed by sponsor where it is typically stored in the Leeds Sponsor archive facility and site data and documents. Following authorisation from the Sponsor, arrangements for confidential destruction will then be made.

Intervention

Details of the blended/incentive-driven contracts for the INCENTIVE practices are described in detail in Chapter 2. In brief, within the INCENTIVE practices, the blended/incentive-driven contracts were aimed at: ensuring evidence-based preventive interventions are delivered in line with identified needs for a defined population; increased access to dentistry; that care is provided by the most appropriate team member to encourage skill mix. Within the contracts 60% of the contract value is apportioned to delivery of a set number of UDAs. The remaining 40% is dependent on the delivery of quality – 20% systems, processes, infrastructure (e.g. cross infection, policies, Standards for Better Health latterly becoming Care Quality Commission domains) and 20% OHImp.

The TRADITIONAL practices operated under the nGDS contracts which are based on payment for UDAs with the number of UDAs based on historic activity and agreed between PCTs and dental practices. The nGDS contracts meant that the payment mechanism changed from one-off fee per item of service to a system whereby providers are paid an annual sum in return for delivering an agreed number of 'courses of treatment' weighted for complexity.

Main outcomes measures

The primary outcome of the clinical effectiveness study was the percentage of points BoP, assuming 32 teeth per patient and 6 points per tooth (reduced by the number of missing teeth (ICDAS codes ‘97’, ‘98’, ‘99’ or ‘P’) a patient has).

The secondary outcomes are:

1. Percentage of sound surfaces (defined as free of obvious caries, if any of the following ICDAS codes ‘00', '01', '02', '10', '11', '12', '20', '21' or '22' are recorded), assuming 32 teeth per patient and 5 surfaces per tooth (reduced by the number of missing teeth a patient has).
2. Percentage of extracted & filled teeth, assuming 32 teeth per patient (reduced by the number of missing teeth a patient already has). A tooth was defined as filled if the first digit of ICDAS code was '3', '4', '5', '6', '7' or '8' and second digit of the ICDAS code was not '4', '5' or '6'. A tooth was defined as extracted if it was ICDAS code was ‘97’.
3. OHIP-14 total score (integer count between 0 - 56). Each of the 14 individual questions are scored on a 0-4 scale. Any scores outside of this range are regarded as missing. If two or one of the individual questions is missing then median imputation is used to impute the individual question scores[125]. If three of more individual questions are missing then the total score is regarded as missing and the patient excluded from analysis.

Exploratory analyses of the RAG were conducted to study:

1. The distributions across categories (red, amber, green) at baseline and follow up.
2. The transitions between categories from baseline to follow up.
3. The proportion of risk assessments that were manually overridden at baseline and follow up.

Analysis

Multiple linear regression[126] is used to model the primary and secondary outcome measures. In our analysis plan we identified the difference in the measurement from baseline to follow up as the outcome. However, given the reduced sample size due to loss to follow up, to

improve power, we use an analysis of covariance (ANCOVA) approach with follow up measurement as the outcome and baseline measurement as a covariate. An important requirement for ANCOVA is there to be no interaction between the groups and baseline measure[127]. Whilst it is plausible to assume no interaction within each INCENTIVE-TRADITIONAL practice matched-pair, it is not clear if an interaction will be present across the three matched-pairs. For this reason we first analyse the matched pairs separately before combining in a single analysis. Because of the reduced sample size and staff turnover, we have not been able to include practitioner level variables in our analyses. Imputation was conducted when constructing OHIP-14 total score as described above.

Results

Sample

Recruitment started on 1st June 2012 and the first patient entered the study on 14th June 2012. Recruitment finished on 31st January 2013. In total 550 participants were recruited to the study at baseline. However, only 291 participants attended both baseline and a follow up appointment at 24 months. The reasons for non-attendance at the 24 months were recorded by the dental practices and are grouped as follows:

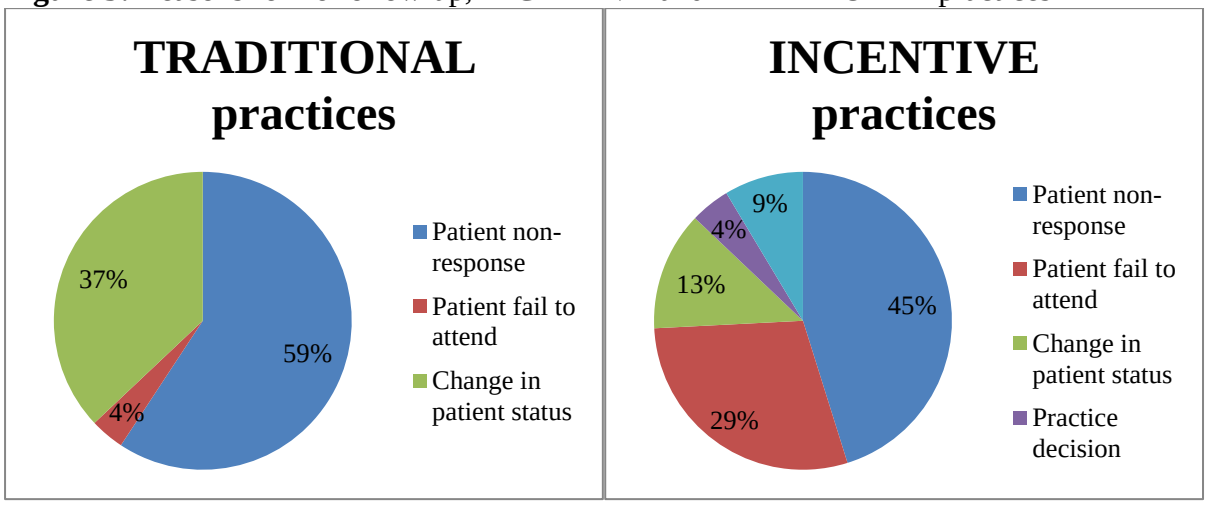
- Patient non-response: patient did not respond to any letters, text messages (sms) or voicemails;
- Patient failed to attend: patient failed to attend or cancelled the appointment(s) the last minute (i.e. less than 24 hours' notice);
- Change in patient status: patient moved away or was unable to attend due to financial difficulties or cancelled the appointment due to health reasons (e.g. a recent operation) or changed practice;
- Practice decision: de-registered patients or cases where the practice cancelled the appointment due to severe weather;
- Practice error: dentist failed to do the follow-up study/assessment.

We should note that for some de-registered patients in the 'practice decision' category, no further reason was provided. For others in the same group, the practice de-registered the patient for a variety of reasons that included failure to attend multiple appointments and the

patient consecutively cancelling appointments. In addition this category included de-registration as patient had moved away. This latter reason overlaps with the change in patient status category and as such the interpretation of these categories should be treated with caution.

Reasons for no follow-up at 24 months were available for 120 of the patients who did not attend the follow-up. From the answers provided, 27 patients are from the TRADITIONAL practices and 93 patients from the INCENTIVE practices. As shown in Figure 5, 'patient non-response' in both INCENTIVE and TRADITIONAL practices is the most frequent reason for not completing the study (45% and 59% respectively). In the TRADITIONAL practices, one patient (4%) did not complete the follow-up because of 'failure to attend' but this number was much higher in the INCENTIVE practices – 29% (27 patients). 'Practice decision' or 'centre error' are not reported in the TRADITIONAL practices and even for the INCENTIVE practices the percentages are very low (4% and 9% respectively).

Figure 5: Reasons for no follow-up, INCENTIVE and TRADITIONAL practices



Of the 550 recruited, 529 had a BoP measure at baseline. 291 participants attended both baseline and follow up but only 270 had a BoP at both time periods (51.04% of those with BoP at baseline). Following quality assurance 188 were included in the BoP analysis (n=90 INCENTIVE, n=98 TRADITIONAL practice). Full details of the sample number available for analyses for each measure, is included in table 7.

Demographic and baseline outcome measures split by status (completed follow up / loss to follow up) is shown in Table 8. Outcomes data were manually reviewed and quality controlled by a clinician prior to the modelling reported in Tables 9 onwards. Patients with implausible data were excluded from modelling. This manual review was conducted only for those with completed follow up. To enable comparison with those lost to follow up. Table 8 uses outcomes data prior to this manual review and quality control process.

Table 7: Sample number available for analyses for each measure

	Incentive Practices				Traditional Practices			
Type of Contract	**Blended contract– UDA and Incentives for Health promotion/prevention activity**				**Working to 2006 NHS dental contract (nGPS Contract)**			
Practice	**Practice 3**	**Practice 2**	**Practice 1**	**Total**	**Practice 6**	**Practice 5**	**Practice 4**	**Total**
Recruitment n	40	161	76	277	37	91	124	252
Loss to follow up n (%)	14 (35.00)	79 (49.07)	56 (73.68)	149 (53.79)	21 (56.76)	35 (38.46)	54 (43.55)	110 (43.65)
Available for scrutiny n (%)	26 (65.00)	82 (50.93)	20 (26.32)	128 (46.21)	16 (43.24)	56 (61.54)	70 (56.45)	142 (56.35)
Loss to quality control: BoP n (%)	3 (7.50)	29 (18.01)	6 (7.89)	38 (13.72)	6 (16.21)	16 (17.58)	22 (17.74)	44 (17.46)
Available for analysis: BoP n (%)	23 (57.50)	53 (32.92)	14 (18.43)	90 (32.49)	10 (27.03)	40 (43.96)	48 (38.71)	98 (38.89)
Loss to quality control: SS n (%)	3 (7.50)	28 (17.39)	5 (6.58)	36 (13.00)	8 (21.62)	16 (17.58)	23 (18.55)	47 (18.65)
Available for analysis: SS n (%)	23 (57.50)	54 (33.54)	15 (19.74)	92 (33.21)	8 (21.62)	40 (43.96)	47 (37.90)	95 (37.70)
Loss to quality control: E&F n (%)	3 (7.50)	28 (17.39)	5 (6.58)	36 (13.00)	6 (16.21)	15 (16.48)	22 (17.74)	43 (17.06)
Available for analysis: E&F n (%)	23 (57.50)	54 (33.54)	15 (19.74)	92 (33.21)	10 (27.03)	41 (45.06)	48 (38.71)	99 (39.29)
Loss to quality control: OHIP-14 n (%)	4 (10.00)	32 (19.88)	8 (10.53)	15 (5.42)	6 (16.21)	20 (21.98)	24 (19.35)	50 (19.84)
Available for analysis: OHIP 14 n (%)	22 (55.00)	50 (31.05)	12 (15.79)	84 (30.32)	10 (27.03)	36 (39.56)	46 (37.10)	92 (36.51)

Table 8: Demographic and baseline outcome measures by follow up status

	INCENTIVE Practices			TRADITIONAL Practices		
Practice	**Practice 3**	**Practice 2**	**Practice 1**	**Practice 6**	**Practice 5**	**Practice 4**
N	26 vs 14	82 vs 79	20 vs 56	16 vs 21	56 vs 35	70 vs 54
Age	47.11 vs 48.50 (17.58 vs 18.12)	41.18 vs 39.38 (13.51 vs 12.81)	35.25 vs 34.43 (14.27 vs 11.33)	42.50 vs 39.48 (16.85 vs 15.70)	39.05 vs 37.57 (14.47 vs 13.33)	44.13 vs 36.93 (16.34 vs 12.85)
Gender: Male/Female	12/14 vs 7/7 (46.15/53.84 vs 50.00/50.00)	37/38* vs 40/37* (45.12/46.34 vs 50.63/46.83)	7/13 vs 29/27 (35.00/65.00 vs 51.78/48.21)	7/9 vs 8/13 (43.75/56.25 vs 38.10/61.90)	30/26 vs 19/16 (53.57/46.43 vs 54.29/45.71)	30/37* vs 31/18* (42.86/52.86 vs 57.41/33.33)
Ethnicity: White/Other	24/2 vs 13/1 (92.31/7.69 vs 92.86/7.14)	49/28* vs 56/23 (59.76/34.15 vs 70.89/29.11)	15/5 vs 34/22 (75.00/25.00 vs 60.71/39.29)	15/1 vs 20/1 (93.75/6.25 vs 95.24/4.76)	40/16 vs 19/16 (71.43/28.57 vs 54.29/45.71)	37/9* vs 22/8* (52.86/12.86 vs 40.74/14.81
% BoP	26.04 vs 32.40 (20.17 vs 18.98)	25.09 vs 34.39 (27.42 vs 48.52)	6.19 vs 7.67 (5.79 vs 8.18)	22.39 vs 32.07 (12.21 vs 21.10)	27.23 vs 38.28 (23.48 vs 36.49)	30.66 vs 40.56 (38.56 vs 42.38)
% sound surfaces	84.44 vs 77.60 (9.18 vs 15.66)	81.29 vs 75.04 (17.13 vs 22.78)	77.92 vs 85.75 (16.85 vs 9.10)	80.76 vs 73.94 (17.45 vs 13.36)	83.06 vs 80.21 (20.54 vs 15.52)	77.84 vs 78.38 (16.86 vs 18.71)
% extracted & filled teeth	32.63 vs 33.19 (25.56 vs 16.80)	39.39 vs 44.13 (31.96 vs 31.34)	32.36 vs 34.87 (23.74 vs 29.48)	47.41 vs 56.01 (31.08 vs 30.64)	33.97 vs 51.26 (33.11 vs 37.11)	44.96 vs 39.67 (34.16 vs 31.80)
OHIP-14 total score	2.50 vs 5.79 (3.86 vs 5.77)	12.08 vs 15.30 (11.11 vs 13.67)	12.89 vs 11.47 (14.64 vs 9.33)	13.19 vs 10.38 (14.01 vs 13.49)	10.43 vs 18.69 (11.75 vs 13.32)	7.20 vs 10.30 (8.74 vs 10.23)
Risk assessment: Red/Amber/Green	8/14/4 vs 7/5/2 (30.77/53.85/15.38 vs 50.00/35.71/14.29)	64/13/5 vs 66/11/2 (78.05/15.85/6.10 vs 83.54/13.92/2.53)	15/5/0 vs 44/11/0* (75.00/25.00/0.00 vs 80.00/20.00/0.00)			

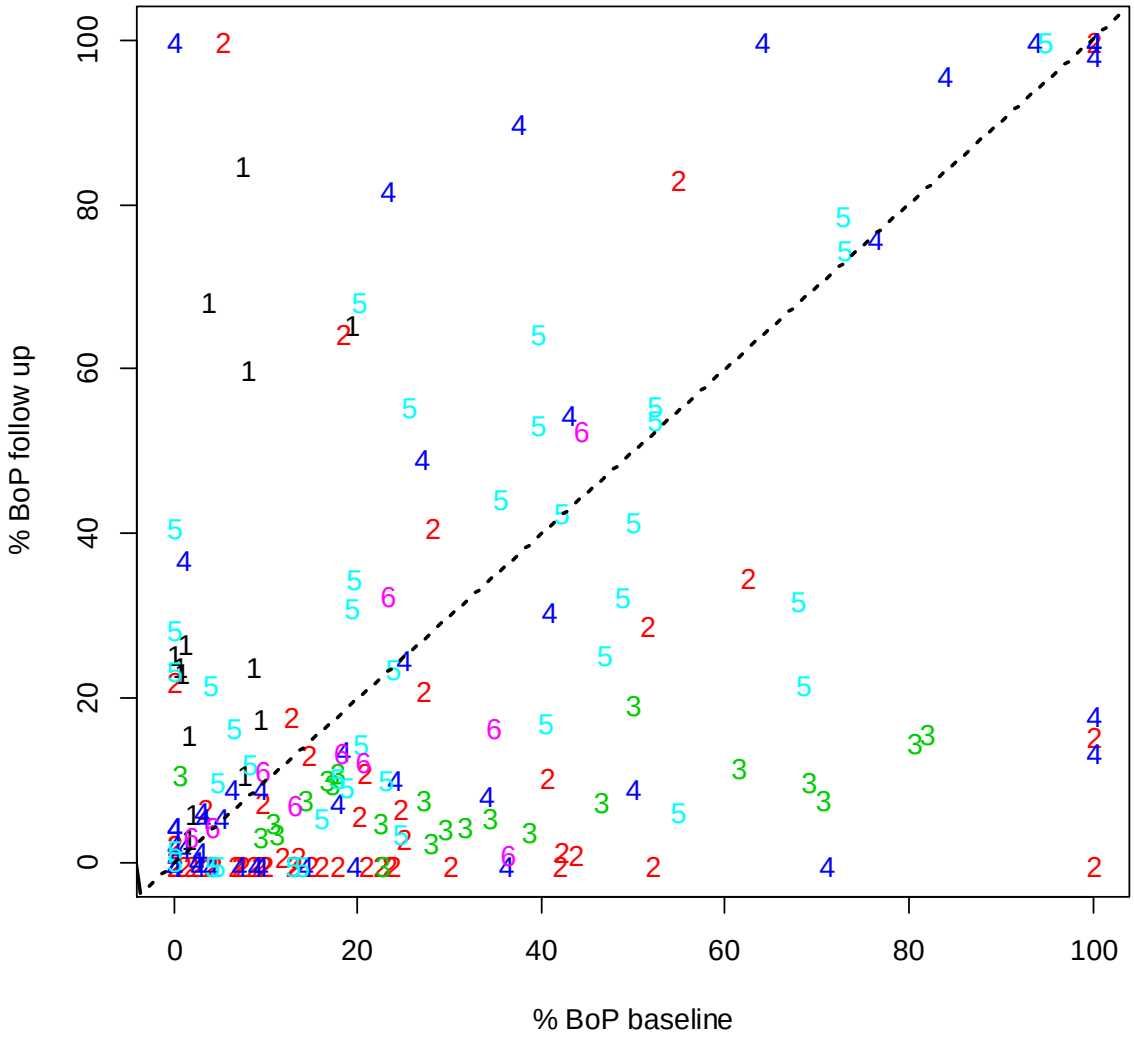
(completed follow up vs loss to follow up, mean (SD) for continuous variables, n (%) for categorical variables, *=counts do not add to total due to missing data)

Those who are lost to follow up are generally younger and more likely to be male. In terms of outcomes those lost to follow up have worse oral health although this is more variable (a higher mean and standard deviation). This is replicated in the OHIP-14 where those lost to follow up high higher mean scores (indicating poorer oral health related quality of life). In the practices that undertook a RAG rating those lost to follow up were more likely to have a red RAG rating.

Bleeding on probing (BoP)

Figure 6 shows a scatter plot of BoP at baseline and follow up. The mean (SD) of BoP at baseline and follow up were 41.88 (47.24) and 32.97 (47.66), respectively. There were 82 patients excluded following manual review for quality control in addition to those lost to follow up (see Table 7). This comprised 3, 29, 6, 6, 16 and 22 patients for 3, 2, 1, 6, 5 and 4 practices, respectively. In addition, 4 patients with BoP in excess of 100% had BoP imputed to 100%. This gave a sample for analyses of n=188 (n=90 INCENTIVE practices; n=98 TRADITIONAL practices).

Figure 6: Scatter plot of BoP by practice (colour and plotting symbol identify patients practice, dashed line is line of equality)



First we analyse the matched pairs separately using baseline adjusted ANCOVA. Table 9 relates to matched pair 1-4. Table 9 to matched pair 2-5 and Table 10 to matched pair 3-6.

Table 9: ANCOVA for BoP in 1-4 matched pair (n=14,48)

	Coefficient	SE	95% CI	p-value
Intercept	29.04	7.50	(14.04,44.04)	<0.01
Baseline	0.71	0.18	(0.47, 0.94)	<0.01
Practice: TRADITIONAL	-22.55	8.93	(-40.41, -4.69)	0.01

(Reference practice: INCENTIVE)

Table 10: ANCOVA for BoP in 2-5 matched pair (n=53,40)

	Coefficient	SE	95% CI	p-value
Intercept	0.38	3.59	(-6.76, 7.53)	0.92
Baseline	0.49	0.09	(0.31, 0.67)	<0.01
Practice: TRADITIONAL	14.57	4.54	(5.55,23.59)	<0.01

(Reference practice: INCENTIVE)

Table 11: ANCOVA for BoP in 3-6 matched pair (n=23,10)

	Coefficient	SE	95% CI	p-value
Intercept	2.10	3.10	(-4.24, 8.43)	0.50
Baseline	0.17	0.07	(0.03, 0.32)	0.02
Practice: TRADITIONAL	9.98	3.47	(2.90,17.06)	<0.01

(Reference practice: INCENTIVE)

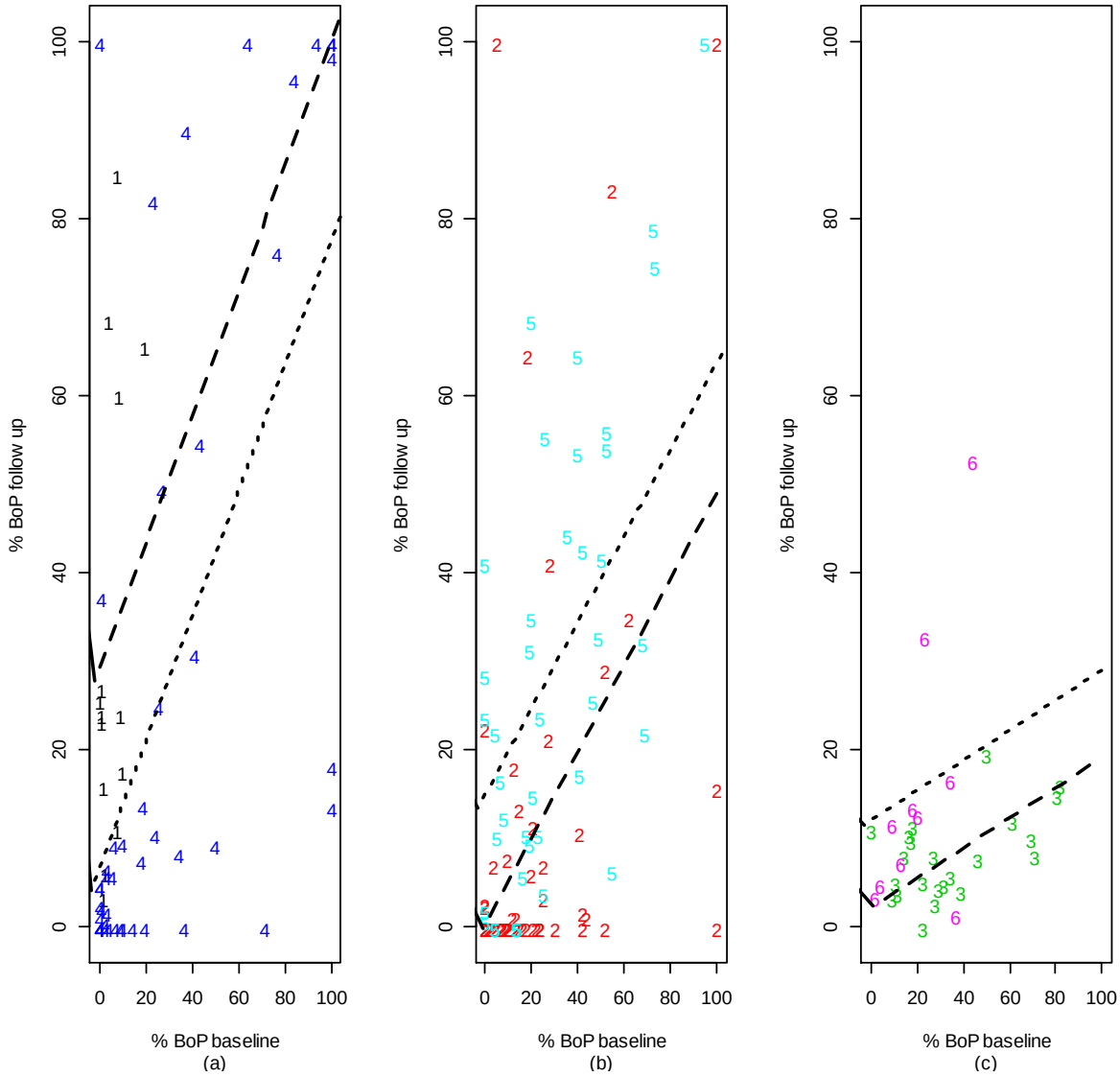
The model in Table 9 implies that BoP was lower at follow up for patients in TRADITIONAL practice 4 (compared to INCENTIVE practice 1) by an average of 22.55% (95% CI 4.69% to 40.41%), p=0.01.

The model in Table 10 implies that BoP was higher at follow up for patients in TRADITIONAL practice 5 (compared to INCENTIVE practice 2) by an average of 14.57% (95% CI 5.55% to 23.59%), p <0.01.

The model in Table 11 implies that BoP was higher at follow up for patients in TRADITIONAL practice 6 (compared to INCENTIVE practice 3) by an average of 9.98% (95% CI 2.90% to 17.06%), p <0.01.

Scatter plots of BoP at baseline and follow up are shown for the matched pairs in Figure 7. Lines of best fit from the models described in Tables 3-5 are superimposed.

Figure 7: Scatter plot of BoP by INCENTIVE vs TRADITIONAL practice: (a) 1-4 matched pair; (b) 2-5 matched pair; (c) 3-6 matched pair (colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed lines are best fit for INCENTIVE practices, dotted lines are best fit for TRADITIONAL practices).



Combining the matched pairs into a single ANCOVA model produces the output shown in Table 12. This should be interpreted with caution due to the difference between the matched pairs observed in the analyses above.

