Timings and skill mix in primary dental care: a pilot study

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Key points

- Suggests patterns of time taken to provide common dental procedures within the dental workforce which should be explored through further research.
- Highlights a range of factors influencing the time taken to deliver aspects of dental care.
- Raises issues such as the type of remuneration system, philosophy of care emphasising quality, system of care, practice environment, and patient complexity that need to be accounted for to help with understanding of timings and when considering human resource in primary dental care in England.

Abstract

Aim The aim of this pilot study was to explore the time taken to complete key contemporary dental procedures by dentists and dental hygienists/therapists (DH/DTs) working in primary dental care and their views on the factors that influence the length of time taken to complete individual dental procedures.

Materials and methods An exploratory mixed methods study of linear design, involving a questionnaire survey followed by focus group discussions exploring time required to complete dental procedures and influences, was conducted using a purposive sample of dental professionals working in primary dental care within the south east of England. Descriptive analysis of absolute timings was performed, together with thematic analysis of their reported influences.

Results Twenty-nine dental professionals completed the questionnaire survey, 11 of whom participated in subsequent focus group discussions to explore the initial findings. While dentists reported higher average times and a wider range for clinical examination and treatment planning, DH/DTs reported spending longer on prevention. Average timings for restorations and extractions were similar across both professional groups. Perceived influences on the length of time required to complete dental procedures were patient complexity, system of care, type of remuneration system and philosophy of care emphasising quality, together with practice environment, including the level of nursing support and surgery-location within the building; individual clinician factors relating to the type of dental professional, their interests and expertise were also identified. Whilst there was general agreement amongst respondents over the range of influencing factors, DH/DTs reported being particularly affected by the current type of remuneration system and level of support within practice.

Conclusions Within the limits of a pilot study, this research suggests patterns in timings of the delivery of primary dental care procedures and identifies multiple diverse influences. Further research at national level is required to develop a deeper understanding of the time taken to deliver primary dental care and the impact of various influences to confirm the findings and inform human resource considerations in addressing population oral health needs.

Introduction

It is recognised globally that an appropriate health workforce is required to provide an optimal level of access to healthcare for every citizen,[1,2,3,4,5] and facilitate achieving the United Nations Sustainable Development Goals for 2030.[6] Within England, the importance of having 'the right person with the right skills in the right place at the right time',[7] in order to provide effective, efficient and equitable access to care has been ackowledged.[8,9,10] This is particularly important as we consider our rapidly ageing population,[11,12] with changing oral health needs and demands.[13,14]

Workforce capacity relates to the type[10] and number of care professionals,[15,16,17] and hours of treatment available.[18] Research suggests that greater use of skill mix of the dental team, involving delegating and substituting simple and routine tasks to dental care professionals (DCPs) who include dental hygienists and dental therapists (DH/DTs), may be an efficient way to increase workforce capacity and access to care by allowing dentists more time to perform complex tasks.[19,20,21,22,23,24,25] Planners at global level,[5,21] and within the National Health Service (NHS) England support skill mix use.[26] This is advocated in response to changing patterns of disease,[14] evolving approaches to care,[27] and an increasing emphasis on preventive care.[14,28,29]

The working time of dental professionals is an important resource.[19,30] How dental professionals of various grades use available time has implications for skill mix use.[19] Information relating to the time taken to perform common dental procedures by dental professionals is required for the consideration of effective and efficient access to care provision.[19] Previous

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analysis of timings known as '1999 BDA Heathrow Timings Inquiry' provided information about absolute and related timings of key dental procedures.[30] Based on those findings, the authors designed an hourly-rate model for general dental practice which informed pay negotiations.[30] A more recent study was conducted to explore the timings of certain dental procedures performed by NHS dentists which were not included in the previous inquiry.[19] Both inquiries only considered views of NHS professionals.[19,30] Given changes in and concerns over appropriateness of the current contract system,[31,32,33] changing patterns of disease[13] and care,[27] emphasis on team working,[19] evidence-based dentistry[34,35,36] including preventive treatment items advised in *'Delivering better oral health toolkit'*,[28,29] and direct access to DH/DTs,[37] a more relevant inquiry is required. In addition, as around 15% of dentists work exclusively in private practice and most dentists (70%) work in mixed practices,[10] it is considered that practitioners from all systems of care should be involved in identifying influencing factors. There is little evidence on whether DH/DTs perform dental procedures at similar rates to dentists. Thus, DH/DTs working across all systems of care should be involved in a fresh timings inquiry to investigate the potential for skill mix use.

