Evaluating the co-delivery of orthodontic treatment by dentists and orthodontic therapists

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Submitted in accordance with the requirements for the degree of Masters by Research.

The University of Leeds School of Dentistry

January 2024

i. Intellectual Property and Publication Statements

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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iii. Abstract

Introduction: The first orthodontic therapists (OTs) registered with the General Dental Council in 2007. There has been limited research around the role of OTs in the last five years, and the barriers and enablers to effective working practices between OTs and supervising clinicians (SCs) have not previously been investigated.

Aim: To establish how orthodontics is currently co-delivered by OTs and SCs, and to explore clinicians' perceptions of these working arrangements.

Objectives: To establish:

- The working arrangements of OTs with SCs.
- Clinician perceptions of their contribution to patient care.
- Clinician perceptions of the barriers and enablers to co-delivery of treatment by orthodontists and OTs.

Study design: Cross-sectional survey using an online questionnaire.

Method: A link to the online questionnaire was emailed to all members of the British Orthodontic Society and Orthodontic National Group and was posted in two Facebook groups. Reminder emails and Facebook posts were sent.

Results: A total of 161 responses were received from 89 SCs and 72 OTs. Most worked in primary care as their main clinical role. Most OTs in primary care provided a mix of NHS and private care. Appointments with OTs were most likely to be supervised every other visit, with more frequent supervision reported by SCs, and by clinicians in secondary care. A total of 63% of OTs reported being supervised remotely at times. OTs and SCs disagreed about the barriers and enablers to effective working practices: whilst OTs reported improved patient satisfaction as the main consequence of their utilisation in the orthodontic workforce, SCs described improved clinical efficiency.

Conclusion: OTs are generally working within their scope of practice, although some respondents indicated a desire for this to expand. Remote supervision has been reported for the first time. More research is needed to explore the working relationships between OTs and SCs.

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vi. Abbreviations

AC – Aesthetic component

BOS – British Orthodontic Society

CCST – Certificate of Completion of Specialty Training

DCP – Dental Care Professional

DH – Department of Health

DHC – Dental health component

GDC – General Dental Council

HEE – Health Education England

IOTN – Index of Orthodontic Treatment Need

IPR – Interproximal reduction

ISFE – Intercollegiate Specialty Fellowship Examination

NHS – National Health Service

NHSBSA – National Health Service Business Services Authority

ONG – Orthodontic National Group

OT – Orthodontic therapist

PIS – Participant information sheet

PAR – Peer Assessment Rating

UK – United Kingdom

US – United States

YOTC – Yorkshire Orthodontic Therapy Course

vii. Glossary

Orthodontist – a dentist who has completed specialist training and is registered with the GDC as a specialist orthodontist.

Supervising dentist – a dentist who supervises OTs, who has not undertaken specialist training and is not registered with the GDC as a specialist orthodontist.

Supervising clinicians (SCs) – a collective term to describe both orthodontists and supervising dentists.

1 Literature Review

1.1 How is orthodontics delivered in the UK?

1.1.1 What is orthodontics?

Dentistry is a field of medicine focused on diagnosing, preventing, and treating diseases of the dentition and oral cavity, and treating oral and facial injuries. Orthodontics is a specialty within dentistry concerned with the growth and development of the face, teeth and occlusion, including the assessment, diagnosis and treatment of malocclusions and facial irregularities (NHS England, 2015; Littlewood and Mitchell, 2019). A malocclusion is a variation of an 'ideal' occlusion which is aesthetically or functionally unsatisfactory, but by itself does not represent a pathological state (Cobourne and DiBiase, 2015).

Within the UK, orthodontics is provided within the National Health Service (NHS) and the private sector. There are several professional roles involved with the delivery of orthodontics, and all need to be registered with the General Dental Council (GDC) as the regulatory body for UK dentistry. These roles include orthodontic nurses, orthodontic therapists (OTs), orthodontic technicians, general dentists, specialist orthodontists and orthodontic consultants. These roles, and their permitted scope of practice, are made clear by the GDC (General Dental Council, 2013a). The overlapping roles between some registrants can make their distinction, at times, complex.