Table 12: ANCOVA of BoP across all matched pairs (n=90,98)

	Coefficient	SE	95% CI	p-value
Intercept	2.95	2.97	(-2.90, 8.80)	0.32
Baseline	0.48	0.07	(0.35, 0.60)	<0.01
Practice: TRADITIONAL	10.24	3.55	(3.23,17.25)	<0.01

(Reference practice: INCENTIVE)

The model in Table 12 implies that BoP was higher at follow up for patients in TRADITIONAL practices (compared to INCENTIVE practices) by an average of 10.24% (95% CI 3.23% to 17.25%), p <0.01.

A scatter plot of BoP at baseline and follow up is shown across all the matched pairs in Figure 8. Lines of best fit from the model described in Table 12 are superimposed.

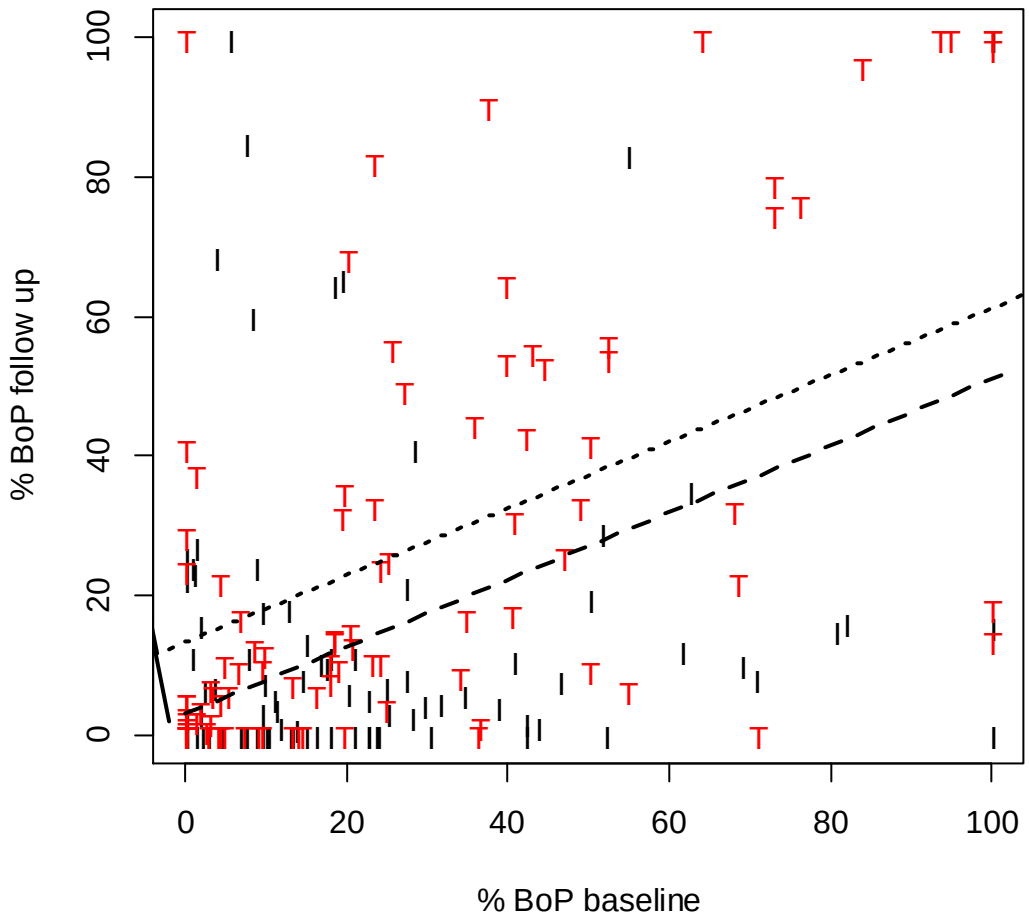


Figure 8: Scatter plot of BoP by INCENTIVE vs TRADITIONAL practice across all matched pairs (colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed line is best fit for INCENTIVE practices, dotted line is best fit for TRADITIONAL practices).

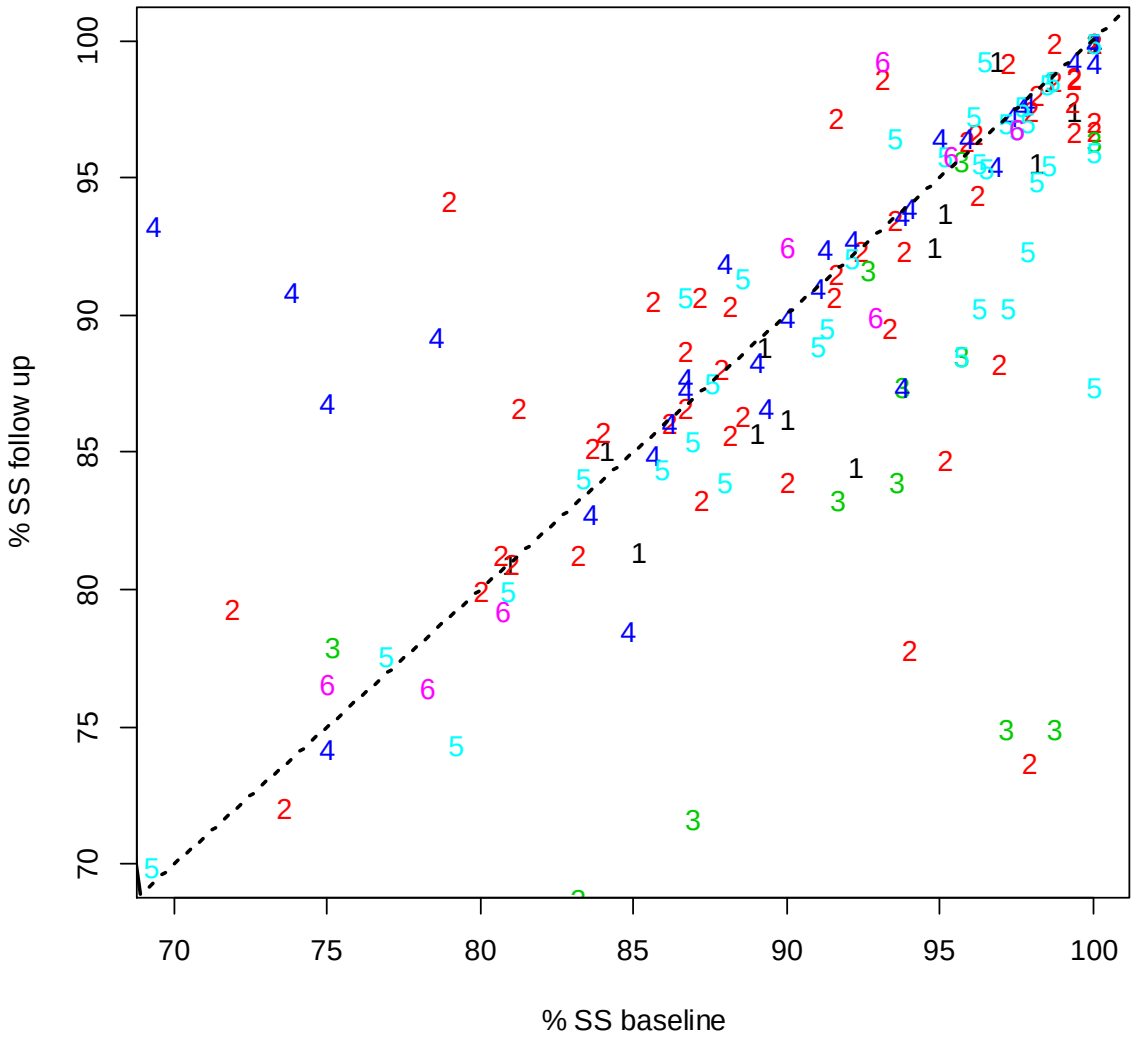
In summary for BoP pooled across practices a 95% CI for the effect size was (3.23%, 17.25%) indicating a positive effect for INCENTIVE but with considerable uncertainty in magnitude. Together with reservations about the validity of pooling (due to heterogeneity of effects across practice pairs) and differential drop out results should be treated with caution.

ICDAS change in sound surfaces (SS)

Figure 9 shows a scatter plot of Sound Surfaces at baseline and follow up. The mean (SD) of Sound Surfaces at baseline and follow up were 84.52 (16.45) and 82.67 (18.09), respectively.

There were 83 patients excluded following manual review for quality control in addition to those lost to follow up (see Table 6). This comprised 3, 28, 5, 8, 16 and 23 patients for 3, 2, 1, 6, 5 and 4 practices, respectively.

Figure 9 Scatter plot of Sound Surfaces by practice **(colour and plotting symbol identify patients practice, dashed line is line of equality)**



First we analyse the matched pairs separately using baseline adjusted ANCOVA. Table 13 relates to matched pair 1-4. Table 14 to matched pair 2-5 and Table 14 to matched pair 3-6.

Table 13: ANCOVA for Sound Surfaces in 1-4 matched pair (n=15,47)

	Coefficient	SE	95% CI	p-value
Intercept	5.49	3.33	(-1.19,12.17)	0.11
Baseline	0.94	0.03	(0.87, 1.00)	<0.01
Practice: TRADITIONAL	1.03	1.61	(-2.19, 4.25)	0.52

(Reference practice: INCENTIVE)

Table 74: ANCOVA for Sound Surfaces in 2-5 matched pair (n=54,40)

	Coefficient	SE	95% CI	p-value
Intercept	-1.72	6.61	(-14.86,11.41)	0.80
Baseline	1.00	0.07	(0.85, 1.14)	<0.01
Practice: TRADITIONAL	1.15	1.78	(-2.38, 4.68)	0.52

(Reference practice: INCENTIVE)

Table 15: ANCOVA for Sound Surfaces in 3-6 matched pair (n=23,8)

	Coefficient	SE	95% CI	p-value
Intercept	-5.44	10.05	(-26.02,15.15)	0.59
Baseline	0.91	0.12	(0.66,1.17)	<0.01
Practice: TRADITIONAL	13.49	4.45	(4.38,22.60)	<0.01

(Reference practice: INCENTIVE)

The model in Table 13 implies that SS was higher at follow up for patients in TRADITIONAL practice 4 (compared to INCENTIVE practice 1) by an average of 1.03% (95% CI -2.19% to 4.25%). This was not a significant difference between TRADITIONAL and INCENTIVE practices, p=0.52.

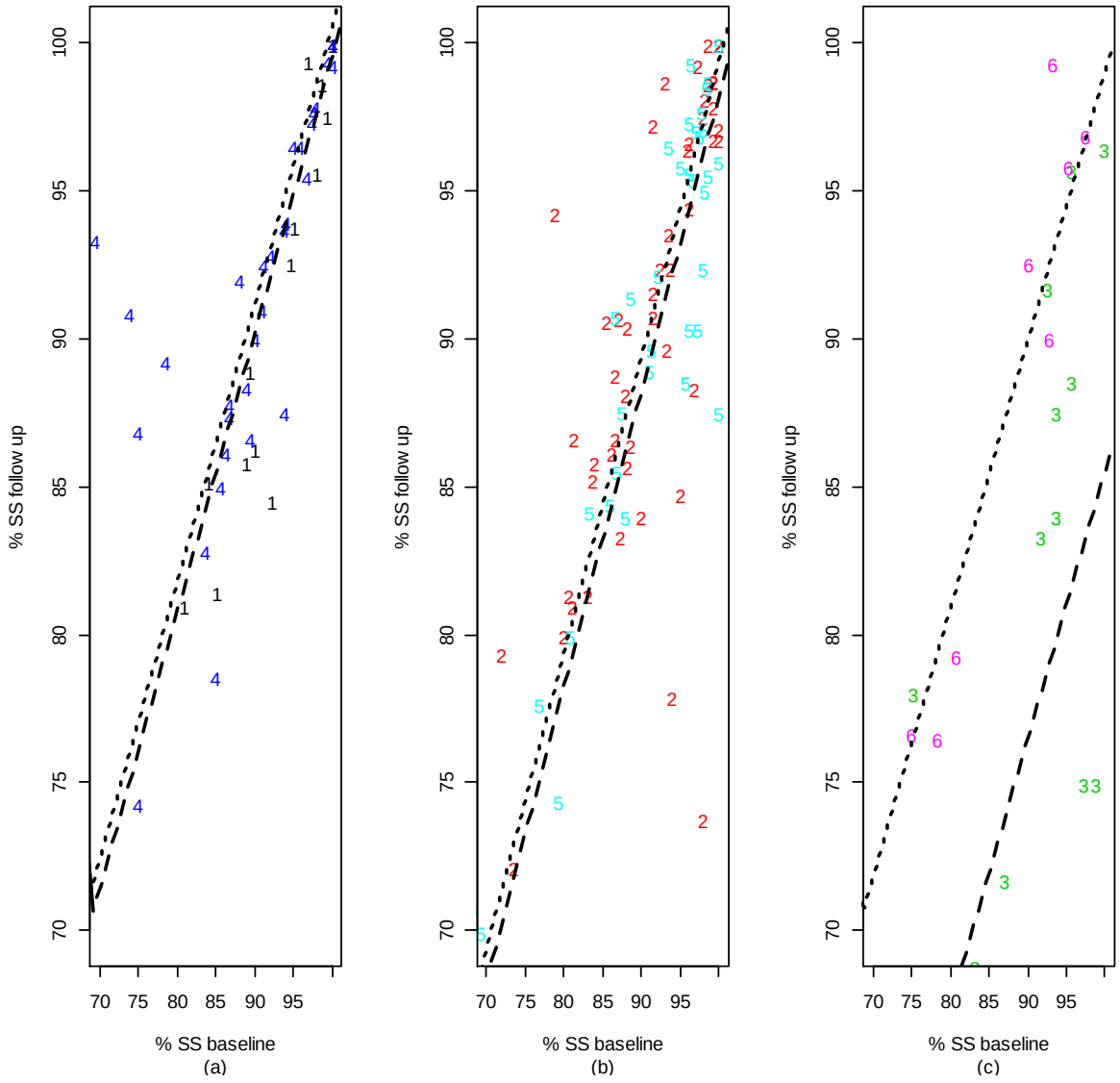
The model in Table 14 implies that SS was higher at follow up for patients in TRADITIONAL practice 5 (compared to INCENTIVE practice 2) by an average of 1.15%

(95% CI -2.38% to 4.68%). This was not a significant difference between TRADITIONAL and INCENTIVE practices, p=0.52.

The model in Table 15 implies that SS was higher at follow up for patients in TRADITIONAL practice 6 (compared to INCENTIVE practice 3) by an average of 13.49% (95% CI 4.38% to 22.60%), p <0.01.

Scatter plots of Sound Surfaces at baseline and follow up are shown for the matched pairs in Figure 10. Lines of best fit from the models described in Tables 13-15 are superimposed.

Figure 10: Scatter plot of Sound Surfaces by INCENTIVE vs TRADITIONAL practice: (a) 1-4 matched pair; (b) 2-5 matched pair; (c) 3-6 matched pair **(colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed lines are best fit for INCENTIVE practices, dotted lines are best fit for TRADITIONAL practices).**



Combining the matched pairs into a single ANCOVA model produces the output shown in Table 16. This should be interpreted with caution due to the difference between the matched pairs observed in the analyses above.

Table 16: ANCOVA of Sound Surfaces across all matched pairs (n=92,95)

	Coefficient	SE	95% CI	p-value
Intercept	-2.62	3.46	(-9.44,4.20)	0.45
Baseline	0.98	0.04	(0.91,1.06)	<0.01
Practice: TRADITIONAL	4.68	1.27	(2.18,7.18)	<0.01

(Reference practice: INCENTIVE)

The model in Table 16 implies that SS was higher at follow up for patients in TRADITIONAL practices (compared to INCENTIVE practices) by an average of 4.68% (95% CI 2.18% to 7.18%), p <0.01.

A scatter plot of Sound Surfaces at baseline and follow up is shown across all the matched pairs in Figure 11. Lines of best fit from the model described in Table 16 are superimposed.

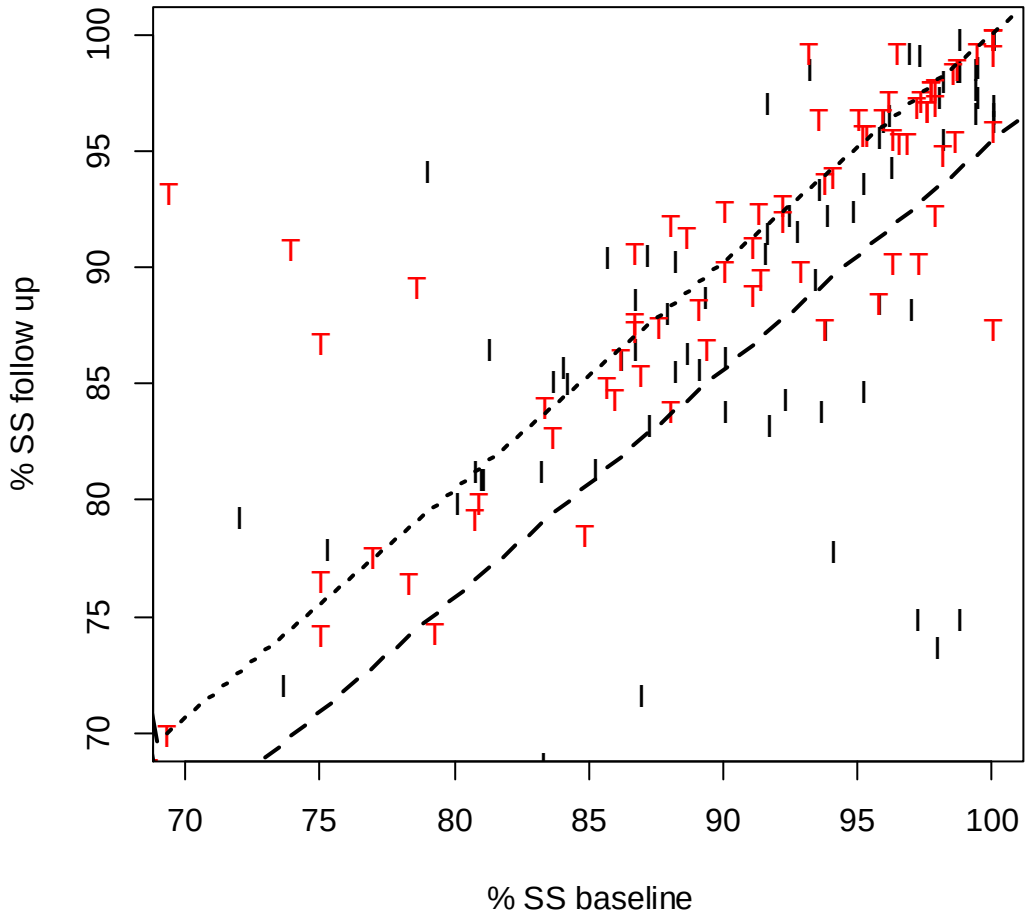


Figure 11: Scatter plot of Sound Surfaces by INCENTIVE vs TRADITIONAL practice across all matched pairs **(colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed line is best fit for INCENTIVE practices, dotted line is best fit for TRADITIONAL practices).**

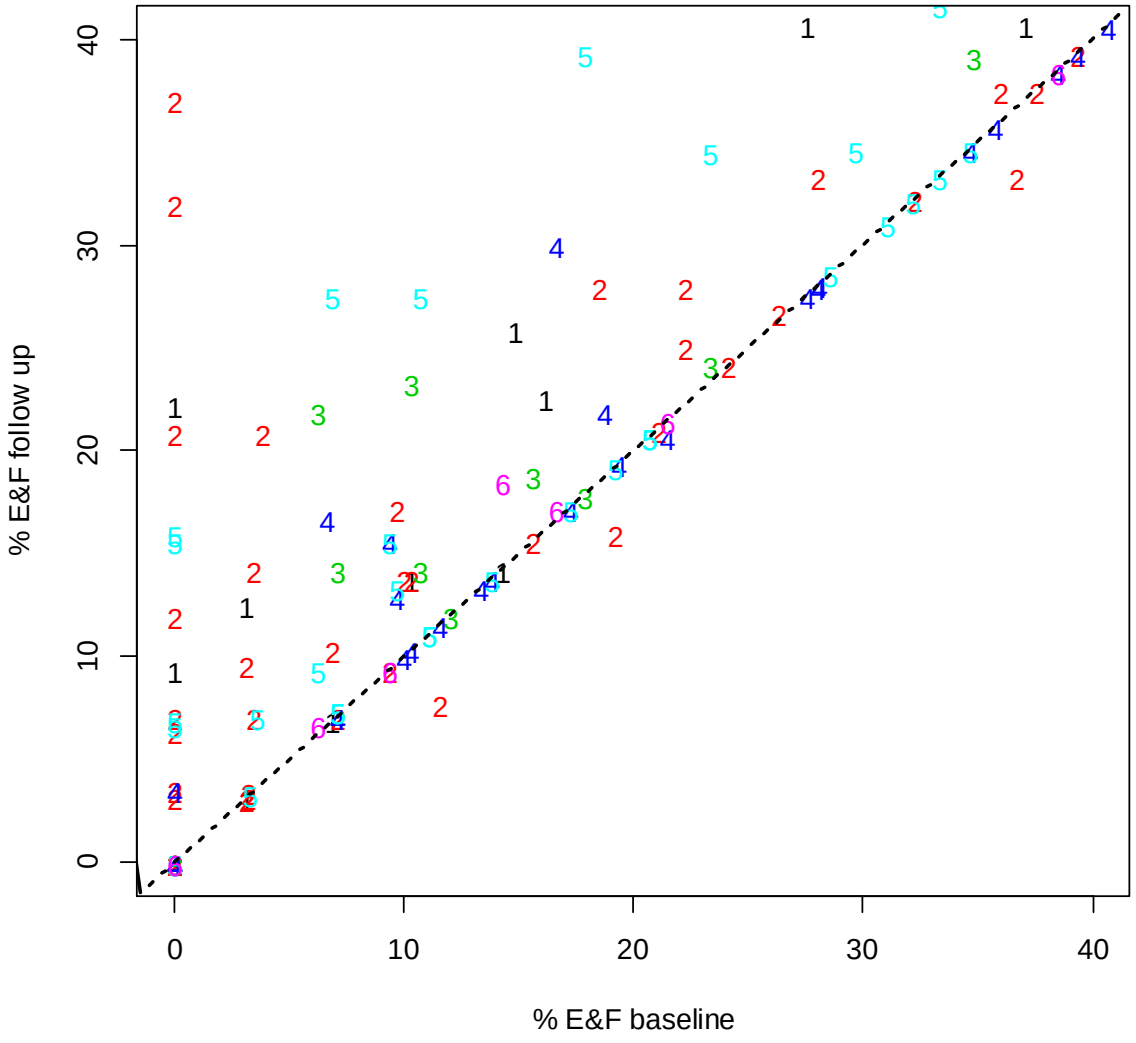
In summary for Sound Surfaces (defined as caries-free and initial caries ICDAS codes 1 and 2), the TRADITIONAL practices had a higher proportion of Sound Surfaces at follow up (4.68%) – although two of the pairings had a non-significant difference between Sound Surfaces.

ICDAS change in extractions and fillings (E&F)

Figure 12 shows a scatter plot of extractions and fillings (E&F) at baseline and follow up. The mean (SD) of E&F at baseline and follow up were 29.36 (27.02) and 34.19 (27.89),

respectively. There were 81 patients excluded following manual review for quality control in addition to those lost to follow up (see Table 7). This comprised 3, 28, 5, 6, 17 and 22 patients for 3, 2, 1, 6, 5 and 4 practices, respectively. In addition, 10 patients with E&F in excess of 100% had E&F imputed to 100%.

Figure 12: Scatter plot of E&F by practice **(colour and plotting symbol identify patients practice, dashed line is line of equality)**



First we analyse the matched pairs separately using baseline adjusted ANCOVA. Table 17 relates to matched pair 1-4. Table 18 to matched pair 2-5 and Table 19 to matched pair 3-6.

Table 8: ANCOVA for E&F in 1-4 matched pair (n=15,48)

	Coefficient	SE	95% CI	p-value
Intercept	15.34	2.30	(10.72,19.94)	<0.01
Baseline	1.01	0.04	(0.93, 1.09)	<0.01
Practice: TRADITIONAL	-15.11	2.63	(-20.38,-9.84)	<0.01

(Reference practice: INCENTIVE)

Table 98: ANCOVA for E&F in 2-5 matched pair (n=54,41)

	Coefficient	SE	95% CI	p-value
Intercept	7.32	2.05	(3.24,11.39)	<0.01
Baseline	0.96	0.04	(0.86,1.05)	<0.01
Practice: TRADITIONAL	-0.95	2.65	(-6.21,4.32)	0.72

(Reference practice: INCENTIVE)

Table 19: ANCOVA for E&F in 3-6 matched pair (n=23,10)

	Coefficient	SE	95% CI	p-value
Intercept	4.94	1.82	(1.23,8.64)	0.01
Baseline	0.97	0.04	(0.89,1.05)	<0.01
Practice: TRADITIONAL	-2.89	1.98	(-6.92,1.15)	0.15

(Reference practice: INCENTIVE)

The model in Table 17 implies that E&F was lower at follow up for patients in TRADITIONAL practice 4 (compared to INCENTIVE practice 1) by an average of 15.11% (95% CI 9.84% to 20.38%), p<0.01.