Over 85% of dentists nationally reported that the current dental contract system restricts time available for care.[38] Whilst, several reports and studies have suggested the potential for delegating clinical care to DH/DTs,[19,20,21,22,23,24,25] the current NHS dental contract system appears to act as a disincentive for using workforce skill mix by putting pressure on referral and appointment structures of dental professionals to maintain financial viability, possibly acting as a barrier for utilising DH/DTs.[32,33] As an influence on timings of dental procedures by various dental professionals this factor requires exploration. Factors arising from the diversity of settings and facilities used for primary dental care, as well as the variability within the wide compass of patients, may have an influence on timings. The literature suggests a number of further factors that may influence the length of time taken to deliver dental procedures, including patient anxiety,[39,40] complexity,[41] trust in dental teams,[42,43] emphasis on quality,[44,45,46] system of care,[47] and equipment available;[48,49] together with communication, management, leadership skills and experience of practitioners.[47] Information about the extent and effect of these factors on treatment timings is required to effectively investigate for informing about appropriate use of dental professionals across all settings.

Aim and objectives

The aim of the study was to explore the time taken by dentists and DH/DTs working in primary dental care to complete key contemporary dental procedures and their views on the factors which influence the length of time taken to complete individual dental procedures.

We had three objectives as follows:

1. To explore the time taken for contemporary dental procedures in primary dental care
2. To identify factors which dental professionals consider influence timings of dental procedures
3. To explore views on the above findings by type of dental professional.

Materials and methods

We conducted a mixed methods study involving an online questionnaire survey followed by focus group discussions. It represented a linear design,[50] in which the results of the questionnaire survey were used as a basis for further discussion in the focus groups. This study was a modified replication of the previous British Dental Association Timings inquiry,[30] and more recent research,[19] modified to include DH/DTs, private and mixed practitioners, and contemporary dental procedures, but excluding costs consideration. It was approved by the Biomedical Sciences, Dentistry, Medicine and Natural & Mathematical Sciences Research Ethics Subcommittee (REC Reference Number: LRU16/174012).

Study population

A purposive sample of dental professionals working in NHS, private or mixed practices and active in primary dental care were approached to participate in the study. Dental professionals comprised dentists and DCPs, the latter included dental hygienists and dental therapists who were combined into one category of DH/DTs to compare timings of dentists and these DCPs based on their professional roles. Individuals, aged 30 to 60 years of age were recruited as they are reported to be the most active and established members providing primary dental care.[16] We excluded individuals who had not practised for one year, were on maternity leave, or were registered as specialists. We sought a purposive sample of 40 participants based on previous work,[19,30] qualitatively representing current practitioners by the current number of dental professionals, type of practice, work characteristics, age, gender[16,17] and ethnicity.[51]

Data collection

Participants were identified through gatekeeper organisations, the 'British Dental Association (BDA)' and 'British Society of Dental Hygiene and Therapy (BSDHT)', and academic institutions in London that employ primary dental care practitioners as tutors. An invitation letter was sent to gatekeepers regarding the study and requesting them to circulate an invitation letter and information sheet among the members/staff. Those interested in participating in our study as independent individuals were invited to email the researcher (SG) to express their interest. Contacts with the participants were made in accordance with Dillman's protocol for conducting surveys in support of quality.[52]

An email containing a personal link to the short demographic questionnaire, including background questions related to age, gender, ethnicity and work-related questions, was sent to interested practitioners. After receiving responses, a final sample of dentists and DH/DTs was selected based on the inclusion-exclusion criteria and those participants were invited to complete the main questionnaire.