Orthodontic therapists (OTs) are permitted to carry out certain aspects of an orthodontic treatment plan, under the prescription and/or supervision of the supervising clinician (SC). They are not permitted to independently undertake irreversible procedures, diagnose or treatment plan (General Dental Council, 2013a). General dentists are involved in orthodontics in two main ways. Firstly, they act as the gatekeeper to refer patients on to orthodontic care when they identify problems with a patient's occlusion. Secondly, general dentists are permitted to complete orthodontic treatment provided they are competent in doing so. In the UK, NHS contractual arrangements from 2006 mean that general dentists undertake very little

orthodontic treatment within the NHS (Hodge and Parkin, 2015b). General dentists are not permitted to call themselves specialist orthodontists without being formally recognised as a specialist on the GDC register (Hodge and Parkin, 2015b).

Orthodontic specialists are recognised by the GDC through the award of the certificate of completion of specialty training (CCST) (NHS England, 2015). This usually follows a successful three-year period of full-time training in limited competitive training programme posts (Health Education England, 2021b). Training posts are based within the orthodontic departments of dental hospitals and district general hospitals, and, following CCST, orthodontists are permitted to perform the full range of orthodontic procedures as outlined by the Curriculum of Specialist Training (NHS England, 2015).

Consultant orthodontists undertake a further period of training following CCST (NHS England, 2015). Consultant orthodontists work within secondary or tertiary care, in district general hospitals or dental hospitals, often treating patients requiring more complex interdisciplinary care. Such patients may have a cleft lip and palate or facial deformity, potentially requiring surgery and orthodontics to manage.

1.1.2 Orthodontic provision in the UK

The vast majority of orthodontic services in the UK is carried out by specialist orthodontic practitioners in primary care (NHS England, 2015). Around 15% of orthodontic treatment is delivered in secondary care (NHS England, 2020b). Over the past 10 years, 2.3% of the total primary dental care budget was spent on delivering primary care orthodontic activity (NHS England, 2020b). An orthodontic needs assessment undertaken in Yorkshire and the Humber from 2017-2020 found that an estimated £19,889,838 (89% of orthodontic spend) is spent on primary care orthodontics provision, and a further £2,166,416 (11%) in secondary care hospital services (NHS England, 2020b).

The demand and uptake of orthodontic treatment is influenced by a number of variables, including the dental health needs of the patient, perceived needs, gender of

the patient, dental attendance patterns, as well as access to dentistry in general (O'Brien et al., 1996; Jawad et al., 2015). The most recent Child Dental Health Survey in 2013 found that 13% of 12 and 15 year old children in the UK were undergoing orthodontic treatment, but a further 28% had an unmet orthodontic treatment need (Health and Social Care Information Centre, 2015). The last three decades have also seen an increase in the provision of private orthodontic treatment, most often for adult patients seeking to improve their appearance or perceived social acceptance (Jawad et al., 2015; Fenton et al., 2022). This has been attributed to greater accessibility to orthodontic care, more disposable income, more aesthetic appliances, and increased advertising (Fenton et al., 2022).

Given the prevalence of malocclusion and demand for orthodontic treatment, indices have been developed to attempt to prioritise need for orthodontic treatment, especially within state-funded healthcare systems (Cobourne and DiBiase, 2015). In the UK, the normative need is assessed using the Index of Orthodontic Treatment Need (IOTN), developed by modifying an index used by the Swedish Dental Health Board (Brook and Shaw, 1989). The need for such an index in the UK was highlighted following the publication of the Schanshieff report in 1986, verifying concerns that patients were being treated at times unnecessarily and to a poor standard (Jawad et al., 2015).

The IOTN attempts to rank malocclusions according to the single worst occlusal trait and the perceived aesthetic detriment, to provide clinicians and patients with an idea as to how much patients are likely to benefit from orthodontics (Brook and Shaw, 1989). The index includes a Dental Health Component (DHC), which records a need for treatment from a dental or functional perspective on a scale of 1 to 5, and an Aesthetic Component (AC), which informs the need for treatment on socio-psychological grounds on a scale of 1 to 10 (Evans and Shaw, 1987; Brook and Shaw, 1989). In the UK, the cut off for NHS eligibility for orthodontic treatment for children and adolescents is an IOTN score of 3.6 (DHC.AC) or above (NHS England, 2015).