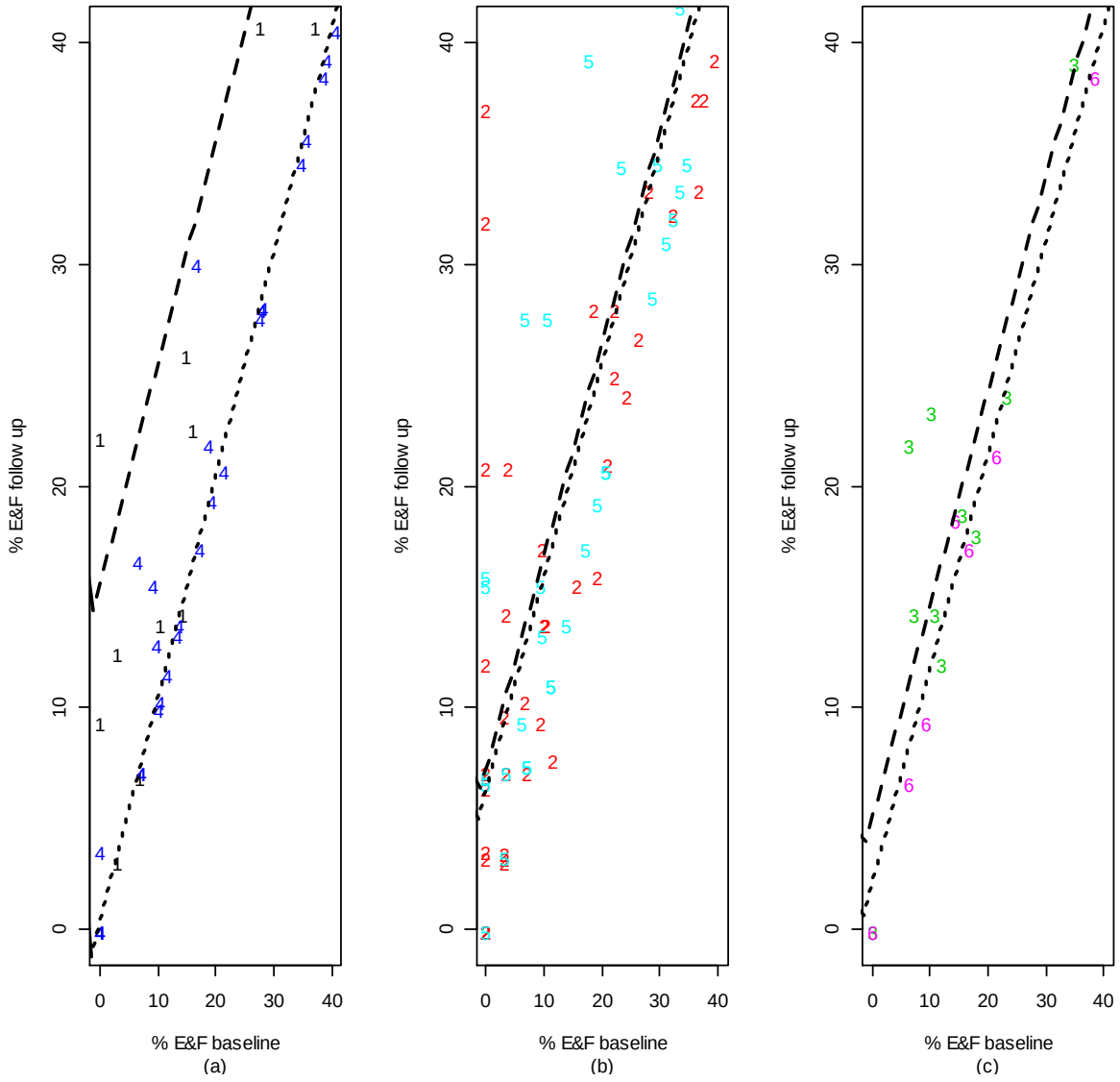
The model in Table 18 implies that E&F was lower at follow up for patients in TRADITIONAL practice 5 (compared to INCENTIVE practice 2) by an average of 0.95%

(95% CI 4.32% to- 6.21%). This was not a significant difference between TRADITIONAL and INCENTIVE practices, p=0.72.

The model in Table 19 implies that E&F was lower at follow up for patients in TRADITIONAL practice 6 (compared to INCENTIVE practice 3) by an average of 2.89% (95% CI 6.92% to -1.15%). This was not a significant difference between TRADITIONAL and INCENTIVE practices, p=0.15.

Scatter plots of E&F at baseline and follow up are shown for the matched pairs in Figure 13. Lines of best fit from the models described in Tables 17-19 are superimposed.

Figure 13: Scatter plot of E&F by INCENTIVE vs TRADITIONAL practice: (a) 1-4 matched pair; (b) 2-5 matched pair; (c) 3-6 matched pair **(colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed lines are best fit for INCENTIVE practices, dotted lines are best fit for TRADITIONAL practices).**



Combining the matched pairs into a single ANCOVA model produces the output shown in Table 20. This should be interpreted with caution due to the difference between the matched pairs observed in the analyses above.

Table 20: ANCOVA of E&F across all matched pairs (n=92,99)

	Coefficient	SE	95% CI	p-value
Intercept	8.26	1.35	(5.61,10.92)	<0.01
Baseline	0.96	0.03	(0.90,1.01)	<0.01
Practice: TRADITIONAL	-4.43	1.57	(-7.52,-1.34)	0.01

(Reference practice: INCENTIVE)

The model in Table 20 implies that E&F was lower at follow up for patients in TRADITIONAL practices (compared to INCENTIVE practices) by an average of 4.43% (95% CI 1.34% to 7.52%), p=0.01.

A scatter plot of E&F at baseline and follow up is shown across all the matched pairs in Figure 14. Lines of best fit from the model described in Table 19 are superimposed.

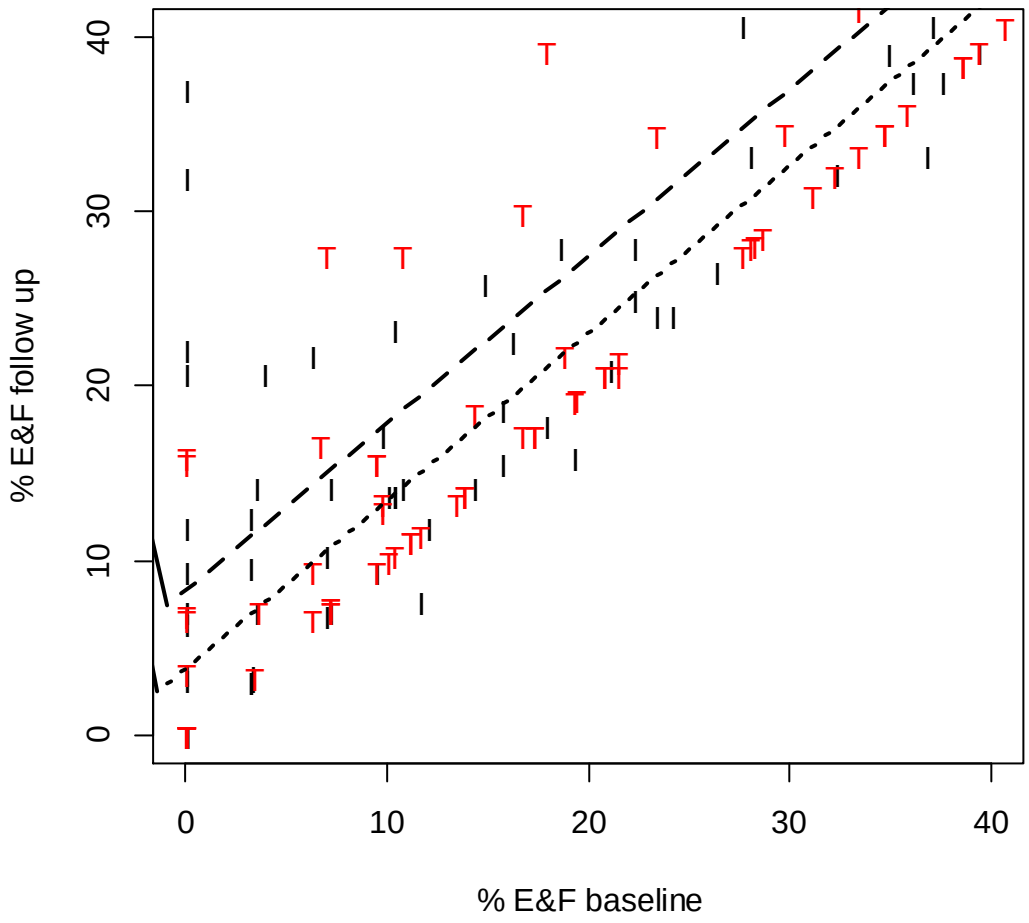


Figure 14: Scatter plot of E&F by INCENTIVE vs TRADITIONAL practice across all matched pairs **(colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed line is best fit for INCENTIVE practices, dotted line is best fit for TRADITIONAL practices).**

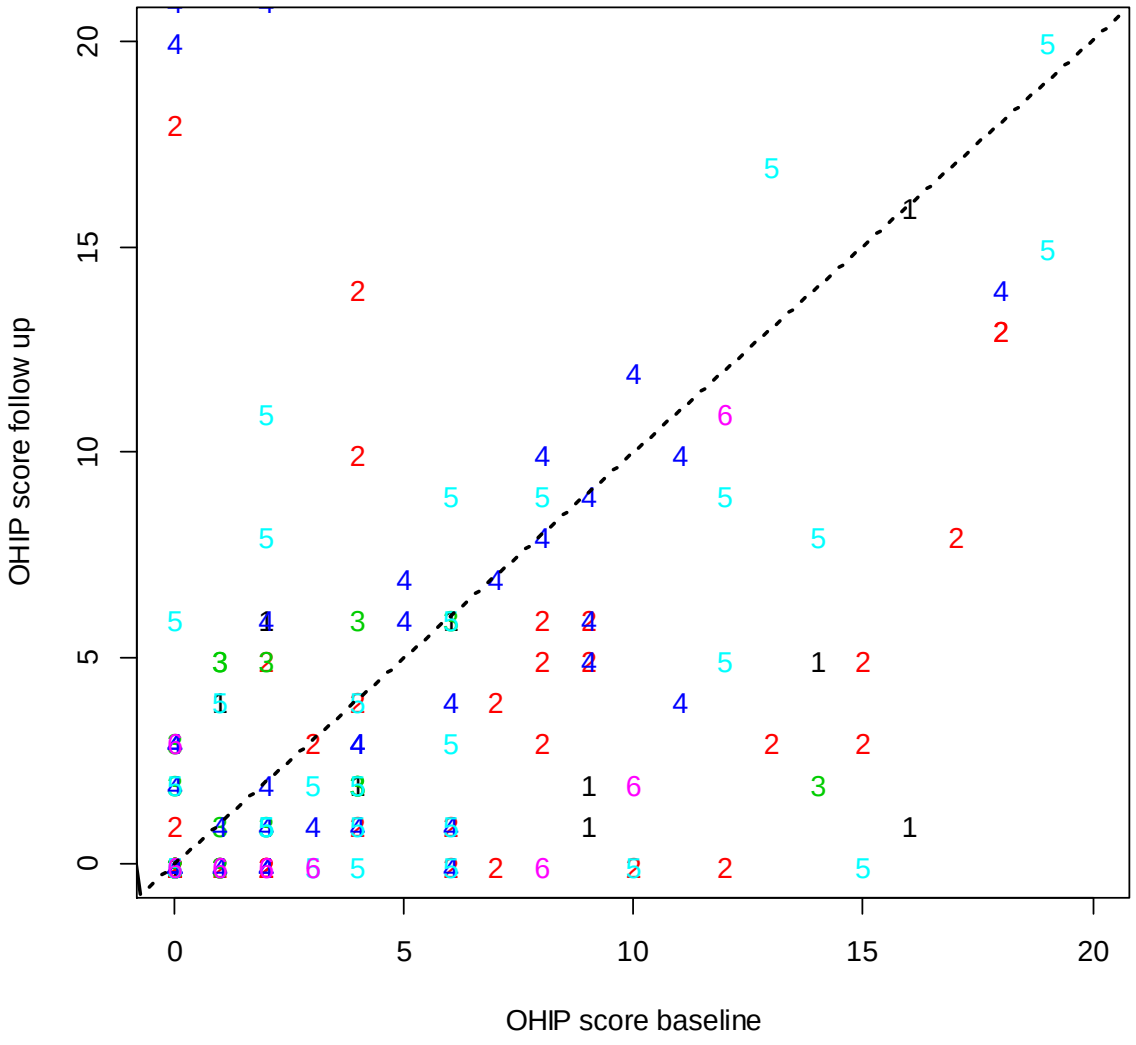
In summary, the TRADITIONAL practices had lower extraction and filings at follow up by 4.43%. Although for two of the three pairings there was no significant difference in E&F.

OHIP-14

Figure 15 shows a scatter plot of OHIP-14 at baseline and follow up. The mean (SD) of OHIP-14 at baseline and follow up were 9.00 (10.37) and 6.09 (8.08), respectively.

At baseline, there were 3 patients with three or more missing questions to be excluded and 12 patients with two or one missing questions (that were imputed as noted above). At follow up (excluding those lost to follow up) there were 10 patients with three of more missing questions to be excluded and 10 patients with two or one missing questions (that were imputed as noted above). Overall, there were 96 patients excluded following manual review for quality control in addition to those lost to follow up (see Table 7). This comprised 4, 32, 8, 6, 22 and 24 patients for 3, 2, 1, 6, 5 and 4 practices, respectively.

Figure 15: Scatter plot of OHIP-14 by practice (colour and plotting symbol identify patients practice, dashed line is line of equality)



First we analyse the matched pairs separately using baseline adjusted ANCOVA. Table 21 relates to matched pair 1-4. Table 22 to matched pair 2-5 and Table 23 to matched pair 3-6.

Table 21: ANCOVA for OHIP-14 in 1-4 matched pair (n=12,46)

	Coefficient	SE	95% CI	p-value
Intercept	-1.81	1.98	(-5.78,2.15)	0.36
Baseline	0.60	0.10	(0.41,0.80)	<0.01
Practice: TRADITIONAL	5.15	1.99	(1.17,9.14)	0.01

(Reference practice: INCENTIVE)

Table 22: ANCOVA for OHIP-14 in 2-5 matched pair (n=50,36)

	Coefficient	SE	95% CI	p-value
Intercept	0.85	1.22	(-1.58,3.28)	0.49
Baseline	0.44	0.06	(0.31,0.57)	<0.01
Practice: TRADITIONAL	2.74	1.47	(-0.18,5.68)	0.07

(Reference practice: INCENTIVE)

Table 23: ANCOVA for OHIP-14 in 3-6 matched pair (n=22,10)

	Coefficient	SE	95% CI	p-value
Intercept	0.51	1.04	(-1.61,2.63)	0.63
Baseline	0.67	0.11	(0.45,0.89)	<0.01
Practice: TRADITIONAL	-1.63	2.04	(-5.80,2.53)	0.43

(Reference practice: INCENTIVE)

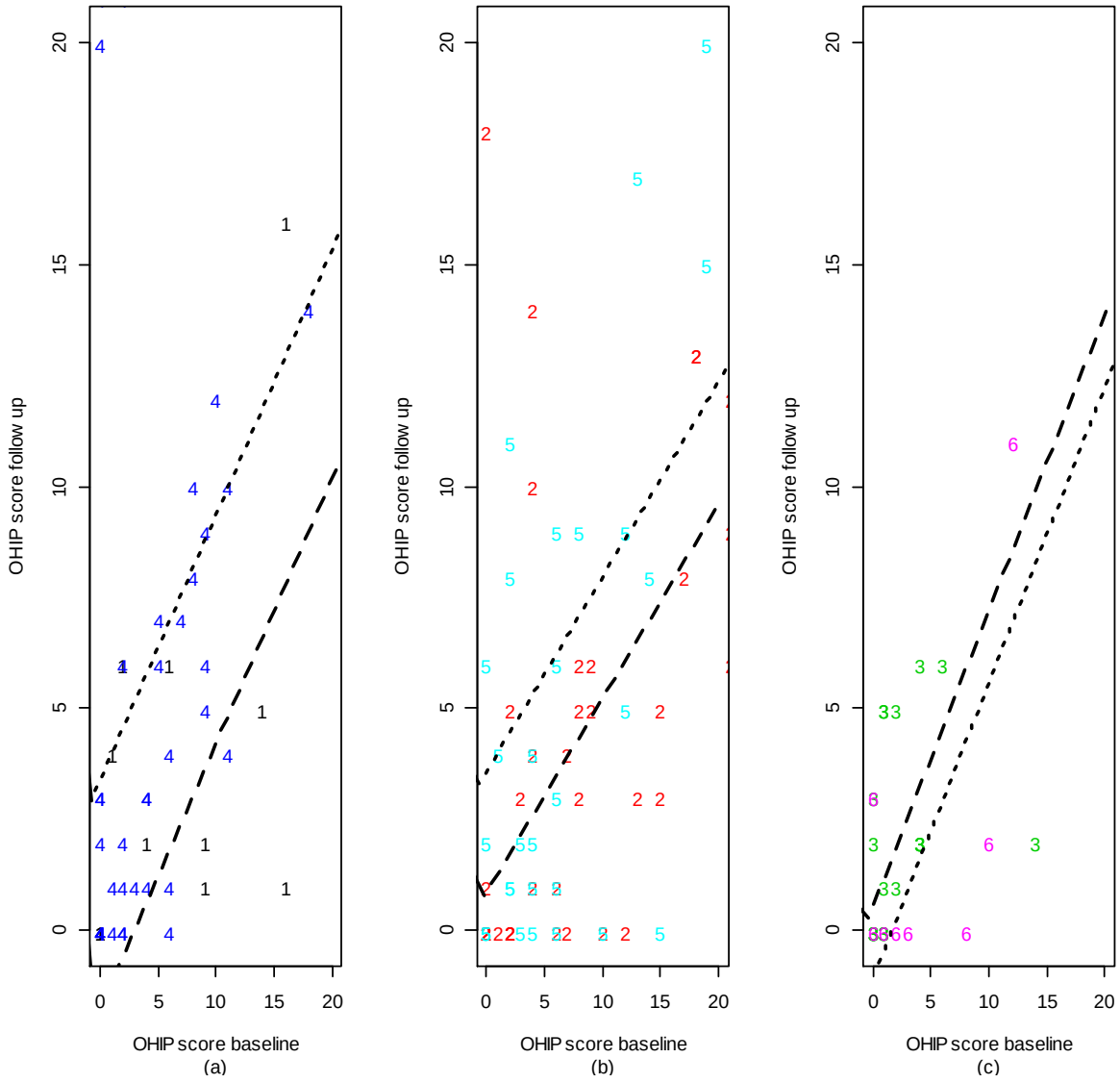
The model in Table 21 implies that the OHIP-14 score was higher at follow up for patients in TRADITIONAL Practice 4 (compared to INCENTIVE practice 1) by an average of 5.15 (95% CI 1.17 to 9.14), p=0.01.

The model in Table 22 implies that the OHIP-14 score was higher at follow up for patients in TRADITIONAL practice 5 (compared to INCENTIVE practice 2) by an average of 2.74 (95% CI 5.68 to-0.18). This was not a significant difference between TRADITIONAL and INCENTIVE practices, p=0.07.

The model in Table 23 implies that the OHIP-14 score was lower at follow up for patients in TRADITIONAL practice 6 (compared to INCENTIVE practice 3) by an average of 1.63 (95% CI 5.80 to -2.53). This was not a significant difference between TRADITIONAL and INCENTIVE practices, p=0.43.

Scatter plots of the OHIP-14 at baseline and follow up are shown for the matched pairs in Figure 16. Lines of best fit from the models described in Tables 20-22 are superimposed.

Figure 16: Scatter plot of the OHIP-14 by INCENTIVE vs TRADITIONAL practice: (a) 1-4 matched pair; (b) 2-5 matched pair; (c) 3-6 matched pair **(colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed lines are best fit for INCENTIVE practices, dotted lines are best fit for TRADITIONAL practices).**



Combining the matched pairs into a single ANCOVA model produces the output shown in Table 24. This should be interpreted with caution due to the difference between the matched pairs observed in the analyses above.

Table 10: ANCOVA of OHIP-14 across all matched pairs (n=84,92)

	Coefficient	SE	95% CI	p-value
Intercept	0.27	0.79	(-1.29,1.84)	0.73
Baseline	0.49	0.05	(0.40,0.58)	<0.01
Practice: TRADITIONAL	3.05	0.94	(1.20,4.90)	<0.01

(Reference practice: INCENTIVE)

The model in Table 24 implies that OHIP score was higher at follow up for patients in TRADITIONAL Practices (compared to INCENTIVE practices) by an average of 3.05 (95% CI 1.20 to 4.90), $p<0.01$.

A scatter plot of OHIP-14 at baseline and follow up is shown across all the matched pairs in Figure 17. Lines of best fit from the model described in Table 23 are superimposed.

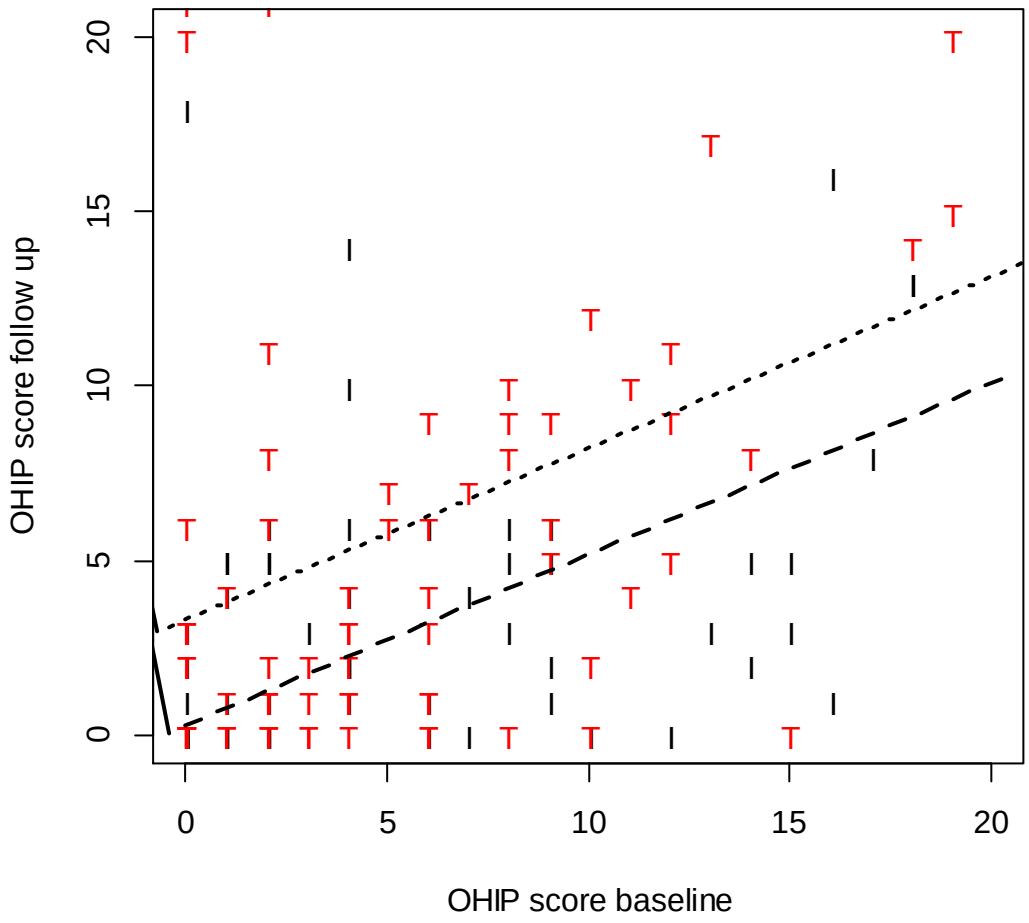


Figure 17: Scatter plot of OHIP-14 by INCENTIVE vs TRADITIONAL practice across all matched pairs **(colour and plotting symbol identify INCENTIVE vs TRADITIONAL practice, dashed line is best fit for INCENTIVE practices, dotted line is best fit for TRADITIONAL practices).**

In summary, for OHIP-14 total scores, overall TRADITIONAL practices had a higher follow up score by 3.5 indicating worse oral health related quality of life. Again for two of the three pairings there was no significant difference.

Risk assessment traffic light (RAG)

Table 25 shows the distribution of risk assessments in the red, amber and green categories at baseline and follow up. All patients that reported a risk assessment rating are included

regardless of whether they had BoP at baseline and follow up, or whether they were excluded from modelling work following manual data review for quality control.

Table 25: Risk assessment traffic lights at baseline and follow up

	Red	Amber	Green	Total
Risk assessment: baseline	207 (73.93%)	60 (21.43%)	13 (4.64%)	280 (100%)
Risk assessment: follow up	49 (44.14%)	43 (38.74%)	19 (17.11%)	111 (100%)

(shown as n (%) for categorical variables)

Table 24 implies that the most common risk assessment category at both baseline and follow up was Red (73.93% and 44.14% respectively) and the least common risk assessment category in both time periods was Green (4.64% and 17.11% respectively). The table suggests a possible improvement in risk assessment category from baseline to follow up with increasing proportions of patients in Amber and Green categories as opposed to Red. However, the inclusion of patients lost to follow up in the baseline assessments may also account for these changes.