The survey instrument contained questions regarding treatment timings and influences based on the BDA Heathrow Timings Inquiry,[30] and more recent research,[19] contemporary evidence base,[28] key components of care in current NHS practice,[53] and influencing factors.[32,33,39,40,41,42,44,45,46,47,48,49] An email containing a personal link and PDF of the same was sent to participants using Qualtrics software (https://www.qualtrics.com/). Participants were requested to specify average, minimum, and maximum times in minutes a task would take to complete, based on their experience. A task was defined as one treatment item regardless of whether it was performed in one or more appointments. Participants were requested to assume that they carried out all the procedures themselves, and to calculate average timings by including the time required for the patient to enter the surgery, administration of local anaesthetic, performing the task, and patient departure from the surgery.[30] A further section of the questionnaire sought participants' opinions on influencing factors.

Data were pseudo-anonymised and linked by means of unique identifying numbers. Personal data for contact purposes were stored separately. Non-responders were followed-up twice with reminder emails, after two and three weeks. These contained a replacement link and copy of the questionnaire. Participants were informed that answering and returning a completed questionnaire implied consent.

The findings were tested during focus group discussions,[54] and the reasons for similarities and differences in the findings by type of dental care professional were explored, together with the views of participants about influencing factors.[32,33,39,40,41,42,44445446,47,48,49] Discussions were conducted separately for dentists and DH/DTs at mutually convenient locations. Invitations, including a topic guide and consent form, were sent by email to all participants who completed the questionnaire survey. Participants were informed that the discussion would be audio-recorded, and written consent was obtained prior to commencement of the discussions. Each focus group was scheduled to last for approximately one hour. An overview of the findings of the questionnaire survey and an outline structure for the discussion were provided at the start of the meeting. The lead supervisor (JEG) and the student researcher (SG) conducted the focus groups. The researcher transcribed the audio-recording for analysis. All data were anonymised and cleaned for analysis.

Analysis

Descriptive analysis of the timings of common dental procedures from the questionnaires (mean; mode; range) was performed separately for dentists and DH/DTs and compared. Thematic analyses of participants' responses to the open-ended questions were conducted by classifying responses into themes and sub-themes, forming a table of the results to use as a basis for the focus group discussions.

Focus group discussions provided an insight to reported timings and influences from the questionnaire survey. Thematic analysis of data collected through the focus group discussions used a framework approach,[54] for the data management process, whereby the literature informing the initial framework was tested and amended by reading and re-reading study data. The framework was then applied to the data which were organised by indexing and sorting to summarise into themes and sub-themes.

Table 1 Characteristics of the participants

Characteristic	Number of dentists	Percentage of dentists	Number of DH/DTs	Percentage of DH/DTs
Gender				
Male	10	66.7	0	0
Female	5	33.3	14	100
Age (in years)				
30–44	8	53.3	7	50.0–50.0
45–60	7	46.6	7	
Ethnicity				
White	5	33.3	12	85.7
Asian or Black British	8	53.3	1	7.1
Mixed	1	6.7	0	0
Other groups	1	6.7	1	7.1
Number of sessions per week				
≤10	13	86.7	12	85.7
11–20	2	13.3	2	14.3
Number of patients treated under NHS				
None	3	20	0	0
1–29	6	40	10	71.4
30–59	3	20	3	21.4
60–89	2	13.3	1	7.1
90–100	1	6.7	0	0
Number of patients treated privately				
None	4	26.7	1	7.1
1–29	7	46.6	10	71.4
30–59	4	26.7	2	14.3
60–89			1	7.1
90–100				
Total	**15**	**100**	**14**	**c**

Results

Respondents

The main questionnaire survey was conducted in June/July 2017. Out of 21 dentists interested in participating, 19 responded to the short introductory demographic questionnaire. After excluding two responses from specialists, we achieved fifteen responses (88.2%) from dentists to the main questionnaire. Twenty DH/DTs conveyed their interest to participate, 17 of whom responded to the short demographic questionnaire. We excluded one volunteer who was not actively practising clinically and achieved 14 DH/DTs' responses (87.5%) to the main survey. Our final sample therefore involved 29 participants (15 dentists; 14 DH/DTs) (72.5%) as shown in Table 1. Two thirds of dentists were male, and all DH/DTs were female. All categories of the purposive sample were covered except male DH/DTs. Three face-to-face focus group discussions were conducted, in which four dentists and seven DH/DTs participated.