1.2 History of orthodontic therapists

1.2.1 When were orthodontic therapists introduced?

The first UK OTs qualified and registered with the GDC in 2007, following a significant period of campaigning by orthodontists (The British Orthodontic Society Archive and Museum Committee, 2011). Orthodontic "auxiliaries" had been in use for some time in both Europe and the United States (US) prior to the UK (Blau, 1973; O'Brien and Shaw, 1988; Moss, 1993; Pollard, 2000). Particular attention was drawn to the fact that, in UK medicine, many clinical duties are carried out by clinicians who are not doctors, something which had not yet carried over to orthodontics despite the shortage of orthodontists, high orthodontic workload, and geographically uneven distribution of specialists (Anderssohn et al., 1992; Pollard, 2000).

In the US, a 1973 survey supported the introduction of auxiliary dental personnel to delegate clinical responsibilities (Blau, 1973). However, the same survey identified some who opposed this, citing concerns such as a poorer quality of service, impacted patient-orthodontist relationships and low acceptance amongst patients and parents. A survey carried out fifteen years later showed a high level of delegation of orthodontic clinical duties in US practices to auxiliary staff (Gottlieb et al., 2001). This survey was repeated a further five times up to 2001, and showed that the level of delegation increased for the vast majority of clinical treatments (Gottlieb et al., 2001).

In Europe, following positive discussions in the UK around the introduction of orthodontic auxiliary staff (Anderssohn et al., 1992), Moss (1993) distributed a questionnaire to orthodontists in 26 European countries. At this time, 15 countries reported the use of orthodontic auxiliaries, with them performing a variety of clinical duties including:

- Impression taking
- Radiography
- Cement removal
- Scaling/polishing
- Arch wire placement

- Ligature placement
- Fitting bands and bonds

A survey of 22 European countries in 2000 investigated the delegation of orthodontic duties as well as the training of staff. It found that most countries did delegate tasks, with impression taking and radiography the most frequently delegated duties (Seeholzer et al., 2000). More recently, 22 European countries were represented in a survey of the utilisation of orthodontic auxiliaries across Europe, with the results showing a wide variety in training and scope of practice between countries (Barber et al., 2018).

In the UK, the use of orthodontic ancillary workers was first suggested in 1967, with a questionnaire distributed amongst the Consultant Orthodontists' Group to gather opinion about the principle of their introduction (The British Orthodontic Society Archive and Museum Committee, 2011). The positive response to this led to the chairman of the Group asking the GDC to consider auxiliary workers for consultant orthodontists working in secondary care. The British Society for the Study of Orthodontics Council formed a sub-committee which published "The Extended Role of Dental Ancillaries", which again was submitted to the GDC (Hodge, 2010). This report proposed three types of dental ancillary workers, including the dental hygienist, orthodontic auxiliary and the dental auxiliary (The British Orthodontic Society Archive and Museum Committee, 2011). No action was taken at this stage by the GDC.

It was not until 1999 that the GDC formally agreed to establish orthodontic "Professionals Complementary to Dentistry", and the term "Orthodontist Therapist" was agreed (Pollard, 2000). At the same time, it was determined at an early stage that the OT would work under the direct supervision of a qualified dentist who had previously examined the patient and formed a treatment plan (Pollard, 2000). However, there was evident impatience within the profession at the slow speed of progress for developing dental auxiliaries and OTs specifically (Stephens, 1996; Pollard, 2000).

It was also necessary to determine a training pathway for OTs. The 'Orthodontic Therapists Curriculum Working Group' was formed by the GDC in 2000 alongside the

BOC and Orthodontic National Group (ONG) (The British Orthodontic Society Archive and Museum Committee, 2011). The GDC published the orthodontic therapy curriculum in 2004, and after the Register for dental care professionals (DCP) was opened in 2006, the framework was formally finalised for OT training and registration in the UK (Hodge, 2010). Thus, the process to establish OTs in the UK took more than three decades. The GDC currently lists eight recognised national OT programmes, all providing the qualification of Diploma in Orthodontic Therapy (General Dental Council, 2019b).