At the practice level, there were 2, 1 and 0 incomplete risk assessment traffic lights at practices 1, 2, and 3, respectively. At follow up (excluding those lost to follow up) the figures were 7, 14 and 1, respectively.

Table 26 shows the transitions between categories from baseline to follow up.

Table 11: Risk assessment traffic light (RAG) transitions from baseline to follow up

		Follow up			
		Red	Amber	Green	Total
Baseline	Red	47	26	3	76 (68.47%)
	Amber	2	14	10	26 (23.42%)
	Green	0	3	6	9 (8.11%)
	Total	49 (44.14%)	43 (38.74%)	19 (17.11%)	111 (100%)

(shown as n (%) for categorical variables)

Table 26 implies that, in general, patients risk assessments improve from baseline to follow up. Of the 76 patients in the Red category at baseline who attended follow up, only 47 (61.84%) remain red with 26 (34.21%) moving to Amber and 3 (3.95%) moving to Green. Of the 26 patients in the Amber category at baseline attending for follow up, 10 (38.46%) moved to Green and only 2 (7.69%) to red. Of the 9 patients in the Green category at baseline who attended follow up, 6 (66.67%) remained Green with the other 3 (33.33%) moving to Amber. Those patients who were Red at baseline were less likely to attend follow up (76 of 207, 36.71%) than those who were Amber at baseline (26 of 60, 43.33%) or Green (9 of 13, 69.23%).

Table 27 shows the distribution of risk assessments that were manually overridden at baseline and follow up.

Table 12: Risk assessment traffic light (RAG) manual overrides at baseline and follow up

	Red	Amber	Green	Total
Risk assessment: baseline	4 (30.77%)	8 (61.54%)	1 (7.69%)	13 (100%)
Risk assessment: follow up	3 (37.50%)	4 (50.00%)	1 (12.50%)	8 (100%)

(shown as n (%) for categorical variables)

Table 27 implies that very few risk assessments were overridden (13 of 280, 4.64% at baseline and 8 of 111, 7.21% at follow up). Whilst it would be unwise to over interpret given these small numbers, overrides to Red or Amber are more common than overrides to Green (92.31% versus 7.69% at baseline compared with 87.50% versus 12.50% at follow up).

At the practice level, there were 10, 1 and 1 incomplete manual override records at practices 1, 2, and 3, respectively. At follow up (excluding those lost to follow up) the figures were 9, 15 and 1, respectively.

Dental practitioners are asked within the assessment to give reasons for any overrides made in the risk assessment and thus the changed care pathway. Overrides to a lower risk tended to be characterised by general comments about improved oral health, the patient's commitment to improved oral health and reference to caries. The following are typical responses:

Oral health improved

Oral hygiene improved. Patient is caries free

Moderate risk for perio and caries

Patient currently amber but committed to improving oral health

Minor calculus present in two quadrants plus heavy calculus in one gives red but as everything else is healthy and the patient is highly motivated moved to amber

Minimum calculus present and committed to improving

More carious teeth last visit

There were however examples of overrides related to family health conditions or medication which put the patient in a higher risk category than the dentist thought warranted:

Patient on hay fever tablets – computer placed on red pathway, override to amber

Diabetes in the family. Placed on high risk. Override to medium risk

The overrides that placed patients on higher risk than indicated by the RAG included changes based on the result of investigations within the dental appointment (specifically x-rays) and the patient's lack of commitment to their oral health improvement evidenced through attendance at the dentist:

After further investigation of the bite wings xrays taken, bone loss found which makes the patient high risk because of compromised periodental health

Patient failed to attend for treatments

Irregular attender

In summary for RAG (INCENTIVE practices only), for those who attended both baseline and follow up there was an improvement with 68% red at baseline and 44% red at follow up. Those who were red at baseline were less likely to attend follow up. 36.71% of those who were red at baseline attended follow up; 69.23% of those who were green at baseline attended follow up. There were very few decision overrides on the RAG.

Discussion

The matched pair design was chosen to help control for important differences between practices in the absence of a randomised design. However there are acknowledged limitations inherent in not using a randomised controlled trial. We match practices on deprivation of location of the practice, the ethnic mix of the location, the practice profile of patient age and size of practice. In practice the matching process was successful in as much as it resulted in pairs being balanced in terms of ethnicity. Although not matched for gender the pairings were well matched in this area. One area that did show differences was the average age of patients. But it is important to note that we matched on the practice profile of existing patients – the profile of participants indicated that the age of new patients differed. Practice 1 had the lowest mean age of 34.64 years (matched with Practice 4 at 40.99 years) whilst Practice 3 had the highest 47.60 years (matched with Practice 6, 40.78 years).

In terms of baseline oral health the matching produced relative balance in terms of BoP and caries with the exception of the 1-4 pairing in which 1 far lower BoP indicative of better oral health. For those patients who are included in the baseline and follow up analysis a mean score of BoP at follow up of 6.19 was recorded for practice 1 vs a mean score of 30.66 for practice 4. In respect of OHIP-14 scores, pairings were relatively balanced with the exception of pairing 3-6 (mean OHIP-14 score of 2.5 in practice 3 vs 13.19 in practice 6 for those patients who are included in the baseline and follow up). Despite the pairings being matched for practice size recruitment rates in matched pairs differed especially in pairings 2-5 and 1-4.

If we pool our results across the three pairings, the results are mixed. Our primary outcome, BoP, is assessed to be in favour of the INCENTIVE practices as are the OHIP-14 results. Conversely the sound surfaces and E&F taken from the ICDAS data show in favour of the TRADITIONAL practices. However, numbers of patients available for analyses for pairs 1-4 and 3-6 were unbalanced. This leads us to question whether it is robust to pool the three pairings in single analyses. If we are not willing to pool them then the only pairing with balanced numbers for analyses is the 2-5 pairing. The results from this single pairing show only a significant difference for the primary outcome, BoP in favour of the blended/incentive-driven contract. It is of note, whether the pooled analyses or only the analyses from the balanced pairing are used, that primary outcome of BoP is significantly in favour of INCENTIVE practices which gives a degree of confidence in this result.

Loss to follow up also differed amongst practices ranging from 35% to 74%. Even at the lower end of the range this was far higher than the 10% anticipated[122]; this was despite dental practices using a variety of mediums to contact patients to optimise attendance at 24 month appointments (letter by post, telephone, SMS). Individual practices also opened their surgeries out of usual hours (evening and weekend) to encourage study participants to attend the 24 month recall appointment. Although we do not have a complete record of reasons for non-attendance, patients *not responding to contact* from the dental practices was the most frequently cited reason across INCENTIVE and TRADITIONAL practices. Within the INCENTIVE practices there were also a substantial number of patients who failed to attend pre-booked appointments. One potential explanation for the difference in loss to follow up rates between our study and other studies is that all participants in the study were *new* patients rather than existing patients who were regular attenders as in most previous studies. It is also of interest that the practice with the lowest loss to follow up was in an affluent area and had the oldest study population. Conversely the practice with the highest loss to follow up is based within the 10% most deprived wards in the country, with associated adverse income, living environment, education, health and employment indicators. The practice estimates that approximately 80% of its patients are eligible for benefits. The study population was the youngest of all the practices.

With regard to data quality, within the study training was provided for all team members in completion of the ICDAS and BoP charts. This initially took place prior to recruitment of patients. The training was provided by an experienced clinician on the study team. Training was in the individual practice premises over a period of weeks. The training was competence based with practices encouraged request follow up training until all personnel felt competent in the use of the indices. For some practices this was a single training session before recruitment began, for others this was two or three sessions. On line training materials were made available and power point materials from the training presentations were kept by the practices. Prior to follow up at 24 months all practices undertook repeat training to ensure comparability. Despite this training, the quality of the data for ICDAS has proved to be variable. Whilst the majority of charts were completed to an acceptable standard a number of issues were evident which give cause for caution in interpretation of the results. For example, in some instances teeth with obvious caries or fillings at baseline were charted as sound at follow up, even allowing for errors in the transposition of adjacent teeth. Indeed concerns

about the implausibility and missing data meant that all the charts for those who completed baseline and follow up were manually reviewed and quality controlled by an experienced clinician. The manual review of data resulted in the exclusion of 71 patients from the analyses. Thirty five of those has impossible transitions such as dentine caries at baseline charted as sound at follow up (n=22); teeth charted as missing at baseline charted as sound at follow up (n=5); and restoration charted at baseline as sound at follow up (n=8). Charting errors were found in a further 17 records (partial data missing n=14; single digit coding n=2; 'illegal' code n=1 (an illegal code is one not on the ICDAS range of response codes)). Nineteen charting pairs were missing either the baseline or follow up chart.

It should be noted that all ICDAS was completed by the dental practitioners using a paper form. Given the comprehensive training provided future studies should consider electronic completion which has built in automatic error checks. We had intended to use this electronic capture in this study but unfortunately the dental practices' computer terminals were not within the dental surgery in all practices. As a result of this, and to ensure no bias resulting from method of completion, we used the paper form of the ICDAS in all practices.

Use of the ICDAS was exploratory in the study. It has proved to be illuminating in as much as there are lessons to take forward. The data suggest there are issues in relation to the capability within practices of recording this clinical outcome accurately. Indeed, the lack of confidence in the quality of the ICDAS data means that we have not explored the enamel transitions in the way that we would have wanted to. Indeed changes in the ICDAS scores may be the result of multiple factors such as attrition of study participants, diagnostic inaccuracies, poor completion, complexity of ICDAS, difficulty in diagnosing enamel caries in general dental practice, errors in syntax or the relatively short time frame of the study.

The traffic light risk assessment (RAG) showed improvement from baseline to follow up which suggests a degree of responsivity. However, more work is needed to validate this as there may be some operator bias. One of the concerns *a priori* was that for some with particular irreversible medical conditions it was not possible to move out of the red category. Within our sample there were very few overrides, and from the small number that had been overridden we are unable to ascertain whether this a priori concern was borne out. Explanations for over-rides, especially moves away from red suggest other reasons. Only one

patient score was overridden due to a family medical condition (diabetes). It is of note that those who were red at baseline were less likely to attend follow up.

Conclusions

Whilst the study results favour the blended/incentive model, this is with the caveats relating to sample size and data quality given 16% of participants were excluded from the analyses of the primary outcome for issues of data quality. However a large proportion of people in this study who had access to a dentist did not follow up on oral care. These individuals are more likely to be younger males and have poorer oral health. Within this patient group whilst access to dental services was increased this did not appear to facilitate continued use of services. Further work is required to understand how best to promote and encourage appropriate dental service attendance especially amongst those with high level of need to avoid increasing health inequalities.

Should services consider an oral health related outcome measure of clinical effectiveness, this study would support the use of BoP as a potential measure. However further work is required to validate this information. In terms of a dental caries, further work is indicated for both accuracy and validity of recording

.

Chapter 5: Economic study

Introduction

In order to assess value for money of the new blended/incentive-driven contract, this part of the study provides an economic evaluation of a new service delivery model (INCENTIVE) compared to the standard (TRADITIONAL) practice model. The evaluation identifies within-study incremental cost-effectiveness ratios (ICERs) for the INCENTIVE model compared to TRADITIONAL practice. Use of these ratios enable comparison of any additional financial costs imposed by the new model over standard care practice with any additional benefits it delivers.

The primary analyses take the perspective of the commissioners of the service, taking into account differences in contractual payments. Secondary analysis takes the perspective of the service provider including the cost of dental practitioners' time and treatment materials. The price year is 2012.

The analyses uses the EQ-5D-3L to derive quality adjusted life years (QALYs)[128,129]. However, given the apparent insensitivity of the EQ-5D-3L in oral health[130], it also uses the OHIP (OHIP-14), an Oral Health Related Quality of Life (OHQoL) measure[118,119]. The analyses will show the cost per QALY and cost per unit change in OHIP-14 score of INCENTIVE over TRADITIONAL care practice.

The OHIP measure has been used extensively in cost-effectiveness analyses in oral health (see for example[130,131]). However, in the UK the recommended outcome measure in cost-effectiveness analysis is the QALY[132]. Production of QALYs requires a preference based measure. At the present time there is no preference based measure specific to oral health and, given that OHIP-14 is not preference based, QALYs cannot be derived directly from it. Within this study the OHIP-14 scores will also be mapped using regression techniques to the baseline EQ-5D-3L scores. Our analysis explores the potential for estimating utility scores that can be used to produce QALYs based on responses to the OHIP-14.

Methods

Outcome measures

Patient health-related quality of life was assessed using the OHIP-14[118,119] and the EQ-5D-3L[128,129]. Patients completed both measures at baseline and at the end of the two years (24 months) assessment period.

The Oral Health Impact Profile (OHIP) is a non-preference based measure of the impact of oral disorders on individuals' well-being[118]. It contains 49 questions (seven questions for each of the seven dimensions of impact of an oral condition) based on a theoretical model of oral health[133]. The OHIP-14 used here is a shorter version of the OHIP based on a subset of two questions for each of the seven dimensions[119]. The OHIP-14 questionnaire asks patients to rate the problems they had with their mouth, teeth or gums in the last six months. It consists of 14 items that capture seven dimensions of functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. Response options to each of these items ranged between 0 and 4, with 4 = very often, 3 = fairly often, 2 = occasionally, 1 = hardly ever and 0 = never. The total OHIP score was calculated using the additive method i.e. sum of the responses to the 14 items. This method was selected because of its operational simplicity and its effectiveness in measuring OHQoL between groups[120]. The total OHIP score ranges between 0 and 56 points with lower scores indicating better OHQoL.

QALYs were estimated using EQ-5D-3L. EQ-5D-3L is a standardised generic instrument for use as a measure of health outcome[129]. It can be applied to a range of health conditions and treatments and provides a health state profile or a utility value index for an individual. In the EQ-5D-3L questionnaire, patients were asked to rate their health on five health state dimensions. These dimensions were: mobility (e.g. walking about), self-care (e.g. washing or dressing), usual activities (e.g. work, study, housework, family or leisure activities), pain/discomfort and anxiety/depression. Each of the five health states has a 3-level response (1 = no problems, 2 = some/moderate problems, 3 = extreme problems/unable). The item responses were converted to health-state utility values using an algorithm derived from a UK tariff[134]. The health state values could take negative values i.e. worse than death, but could

not exceed 1 (i.e. full health). These utility values were then used to estimate QALYs using the area under the curve approach (AUC), where 1 QALY is the equivalent of 1 year of full health. As any effects were observed over 2 years discounting of QALY and OHIP was necessary. The recommended rate of 3.5% was used[132].

For the mapping exercise, we used baseline data from the EQ-5D-3L, OHIP-14 and information on other controls including date of birth and gender. To simplify the analysis, the responses to each of the OHIP-14 items were re-coded into three wide groups: 'Never', 'Hardly ever' and 'Occasionally/Fairly often/Very often'. These groups were also converted into indicator variables with zero values if there was no response in that group and one if there was a positive response in that group. Age was calculated in years using the reported year of birth and gender was coded 1 for male and zero for female.

Resource use and costs

To recap, as set out in Chapter 2, within the INCENTIVE practices, 60% of the contract value is apportioned to delivery of a set number of UDAs. The remaining 40% is dependent on the delivery of quality - 20% systems, processes, infrastructure (e.g. cross infection, policies, Standards for Better Health latterly becoming Care Quality Commission domains) and 20% OHImp. With the TRADITIONAL practices contracts are drawn up to deliver a set number of UDAs for an agreed financial value. Thus, all practices were paid the cost of the UDAs claimed but INCENTIVE practices *also* received a 'fixed' cost equivalent to 40% of the total contract value (TVC).

UDAs are based on three treatment bands (Band 1: diagnosis, treatment planning and maintenance; Band 2: simple treatment e.g. fillings; and Band 3: complex treatment e.g. bridges or crowns). Each band attracts a set number of UDAs (Band 1 = 1 UDA; Band 2 = 3 UDAs; Band 3 = 12 UDAs) and UDAs awarded for completed treatments[2] (1).

It is important to note that the value of UDAs (i.e. the payment made for each UDA) varies between dental practices and thus UDA values vary from provider to provider. Typically, the greater the need for NHS dentists in an area the higher the UDA value

For the analysis from the commissioner's perspective, NHS England provided us with the financial value of UDAs for the TRADITIONAL practices in the relevant years. The UDA value assigned to the INCENTIVE practices in this analysis includes the 40% of the contract value paid to the practices dependent on delivery of quality and systems, processes and infrastructure.

Information on the number, and value, of UDAs claimed per patient within the study was collected from recorded appointment history data from the practices.

The analysis from the service provider's perspective included information on: the number and duration of appointment, the type of treatment and the dental professional carrying out the appointment/treatment. This information was provided by the dental practices and taken from the appointment history of each patient. Material costs such as the cost of films used in x-rays or the cost of filling materials are based on the Kent Catalogue[136] and are shown in Table 29. The salaries of the different staff involved in the treatment were obtained from national sources such as the Pay Circular and the NHS Agenda for Change and overhead costs were calculated using the same method as in Hulme and colleagues[130] (see Table 28). Costs and salaries are adjusted for inflation using the CCEMG-EPPI Centre Cost Converter[135]. Discounting of costs was also necessary and a discount rate of 3.5% was used[132].

Table 28: Salaries and overheads

Salary	**per hour**	**Source**			
Dentist	£32.89	Pay Circular (M&D) 1/2011			
Therapist	£16.59	NHS Agenda for Change pay scales 2011/2012			
Hygienist	£13.56				
Oral Health Educator	£11.17				
Overheads	% of income	Dentist	Therapist	Hygienist	Oral Health Educator
Wages and NI (per hour)	17.42%	£32.89	£16.59	£13.56	£11.17
Overheads (per hour)	12.77%	£24.11	£12.16	£9.94	£8.19

Table 29: Cost of materials and lab cost

Material	**Description**	**Cost**	**Source**
X-rays	Optimum film	£0.33	Kent express catalogue (2014)[136]

	Periapical film	£0.28	
Amalgam filling	1 spill Dycal (base 13g and catalyst 11g)	£0.90 £21.20	
Lab	***Description***	***Cost***	***Source***
Denture	Full upper or lower only with standard teeth (x2 for F/F)	£167.05	Mgill price list (2011)[137]
Crown	-	£116.00	
Bridge	-	£131.00	

All material costs include VAT and 15% off the Kent Catalogue price.

The cost of chemicals used to develop the film is excluded but is minimal.

Cost-effectiveness

The outcome of the cost-effectiveness analyses was the incremental cost per unit change in OHIP-14 and the cost per QALY. We present incremental ICERs representing the ratios of the incremental cost and incremental benefits (OHIP points/QALYs) between INCENTIVE and TRADITIONAL care practice. The ICER represents the additional cost per one unit of outcome gained, in this case per OHIP lost/QALY gained for INCENTIVE versus TRADITIONAL practice. As a guideline rule, the National Institute for Health and Care Excellence[132] accepts as cost-effective those interventions with an ICER of <£20,000 per QALY. NICE states that, in general, if a treatment costs more than £30,000 per QALY it would not be considered cost-effective. In addition, we present cost-effectiveness plane scatterplots showing the uncertainty surrounding the cost-effectiveness estimates. The cost-effectiveness planes were derived using bootstrapping with replacement. This stochastic uncertainty analysis involved running 10,000 bootstrapped estimates of the incremental costs and QALYs/OHIP scores. The bootstrap approach is a non-parametric method that treats the original sample as though it was the population and draws multiple random samples from the original sample. Cost-effectiveness acceptability curves were also generated to illustrate the probability that each treatment would be cost-effective given a range of acceptable threshold values[138].

Sensitivity analyses were further carried out to account for uncertainty in the cost values. For the commissioner's perspective we performed one-way sensitivity analyses by assuming either no change or a 3% increase in the TVC per (financial) year or a 0%, 10% increase or 10% decrease in the number of patients treated per year. For the analysis from the service

provider's perspective, costs were altered by +/-20%. Whilst these values are essentially arbitrary it was considered likely to represent any uncertainty in the cost values.

Missing data

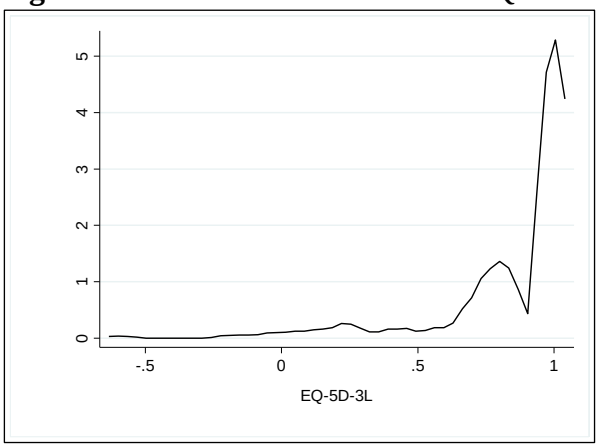
Following Slade and colleagues[125], we use median imputation if 2 or less OHIP item scores are missing. Participants who had more than 2 components of the OHIP missing or missing EQ-5D-3L at baseline and follow-up are excluded from the analysis. Multiple imputation was also attempted to deal with missing EQ-5D-3L/OHIP scores at follow-up however, the missing values were not missing at random (MAR), making this technique not appropriate to use here (see Appendix 3 for more details).

Mapping OHIP-14 to EQ-5D-3L

In mapping the OHIP-14 to the EQ-5D-3L we used the methods set out by Brennan and Spencer[139]. Using baseline data, we split the data into estimation and validation samples. We ran different types of models where the observed EQ-5D-3L was the dependent variable and the OHIP-14 items, age, age-squared (to account for a potential non-linear relationship between age and EQ-5D-3L) and gender being the independent variables.

Firstly, we ran an ordinary least squares regression (OLS). A common phenomenon observed in the health profile (EQ-5D-3L) is that its distribution is skewed to the left i.e. a large proportion of the sample is at full health - known as a ceiling effect, which we also observed in the data (see Figure 18 for an illustration).

Figure 18: Distribution of observed EQ-5D-3L



This ceiling effect makes OLS regression inappropriate as it will give biased and inconsistent results. The Tobit model is proposed as a solution, often used in 'mapping' studies[139-140]. Simply, in the Tobit the unobservable EQ-5D-3L linearly depends on the independent variables. Then, the observable EQ-5D-3L is equal to the unobserved one whenever the true unobservable EQ-5D-3L is greater than or equal to the ceiling value (1 in our case). Tobit also assumes that the error terms are normally distributed with uniform variance (homoscedasticity) but evidence suggests that the distribution of utility scores does not follow these assumptions[141]. Therefore, results from Tobit should be interpreted cautiously. A more flexible approach to address the fact that utility scores usually have mixed distributions (i.e. the majority of observations are at the ceiling and there is a left-skewed distribution not at the ceiling) is the two-part model (TPM). In the TPM, the respondents reporting full health in all five health states of EQ-5D-3L are modelled separately from those reporting all other EQ-5D-3L scores. The logic is that individuals reporting full health in all states are different in some fundamental way from others who report at least one problem in any of the EQ-5D-3L dimensions. For this reason, in the first stage we used the logit regression to estimate the probability of reporting full health in the whole sample, whereas in the second stage OLS regression was used to estimate an EQ-5D-3L score for those without full health.

The possibility of adding more control variables was also examined as there was available information on the risk of an oral disease. However, the high number of missing values in these variables at baseline made most of the estimations impossible.

All analyses were conducted using STATA© (StataCorp LP) and Excel© (Microsoft).

Results

Sample

A total of 550 patients were recruited in this study (see Chapter 4). Two hundred and ten of those patients were included in the cost-effectiveness analyses. In detail, 4 patients withdrew prior to their appointment, 5 patients did not have appointment history data at baseline and/or follow-up (hence, costs could not be estimated) and 289 patients did not do the follow-up assessment. From the remaining 252 patients, 42 two patients had more than 2 components of the OHIP missing or missing EQ-5D-3L at baseline and follow-up and are excluded from the analysis (13 patients at baseline and 10 patients at follow-up had 2 or less OHIP item scores missing so we were able to impute the missing data and include these in the analysis). Thus, data from 210 patients (108 INCENTIVE and 102 TRADITIONAL practices) had complete data (costs, EQ-5D-3L and OHIP-14 (after imputation for those with less than two missing items)) and were included in the cost-effectiveness analyses. Baseline characteristics of the patients are presented in Table 30. There are no statistically significant differences in age, gender or ethnicity between those included in these analyses and those lost to follow up.

Table 30: Baseline characteristics of the patients

		INCENTIVE practices	TRADITIONAL practices
Age (years)	Mean (SD)	40.66 (14.66)	43.14 (16.34)
Gender*	Male	n=47 (45.6%)	n=51 (51%)
Ethnicity*	White	n=76 (72.4%)	n=68 (79.1%)

**About 3% and 9% of the sample used in the economic analyses had missing information on gender and ethnicity respectively. Age was recorded for all participants.*

Resource use and costs

Table 31 shows the average number of UDAs per person over the 2 years of the study. There are negligible differences in the average number of UDAs per person if the treatment/appointment was carried out by a dentist. It is difficult to draw conclusions for the therapist and hygienist as some of the INCENTIVE and/or TRADITIONAL practices did not have these dental professionals. Table 32 shows the average number of appointments per person over the study. Patients in the INCENTIVE practices had more appointments on average than those in the TRADITIONAL practices. The picture is similar when looking at the appointments carried out by a dentist. A patient had on average the same number of appointments with an Oral Health Educator in both groups. Again it is not possible to compare INCENTIVE with TRADITIONAL practices with regards to the number of appointments performed by the rest of the dental professionals.