Timings

The reported absolute timings from the questionnaire survey are presented in Table 2 and Table 3, by type of dental professional. Clear patterns emerged overall. The mean and upper range for clinical examination and treatment

Table 2 Absolute timings of key dental procedures performed by dentists and dental hygiene therapists

Clinical activity	Timings (in minutes) of dental procedures for dentists Mean	Timings (in minutes) of dental procedures for dentists Mode	Timings (in minutes) of dental procedures for dentists Range	Timings (in minutes) of dental procedures for DH/DTs Mean	Timings (in minutes) of dental procedures for DH/DTs Mode	Timings (in minutes) of dental procedures for DH/DTs Range
Clinical examination and treatment planning	16.4	10	2–60	8.0	10	4–30
Radiograph(s) one/multiple	4.4	2	1–15	6.4	5	2–20
Health advice: diet	5.0	2	0–20	5.6	3	2–20
Health advice: oral hygiene	5.0	5	0–20	6.8	2	1–60
Health advice and support: tobacco	2.1	1	0.5–10	4.1	2	1–20
Health advice and support: alcohol	2.3	2	0–10	3.5	2	1–20
Fluoride varnish application	6.4	5	0–20	3.0	5	1–10
Fissure sealant application	9.3	10	2–20	12.7	10	5–30
Scale and polish	15.4	10	2–60	25.9	15	5–60
Single surface amalgam filling	19.3	30	5–60	20.7	20	10–45
Two or more surface amalgam fillings	25.8	30	5–60	26.4	30	10–60
Resin restoration: one filling	26.6	30	10–60	27.8	30	15–45
Resin restoration2/ more	38.5	35	10–120	37.1	45	20–60
Extraction: primary teeth	21.1	20	5–80	21.2	20	10–30

planning were higher for dentists (16.4; 60) than DH/DTs (8.0; 30). This was explained by the scope of practice of dentists which included complex treatment planning. Whilst average timings for restorations and primary teeth extractions were similar for both groups, DH/DTs reported spending longer on delivering health advice (diet, oral hygiene, smoking and alcohol) and undertaking a scale-polish than dentists, in contrast to fluoride-varnish application at which they were reportedly faster.

Influencing factors

Figure 1 illustrates main themes of the qualitative findings relating to influencing factors such as patient complexity, philosophy of care emphasising quality, system of care, practice environment, personal skills or experience, and type of remuneration system. Table S1 (available in the online supplementary information) provides an overview of themes and sub-themes along with quotations identified by the type of respondent.

For the patient complexity factor, the main themes identified were type of patient, case complexity level and diversity of patients. Dental anxiety, oral health behaviour, cooperation, expectations, language, patient health awareness, and punctuality were important features.