1.2.2 What are the training pathways for orthodontic therapists?

In the late 1990s, two influential papers discussed the potential training model for orthodontic auxiliaries and formed the basis for the numerous OT training programmes in existence today (Stephens et al., 1998; Atack et al., 1999). This included a pilot orthodontic auxiliary training course, which sought assistance from the University of British Columbia in Vancouver, Canada, where a successful course had already been in existence for over ten years (Atack et al., 1999).

A four-week training programme with 17 elements was devised, developing basic dental skills and specific orthodontic skills (Atack et al., 1999). Following handouts sent out ahead of time, four weeks of formal teaching took place through lectures, multimedia presentations and practical demonstrations, with practical experience on typodonts, peers and patients. This pilot found that all eight trainees were able to carry out the taught skills safely and competently at a level similar to postgraduate orthodontic trainees. The Bristol pilot would go on to form the basis for the OT training programmes at Bristol and Leeds, where an initial four-week intensive course is followed by study days throughout the course whilst working within a primary care training practice (Bain et al., 2009). The first orthodontic therapy course commenced as a one-year course in 2007 at the Leeds Dental Institute, with successful students achieving a Diploma in Orthodontic Therapy from the Royal College of Surgeons (England) (Onabolu et al., 2018).

In order to train as an OT and undertake the Diploma in Orthodontic Therapy, applicants need to be registered with the GDC as an orthodontic nurse or DCP (Royal College of Surgeons of England, 2021). To complete the diploma, trainees are required to undertake one of the approved training programmes followed by a final assessment (Royal College of Surgeons of England, 2020). The necessary requirements of the training programme are (Royal College of Surgeons of England, 2020):

- That the course is approved by the Faculty of General Dental Practitioners (UK) and by the Faculty of Dental Surgery, following their recommended teaching and assessment format and in adherence with the GDC's curriculum for orthodontic therapy.
- That courses are the equivalent of at least 45 weeks' full-time training, providing evidence of completion and a verified logbook demonstrating competency with skills outlined in the curriculum.

1.2.3 What is the scope of practice of orthodontic therapists?

The GDC is the independent regulator of dentists and DCPs, including OTs, in the UK. It is responsible for holding a register of qualified professionals, assuring the quality of dental education, maintaining patient safety and upholding public confidence in the profession (General Dental Council, 2019a). Originally published in 2009 and updated in 2013, the GDC's "Scope of Practice" document describes the areas within which each dental registrant group are permitted and competent to practise in the best interests of patients (General Dental Council, 2013a). Registrant groups can also develop "additional skills" following initial registration. OTs are permitted to undertake reversible orthodontic procedures under the prescription of a dentist (Table 1).

There are certain treatments that the GDC does not permit OTs to perform as they fall under the competence of dental hygienists, dental therapists or dentists (General Dental Council, 2013a). This includes irreversible dental procedures, including interproximal reduction (IPR). OTs also do not complete laboratory work. Specific treatments not permitted are:

- Modifying prescribed arch wires
- Giving local analgesia
- Removing subgingival deposits
- Re-cementing crowns
- Placing temporary dressings
- Diagnosing disease
- Treatment planning

Table 1: The GDC scope of practice for orthodontic therapists.

Permitted to undertake if trained, competent and indemnified:	**Additional skills with further training:**
Clean and prepare tooth surfaces ready for orthodontic treatment.	Applying fluoride varnish to the prescription of a dentist.
Identify, select, use, and maintain appropriate instruments.	Repairing the acrylic component part of orthodontic appliances.
Insert passive removable orthodontic appliances.	Measuring and recording plaque indices.
Insert removable appliances activated or adjusted by a dentist.	Removing sutures after the wound has been checked by a dentist.
Remove fixed appliances, orthodontic adhesives, and cement.	
Identify, select, prepare, and place auxiliaries.	
Take impressions.	
Pour, cast, and trim study models.	
Make a patient's orthodontic appliance safe in the absence of a dentist.	
Fit orthodontic headgear.	
Fit orthodontic facebows which have been adjusted by a dentist.	
Take occlusal records including orthognathic facebow readings.	
Take intra- and extra-oral photographs.	
Place brackets and bands.	
Prepare, insert, adjust, and remove arch wires previously prescribed or, where necessary, activated by a dentist.	