Table 31: Average number of UDAs per person

		INCENTIVE practices	TRADITIONAL practices
	Mean (SD)	11.23 (8.08)	10.74 (8.23)
By dental professional		INCENTIVE practices	TRADITIONAL practices
Dentist	Mean (SD)	10.70 (8.07)	10.58 (8.25)
Therapist	Mean (SD)	0.65 (1.66)	N/A
Hygienist	Mean (SD)	N/A	4.05 (6.10)
Oral Health Educator	Mean (SD)	0.80 (1.30)	0.00 (-)*

*There was one appointment but no UDA was claimed

Table 32: Average number of appointments per person

		INCENTIVE practices	TRADITIONAL practices
	Mean (SD)	8.89 (4.50)	6.63 (2.93)
By dental professional		INCENTIVE practices	TRADITIONAL practices
Dentist	Mean (SD)	7.13 (4.02)	6.56 (2.95)
Therapist	Mean (SD)	2.28 (1.60)	N/A
Hygienist	Mean (SD)	N/A	1.50 (1.00)
Oral Health Educator	Mean (SD)	1.00 (0.00)	1.00 (-)*

*There was one appointment but no UDA was claimed

Cancelled appointments are not included.

For the patients who were lost to follow up (and for who we had appointment data) the average number of dental appointments was 7.97 (SD 5.34; n=152) for the INCENTIVE practices and 4.99 (SD 3.53; n=131) for the TRADITIONAL practices. Treatment within these appointments included fillings, dentures and crowns. For example, 72% of patients in the INCENTIVE practices and 60% in the TRADITIONAL practices had one or more fillings; 77% and 69% respectively had had x-rays taken; 18% and 20% respectively had had dentures made and 6% and 5% had had a crown.

For the 210 people included in the health economics study, the mean time spent with the dental professional by group is presented in Table 33. In the INCENTIVE practices, patients spent less time with the dentist, on average, than the TRADITIONAL practices. Comparing by dental professional, therapists and dentists in the INCENTIVE and TRADITIONAL practices respectively spent more time with the patient on average.

Table 33: Average appointment duration per person

		INCENTIVE practices	TRADITIONAL practices
		Time (minutes)	Time (minutes)
Dentist	Mean (SD)	16.91 (7.35)	24.44 (10.46)
Therapist	Mean (SD)	23.89 (10.49)	N/A
Hygienist	Mean (SD)	N/A	21.25 (8.54)
Oral Health Educator	Mean (SD)	22.00 (4.47)	20.00 (.)

Costs from the perspective of the commissioner

The UDA value paid for each of the practices is shown in Table 34 (the INCENTIVE UDA value includes the 40% of the contract dependent on quality and processes)..

The mean per person cost over the study of the INCENTIVE practices is £459.77 whereas for the TRADITIONAL practices is £281.57 (Table 35).

Table 34: UDA value per practice

INCENTIVE practice	
M	£33.69
B	£33.62
G	£33.62
TRADITIONAL practice	
O	£27.31

A	£25.47
H	£28.80

Table 35: Per patient cost of UDAs

	Mean (SD)
INCENTIVE practice	
M	518.37 (269.04)
B	507.22 (287.06)
G	286.26 (181.37)
TRADITIONAL practice	
O	£291.99 (206.09)
A	£256.36 (203.20)
H	£370.29 (319.10)

Costs from the perspective of the dental provider

As highlighted earlier, the costs to the dental provider are made up of the practitioners' time, materials and lab costs. In addition the dental surgeries receive a payment for UDAs delivered (INCENTIVE and TRADITIONAL practices). The sum of these payments is subtracted from the costs accruing to the dental provider (time/material/lab costs). These payments are the cost to the commissioner detailed in the previous section.

The mean cost of the materials and any lab cost per person are presented in Table 36.

Table 36: Per patient cost of materials and lab cost*

	INCENTIVE practices			TRADITIONAL practices		
	Dentist	Therapist	Oral Health Educator	Dentist	Hygienist	Oral Health Educator
	Cost (£)	Cost (£)	Cost (£)	Cost (£)	Cost (£)	Cost (£)
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
X-rays	0.75 (0.46)	0.32 (0.00)	N/A	0.54 (0.34)	N/A	N/A
Periapical	0.46 (0.26)	0.27 (0.00)	N/A	N/A	N/A	N/A
Filling	8.59 (7.87)	4.95 (3.78)	N/A	8.98 (6.34)	N/A	N/A
Denture	243.67 (123.31)	N/A	N/A	234.71 (110.26)	N/A	N/A
Crown	134.53 (44.49)	N/A	N/A	162.98 (76.56)	N/A	N/A
Bridge	132.93 (-)	N/A	N/A	N/A	N/A	N/A

*Mean cost per patient who had that treatment, e.g. all who had at least one filling

The costs are combined with the cost of the time spent by the different dental professionals, and the per patient cost of UDAs (Table 35) to find the per patient cost from the perspective of the service provider. The mean per person cost from the perspective of the service provider, of the INCENTIVE practices is £-209.26 whereas for the TRADITIONAL practices is £-116.21 (Table 37).

Table 37: Total mean per patient cost to dental providers

Resource	INCENTIVE practices	TRADITIONAL practices
	Mean (SD)	*Mean (SD)*
Time of dental professionals	£195.63 (102.92)	£107.02 (55.55)

Materials and lab costs	£54.88 (114.47)	£58.34 (111.25)
Total	£250.51 (186.85)	£165.37 (146.28)
Payment to providers	£459.77 (278.42)	£281.57 (218.71)
Total mean health care costs	**£-209.26 (123.36)**	**£-116.21 (99.16)**

Outcome (quality of life) data

Overall, improvement is observed in the OHIP-14 scores between baseline and follow-up for both the INCENTIVE and TRADITIONAL practice groups (Table 38). However, no statistically significant difference in EQ-5D-3L score was found between groups or over time. There are no statistically significant differences in the OHIP scores between groups but there are statistically significant differences (at 5% level) in these scores over time in both groups.

Table 38: Mean total OHIP scores by group

Time point		INCENTIVE practices (N=108)	TRADITIONAL practices (N=102)
Baseline	Mean (SD)	8.99 (10.30)	9.12 (10.98)
Follow-up (24 months)	Mean (SD)	5.60 (7.58)	7.38 (8.89)
Change	Mean (p-value)	3.39 (<0.001)	1.74 (0.051)

Also, the changes in the EQ-5D-3L scores by group (or over time) are negligible (see Table 39) making it difficult to draw any conclusions about the impact of the new care practice on the patients' general health-related quality of life.

Table 39: Mean EQ-5D-3L scores by group

Time point		INCENTIVE practices	TRADITIONAL practices

		(N=108)	(N=102)
Baseline	Mean (SD)	0.880 (0.250)	0.896 (0.232)
Follow-up (24 months)	Mean (SD)	0.882 (0.207)	0.897 (0.257)
Change	Mean (p-value)	-0.018 (0.235)	0.014 (0.552)

Cost-effectiveness results

Table 40 shows the costs, from the commissioner's perspective, and OHIP changes for each of the two groups. The TRADITIONAL practices had lower costs and higher OHIP score i.e. patients in the TRADITIONAL practices had worse OHQoL. This represents an estimated cost of £199.22 per one unit decrease (improvement) in OHIP-14 score for INCENTIVE.

Table 40: Cost-effectiveness results (outcome measure: OHIP, commissioner's perspective)

	Costs (£)	OHIP (points)	
	Mean (SD)	*Mean (SD)*	
INCENTIVE practices	459.77 (278.42)	7.110 (7.673)	
TRADITIONAL practices	281.57 (218.71)	8.005 (8.699)	
	Incremental cost	Incremental OHIP	ICER (£/OHIP)
INCENTIVE *vs* TRADITIONAL practices	178.20	-0.895	199.22

Similarly, Table 41 shows the costs from the service provider's perspective. INCENTIVE practices had lower costs to the dental providers (a greater surplus once costs, and income from payments for services delivered, had been taken into account) and better health outcomes. Thus, from the dental provider's perspective INCENTIVE dominates TRADITIONAL.

Table 41: Cost-effectiveness results (outcome measure: OHIP, service provider's perspective)

	Costs (£)	OHIP (points)	
	Mean (SD)	*Mean (SD)*	
INCENTIVE practices	-209.26 (123.36)	7.110 (7.673)	
TRADITIONAL practices	-116.21 (99.16)	8.005 (8.699)	
	Incremental cost	Incremental OHIP	ICER (£/OHIP)
INCENTIVE *vs* Traditional practices	-93.05	-0.895	-104.03 INCENTIVE DOMINATES

Similarly, Tables 42 and 43 show the costs and QALYs for each of the two groups. They also provide the incremental costs and benefits (expressed as QALY gains) as well as the ICER. Any interpretation in this case should be tempered given the negligible differences in QALY gains between the two groups.

Table 132: Cost-effectiveness results (outcome measure: QALY, commissioner perspective)

	Costs (£)	QALY	
	Mean (SD)	*Mean (SD)*	
INCENTIVE practices	459.77 (278.42)	1.659 (0.451)	
TRADITIONAL practices	281.57 (218.71)	1.660 (0.342)	
	Incremental cost	Incremental QALY	ICER (£/QALY)
INCENTIVE *vs*	178.20	-0.0008	INCENTIVE

TRADITIONAL practices			DOMINATED

Table 43: Cost-effectiveness results (outcome measure: QALY, service provider's perspective)

	Costs (£)	QALY	
	Mean (SD)	*Mean (SD)*	
INCENTIVE practices	-209.26 (123.36)	1.659 (0.451)	
TRADITIONAL practices	-116.21 (99.16)	1.660 (0.342)	
	Incremental cost	Incremental QALY	ICER (£/QALY)
INCENTIVE *vs* TRADITIONAL practices	-93.05	-0.0008	122,089.48

Figure 19 shows the cost-effectiveness plane for INCENTIVE care practice compared with TRADITIONAL care practice using QALY. The sample estimates are spread mainly in the north-west and north-east quadrants, suggesting that INCENTIVE care practice is unlikely to be cost-effective from the commissioner's perspective. Iteration results seem to be equally spread in north-east and north-west quadrants making it difficult to draw conclusions on which of the two care practices leads to better general health-related quality of life. Similarly, Figure 20 shows the cost-effectiveness plane for INCENTIVE compared with TRADITIONAL care practice using QALY from the perspective of the service provider. Iteration results in this case are spread in the south-west and south-east quadrants indicating that INCENTIVE practices had lower costs than the dental providers.

Figure 19: Cost-effectiveness plane for INCENTIVE compared with TRADITIONAL care practice (outcome measure: QALY, commissioner's perspective)

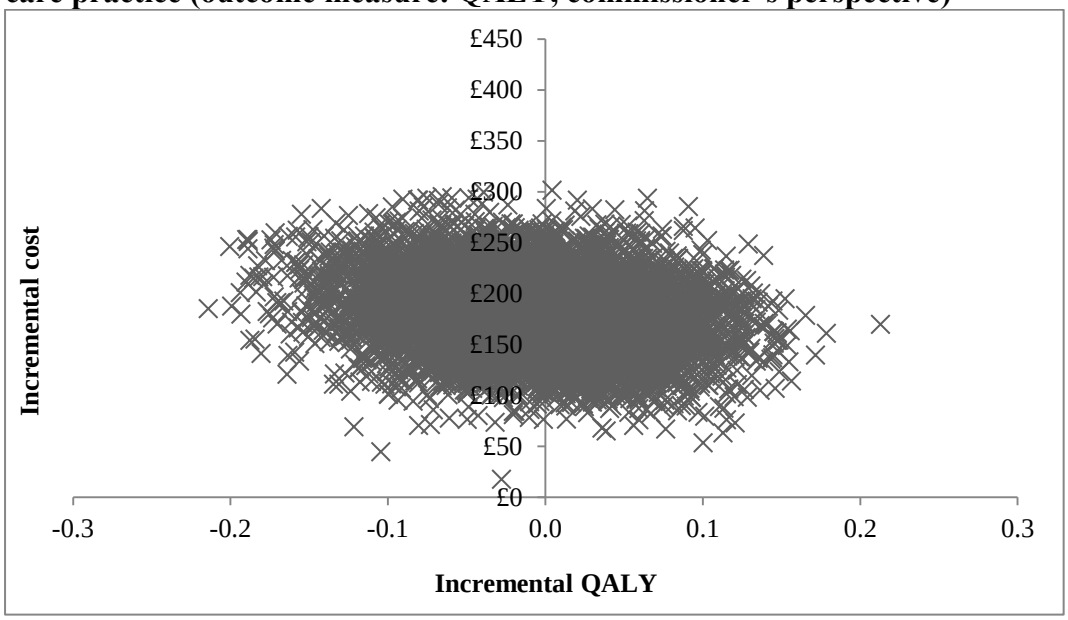
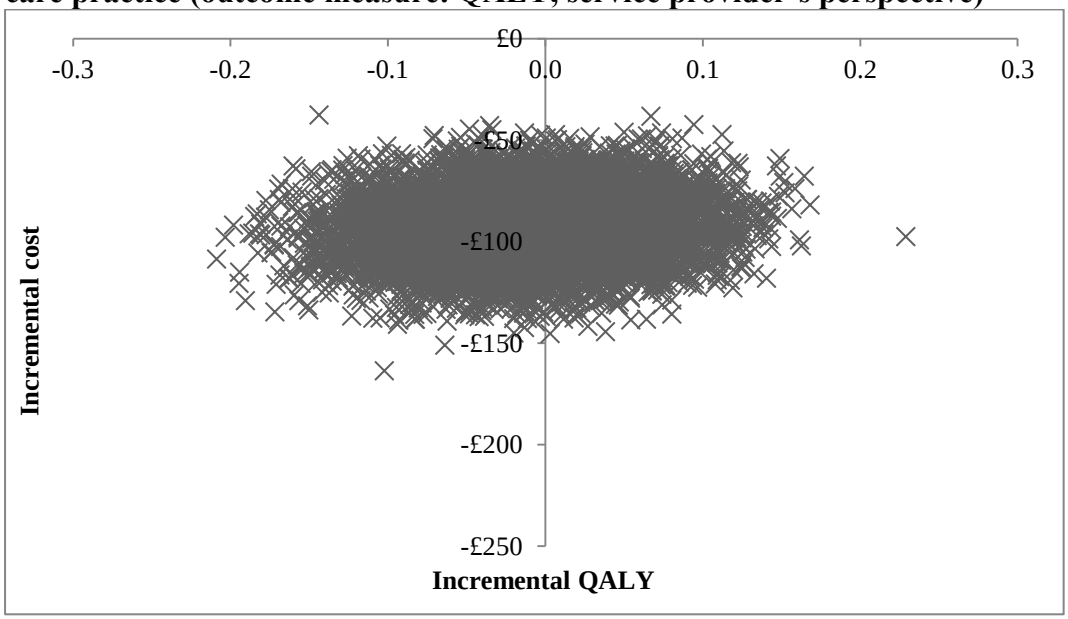


Figure 20: Cost-effectiveness plane for INCENTIVE compared with TRADITIONAL care practice (outcome measure: QALY, service provider's perspective)



Figures 21 and 22 show the cost-effectiveness plane for INCENTIVE compared to TRADITIONAL care practice using OHIP, from the commissioner's and service provider's perspective respectively. For the commissioner's perspective the estimated ICERs are mostly located in the north-east quadrant implying that INCENTIVE is more effective with regards to improving OHQoL but more expensive compared to TRADITIONAL care practice. For

the service provider, the ICERs are mostly spread in the south-east quadrant suggesting again that INCENTIVE is more effective than the traditional care practice in terms of improving OHQoL.

Figure 21: Cost-effectiveness plane for INCENTIVE compared with TRADITIONAL care practice (outcome measure: OHIP, commissioner's perspective)

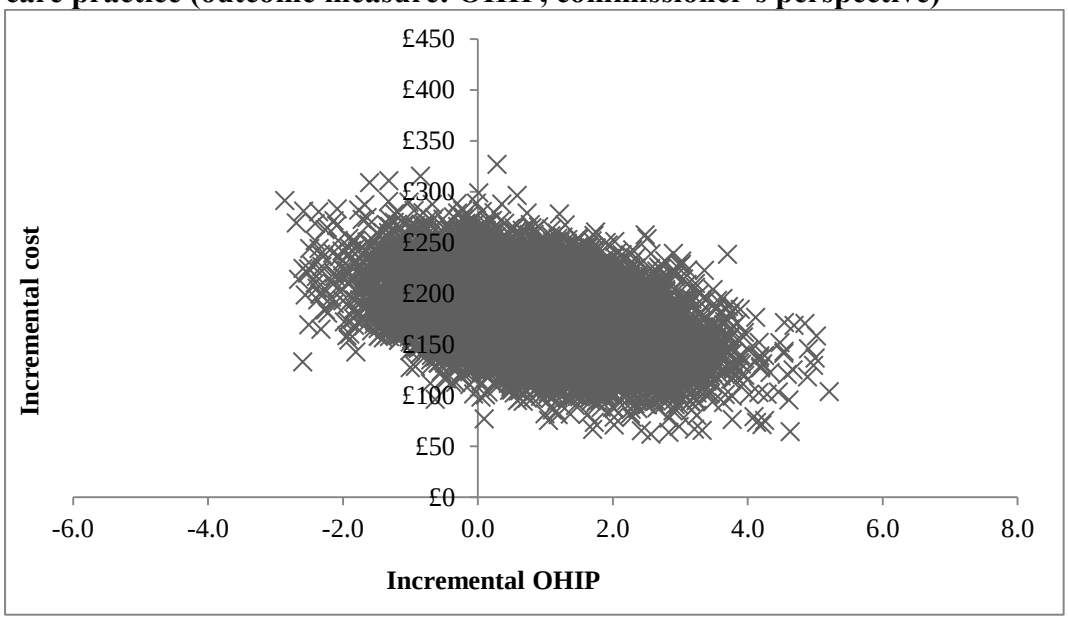
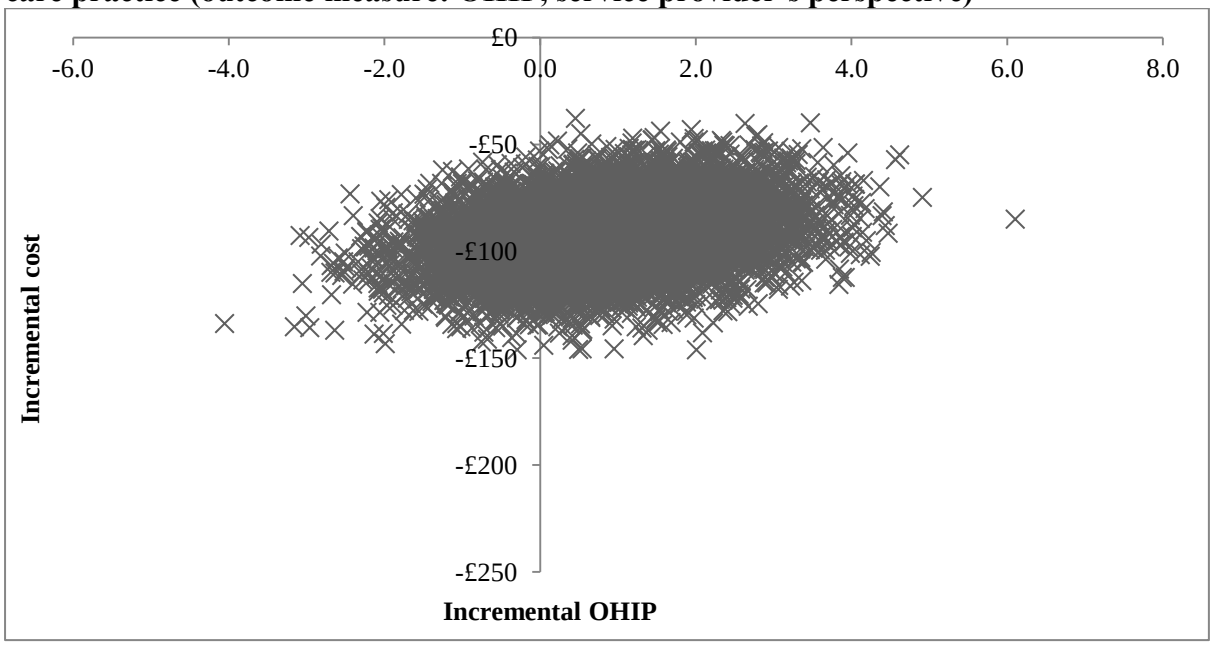


Figure 22: Cost-effectiveness plane for INCENTIVE compared with TRADITIONAL care practice (outcome measure: OHIP, service provider's perspective)



To account for uncertainty around mean incremental costs and effectiveness, we conducted sensitivity analyses and non-parametric bootstrapping (see Tables 44 and 45). From the commissioner's perspective, the univariate sensitivity analysis varied the total value of the contract per year by 0% or 3%. We also looked at the case where the number of patients treated remained the same per year or increased/decreased by 10%. From the service provider's perspective, we added and subtracted 20% of the cost of and assessed the subsequent impact on the ICERs. The ICER estimates from the bootstrapping were similar to those of the deterministic base-case scenario from both perspectives.

Figures 23 and 24 show the cost-effectiveness acceptability curve (CEAC) for QALY values between zero and £60,000; the probability that the INCENTIVE care practice will be cost-effective compared to TRADITIONAL care practice given a range of threshold values. The curve is based on 10,000 replications. Using the threshold of £20,000 that is recommended by NICE, from the commissioner's (service provider's) perspective the probability that INCENTIVE care practice is effective, is 0.37 (0.47) compared to a probability of 0.63 (0.53) for the TRADITIONAL care practice. At lower levels of willingness-to-pay thresholds (<£18,000) there is a lower (higher) probability of the INCENTIVE care practice being cost-effective from the commissioner's (service provider's) perspective. It is worth reiterating at this point that whilst we have presented the sensitivity analysis and bootstrapping results, the results should be interpreted with caution given the negligible difference between the QALYs in INCENTIVE and TRADITIONAL practices.

Table 14: Sensitivity analyses (commissioner's perspective)

INCENTIVE *vs* TRADITIONAL practices	Incremental cost	Incremental OHIP	ICER (£/OHIP)
TVC 0% change per year	177.09	-0.895	197.97
TVC 3% increase per year	187.99	-0.895	210.16
Number of patients treated 0% change per year	179.34	-0.895	200.49
Number of patients treated 10% increase per year	179.72	-0.895	200.92
Number of patients treated 10% decrease per year	199.26	-0.895	222.76
Bootstrapping (10,000 replications)	179.75	-0.862	208.59
INCENTIVE *vs* TRADITIONAL practices	Incremental cost	Incremental QALY	ICER (£/QALY)
TVC 0% change per year	177.09	-0.0008	INCENTIVE dominated
TVC 3% increase per year	187.99	-0.0008	INCENTIVE dominated
Number of patients treated 0% change per year	179.34	-0.0008	INCENTIVE dominated
Number of patients treated 10% increase per year	179.72	-0.0008	INCENTIVE dominated
Number of patients treated 10% decrease per year	199.26	-0.0008	INCENTIVE dominated
Bootstrapping (10,000 replications)	180.42	-0.0088	INCENTIVE dominated

Table 45: Sensitivity analyses (service provider's perspective)

INCENTIVE *vs* TRADITIONAL practices	Incremental cost	Incremental OHIP	ICER (£/OHIP)

20% increase in costs	-111.66	-0.895	-124.83 INCENTIVE DOMINATES
20% decrease in costs	-74.44	-0.895	-83.22 INCENTIVE DOMINATES
Bootstrapping (10,000 replications)	-92.76	-0.830	-111.82 INCENTIVE DOMINATES
INCENTIVE *vs* Traditional practices	Incremental cost	Incremental QALY	ICER (£/QALY)
20% increase in costs	-111.66	-0.0008	146,507.37
20% decrease in costs	-74.44	-0.0008	97,671.58
Bootstrapping (10,000 replications)	-92.79	-0.0098	9,483.68^

^The ICER is driven mostly by the incremental QALY; a small increase in the (already small) incremental QALY will have a big impact on the ICER.