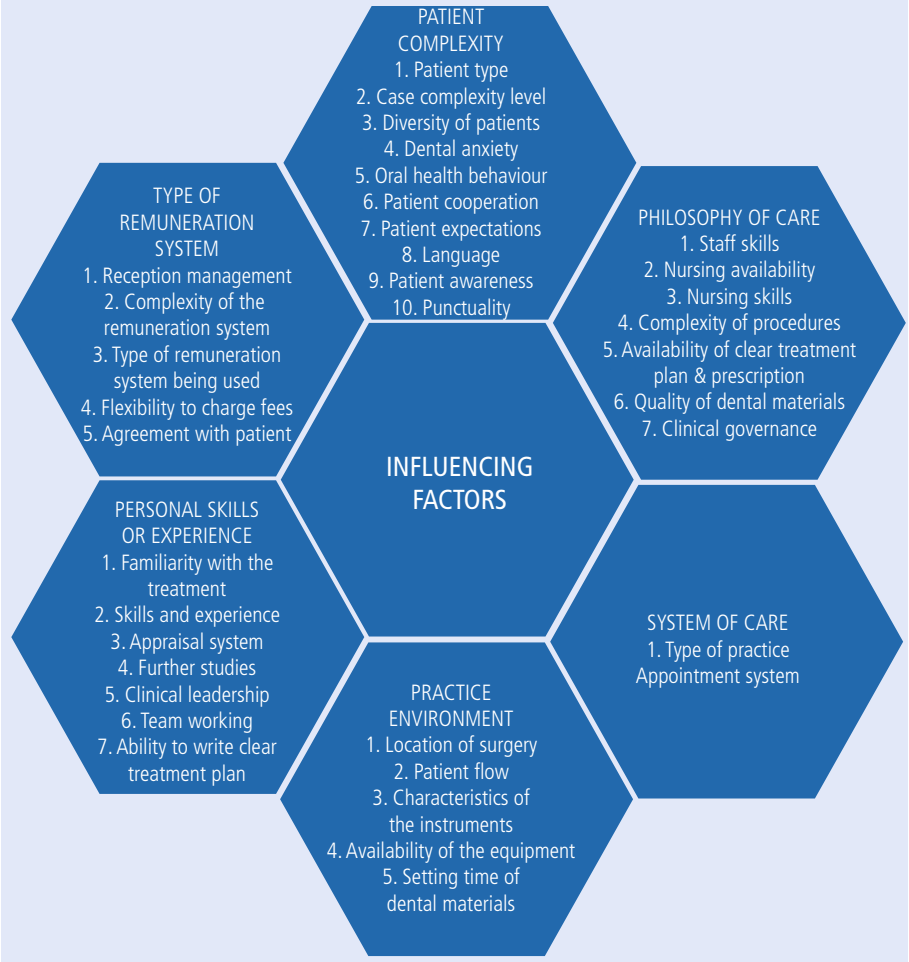
Table 3 Absolute timings of key dental procedures performed by dentists

Clinical activity	Timings (in minutes) of dental procedures for dentists Mean	Timings (in minutes) of dental procedures for dentists Mode	Timings (in minutes) of dental procedures for dentists Range
Single root canal treatment	57.5	60	25–120
Multiple root canal treatment	96.4	150	30–240
Metallic crown	60.8	60	10–150
Crown	77.5	60	25–150
Onlay treatment	65.0	40	25–150
Veneer applied	56.0	40	15–150
Extractions-Permanent teeth	23.9	20	5–80
Removable partial denture	78.9	90	20–200
Fixed partial denture	104.1	120	36–320
Complete lower denture- acrylic Complete upper denture- acrylic	120.8	120	30–300
Complete lower denture- metal Complete upper denture- metal	122.1	120	35–300
Prescription issued	10.1	5	5–30

'A well-behaved patient with clean mouth and who goes numb quickly and who sits still through the procedure is a boon!' (male dentist4)

'We have a therapist; she usually deals with children who are anxious and will take longer treatment time.' (Group3-female dentist3)

Fig. 1 Influencing factors and main themes



For the philosophy of care emphasising quality factor, themes such as staff skills, nursing availability, nurses' skills, complexity of procedures, availability of clear treatment plan and prescription, quality of dental materials and clinical governance received importance. The lack of a dental nurse was considered a particular challenge as outlined below:

'I do two jobs in absence of nursing support! It is very important that you have a nurse. Otherwise, you are exhausted and are no longer able to work at the end of the day!' (Group1-female DH/DT3).

Type of practice including private, NHS, mixed, and corporate practice, and nature of appointment system, were recognised as main themes under system of care.

'I work in mixed practice, there is difference in timings in my practice depending on whether it's private or NHS treatment.' (Group3-male dentist2).

'My clinical exams are fast because my appointments are fixed, and I haven't got much flexibility to expand my appointments.' (Group1-female DH/DT1).

'Current NHS system puts great pressure on dentist to complete the treatment in less amount of time regardless of the complexity of the procedure required.' (female dentist7).

Location of the surgery and sterilisation room, and patient flow were the main themes reported for the practice environment, over which DH/DTs had less control. All participants agreed that high quality instruments reduce the time required to complete dental procedures. Characteristics and availability of instruments and setting time of dental materials were also considered to be main themes for this factor.

'Takes more time to go the upstairs surgery, downstairs surgery is more convenient for older patients.' (male dentist5).