Give advice on appliance care and oral health instruction.	
Fit tooth separators.	
Fit bonded retainers.	
Carry out Index of Orthodontic Treatment Need (IOTN) screening either under the direction of a dentist or direct to patients.	
Make appropriate referrals to other healthcare professionals.	
Keep full, accurate, and contemporaneous patient records.	
Give appropriate patient advice.	

A review of the current Scope of Practice document began in 2019, with initial research showing that dental professionals had a poor understanding of the scope of practice of other registrants (General Dental Council, 2023d). This was supported with stakeholder meetings and patient and public involvement. The formal consultation period of new draft Scope of Practice guidance took place between February and May 2023 (General Dental Council, 2023a; General Dental Council, 2023b). Up to the point of submission of this thesis, this revised document remained a draft, and the 2013 version of the Scope of Practice guidance was used during questionnaire development, data collection and analysis.

1.2.4 How are orthodontic therapists utilised in the dental workforce?

After the first training course began in 2007, and the first 16 OT registrants entered the orthodontic workforce in 2008, the number of OTs registered with the GDC increased to 364 by May 2014 (Hodge and Parkin, 2015b). By October 2023, this number had increased to 1015 (General Dental Council, 2023c). Therefore, their introduction has led to an increase in the orthodontic workforce in the UK, which by extension should increase access to specialist orthodontic care and reduce geographical inequality.

However, there is little evidence to support this inference in the literature (Hodge and Parkin, 2015b). Anecdotally, the introduction of OTs has maximised the skill mix within an orthodontic practice, with more time for orthodontists to focus on treatment planning and treating complex cases (Hodge et al., 2015). At the same time, OTs can

manage more straightforward cases under direct supervision or working to a prescription. This improvement in efficiency and skill mix has been enhanced further by using dental nurses trained with additional skills, such as clinical photography, impression-taking and radiography (General Dental Council, 2013a).

The Yorkshire Orthodontic Therapy Course (YOTC) was the first to begin training OTs in 2007 (Hodge, 2010). An audit of the trainers involved in this course over the first four years found that, once qualified, OTs would perform a range of permitted procedures within orthodontic practice (Hodge et al., 2015). OTs would generally work as an employee within hospital settings, but 20% were self-employed in primary care specialist practice. Again anecdotally, the cap on expenditure within a state-funded healthcare system has led to a reduction in the number of general dentists working within primary and secondary orthodontic care following the introduction of OTs (Hodge et al., 2015). Furthermore, 50% of primary care practices participating in the YOTC audit had not taken on any new specialist orthodontists, with a smaller number of practices reducing orthodontist hours in favour of OTs.

The same audit of the trainers of the YOTC found that most orthodontists would supervise one to two OTs at any one time, with only two orthodontists confirming they would sometimes supervise three or four (Hodge et al., 2015). Since their introduction in the UK, there has been discussion about what constitutes an appropriate level of supervision of OTs when working to a dentist's prescription (Hodge and Parkin, 2015b). This can be summarised by asking the following question: "after the dentist has seen a patient, formed an orthodontic plan and delegated treatment to an OT, how long should it be before a new re-assessment and dentist prescription is necessary?" (Day and Hodge, 2011).

Some have felt that a new re-assessment at every patient visit would be necessary due to the nature of orthodontic treatment, where specific clinical decisions are necessary at each visit depending on how teeth are responding to the forces applied to them (Hodge and Parkin, 2015b). On the other hand, it is obvious that there are certain aspects of orthodontic care, such as taking photographs and fitting retainers, that can be safely and competently performed by an OT without the direct supervision of a

dentist (General Dental Council, 2013a). Initially, it was left for the dentist and OT to determine when they felt a new treatment planning decision was necessary, making it difficult to know if an OT could work independently if a dentist was not in the practice at the same time.