Figure 23: Cost-effectiveness acceptability curve based on bootstrap replications for INCENTIVE compared with TRADITIONAL practice care (outcome measure: QALY, commissioner's perspective)

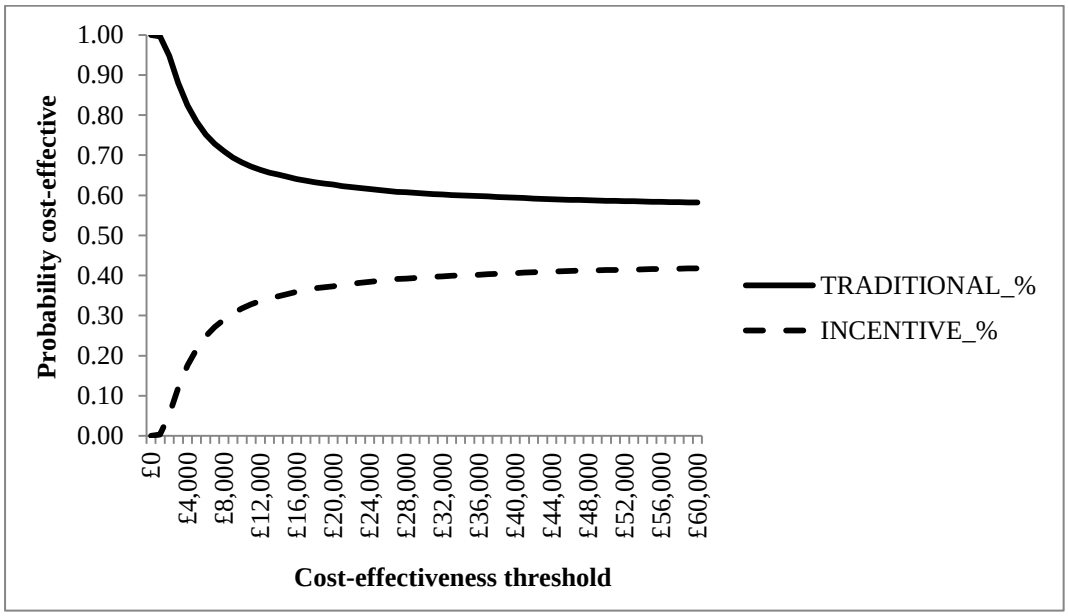
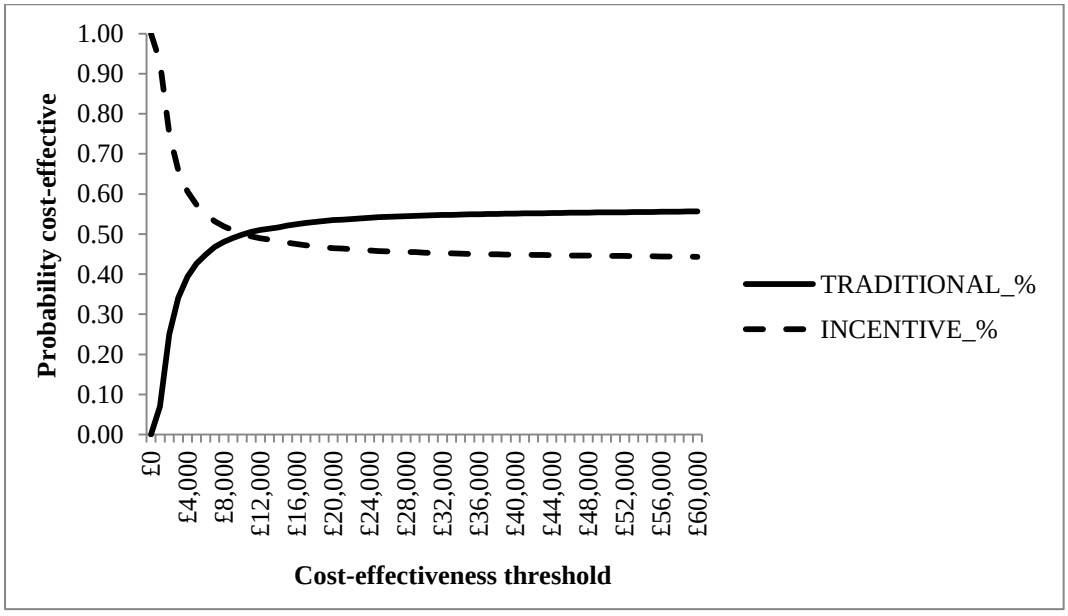


Figure 24: Cost-effectiveness acceptability curve based on bootstrap replications for INCENTIVE compared with TRADITIONAL practice care (outcome measure: QALY, service provider's perspective)



Results mapping

Characteristics of patients

As described in the earlier methods section, for this analysis we used only baseline data. We included all participants who had fully completed EQ-5D-3L and OHIP-14 questionnaires. Details of our sample in this part of the analysis are reported in Table 45. Females accounted for slightly more than half of the sample (50.8%) and the mean age was 40.4 years. The mean EQ-5D-3L was 0.852 with 95% confidence interval of 0.829 to 0.875. Many patients - more than 30% - reported no symptoms in all OHIP-14 items. Only a few reported that the symptoms were 'Occasionally/Fairly often/Very often', with responses ranging from 0.77% for 'trouble in pronouncing words' to 14.09% for 'Felt self-conscious'. Symptoms were 'Hardly ever' for a bigger percentage of the sample, ranging from 18.34% for 'Unable to function' up to 54.74% for 'Uncomfortable eating'. The mean values for the OHIP-14 items ranged from 0.203 for 'Unable to function' to 0.710 for 'Uncomfortable eating'.

Table 46: Characteristics of sample in mapping analyses

				95% CI	
Variable	n	Percent	Mean	Lower bound	Upper bound
Trouble pronouncing words	519		0.216	0.179	0.253
Never		79.19			
Hardly ever		20.04			
Occas., F/Often, V/Often		0.77			
Sense of taste worsened	519		0.268	0.226	0.309
Never		74.95			
Hardly ever		23.31			
Occas., F/Often, V/Often		1.73			
Painful aching in mouth	513		0.639	0.590	0.689
Never		40.94			
Hardly ever		54.19			
Occas., F/Often, V/Often		4.87			
Uncomfortable eating	517		0.710	0.657	0.762
Never		37.14			
Hardly ever		54.74			
Occas., F/Often, V/Often		8.12			
Felt self-conscious	518		0.708	0.648	0.769
Never		43.24			
Hardly ever		42.66			
Occas., F/Often, V/Often		14.09			

Felt tense	514		0.533	0.479	0.587
Never		53.89			
Hardly ever		38.91			
Occas., F/Often, V/Often		7.20			
Diet unsatisfactory	519		0.362	0.315	0.410
Never		67.24			
Hardly ever		29.29			
Occas., F/Often, V/Often		3.47			
Interrupt meals	515		0.400	0.352	0.448
Never		63.50			
Hardly ever		33.01			
Occas., F/Often, V/Often		3.50			
Difficulty relaxing	517		0.478	0.428	0.527
Never		56.09			
Hardly ever		40.04			
Occas., F/Often, V/Often		3.87			
Been embarrassed	520		0.621	0.562	0.680
Never		49.62			
Hardly ever		38.65			
Occas., F/Often, V/Often		11.73			
Irritable with other people	518		0.392	0.341	0.442
Never		66.02			
Hardly ever		28.76			
Occas., F/Often, V/Often		5.21			
Difficulty doing usual jobs	520		0.262	0.220	0.303
Never		75.58			
Hardly ever		22.69			
Occas., F/Often, V/Often		1.73			
Life less satisfying	519		0.432	0.379	0.484
Never		63.01			
Hardly ever		30.83			
Occas., F/Often, V/Often		6.17			
Unable to function	518		0.203	0.166	0.239
Never		80.69			
Hardly ever		18.34			
Occas., F/Often, V/Often		0.97			
EQ-5D-3L	507		0.852	0.829	0.875
Age (in years)	528		40.4	39.11	41.76
Gender	528				
Female		50.76			

Regression results

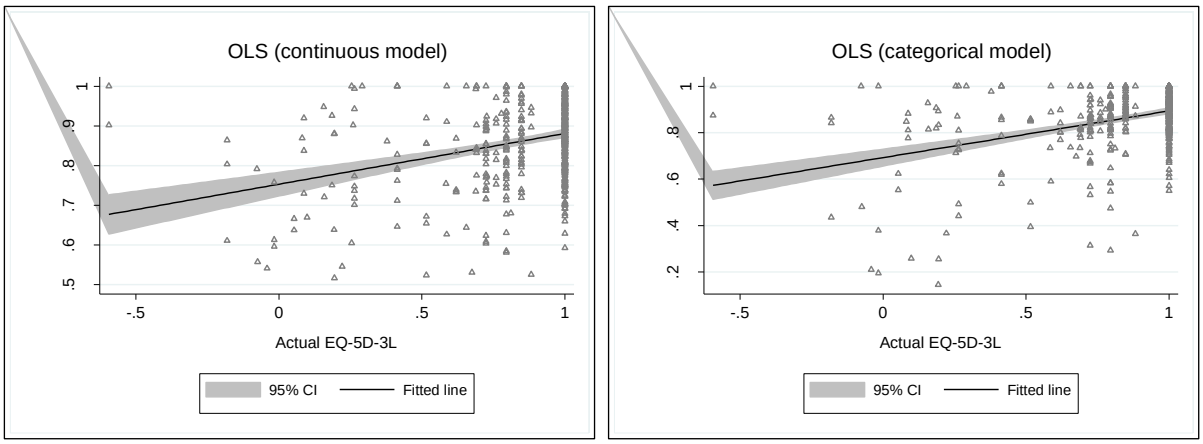
Figure 25 shows the actual versus the predicted health state values. (The graphs are presented separately for the OHIP-14 items as continuous and categorical variables.) OLS, Tobit and the two-part model seem to perform similarly in the categorical model. In the continuous

model, the two-part model seems to predict better the EQ-5D-3L values compared to OLS and Tobit.

In support of Figure 25, Table 47 shows the mean values of the observed and predicted EQ-5D-3L scores, for different ranges of observed health state values for the continuous model. At high levels of observed EQ-5D-3L (greater than 0.8), the mean observed value exceeds the fitted one. The mean observed value is less than the fitted at any other level of observed EQ-5D-3L. Similar results are reported in the respective table for the categorical model (see Appendix 3, Table 52 for more details) with the only exception that the predicted mean is smaller for low levels of EQ-5D-3L compared to the one we obtain from the continuous model in the two-part model.

Finally, in Table 48 we report the mean forecast errors $\left[\frac{Actual\ EQ{-}5D{-}3L{-}Predicted\ EQ{-}5D{-}3L}{Mean(Actual\ EQ{-}5D{-}3L)}100\right]$ for both the categorical and continuous models. Mean forecast errors relative to the mean observed health state value were higher (in absolute values) when fitted to the categorical model but the magnitude varies depending on the type of regression used. The forecast errors were higher for the continuous model at each of the different levels of observed health state value except for the two-part model.

Figure 25: Actual versus predicted health state values



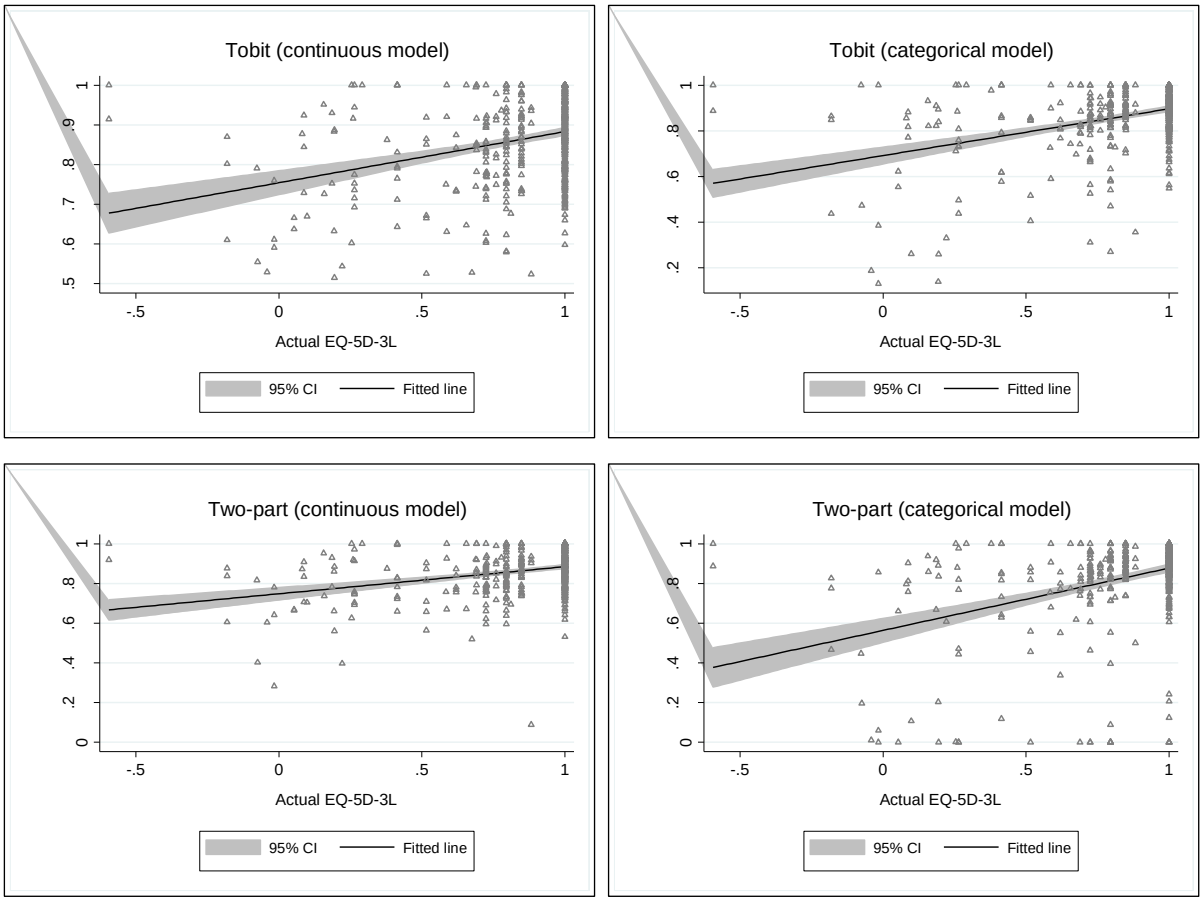


Table 47: Mean observed and fitted health state values within categories of observed health state values: continuous model

		Observed values		Fitted values					
				OLS		Tobit		Two-part	
	n	Mean	[95% CI]	Mean	[95% CI]	Mean	[95% CI]	Mean	[95% CI]
Observed health state category									
<0.70	28	0.33	[0.22-0.43]	0.81	[0.75-0.86]	0.81	[0.75-0.87]	0.81	[0.75-0.86]
0.70-<0.80	24	0.76	[0.75-0.78]	0.83	[0.78-0.88]	0.84	[0.79-0.89]	0.84	[0.79-0.88]

>0.80	151	0.98	[0.97-0.99]	0.88	[0.86-0.89]	0.88	[0.87-0.9]	0.88	[0.86-0.9]
All	203	0.86	[0.83-0.9]	0.86	[0.85-0.88]	0.87	[0.85-0.88]	0.87	[0.85-0.88]

Table 48: Mean relative forecast errors within categories of observed health state values for categorical and continuous models

Continuous model							
		OLS		Tobit		Two-part	
	N	Mean	[95% CI]	Mean	[95% CI]	Mean	[95% CI]
Observed health state category							
<0.70	28	-55.85%	[-66.47%,-45.24%]	-56.10%	[-66.65%,-45.55%]	-55.68%	[-66.68%,-44.69%]
0.70-<0.80	24	-8.36%	[-13.79%,-2.93%]	-8.59%	[-14.12%,-3.05%]	-8.6%	[-13.76%,-3.45%]
>0.80	151	11.77%	[9.88%,13.66%]	11.59%	[9.68%,13.49%]	11.58%	[9.5%,13.66%]
All	203	0.06%	[-3.77%,-3.89%]	-0.13%	[-3.97%,3.7%]	-0.08%	[-3.97%,3.8%]
Categorical model							
		OLS		Tobit		Two-part	
	N	Mean	[95% CI]	Mean	[95% CI]	Mean	[95% CI]

Observed health state category							
<0.70	28	-53.38%	[-66.17%,-40.59%]	-53.51%	[-66.3%,-40.73%]	-38.51%	[-66.68%,-44.69%]
0.70-<0.80	24	-8.25%	[-16.12%,-0.39%]	-8.51%	[-16.44%,-0.58%]	-3.75%	[-13.76%,-3.45%]
>0.80	151	10.60%	[8.64%,12.56%]	10.37%	[8.4%,12.35%]	13.38%	[9.5%,13.66%]
All	203	-0.45%	[-4.33%,3.42%]	-0.67%	[-4.54%,3.2%]	4.2%	[-3.97%,3.8%]

Discussion

210 participants were included in the cost and cost-effectiveness analyses. There are no statistically significant differences in age, gender or ethnicity between those who were included in these analyses and those lost to follow up. It is of note that those lost to follow up had had multiple appointments. Specifically those in the INCENTIVE practices had had on average around 8 appointments. Of those lost to follow up with details available of their appointment 72% of participants in the INCENTIVE practices and 60% in the TRADITIONAL practices had had one or more fillings. Reasons for not attending follow up were outlined in Chapter 4. As stated in Chapter 4, although we do not have a complete record of reasons for non-attendance, patients *not responding to contact from the dental practices* was the most frequently cited reason across INCENTIVE and TRADITIONAL practices. Within the INCENTIVE practices there were also a substantial number of patients who failed to attend pre-booked appointments. Given the multiple appointments that this group *did* attend prior to the 24 month follow up and the treatment carried out there are two likely explanations for non-response for follow up and/or non-attendance at pre-booked appointments. The first is that participants did not feel the recall was timely given their previous dental treatment. The second is that the problem they had visited the dental surgery

for had been rectified and, in the absence of any current dental problems, they did not wish to visit the dentist for a 'check-up' (this aligns with previous figures that suggest around a third of the population in the UK only go to the dentist when they have a problem[2]. In the absence of further details outlining the reasons for no follow up, the explanations we propose are speculative but have implications for research and practice. If the first scenario holds, the time over which treatment is delivered warrants further consideration in planning future research in dentistry that includes a follow up visit. If the second scenario or explanation holds then this has implications for how to encourage appropriate preventative dental visits.

Cost and cost effectiveness

The cost-effectiveness analyses were undertaken from two perspectives, the commissioner and the service (dental) provider. The analyses from each perspective uses two distinct outcomes – firstly use of OHIP-14 scores and secondly QALYs derived from the EQ-5D-3L. Within the analyses there were negligible between-group differences observed in QALY gains and no statistically significant difference in EQ-5D-3L score was found between groups or over time. Whilst the EQ-5D is the NICE recommended outcome of choice for economic evaluation[132], the apparent insensitivity of the EQ-5D-3L in oral health led to use of the OHIP-14[130]. The EQ-5D-3L has been reported to have adequate construct and convergent validity, but may not be as sensitive as specific measures of oral health-related quality of life[142-144].

With respect to the OHIP-14, although we found no statistically significant differences in the OHIP scores between groups, there were statistically significant differences (at 5% level) in these scores over time in both groups, suggesting an overall improvement in oral health related quality of life for both the INCENTIVE and TRADITIONAL groups. The magnitude of change in scores did not achieve the level that corresponds to a minimal important difference (MID). The MID is defined as "the smallest difference in scores in the domain of interest which patients perceive as beneficial and which would mandate, in the absence of troublesome side effects and excessive cost, a change in the patient's management"[145]. Locker and colleagues[121] suggest a 5 point difference in OHIP-14 score could be considered the MID. In this study the mean improvement in OHQoL over the 24 months was 3.39 in INCENTIVE and 1.74 in TRADITIONAL practices. However, it is important to note that the OHIP-14 is a secondary outcome; the study was powered on changes in BoP and thus changes in OHIP-14 scores should be treated with caution.

Given the negligible between group differences, in the EQ-5D-3L and the derived QALY at least, the cost of the two services was driving the cost-effectiveness ratios. The cost of the INCENTIVE practices from the commissioners' perspective is based on the contractual terms which specify a UDA value and payment for quality indicators (systems, processes, infrastructure oral health improvement). (In this analyses the UDA values assigned to the INCENTIVE practices included the payment for quality indicators.) TRADITIONAL practices are based on purely UDAs – no additional payment is made. The value of the UDA is based in part on the practice location, for example, whether it is in an area of need, and, for the TRADITIONAL practices, historical data relating to previous work carried out. (In the cases of the INCENTIVE practices, these were brand new practices when the contract terms were agreed and thus there was no historical data to take account of.) The INCENTIVE practices were located in areas where there was no, or limited provision of NHS dentistry with the aim of increased access to NHS dentistry, and this is likely to have been influential in negotiation of the UDA payment value which was higher in the INCENTIVE practices than the TRADITIONAL practices.

In fact within the study period for the 210 participants included in the economic analysis, the INCENTIVE practices showed, on average a higher number of UDAs claimed per patient than the TRADITIONAL practices (11.23 vs. 10.74); this was accompanied by an overall higher number of appointments per patient (8.89 vs. 6.63). The differences in the number of appointments might in part be explained by skill mix within the two different types of practice. The blended/incentive-driven contracts were designed to facilitate provision of dental care by the most appropriate team member - to encourage skill mix. It was intended that all the incentive-driven practices would fully utilise skill mix including for example, dental therapists and hygienists and extended duty dental nurses. There are indications in our data that more use was made of skill mix within the INCENTIVE practices with fewer appointments with the dentists and more appointments with the dental therapist in INCENTIVE practices. The dentists within the TRADITIONAL practices had a marginally higher number of appointments per patient and the mean duration of those appointments was over 40% higher (16.91 minutes in INCENTIVE vs. 24.44 minutes TRADITIONAL). Within the INCENTIVE practices, on average patients saw the therapist 2.28 times over the 24 months; in the TRADITIONAL practices on average patients saw the hygienist 1.5 times. The difference in use of different practitioners will inevitably be due to staff configuration

and thus the availability of, for example dental therapists and hygienists. For example, one TRADITIONAL practice did not employ any dental therapists or dental hygienists. However, the INCENTIVE practices were actively encouraged to increase skill mix as part of the bidding process for the dental contracts which might go some way to explain the more prevalent use of dental therapists and the fewer number of appointments with dentists in the INCENTIVE practices.

Mapping from the OHIP to the EQ-5D-3L

There are two areas worthy of particular discussion with regards to the mapping exercise. The first is the choice of the model for mapping from OHIP-14 to the EQ-5D-3L. The second is the strengths and weaknesses of this approach.

We presented results from OLS, Tobit and two-part models in order to account for the prevalence of full health state values in the sample - ceiling effect. Estimation results did not seem to differ, at least in terms of significance, but when looking at the plots of the fitted versus the observed health state values, the two-part model seems to be the best way to proceed; the regression line is closer to the observed outcomes especially when the OHIP is continuous (i.e. each subgroup of the 14 questions is a dummy variable). When OHIP is included as a categorical variable in the estimation, the results between the different techniques are more obscure.

The availability and inclusion of more personal characteristics such as ethnicity or marital status in the estimation analysis can potentially improve the estimation results. For example, it can be argued that black minorities face worse health than their white counterparts[146] or that having a partner can improve individual's health, especially for the older population where one can act as a carer for the other. In this study, marital status was not available and the response rate to the ethnicity question was low making it impossible to test for these arguments.

The mapping exercise shows that it is possible to perform economic evaluations when a general health state outcome is not available using mapping but the approach has severe limitations, especially for those patients reporting a low EQ-5D-3L score. This is because, consistently with other mapping studies[139,147], we fail to predict correctly low levels of EQ-

5D-3L, i.e. the mean of the predicted EQ-5D-3L is by far greater than the mean of the observed EQ-5D-3L. This however, may be related to the different time framework set for the two measures; OHIP-14 asks about problems with oral health in the *last six months* whereas EQ-5D-3L asks about health '*today'*. It may also be related to how well an oral health measure can predict a more general heath outcome such as EQ-5D-3L. It would be interesting to explore how much information from the OHIP-14 is 'transferred' to the EQ-5D-3L but this remains for future research.

Conclusion

Whilst the cost analysis from the commissioners' perspective has shown the INCENTIVE group to attract higher costs, overall OHQoL was higher for participants in the INCENTIVE practices than it was for those in the TRADITIONAL practices. This represents an estimated cost of £199.22 per one unit decrease (improvement) in OHIP-14 score for INCENTIVE practices. But this is caveated in as much as the improvement did not represent a MID. It is also important to note that the OHIP-14 is a secondary outcome; the study was powered on changes in BoP and thus changes in OHIP-14 scores should be treated with caution. In addition interpretation of the cost per QALY results should be treated with caution given the negligible differences in the QALYs. It should also be noted that the timeframe in which participants were followed was relatively short at 24 months. The blended/incentive-driven service model's aim of quality and oral health improvement and the move towards preventative dentistry requires behaviour change by both the dental provider and the patient; the long term impact of blended/incentive-driven contracts on OHQoL will likely provide better insight into the achievement of these aims.

There are indications that skill mix was utilised in the INCENTIVE practices to a greater extent than the TRADITIONAL practices. Whilst on average INCENTIVE patients saw practitioners more times over the study period, in the INCENTIVE practices the number and duration of appointments with dentists was lower as use was made of dental therapists. This would warrant further research to explore oral health improvement and potential cost savings from use of dental therapists, hygienists and extended duty dental nurses.

The acceptability of the blended/incentive-driven contract to dental providers is important. The analysis from the perspective of the provider, including the time spent in appointments with patients and the materials and lab costs indicated that despite the increased number of

appointments per patient, overall the new contract was estimated to provide greater financial returns than those observed in the TRADITIONAL practices. However, for the INCENTIVE practices in this study whilst the analysis included overheads (included in the practitioner time element of the analysis) the costs associated with setting up the new dental practices were not included and these are unlikely to be insubstantial.

CHAPTER 6: Discussion and conclusions

Introduction

Primary care dental services have been contracted by the NHS since its inception in 1948. Initially contracts were centrally determined and relatively undemanding in terms of performance monitoring[186] but since the 1990s contracts have evolved. The PDS pilots (1998-2006) encompassed a wide variety of configurations but concerns were expressed about how they met local needs for service provision, the absence of measures of success or appropriate goals for commissioning and missed opportunities to harness skill-mix[2,9]. In 2006 the current nGDS contracts were introduced with dental commissioning devolved to a local level. The nGDS contracts are activity based with weighted bands of dental activity. However, there are concerns amongst dental practitioners over whether the nGDS contracts have achieved their goal and there is scepticism whether there is sufficient time allocated for prevention[16] and if they restrict access to new patients and those requiring complex treatment[17]. More recently, as part of the Department of Health dental contract reform programme, a series of national NHS dental contract pilots opened in 2011 with the aim of exploring how focus can shift from treatment and repair to prevention and oral health by introducing of a new clinical pathway and new remuneration models[2]. The forthcoming prototypes represent the next stage in the evolution of the NHS Dental Contract reform programme[76]. This evolution is set in the context of substantial increase in demand for dental care and barriers to dental attendance which includes access, cost and dental anxiety[11].