'Things go wrong, sometimes stops working! Not having correct equipment or not assembled increases the time and reduces the quality of the work.' (Group2-female DH/DT2).

For personal skills or experience, participants reported familiarity with the treatment, further studies, leadership, and team working skills as important themes.

'I am quicker than my young associates in diagnosis and my expertise in doing treatment is better!' (Group2-female DH/DT1).

'In NHS you can't afford to spend two appointments of an hour. But, my associate dentist, for example, does book two appointments for an hour for her NHS sector because they're learning.' (Group3 male dentist4).

Both dentists and DH/DTs recognised the type of remuneration system as a factor influencing time of treatment. Reception management, complexity of the remuneration system, type of remuneration system being used and flexibility to charge fees were identified as main themes.

'From my point of view as a principal, working in the NHS system for kids, which I do, it makes no financial sense to have a therapist spend half an hour doing restoration.' (Group3-male dentist1).

'I can book longer appointments for the complex patients as I have got flexibility to charge fees in private practice.' (Group3- female dentist3).

Confirming the questionnaire results of shorter timing for clinical examination, DH/DTs suggested that they undertake a confirmatory examination rather than a diagnostic examination, and they have fixed appointment systems irrespective of case-complexity. Dentists confirmed their longer examination timings which were explained by planning for complex patients and procedures.

'The clinical examination and treatment-planning time may differ by who sees the patient first.' (Group1-female DH/DT1).

DH/DTs confirmed the quantitative data suggesting higher average times to provide health advice about diet, oral hygiene, tobacco and alcohol. They considered that the reported timings were reasonable, emphasising a change from clinical to preventive ways of practice and the importance of providing individualised-advice.

'I can spend 45 minutes in giving oral hygiene advice, it's not a robust act and needs to be worked in an individual manner. Giving right advice in an individualised manner matters to me.' (Group1-female DH/DT4).

In relation to average times for preventive procedures, such as scale-polish and fissure sealants, being higher among DH/DTs, this was considered by both dentists and DH/DTs to relate to different patient needs, health awareness, the use of local anaesthetic, case-complexity, and other issues such as awareness about DH/DTs' role among population, availability of a clear prescription

from dentists, nursing support, regularity of practice, and use of skills.

'I always get old patients because they need more time and my time is cheaper!' (Group1-female DH/DT2).

'Awareness among the patients about DH/DTs' role is important. Explaining it increases time. When I was first qualified, no one knew about therapists. Awareness is increasing slowly.' (Group2-female DH/DT3).

In summary, the major factors identified through literature, tested in the questionnaire and interpreted through focus group discussions were broadly similar; however, our findings identified further themes and subthemes relating to *patient complexity* (type of patient, case complexity and diversity, patient health awareness, language, punctuality) and *system* (type of practice, appointment system, complexity of remuneration, reception management, flexibility to charge fees, regulations), *practice issues* (location of surgery, patient flow, instrument characteristics, nursing support, availability of clear treatment plan and prescription, and quality of dental materials), and *individual factors* (skills, experience, further studies, leadership and team working skills).

Discussion

This research provides insight into the range of possible influences on the absolute timings associated with dental treatments by dentists and DH/DTs and provides an approach which could inform future research. The results suggest the emergence of patterns when average timings are compared by dental profession and type of care. The longer time taken by dentists for clinical examination and treatment-planning as compared with DH/DTs suggests the important influence of case complexity,[41] and health policy regulations,[37,55] in investigating timings. As awareness about direct access to DH/DTs is low amongst the population,[37] and currently is not possible within NHS practices, patients generally approach dentists first. Consequently, dentists perform diagnostic examinations and assessments, whereas DH/DTs most often perform confirmatory examinations. Including more complex procedures in DH/DTs' day-to-day work through direct access, in line with their full scope of practice,[55] may therefore require more time for treatment planning; however, extensive examinations, such as those required by patients seeking dental implants will not be relevant for DH/DTs.