The British Orthodontic Society (BOS) published its first position statement on OT supervision in 2011, stating that best practice would be for the SC to be present within the practice at each patient visit (Day and Hodge, 2011). This was clarified further in a guidance document with the Orthodontic National Group (ONG), a representative group for nurses and OTs. The most recent update to these guidelines was published in 2017 (British Orthodontic Society and Orthodontic National Group, 2017). As well as stating that the SC and OT should always work within their competencies, putting the patients' best interests first, they also make clear that the SC should see the patient at least every other visit. If the dentist is not going to be present, a comprehensive written prescription should be left for the OT and any deviation from these guidelines should be justified and documented. Furthermore, it draws attention to sections from the GDC's 'Standards for the Dental Team', including that a clinician can delegate responsibility but not accountability for a task (General Dental Council, 2013b).

1.3 Challenges of delivering NHS orthodontics

1.3.1 Orthodontic inequalities

The most recent Child Dental Health Survey in 2013 found that 13% of 12- and 15-year-old children in the UK were undergoing orthodontic treatment, but a further 28% had an unmet orthodontic treatment need, indicating that demand exceeds supply (Health and Social Care Information Centre, 2015). This survey assessed children in England, Northern Ireland and Wales, and whilst finding slight geographical variations, there was no significant difference in unmet orthodontic need between the three countries when assessed using the DHC of the IOTN (Health and Social Care Information Centre, 2015).

This research also found a significantly higher rate of 15-year-olds with unmet orthodontic need who were eligible for free school meals (32%), compared to those not eligible for free school meals (17%). Although this difference was smaller for children aged 12, it suggests socioeconomic status may be associated with access to orthodontic treatment. This was supported by significantly higher levels of unmet orthodontic need in 15-year-olds with less frequent toothbrushing, and poorer patterns of dental attendance (Health and Social Care Information Centre, 2015). Children living in less affluent areas are less likely to receive orthodontic treatment, and are less likely to be referred for orthodontics in areas where access to dental care is reduced (Morris and Landes, 2006). Socially deprived 14-15-year-olds have been shown to have a greater perceived need from an aesthetic perspective, with the same study supporting the argument that socially deprived children are less likely to receive orthodontic care (Mandall et al., 2000).

The 2013 Child Dental Health Survey offered several reasons why not all eligible children receive orthodontic treatment:

- Orthodontic treatment is not sought.
- Inability to access orthodontic care.
- Orthodontic treatment delayed for clinical reasons.

- Children and parents are unaware orthodontic treatment is a possibility.
- Child assessed as having too poor a level of oral health, usually due to poor plaque control or active caries.

In England, significant regional variations in the distribution of orthodontists have previously been reported (O'Brien et al., 1989). The same authors suggested that this was related to regional population density, the location of the clinician's undergraduate training, and the original home region of the clinician. In 1989, it was reported that a greater density of orthodontic specialists in primary care were based around London and the South East, with fewer specialists in the West Midlands, Yorkshire and Northern regions (O'Brien et al., 1989). A similar study from 1990 found most hospital orthodontic consultants worked in the South East and Yorkshire, with fewest consultants in East Anglia and Trent (O'Brien and Corkill, 1990).

When the previous fee-per-item contracts were replaced in 2006 and the Unit of Orthodontic Activity (UOA) was introduced, orthodontic contracts were offered to providers who were already providing orthodontic services prior to this (Richmond and Karki, 2012). Similarly, the size of contracts awarded was largely based on historic levels of orthodontic provision rather than being based on a needs assessment. Therefore, any inequalities in access to orthodontic care were maintained during this period of contract change. A review of the provision of orthodontic care in Wales found that the current orthodontic budget was sufficient to meet orthodontic need, but cost-effectiveness could be improved through improved commissioning of contracts and skill mix within the orthodontic workforce (Richmond and Karki, 2012).

This evidence points to the importance of identifying orthodontic inequalities through an appropriate orthodontic needs assessment. Ideally, this should assess normative, perceived, and expressed need. However, Cure (2019) has described the challenges in accurately making assessments and comparisons, including a lack of current local data to estimate need as well as differences in reporting of data between primary and secondary care. The same article suggested that as well as capturing normative need (IOTN), steps should be made to include data about perceived need, and electronic

referral management systems should be introduced to gather comparable data more accurately from primary and secondary orthodontic care (Cure, 2019).