The aim of this project was to evaluate a new model of dental service provision implemented in West Yorkshire in the North of England. The model uses a blended/incentive-driven approach to commission improved health outcomes through the incentivised delivery of evidence-based prevention care pathways, utilising a wider skill mix and increasing access to dentistry in response to identified local NHS dental needs. Our objectives were: (i) To explore stakeholder perspectives of the new service delivery model; (ii) To assess the effectiveness of the new service delivery model in reducing the risk of and amount of dental disease and enhancing oral health related quality of life in patients; and (iii) To assess cost-effectiveness of the new service delivery model in relation to oral health related quality of life.

There has been a substantial move towards the introduction of blended, incentivised contracts in NHS primary care dentistry subsequent to the Steele Report[2]; specifically the introduction of the national dental contract pilots and more recently the proposed prototypes. Whilst the contract evaluated in this project pre-dates the national NHS dental contract pilots, it reflects the ethos of the report on which the national pilots was based[2]; providing an opportunity to evaluate an innovation in healthcare delivery and complementing the pilots with greater granularity. It therefore offers substantial potential benefit for patients and the future commissioning and delivery of dental services throughout England.

Principal findings

Using a non-randomised study design we compared the effectiveness of treatment in the three newly commissioned blended/incentive-driven (INCENTIVE) dental practices with three matched existing (TRADITIONAL) practices working under the nGDS contract. Gingivitis was selected as the primary outcome because it affects over 90% of the population is readily measured in a clinical examination, summarises the participant's personal oral hygiene behaviour over the preceding days, is responsive to interventions (such as oral hygiene advice or using a new toothbrush) within two weeks, is a proxy for other self-care behaviours (such as the use of fluoride toothpaste) and is an interim outcome for periodontitis (which is a significant public health problem)[109-112] and changes are readily demonstrated over a period of two years. Secondary outcomes included assessment of caries, quality of life and cost effectiveness.

The results of the quantitative analysis were mixed. We found the results of the assessment of BoP favoured the blended/incentive driven model of service delivery although the results should be treated with caution given the high attrition and issues of data quality.

The health economics analyses showed the blended/incentive-driven contract was more costly for the commissioner. In respect of our secondary measures of QoL, overall OHQoL, assessed using the OHIP-14, was higher for participants in the blended/incentive driven practices than it was in practices under the TRADITIONAL UDA based contract but it did

not represent a minimal important clinical difference. It is also important to note that the OHIP-14 is a secondary outcome; the study was powered on changes in BoP and thus changes in OHIP-14 scores should be treated with caution. The differences within and between groups for the EQ-5D-3L were negligible. This latter result was not entirely unexpected. Whilst the EQ-5D is the NICE recommended outcome of choice for economic evaluation[133], the apparent insensitivity of the EQ-5D-3L in oral health led to use of the OHIP-14[132]. The EQ-5D-3L has been reported to have adequate construct and convergent validity, but may not be as sensitive as specific measures of oral health-related quality of life[143,145].

Use of the ICDAS was exploratory in the study. It has proved to be illuminating in as much as there are lessons to take forward. Whilst the majority of charts were completed to an acceptable standard a number of issues were evident which give cause for caution in interpretation of the results. For example, in some instances teeth with obvious caries or fillings at baseline were charted as sound at follow up, even allowing for errors in the transposition of adjacent teeth. Lack of confidence in the quality of the ICDAS data means that we have not explored the enamel transitions in the way that we had originally planned to.

As highlighted earlier, in addition to problems with data quality for the ICDAS, data quality for the BoP was also an issue with a substantial number of participants excluded from the analysis following quality assurance. Dentition charting has been highlighted as a problem within the national Dental Contract Pilots. In their early findings they found data on charting was incomplete or absent for many patients[30]. Their findings are interesting in as much as in our study charting was completed by the dental practitioners using a paper form. For the ICDAS in particular we had intended to use electronic completion which has built in automatic error checks. However, within the pilots was a requirement for practices to keep patient records in electronic form and they report “The evidence to date, however, suggests there have been inconsistencies in the quality of electronic data recording from practice to practice and within practices, from clinician to clinician.” It would seem that charting and dentist recording of data is a challenge whether paper based or electronic and despite the training given within the INCENTIVE study many of the issues the pilot sites experienced

appear to be replicated in our study including mis-interpretation and lack of understanding of what is required.

In relation to access to dental services, within our qualitative study we found there were perceptions that the blended/incentive-driven contract increased access to dental care, with the contract determining dentists' and patients' perceptions of need, their behaviours, evaluated and subjective health outcomes and patient satisfaction. These outcomes were then seen to feed back to shape people's predispositions to visit the dentist. However, an important, and unanticipated, finding of the study was the high 'fail to return' rate. A large proportion of people in the study who had access to a dentist did not follow up on oral care. These individuals were more likely to be younger males and have poorer oral health. Within this patient group whilst access to dental services was increased this did not appear to facilitate continued use of services. Although the reasons for non-attendance recorded by the dental practices was incomplete, of those recorded, the most frequently cited was no response to contact from the dental practices and, in the blended/incentive-driven practices, there was also a substantial number who failed to attend pre-booked appointments. Interestingly, those lost to follow up had had multiple appointments and treatment including fillings, crowns and bridges. One possible explanation for this may be that the problem they had visited the dental surgery for had been rectified and, in the absence of any current dental problems, they did not wish to visit the dentist for a 'check-up'. Indeed one patient talks about attitudes in the past which meant she only went to the dentist if there was a problem although she goes on to say that she thinks attitudes have changed now. A dental therapist talks about high levels of need and there being *a lot of neglected mouths. Some haven't seen a dentist in years. Some have lost their motivation because of this.* Another patient recalls not going to the dentist for about three years say *I don't know why I didn't go, I just stopped going and I think then you get thrown off the register.* This aligns with previous figures that suggest around a third of the population in the UK only go to the dentist when they have a problem[2].

In respect of those individuals who failed to attend pre-booked appointments this may, in part be attributed to dental anxiety, a recognised barrier to dental attendance[11]. One patient spoke about cancelling an appointment for a filling because she was *panicking and worrying.*

Another talked about her partner being *scared to death of the dentist* and how *trying to get him through the door of the dentist was a real effort*.

Another possible explanation for the unexpected high loss to follow up within our study – and indeed the difference between estimated and actual loss to follow up - is that all the patients in the study were new patients. This suggests that we had inadvertently selected a sample that were not regular dental attenders although this may still be representative as a third of the population fall into this classification[2]. The study sample size (including allowance for attrition) was powered on a previous study[124]. Within the study Clarkson and colleagues[124] outline their inclusion criteria; eligible patients were dentate adults who had already made an appointment for a routine check-up and had had probing of gingiva not contraindicated at the time of the appointment. This indicates that their sample included primarily regular dental practice attenders rather than new patients who may not have attended a dental appointment for some time. It also indicates, given that exclusion included probing of gingiva contraindicated, that their sample had better oral health than those included in our study.

Furthermore, groups of new patients might be likely to include a larger proportion of patients who were migrants. Most research on the dental attendance of migrants has been conducted in the US or Australia. This work consistently describes the barriers to access amongst migrants[148,149]. Brennan and Spencer[148] noted that service utilisation patterns were related to cultural factors within populations and it may be that groups who have little history of dental attendance do not adopt this behaviour immediately.

The low rate of reattendance for regular dental care (thereby implying a pattern of emergency care) provides support for the care pathway approach recommended in the Steele Report, which legitimises irregular dental attendance for those who choose it. High proportions of patients adopting this pattern will shape the practices in these areas. Such practices will be characterised by the provision of more emergency care and more of the time-consuming initial assessments. This burden might be considered in the commissioning of services in these areas.

Skill mix was of particular interest in our study given one of the aims of the blended/incentive-driven contract is to improve health outcomes through wider skill mix utilisation. In England there has been a steady shift in the make-up of the dental practice team with an expansion of numbers of, for example, dental therapists and dental hygienists[150]. Our analyses indicate that skill mix was utilised in the blended/incentive-driven practices to a greater extent than the practices under the traditional nGDS contract. Whilst on average INCENTIVE patients saw dental practitioners more times over the study period, in the INCENTIVE practices the number and duration of appointments with dentists was lower as use was made of dental therapists. The difference in use of different practitioners will inevitably be influenced by current staff configuration and thus the availability of, for example dental therapists and hygienists. However, the INCENTIVE practices were actively encouraged to increase skill mix as part of the bidding process for the dental contracts which might go some way to explain the more prevalent use of dental therapists and the fewer number of appointments with dentists in the INCENTIVE practices. (Collectively the INCENTIVE patients had, on average more appointments than patients in the TRADITIONAL practices.) In this regard the commissioning strategy was seen to be effective.

There are obstacles to overcome to realise any benefits of the greater deployment of skill mix. Dentists may need support in these areas and to recognise the differences between caring for individual patients and caring for segments of the population, such as that formed by the patient-base of a practice. In addition, one INCENTIVE practice experienced a higher turnover of its dentists than the other practices which was attributed in part to lack of opportunities to carry out complex treatments. This echoes evidence from elsewhere of tension between *acknowledging that less qualified practitioners can contribute directly to dental treatment and the unwelcome consequences of a modularised approach*[151].

Intuitively, the delegation of treatment to staff specialised in only a specific range of treatments could reduce costs and increase access to care[136]. The acceptability of the blended/incentive-driven contract to dental providers is clearly important, not least due to the financial implications. Primary care dentistry, unlike many other medical providers in the UK are operated as businesses[85] with NHS provision of dental services governed using quasi-

market principles[99]. It has been suggested that under the current nGDS contract remuneration structure there are financial barriers that *prevent the profitability and effective use of skill mix*[85]. Our analyses included assessment of costs from the perspective of the dental provider. This included the time spent in appointments with patients and the materials and lab costs. The analysis showed that despite the increased number of appointments per patient, overall the new contract was estimated to provide greater financial returns than those observed in the TRADITIONAL practices. However, for the INCENTIVE practices in this study whilst the analysis included overheads (included in the practitioner time element of the analysis) the costs associated with setting up the new dental practices were not included and are likely to be substantial.

The unit of analysis for the costs in this study was the practice, for the individual GDPs within the practices the financial implications are unclear given that one of the most important barriers is that referral by the dentist, to for example a dental therapist, prevent further earning potential for additional Band 1 treatments[85]. However within the qualitative study dental therapists were perceived to increase the availability of care and patient satisfaction. Practices had increased the utilisation of dental therapists by not reducing the payments to individual dentists who referred their patients to them. Whilst seemingly paying two staff members for the same treatments, this approach incentivised referral, so liberating dentists' time for patient OHAs and more remunerative complex treatments. This might be further explored and evaluated in the evaluations of the forthcoming contract prototypes[76].

The data hint at appreciable challenges related to a general refocussing of care and especially to perceptions about preventive dentistry and use of the risk assessments and care pathways. The quantitative data from the traffic light risk assessment (RAG) showed over 30% of the participants in our sample to be in the highest risk category (red) and less than 7% in the lowest category (green) at baseline. There was an improvement from baseline to follow up which suggests a degree of responsivity. Additionally, there were very few overrides of the traffic light risk assessment system (4.64% at baseline and 7.21% at follow up). Whilst it would be inappropriate to make direct comparisons with findings from the Dental Contract Pilots with regard to changes over time, the proportion of patients in each category at the initial OHA (6% in green and 26% in red for the national pilots and 7% and 30% in the

INCENTIVE study) indicate a similar distribution of patients[30]. One of the concerns *a priori* in our study was that for individuals with particular irreversible medical conditions it was not possible to move out of the amber category. Unfortunately due to the small number of pathways that had been overridden we are unable to ascertain whether this *a priori* concern was borne out. Explanations for overrides, especially moves away from red suggest other reasons. Only one patient score was overridden due to a family medical condition (diabetes). It is of note that those who were red at baseline were less likely to attend follow up.

The OHA traffic light assessment is key to the current national Dental Contract Pilots and integral to the INCENTIVE contract. Within our study practitioners were concerned that it was not sufficiently precise and, as illustrated above, rarely overrode the assessments, even though they could. In practice applications, dentists' assessments may be prone to allocation bias as treatments are apportioned according the ratings, and to measurement bias changes in status are used for contract monitoring. Further research is required to validate the RAG assessment, but in its primary guise for risk assessment, and also in this application as a tool for evaluation.

Strengths and limitations

Overall the evidence of the effectiveness of use of contracting and incentives in health providers is still emerging with further experimental research needed – specifically the impact on patient outcomes[27]. The study design reported here has enabled a direct comparison of practices offering incentive-driven preventative dentistry to those offering traditional solely activity-driven operating under the nGDS. This enhances early findings from the on-going national dental contract pilots introduced following the Steele Report which have focused on patient and practitioners views of the new clinical pathway, reporting them to be strongly supportive[30]. Within more recently reported findings focus has lain on adaptation to the new system but also report positive indications about clinical benefits in terms of a reduction of risk and health improvement (measured through the RAG and a basic periodontal examination). This study adds value to the current evidence base of blended/incentive-driven contracts. The study is the first to systematically evaluate the impact of a dental service provision on oral health outcomes by comparing those operating under the

traditional nGDS and those, driven in part by incentives that have been developed in partnership with the dental practices.

One of the challenges in undertaking the study was the pragmatic study design. Neither the practices nor the participants in the study were randomised. There will inevitably be a degree of bias given all the practices were self-selected. The three INCENTIVE practices had competitively tendered to operate practices under the new contract, and as such may be thought of as early adopters and may well be atypical of dental practices in England. Similarly whilst the TRADITIONAL practices were matched to the INCENTIVE practices they chose to take part in the study. One stumbling block when recruiting traditional practices was that all the study participants had to be new patients. For some practices this was not viable and as such those practices declined our invitation to take part in the study.

The study is also limited by the high loss to follow up. As highlighted, attrition was much higher than anticipated. Whilst we have been able to shed some light on reasons for this, it has meant that two of the three matched practices were unbalanced in terms of participant numbers (pairs 1-4 and 3-6). This leads us to question whether it is robust to pool the three pairings in single analyses. If we are not willing to pool them then the only pairing with balanced numbers for analyses is the 2-5 pairing. Although there is some re-assurance that the effect size for the primary outcome (BoP, pooled across practices) is similar to that included in the original power calculation (10.24% observed versus 10% in calculation) and achieves statistical significance ($p<0.01$) this cannot guarantee the study achieved power of 80% for the primary outcome (as originally specified in the study design). The original power calculation required numbers available for analysis of 500 split equally across INCENTIVE and traditional practices, whereas 188 were available for analysis (37.60% of those required to achieve power of 80% at a significance level of 5%). There was further some indication of differential drop out amongst males and younger patients. Post-hoc power analysis is best avoided[152]. Instead, consideration of sample is better based on confidence intervals. For the primary outcome (BoP pooled across practices) a 95% CI for the effect size was (3.23%, 17.25%) indicating a positive effect for INCENTIVE but with considerable uncertainty in magnitude. Together with reservations about the validity of pooling (due to heterogeneity of effects across practice pairs) and differential drop out results should be

treated with caution and followed up with further study.. However, this loss to follow up also exemplifies the challenges of running a dental practice in order to improve patients' oral health, and from this perspective the data have greater external validity than a highly controlled study with artificially high rates of re-attendance.

For the cost-effectiveness analysis there remains a tension between use of a preference-based utility measure as recommended by NICE[132] and use of a condition specific measure that is posited to be more sensitive to changes in oral health. The OHIP measure has been used extensively in cost-effectiveness analyses in oral health (see for example[130,131]) but is not preference based and therefore cannot be used to produce QALYs. At the present time there is no preference based measure specific to oral health. Within this study the OHIP-14 scores were mapped using regression techniques to the baseline EQ-5D-3L scores to explore the potential for estimating utility scores that can be used to produce QALYs based on responses to the OHIP-14. Unfortunately consistent with other mapping studies[140,147], we fail to predict correctly low levels of EQ-5D-3L, i.e. the mean of the predicted EQ-5D-3L is by far greater than the mean of the observed EQ-5D-3L. This however, may be related to the different time framework set for the two measures; OHIP-14 asks about problems with oral health in the last six months whereas EQ-5D-3L asks about health 'today'. It may also be related to how well an oral health measure can predict a more general heath outcome such as EQ-5D-3L.

It should also be noted that the timeframe in which participants were followed was relatively short at 24 months. Whilst we have confidence that changes to the primary outcome (BoP) can be readily demonstrated over a period of two years, the blended/incentive-driven service model's aim of quality and oral health improvement and the move towards preventative dentistry requires behaviour change by both the dental provider and the patient; the long term impact of blended/incentive-driven contracts on OHQoL will likely provide better insight into the achievement of these aims.

The selection of outcomes in evaluative research is difficult, and the rationale for our choice is presented in chapter 4. BoP was selected because it is responsive to change and readily measured. It can be changed by dental teams' behaviours including preventive advice and treatment but is also subject to changes in patients' behaviours and measurement error. It is

quite likely that the influence of patient behaviours and measurement error would be random and would attenuate the apparent relationships between the contract types and the patient outcome. The estimates of the treatment effect may therefore be underestimated in this study. It is possible that measurement bias may have favoured one or other contract type, but this seems unlikely. The contract type was associated with improvements in this clinical outcome. Few other studies have assessed clinical outcomes in relation to dental contracts. Never the less, the utility of BOP as a surrogate for other oral health outcomes warrants further investigation.

Caries and treatment increments (measured with ICDAS) were selected as a secondary outcome because changes in caries levels may be modest among adults at times of low caries incidence. Furthermore, there were no data on the responsiveness of ICDAS to on which to base power calculations. ICDAS may need more evaluation and greater utility before it can be used for this purpose.

The effects of the mouth on everyday life (as measured with OHIP-14) correlate only weakly with clinical status. OHIP-14 is therefore unlikely to be measurably affected by dental treatment or to reach a minimally important difference in a natural experiment where patients were arriving with different levels of impact and receiving different interventions. It was included as a secondary outcome to incorporate patient reported outcomes and for inclusion in the health economic analysis.

A further potential limitation in the economic evaluation is the use of national salary costs for the dental workforce rather than actual contractual agreements between the workforce and provider. Within any economic evaluation there is tension between making the evaluation specific to a particular setting and the generalizability of the results across settings. This is particularly pertinent to primary care dentistry where dental practices assume different commercial guises (e.g. social enterprises, independent providers and large corporate providers). Within these models there are a wide range of workforce contracts. For example, therapists may be salaried, on an activity based contract linked to UDAs or an hourly rate. The type of contract adopted varies within and across providers. In this case we took a pragmatic view. Whilst we included the *actual* commissioning contracts for the practices (i.e.

UDA values for each of the TRADITIONAL practices and the actual contracts for the INCENTIVE practices) we assumed national salary rates to increase generalizability.

Within our qualitative study we used the Andersen model of access. It provided a useful taxonomy for the data and allowed identification of the effects of the new contract. This fit is unsurprising as the model was developed over a forty year period and remains amongst the most widely cited models of access to health care[64,65,68,153]. However, whilst the model was broadly sustained in the data it might be enhanced by greater conceptual clarity, not regarding contextual and individual factors in sequence and by the incorporation of additional factors.

Public and Patient Involvement (PPI)

We were committed to PPI throughout the INCENTIVE research cycle and patient contributors worked as integral members of the research team from conception of the research idea to shape our research questions and aid delivery, project management and final data interpretation through to reporting. They ensured our research was of relevance to patients and the NHS and would contribute to shape and improve reform of the dental contract to maximise a service designed to address patient needs in terms of improved oral health outcome through a paradigm shift from restorative to preventative oral health care and access to NHS services. Details of how PPI input informed different parts of the study are detailed below.

Identification and/or prioritisation of the research questions and development of the research design

We worked closely with two PPI contributors, each bringing a unique perspective as current users of dental service but covering different age and societal groups - middle aged participants and parents (Susan) and young adults working/students (Alex) where we considered there may be differing expectations and use of dental services that would be of relevance to INCENTIVE. We also sought specific advice from a third PPI advisor (Rosie, 84 years of age) on an ad hoc basis; she did not attend the advisory group meetings.

The qualitative enquiry was informed from discussions with the PPI contributors and the sampling matrix was co-designed to include criteria linked to the objectives of the

programme including demographic factors (age, gender, ethnicity, socio-economic status). Access to dental service was seen as a priority by the PPI contributors and they were central in ensuring that we also collected data from non-patients to understand barriers to access to NHS dentistry. Rosie helped shape the inclusion of elderly patient groups, lobbying for a broad entry criteria and to ensure patients over 65 years were included in the cohort. Susan and Alex welcomed the idea that we were addressing the utilisation of the wider skill mix in our analysis of the contracts.

Our PPI contributors regularly attended the project advisory group meetings and had additional input on a needs basis, for example they made a significant contribution in the preparation and internal development and review of the ethics application to ensure it was understandable, yet not patronising to ensure informed consent was readily achievable and the study not too onerous for participants by carefully considering the volume of paperwork participants would need to complete.

Dissemination: The PPI contributors co-developed the participant information leaflets and are currently assisting in preparation of materials for the dissemination event /ensuring that the study material will improve participant understanding of the importance of INCENTIVE in redesigning the dental contracts as we move forward. Our PPI contributors have ensured our dissemination strategies are inclusive and accessible to research participants, patients and the public.

PPI Identification & training

Two INCENTIVE PPI advisors sit on the study advisory group and all were willing to be contacted by the researchers to contribute to individual work packages as required.

PPI Contributor Training and mentorship

The INCENTIVE PPI contributors were offered training and mentorship to increase their confidence in working in partnership. Similarly the INCENTIVE research team were also trained in how to work with PPI contributors as equal partners. We provided mentorship and personal support to PPI contributors before and after meetings, addressing queries, language and documentation. The PPI contributors were also provided with a 'jargon buster'. The researchers received training to facilitate inclusive project meetings with PPI representatives

by knowledge transfer from "Getting involved in shaping research and building partnerships' workshop".

Throughout we adhered to INVOLVE guidelines and reimbursed PPI members according to INVOLVE recommendations.

Conclusions

The policy context in which the INCENTIVE study was funded has remained remarkably constant in its aims for NHS dentistry over the course of the research. The Steele Report of 2010[2] examined how dental services in England could be developed advocating a commissioning approach to align dentistry with the rest of NHS services and to commission for health outcomes; to develop blended contracts rewarding not only activity but quality and oral health improvement. It recommended that payments explicitly recognise prevention and reward the contribution of the dental team to improvements to oral health, reflected in patient progression along the pathway, adherence to nationally agreed clinical guidelines and the achievement of expected outcomes[2]. Commissioners were asked to support dentists to make best and most cost effective use of the available dental workforce[2]. Despite pre-dating the Steele report the INCENTIVE contracts introduced in West Yorkshire proved themselves to be forerunners of these new blended contracts.

Since the Steele Report[2] we have seen the development of the national Dental Contract Pilots which sat alongside the INCENTIVE contract. Currently nationally dentistry is moving apace towards a more advanced stage which would test a prototype of a potential new system[76]. The aim of the prototype retains the same ethos as set out in the Steele Report[2] with focus lying on the shift of NHS dentistry towards prevention and oral health rather than treatment and repair through a new clinical pathway and new remuneration models. The prototypes have three elements; the use of comprehensive assessments in a pathway approach, remuneration for quality of care and remuneration to encourage continuing care and prevention as well as activity. They aim to test different balances of remuneration for the different elements and will form a stage in the evolution of the contract rather than preparing a large one-off change. With this in mind the findings of this study remain directly relevant to the further evolution of the NHS dental contract. Some of those findings relate to access to care, the use of gingivitis

as an outcome measure, the use of traffic lights in risk assessment, communication and contract monitoring.

Findings from the evaluation of the national dental pilots have been relatively positive although highlighting challenges in a number of areas including use of the OHA, data and feedback, and skill mix. Whilst the two evaluations (the evaluation of the national Dental Contract Pilots and the INCENTIVE study) differ in many respects, our conclusions below highlight where findings converge and learning for future commissioning of NHS dentistry. The final sections summarise the recommendations for future research and implications for practice

Access and inequalities

Access can be assessed using list size as a proxy (as in the national Dental Contract Pilot evaluation)[20]. The INCENTIVE practices were new practices and therefore were still establishing their patient base thus we were unable to assess increased access in this way. However, the siting of the INCENTIVE practices in areas of high need either associated with deprivation and disease or with the poor availability of NHS care meant that access to dental services increased within these communities. But many people who had access to a dentist in these practices, and the new patients included in the study in traditional activity based practices, did not continue with their oral care. These individuals were more likely to be young men and have poorer oral health.

The qualitative data suggested that this was in part a consequence of taking on many new patients who might not wish to receive continued care. Some patients may also have come from minority ethnic groups not used to attending the dentist regularly. Thus, whilst the new practices increased access, further work is required to understand how best to promote and encourage appropriate dental service attendance especially amongst those with high level of need to avoid increasing health inequalities.