The findings suggest that DH/DTs in this study devote a longer time in delivering health advice than dentists. As prevention and oral health education are major parts of DH/DTs' training and scope of practice,[55] they are more involved in preventive rather than invasive care and are more passionate about it.[56] The findings also suggest that, these DH/DTs may care for a higher proportion of more vulnerable patients with multi-morbidities and those who require more health education than dentists. This is in line with results of the previous research,[56,57] which suggests that health advising with an individualistic approach may take longer.

In contrast there were similarities in timings reported for restorative and extraction procedures between dentists and DH/DTs. The results suggest that there is a range of issues influencing DH/DT timings including scope-of-practice,[37,55] social acceptability,[42,43] type of patients and practice,[56,57] appointment system, level of support within practices and funding mechanisms[33] which need to be explored in detail.

Comparing average timings of relevant dental procedures performed by this sample of dentists against the results of the previous inquiry[30] suggests an increase in reported average time taken for 'clinical examination', 'amalgam restoration', 'resin restoration' and 'multiple root canal treatment' amongst our research participants.[30] These differences may be in line with changing patterns of care,[27] and emphasis on evidence-based practice,[28,36,58] but equally could reflect the respondents who may not be representative of the profession. It has been observed nationally that the proportion of the patients having disability, learning disability or dementia is increasing.[41] The findings suggest that providing quality care[44,45,59] to an ageing population,[11] with changing oral health needs and demands,[13] and possible increased case complexity,[41] may lengthen the time required to complete appropriate treatment. This work highlights that patient complexity and diversity are perceived as significant influences on in understanding treatment timings.

Systems of remuneration were recognised as a major factor influencing time available for completion of items of service by dental professionals. Participants were clear that the current NHS contract and method of calculating of remuneration do not support task delegation.[32,33] Private systems retain the flexibility to charge fees as appropriate. Private practitioners can provide longer appointments which enable them to satisfy patients' needs in an appropriately caring and responsive manner. In contrast, the NHS contract takes no account of case complexity. The need to maintain a rigidly timed appointment system to maintain financial viability[25] may prove an increasing challenge as the population ages, retains more natural teeth, and includes more patients who require increasingly complex care. These factors should ideally be reflected in the structure and pricing of NHS dental care, where the most vulnerable groups in the society are more likely to seek care, informed by future research.

This study has several implications for future research, policy and practice. Overall, our results highlight that timings are influenced by multiple factors. Complexities in the current NHS primary dental care contract and remuneration structure, and variations in workforce and in patients suggest that, average timings cannot fairly represent commitment. There is a failure to recognise or give justice to variability of this issue or the financial implications. This needs to be confirmed in wider research and if valid, variability of case complexity within primary care dentistry requires recognition. These findings relating to patterns in timings and influencing factors, if observed nationally, are determining factors in understanding how dental professionals work and how they might be able work in teams to best deliver quality care within the limitations and obligations of health systems, recognising the cost of delivering care.[44,45,59] To provide the best possible future care there is value in exploring the role of DH/DTs, particularly relating to promoting oral health and disease prevention,[28,29] and in the division of labour within in the dental team.[19] Accordingly, a detailed national level inquiry of timings is recommended to study the similarities and differences in timings of common dental procedures based on type of dental professionals, patient, dental procedures and the system. Our pilot study suggests that expanding this research and seeking validation through triangulation from practice data, policy makers and providers will be better informed to plan and commission future dental care including task delegation[32,33] and therefore enable providers to manage appointment systems to accommodate patient case complexity and dental team skill mix.

Conclusions

Within the limits of a pilot study, this research suggests patterns in timings of the delivery of contemporary primary dental care and identifies multiple diverse influences. Whilst, there is general agreement amongst respondents over the range of factors that influence timings, DH/

DTs report being negatively affected by the current type of remuneration system and the level of support within practices. Given the range and complexity of the influences reported, further national level research is required to develop deeper understanding of the time taken to deliver primary dental care and the impact of various influences to confirm the findings and inform human resource considerations in addressing population oral health needs.

Acknowledgements and Author contributions

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Authors' contributions

SGG participated in study design, sought ethics approval, conducted the research, and prepared the manuscript. JWA and JEG contributed to the study design, supervised the research and provided very important inputs to the manuscript. All authors read and approved the final manuscript.

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