1.3.2 Cost-effective orthodontic service provision

Since a significant proportion of orthodontic care is provided within the NHS, it is paramount that this is as cost-effective as possible to use public money most efficiently. Most recently, the end of many orthodontic contracts led to a re-procurement process through NHS England to find new providers for these contracts, as an opportunity to address orthodontic inequalities (NHS England, 2019). Orthodontic needs assessments were undertaken to ensure local needs were met (NHS England, 2019), and varying stakeholder engagement methods were undertaken, such as meetings and surveys of patients in treatment, local authorities, general dental practitioners (GDP), and orthodontists (NHS Arden and Greater East Midlands Commissioning Support Unit, 2019). Despite this, the re-commissioning process was plagued by issues, including reports of it being a 'race to the bottom', successful bidders handing back contracts due to a lack of facilities or staff, and abandonment on the part of NHS England part way through some procurement processes (Evans, 2019).

Although the re-commissioning of contracts within the NHS provides an opportunity to use a set budget more effectively, by itself it cannot address all aspects that improve the cost-effectiveness of orthodontic care. In order to determine the most cost-effective way of delivering orthodontic care, there are several questions that would first need to be answered:

- How are orthodontic services currently delivered?
- What are the costs associated with the different methods of delivery?
- What is 'effectiveness'? – this would include objective occlusal outcomes, as well as patient-reported outcomes measures.
- How does the cost-effectiveness of different orthodontic delivery models compare?

The questionnaire for clinicians that is discussed in this thesis represents the first part of this wider research, analysing how orthodontic services are currently delivered. A large element of possible improvements in cost-effectiveness lies within staffing and the skill mix in orthodontics. Salaries of orthodontists are higher than OTs, and it is possible that the most cost-effective way of providing treatment involves orthodontists supervising a certain number of OTs to deliver orthodontics as a shared care team. It has been reported that there is a financial temptation in primary care to work with an unbalanced ratio of orthodontists supervising OTs to maximise patient output (Hodge, 2010). In the United States, where orthodontic auxiliaries are more established, it has been suggested that orthodontists should not supervise more than four orthodontic auxiliaries at any one time, during which the orthodontist does not see their own patients (Hodge, 2010). In truth, the optimal supervision ratio from a cost-effective perspective is not known, and neither are the factors that are likely to cause it to vary depending on the specific working environment.

1.4 How has the use of orthodontic therapists been investigated previously?

1.4.1 The effect on the orthodontic workforce and access to orthodontic care

There is a limited body of mostly low-quality evidence that has examined how the introduction of OTs has affected the orthodontic workforce and the provision of orthodontics. There is anecdotal evidence that it has affected the employment of dentists and orthodontists (Hodge and Parkin, 2015b; Ainscough et al., 2018), but there has not been a wider assessment of workforce planning to determine the future requirements of orthodontists and OTs. If an increased number of OTs are seeing patients, with the SC usually supervising more than one OT, it is reasonable to assume that fewer orthodontists would be required to deliver the same output of orthodontic care. Similarly, where previously GDPs may have worked alongside orthodontists as clinical assistants, as the cost to employ an OT is significantly less than a dentist, an increasing number of OTs are likely to replace this role.

The introduction of OTs has meant that orthodontists are able to delegate a greater number of clinical tasks, allowing a more efficient use of time for all members of the clinical team. Several articles offer anecdotal evidence to support this argument. Three specific positive changes have been reported following the introduction of OTs: an increase in access to specialist care; facilitating the full scope of secondary care orthodontics; and improvements in primary care efficiencies (Ainscough et al., 2018). In 2005, 17% of orthodontic providers had no orthodontic qualification, and in six areas most treatment was provided by non-specialists (Robinson et al., 2005). Anecdotally, access to specialist-led orthodontic care has increased since the introduction of OTs (Hodge and Parkin, 2015a), as it has enabled commissioners to direct funding towards specialists as non-specialist orthodontic providers retired.