OHA and Skill Mix

As described earlier in the chapter, use of a traffic light risk assessment in our study showed improvement from baseline to follow up which suggests a degree of responsivity. Whilst the RAG ratings were used in risk assessment, participants were concerned that it was not sufficiently precise and rarely overrode the assessments, even though they could. In practice dentists' assessments may be prone to allocation bias as treatments are apportioned according the ratings, and to measurement bias where changes in status are used for contract monitoring. The risk assessments were less frequently used as an aid to patient communication. Within the national pilots sites communication of the care pathway from practitioner to patient was also mixed[20]. Further research is required to validate the RAG assessment, in all these guises: risk assessment, communication aid, contract monitoring tool and also in this application as a tool for evaluation.

The evaluation of the national pilots also reports that the pathway model takes longer to operate per patient than the previous model. Within the INCENTIVE study although patients had a greater number of appointments in INCENTIVE practices, the duration of the appointment was on average shorter than the practices operating under the UDA based contract. The INCENTIVE practices were set up in areas of high need and poor access to dental services and therefore it is not surprising they had more appointments and a higher level of treatment, Although it is not possible to draw any firm conclusions from the figures, the qualitative data hint at appreciable challenges related to a general refocussing of care and especially to perceptions about preventive dentistry and use of the risk assessments and care pathways. There are also obstacles to overcome to realise any benefits of the greater deployment of skill mix. One potential solution would be for contractual drivers to change to be supplemented with educational efforts to support the refocussing of care, perceptions about preventive dentistry, internal practice business models on the use of skill mix, the role of evidence-based dentistry, working with care pathways, communication skills and the need for a greater understanding of the difference between caring for individual patients and a population.

Clinical effectiveness and clinical outcomes

The findings with respect to the clinical effectiveness of the blended/incentivised contracts are mixed. Whilst the results of the primary outcome of gingivitis (BoP) favour the blended/incentivised model, and there is some re-assurance that the effect size is similar to that included in the original power calculation, the results should be treated with caution given the reduced sample size and data quality issues (discussed in more detail in the following sub-section), and reservations about the validity of pooling data.

Few studies have assessed the clinical effectiveness of contracting in dentistry, for example the national pilots' evaluation looks at clinical response using the RAG status between assessment and review[20]. Should services consider an oral health related outcome measure of clinical effectiveness, despite the challenges, this study would support the use of bleeding on probing. Bleeding on probing is readily measured and responsive to change. It can be changed by dental teams' behaviours including preventive advice and treatment but is also subject to changes in patients' behaviours and to measurement error. Random changes in patient behaviours and measurement error would attenuate the apparent relationships between the contract types and bleeding on probing identified in this study. The estimates of the treatment effect may therefore be underestimated. It is possible that measurement bias may have favoured one or other contract type, but this seems unlikely. Few other studies have assessed clinical outcomes in relation to dental contracts. Never the less, the utility of bleeding on probing as a surrogate for other oral health outcomes warrants further investigation.

Data quality

The data quality issues with bleeding on probing were also seen within the ICDAS. In respect of caries assessment, which favoured the TRADITIONAL practices, whilst the majority of ICDAS charts were completed to an acceptable standard a number of issues were evident which give cause for caution in interpretation of the results.

Use of the ICDAS was exploratory and changes in the ICDAS scores may be the result of multiple factors such as attrition of study participants, diagnostic inaccuracies, poor completion, complexity of ICDAS, difficulty in diagnosing enamel caries in general dental practice, errors in syntax or the relatively short time frame of the study. Further work is indicated on both the utility and validity of recording dental caries and treatment experience with an indicator such as ICDAS as a contract outcome. The precision of this system (the number of categories and levels) mean that it is time-consuming to use and dental caries and treatment experience may not change sufficiently quickly for contract monitoring. Standardisation of the dental practice software could facilitate the use of this and other clinical outcomes.

Data quality and dentist data recording has been recently flagged as a challenge within the Dental Contract Pilots with the recommendation that there should be a strong driver in the contract for it to be collected accurately and appropriate training and support for practices. Evidence from the INCENTIVE study supports this.

Cost effectiveness

The economic analysis showed the INCENTIVE arm of the study to attract a higher cost for the dental commissioner but to be financially attractive for the dental provider at the practice level. Caveats also apply to these findings given the high attrition rate and further research is required to assess the financial impact of the contract, and particularly the impact of an increase of skill mix on the individual practitioner, in order to support the model.

Finally, within dentistry, the OHIP measure has been used extensively in cost-effectiveness analyses in oral health but cannot be used to produce QALYs. Within this study the OHIP-14 scores were mapped using regression techniques to the baseline EQ-5D-3L scores to explore the potential for estimating utility scores that can be used to produce QALYs based on responses to the OHIP-14. Unfortunately consistent with other mapping studies we fail to predict correctly low levels of EQ-5D-3L. This suggests that there is a need for the development of a condition specific utility measure for use in oral health for economic evaluation.

Recommendations for future research

Further research is required to:

- Understand how best to promote and encourage appropriate dental service attendance especially amongst those with high level of need to avoid increasing health inequalities
- Assess the financial impact of the contract and particularly the increase of skill mix on the individual practitioner in order to support the model
- Validate the RAG assessment as a risk assessment, communication aid, and contract monitoring tool and as a tool for evaluation
- Explore further the utility of bleeding on probing as a surrogate for other oral health outcomes
- Explore both the utility and validity of recording dental caries and treatment experience with an indicator such as ICDAS as a contract outcome.
- Develop a condition specific utility measure for use in oral health for economic evaluation.

Implications for practice

- The blended/incentive driven contracts were perceived to increase access to dental care, with the contract determining dentists' and patients' perceptions of need, their behaviours, evaluated and subjective health outcomes and patient satisfaction
- A large proportion of people in the study who had access to a dentist did not follow up on oral care. This supports the care pathway approach recommended in the Steele Report, which legitimises irregular dental attendance for those who choose it
- For dental practitioners, there are challenges within the blended/incentive driven contracts related to a general refocussing of care around preventative dentistry, risk assessment and a care pathway approach rather than the focus on treatment inherent in the UDA based contract
- There are obstacles to overcome to realise the benefits of the greater deployment of skill mix. Intuitively, the delegation of treatment to staff specialised in only a specific range of treatments could reduce costs and increase access to care but, as previous

research indicates, there may be financial barriers that prevent the profitability and effective use of skill mix

- Data quality and dentist data recording, particularly dentition charting was challenging. This supports the view that here should be a strong driver in the contract for it to be collected accurately and appropriate training and support for practices.

Appendix 1: Theoretical framework

Theme of new contract	Preliminary areas or enquiry and analysis
Quality	
Systems, processes and infrastructure	• Lay and professional involvement, whether & how process engages users in user forum • Experience and satisfaction with forum • Impact of quality indicators, including unanticipated impacts and the appropriateness of indicators
Health Improvement	• Perceived health outcomes • Appropriateness of indicators, including duration • Changes in risk category • Use of *Delivering Better Oral Health*. Recall of delivery and receipt and how it works in practice. • Effects on self-care • Views of health combine with perceived health outcomes?
Access	
	• Non-patient perspectives • Patient journey • Implications for including new patients (we should go down the inclusion agenda on access)
Activity	

	• Volume and relevance
	• Cost effectiveness
	  ▪ Do stakeholders feel they are getting value for money?
	  ▪ How are dentists using any released time?
	• Affordability
	• Appropriateness of indicators

Care pathways	
Needs assessment, categorisation, traffic lights	• Fitness for purpose • Pts and dentists' experience of risk-categorisation • Consequences of treatment locks • Changes of category • Effects on patient participation in care • Effects on treatment, prevention and self care
Skill mix	• Configuration of team • Volume and appropriateness of delegation • Job analysis, tasks & roles within the team • Legitimacy to patients • Perceived costs and benefits of the new system

Appendix 2: Topic guides

INCENTIVE: improving the organisation and delivery of dental health care to patients.

Qualitative Interview Topic Guide & Schedule for lay people	
Settling in	• Introduce yourself, have something light to say • Ask about them & things they are interested in (small talk). Who are they? • People often have a good story to tell about the dentist! – **Tell me about your experiences of the dentist/thoughts of the dentist** • How do they come to be taking part in project?
Predisposing Factors	Explore what their experience of going to the dentist has been in the past.

	• Had they, or anyone else they knew, been less or more inclined to go to the dentist?
	• What do they think about going to the dentist nowadays?
	• Things that stop/help you get dental care?
	• Explore issues such as costs and affordability.
	  ○ How do you feel about paying for dentistrty?
	  ○ Is having an NHS dentist importa nt?
	• Has the practice they are attending done anything to encourage

	awareness of oral health? • Time ?
Enabling Resources	Did they notice anything different about their practices? i.e. was it different to other practices or changes in these practices? Had anyone they knew taken part in advising their practice? - observations on user forum. Did it make a difference? What did they like? What would they do differently? Had there been any change in ease of getting appointments? Did they know people who had joined the practice or been refused? Had the practice any different ways of working? • Did feel of practices change in other ways? • Did practices do anything differently?

	Explore any changes regarding preventing problems – either by advising the patient i.e. exploring how to improve their oral health Skill-mix • Did they become aware of different team members being present? • How did it affect them? Did they like/dislike? • Right volume, blend? • Any advantages or disadvantages (more time, extra visits, a new face) Have there been any differences in cost? Cap off with open question about practice overall (eg quality – access, relevance, cost,

	effectiveness, efficiency, fairness)
Need	Some practices have started advising patients about their risk of developing problems and have changed their treatments because of this. • Have you noticed the dental team doing this? (within this you might explore if they are aware of the traffic light system, what do patients feel about this?) ○ Do you change your behavio ur? • How did (would) it make you feel? • Did it affect your treatment in anyway? Did you have different treatments or more or less appointments?

	• How did you feel about that? Did it make you act differently? • Did you do anything to try to get into a different category? • Do you think the dental team should do this type of thing? • Do you think the team focussed on the right things? • Did the team communicate these things well?
	• Have they changed the way they look after their mouths? • Oral hygiene, diet, tobacco use, going to the dentist? • Had they thought about these things? • Did the advice of the dental team prompt any of

Interview Topic Guide & Schedule for commissioners

Settling in	• Introduce yourself, have something light to say • Ask about them & things they are interested in (small talk). Who are they? • People often have a good story to tell about the dentist! • How do they come to be taking part in project?
Predisposing	How would they describe the people in the area served by the practice? Has the practice had any effect on those people? If so what and how? Had the practice done anything to change awareness of oral health?
Enabling	Has the practice has changed the way it is working? Had there been any lay involvement? Did it make a difference? What would they do differently? Had there been any changes in access to the practice? Increases/decreases? Hard measures? Other indicators? Types of people? What were the consequences of the new ways of working? Advantages/ disadvantages? Cost implications,

	efficiency, value for money How were they quality assuring the practice? Which quality indicators? Other complaints? Which of them worked? Other administrative /commissioning roles Skill-mix • Right volume, blend? • Any advantages or disadvantages (efficiency, cost, assessment) Had there been any differences in cost? Cap off with open question about practice overall (eg quality – access, relevan efficiency, fairness)	these changes? Was it related to RAG rating?
Need	Had there been any feedback on the RAG rating? Differences it made? Difficu Had the RAG rating influenced other outcomes from their perpective?	
Behaviours	Had there been any indication that the local people or patients were acting diff More or less attendance, more care seeking? Any other indicators	
Outcomes	Are they aware of any outcomes arising from care at the practice? -health, pat outputs, efficiency Unanticipated outcomes – positive and negative	
Oral Health Behaviours		

Interview Topic Guide & Schedule for Dental Teams	
Settling in	• Introduce yourself, have something light to say • Ask about them & things they are interested in (small talk). Who are they? • How did they come to be a dentist/nurse/ therapist etc • How do they come to be taking part in project?
Predisposing	How would they describe the people in the area served by the practice? Has the practice had any effect on those people? If so what and how? Had the practice done anything to change awareness of oral health? How successful had it been? Was it a good idea?
Enabling	Does the practice try to engage patients to influence the way the practice worked? How? How effective is this? Does it have the intended (or any unintended!)

	consequences? Is it satisfactory? How do the practice and the commissioners assure quality in the practice? Which indicators does it use? Do the indicators influence the way the practice works? (eg doing things they are paid for, not doing what not paid for, or in any other ways). Are the indicators appropriate? Does the practice have protocols for prevention? Who does this work? Does it work? Could the systems be improved? **How is payment working for you? Are you happy with this?** Is it easier for patients to get appointments nowadays? New patients or existing? Does the practice seem more patients? Are there different types of patients nowadays (follow up with non-attenders, high risk and demographic groups). How do patients get into the system? Has that changed? Has the type or amount of work done by the practice changed? If so, is it doing more or less appropriate work? Has the team been reconfigured? Is the configuration appropriate? What are the advantages and disadvantages of the configuration? How would they change it? Is the amount of delegation in the practice about right? Have there been benefits to patients or the practice in terms of efficiency or release of time. Have the patients commented? Do you think the service you are providing is better or worse value for money for patients and the NHS? How is it better than other models? Is it better?
Need	How do they assess patient need in the practice? Do they communicate this to the patients? Did they have a formal system for doing this? Do judgements about patients' health risk influence treatment? How do they feel discussing this with the patient? Do patients mind if they cannot have specific treatment because of their levels of risk? Have they changed a risk category for a patient – either immediately or after a period of time?
Behaviours	Does the way that the practice works help patients look after themselves? How? What things to do they try to influence?

	How effective is this? How do they assess all this?
Outcomes	How do they think of oral health? Do they think the way the practice works maximises health outcomes for patients? How do they assess this? Hard measures or other indicators? Are the measures they use appropriate? Do the measures they use tally with other indicators Are they aware of any outcomes arising from care at the practice? -health, patient satisfaction, complaints, outputs, efficiency Unanticipated outcomes – positive and negative

Appendix 3: Lost to follow-up and missing at random (MAR)

Figure 26: Distribution of missing EQ-5D-3L scores in the study

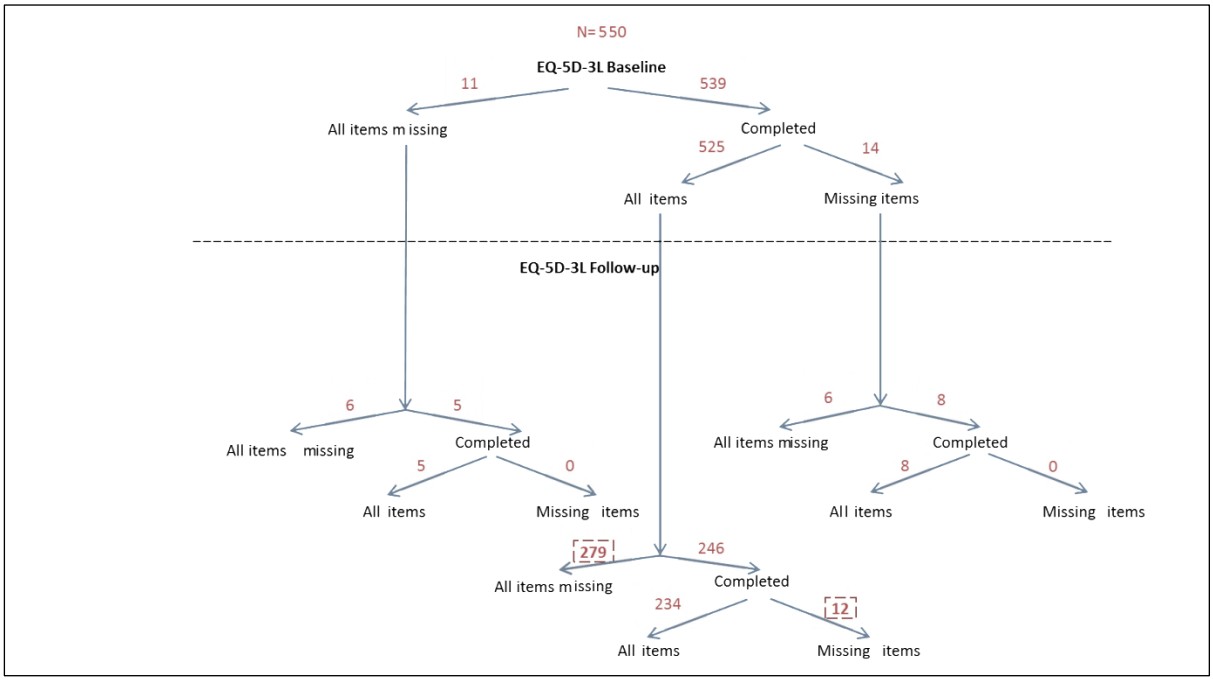


Table 49: Differences in total OHIP scores and EQ-5D-3L between complete and lost to follow-up cases

	Baseline (OHIP-14)		
	Complete (n=210)	Lost to follow-up (n=340)	Change
	Mean (SD)	Mean (SD)	Mean (p-value)
Traditional	9.12 (10.98)	12.30 (2.12)	-3.18 (0.033)
INCENTIVE	9.00 (10.30)	13.52 (12.45)	-4.52 (0.002)
	Baseline (EQ-5D-3L)		
	Complete (n=210)	Lost to follow-up (n=340)	Change
	Mean (SD)	Mean (SD)	Mean (p-value)
Traditional	0.896 (0.232)	0.835 (0.020)	0.061 (0.135)
INCENTIVE	0.880 (0.250)	0.828 (0.023)	0.052 (0.047)

In Figure A1 we can see the distribution of missing EQ-5D-3L scores in the sample over the study. More than half of the patients at follow-up had all or some of the EQ-5D-3L components missing (279 and 12 patients respectively). From the patients who did the follow-up, 16 (10) had all (some) EQ-5D-3L items missing and with regards to the missing OHIP items: 16 patients had all items missing and only 2 patients had some items missing. Adding to this, those patients who did not complete the study had worse OHQoL (i.e. higher total OHIP score) compared to the ones who did complete the study in either traditional or INCENTIVE practices (see Table A1). Differences in either OHIP-14 or EQ-5D-3L between those who did and those who did not complete the study are mostly significant at 5% level suggesting that many patients in this study only visited the practice when they had a problem and did not come back.

Complementary results mapping

Table 50: Regression results of health state values by OHIP-14: continuous model

Continuous model (n=281)			
	OLS	Tobit	Two-part
Variable			
Trouble pronouncing words	-0.028 (0.042)	-0.028 (0.040)	-0.014 (0.039)
Sense of taste worsened	-0.047 (0.039)	-0.048 (0.038)	-0.013 (0.032)
Painful aching in mouth	-0.077*** (0.032)	-0.079** (0.031)	-0.093*** (0.030)
Uncomfortable eating	-0.014 (0.030)	-0.015 (0.028)	-0.011 (0.026)
Felt self-conscious	-0.030 (0.030)	-0.033 (0.029)	-0.015 (0.028)
Felt tense	0.047 (0.035)	0.046 (0.034)	0.014 (0.031)

Diet unsatisfactory	-0.0003 (0.043)	0.001 (0.042)	-0.013 (0.041)
Interrupt meals	0.059 (0.044)	0.058 (0.043)	0.065 (0.040)
Difficulty relaxing	-0.029 (0.040)	-0.029 (0.039)	-0.037 (0.040)
Been embarrassed	-0.031 (0.040)	-0.029 (0.038)	-0.032 (0.034)
Irritable with other people	-0.004 (0.045)	-0.002 (0.043)	-0.008 (0.043)
Difficulty doing usual jobs	0.076 (0.058)	0.078 (0.056)	0.071 (0.056)
Life less satisfying	-0.079* (0.043)	-0.082* (0.042)	-0.060 (0.039)
Unable to function	-0.058 (0.053)	-0.058 (0.051)	-0.026 (0.049)
Sex (male)	0.007 (0.031)	0.011 (0.028)	0.017 (0.026)
Age (years)	-0.008* (0.005)	-0.008* (0.005)	0.006 (0.004)
Agesq (years)	0.0001 (0.00001)	0.0001 (0.0001)	0.0004 (0.0004)
Constant	1.1275*** (0.106)	1.181*** (0.100)	1.142*** (0.089)
F-stat [p-value]	3.07 [0.000]	3.31 [0.000]	3.13 [0.000]

Note: ***, ** and * denote 1, 5 and 10 percent level of significance respectively (robust clustered standard errors in parentheses). For the two-part model the F-stat reported is from the second stage.

Table 51: Regression results of health state values by OHIP-14: categorical model

Categorical model (n=281)			
	OLS	Tobit	Two-part
Variable			
Trouble pronouncing words			
Hardly ever	-0.054	-0.055	-0.027
	(0.044)	(0.040)	(0.039)
Occas., F/Often, V/Often	0.646***	0.678***	0.504**
	(0.223)	(0.225)	(0.217)
Sense of taste worsened			
Hardly ever	-0.051	-0.050	-0.031
	(0.036)	(0.034)	(0.033)
Occas., F/Often, V/Often	-0.211	-0.242	-0.027
	(0.199)	(0.207)	(0.207)
Painful aching in mouth			
Hardly ever	-0.027	-0.031	-0.043
	(0.032)	(0.290)	(0.028)
Occas., F/Often, V/Often	-0.407***	-0.405***	-0.414***
	(0.107)	(0.102)	(0.105)
Uncomfortable eating			
Hardly ever	-0.014	-0.015	-0.009
	(0.033)	(0.030)	(0.026)
Occas., F/Often, V/Often	0.065	0.058	0.034
	(0.081)	(0.075)	(0.075)
Felt self-conscious			
Hardly ever	-0.024	-0.025	-0.024
	(0.033)	(0.030)	(0.030)
Occas., F/Often, V/Often	-0.096	-0.100	-0.065
	(0.072)	(0.068)	(0.070)
Felt tense			

Hardly ever	0.031	0.028	0.012
	(0.107)	(0.031)	(0.030)
Occas., F/Often, V/Often	0.074	0.075	-0.023
	(0.045)	(0.101)	(0.087)
Diet unsatisfactory			
Hardly ever	-0.011	-0.010	-0.006
	(0.150)	(0.042)	(0.041)
Occas., F/Often, V/Often	0.127	0.152	-0.006
	(0.042)	(0.154)	(0.156)
Interrupt meals			
Hardly ever	0.088**	0.088**	0.077
	(0.157)	(0.040)	(0.040)
Occas., F/Often, V/Often	-0.064	-0.079	0.019
	(0.128)	(0.151)	(0.167)
Difficulty relaxing			
Hardly ever	-0.044	-0.045	-0.054
	(0.035)	(0.033)	(0.034)
Occas., F/Often, V/Often	0.087	0.085	0.074
	(0.180)	(0.170)	(0.193)
Been embarrassed			
Hardly ever	-0.039	-0.038	-0.023
	(0.044)	(0.040)	(0.039)
Occas., F/Often, V/Often	0.024	0.031	0.031
	(0.082)	(0.078)	(0.067)
Irritable with other people			
Hardly ever	-0.003	-0.003	0.007
	(0.047)	(0.044)	(0.046)
Occas., F/Often, V/Often	0.021	0.027	-0.062
	(0.122)	(0.116)	(0.119)
Difficulty doing usual jobs			

Hardly ever	0.074	0.075	0.091*
	(0.058)	(0.055)	(0.055)
Occas., F/Often, V/Often	-0.011	-0.015	-0.076
	(0.127)	(0.120)	(0.101)
Life less satisfying			
Hardly ever	-0.019	-0.020	-0.043
	(0.043)	(0.040)	(0.041)
Occas., F/Often, V/Often	-0.297***	-0.310***	-0.188*
	(0.101)	(0.098)	(0.098)
Unable to function			
Hardly ever	-0.031	-0.030	0.018
	(0.051)	(0.047)	(0.042)
Occas., F/Often, V/Often	-0.203	-0.207	-0.142
	(0.199)	(0.186)	(0.181)
Sex (male)	0.008	0.011	0.019
	(0.030)	(0.027)	(0.025)
Age (years)	-0.007	-0.007	-0.005
	(0.005)	(0.004)	(0.004)
Agesq (years)	0.00004	0.0001	0.0002
	(0.0001)	(0.0001)	(0.0004)
Constant	1.120***	1.128***	1.086***
	(0.104)	(0.095)	(0.089)
F-stat [p-value]	5.91 [0.000]	6.48 [0.000]	10.91 [0.000]

Note: ***, ** and * denote 1, 5 and 10 percent level of significance respectively (robust clustered standard errors in parentheses)

For the two-part model the F-stat reported is from the second stage.

Table 52: Mean observed and fitted health state values within categories of observed health state values: categorical model

		Observed values		Fitted values					
				OLS		Tobit		Two-part	
	n	Mean	[95% CI]	Mean	[95% CI]	Mean	[95% CI]	Mean	[95% CI]
Observed health state category									
<0.70	28	0.33	[0.22-0.43]	0.79	[0.7-0.87]	0.79	[0.7-0.88]	0.66	[0.53-0.79]
0.70-<0.80	24	0.76	[0.75-0.78]	0.83	[0.76-0.9]	0.83	[0.76-0.91]	0.79	[0.68-0.91]
>0.80	151	0.98	[0.97-0.99]	0.89	[0.87-0.9]	0.89	[0.88-0.91]	0.87	[0.84-0.89]
All	203	0.86	[0.83-0.9]	0.87	[0.85-0.89]	0.87	[0.85-0.89]	0.83	[0.8-0.86]

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Data sharing agreement

All available data can be obtained from the corresponding author.