Regarding the provision of secondary care, some have argued that the introduction of OTs has allowed continuity of clinical care under the direction of a supervisor's clear prescription, increasing the output of clinical care, and also providing time for consultants to fulfil their other roles within research and teaching (Ainscough et al., 2018). The same authors provide a helpful personal example of how working alongside OTs can reportedly increase capacity by 250%:

- Two consultants have capacity for 6160 follow-up appointments per year, seeing 10 patients per session, over a seven-session week, working 44 weeks of the year.
- The same two consultants, working alone 50% of the time, and supervising three therapists 50% of the time, have capacity for 15500 follow-up appointments per year, where the OTs are seeing 10 patients per sessions, over a nine-session week, working 46 weeks in a year.

For the orthodontist, the use of OTs has reduced the amount of clinical time per clear aligner case by more than 4 hours, as OTs can manage around 75% of this type of treatment, through clinical tasks such as patient education, gathering of orthodontic records, clear aligner delivery and attachment placement (Ainscough et al., 2018).

1.4.2 Orthodontic outcomes

One of the main concerns following the inclusion of OTs in the orthodontic workforce was whether the quality of treatment outcomes would be affected. In 2016, a cross-sectional retrospective study examined this in more detail (Rooney et al., 2016). Data were collected from two specialist orthodontic practices in Yorkshire and compared outcomes from three specialist orthodontists from a time point before the introduction of OTs and at a second time point when OTs were routinely used by the orthodontists. The primary outcome is this case was the Peer Assessment Rating (PAR) index, with the secondary outcomes including overall treatment length (both time and number of appointments).

The PAR index was introduced to determine how far a patient's malocclusion deviates from ideal (Richmond et al., 1992). It was designed in 1987 by a working group of 10 experienced orthodontists, the British Orthodontic Standards Working Party (Richmond et al., 1992). A score is assigned to each occlusal component, with weightings attached, and these weighted scores are then combined, with a higher score representing a greater deviation from a normal occlusion. These weightings were devised at the time of the development of the PAR index, and there have been suggestions that some weightings, particularly for overjet, are too great, such that the change in PAR score is overly sensitive for any case with an increased overjet (Hamdan and Rock, 1999).

Currently, a mean PAR score improvement of greater than 70% represents a very high standard of treatment. Less than 50% shows an overall poor standard of treatment, and less than 30% suggests the patient's malocclusion has not been improved by orthodontic intervention. It has been suggested that 75% of completed cases should show an improvement in the PAR score post-treatment by at least 70%, with fewer than 3% of cases having a less than 30% reduction in PAR (McMullan et al., 2003). It is a statutory requirement of the new NHS orthodontic contract that all performers monitor treatment outcomes using PAR (NHS England, 2005). Each provider (contract holder) must assess 20 cases plus 10% of the remainder of their caseload every year

(NHS England, 2015). Furthermore, PAR is the primary method used for assessing treatment outcome in hospitals.

In the study comparing PAR scores from before and after the introduction of OTs, no statistically different results were found for both primary and secondary outcomes (Rooney et al., 2016). Furthermore, it was found that 56% of treatment was undertaken by OTs, marking a noticeable shift in working practice. However, it should be noted that this study represents the clinical and teamworking abilities of a small number of clinicians, with direct supervision of OTs at every patient visit. This reduces the generalisability of the findings.

Another study has examined the factors influencing orthodontic treatment outcomes in South East Wales from a service commissioning perspective (Quach et al., 2019). Records were requested from 26 orthodontic providers in the region for 20 consecutive cases in 2014-2015. Of these, 4 providers stated that they deliver care alongside an OT, sharing their workload from 5-100%. The study found no significant association between the use of OTs and PAR scores. However, the very low numbers of dentists using OTs and the high variation in amount of treatment completed by the OTs limits the strength of this study when concluding that including OTs would provide a more cost-effective commissioning model.

Whilst both studies provided encouraging data to support the utilisation of OTs, it should also be acknowledged that PAR is not the only outcome measure for orthodontic treatment and may not provide the full picture of orthodontic outcomes if used in isolation. In contrast, The NHS Business Services Authority (NHSBSA) have responsibility for clinical monitoring and reporting (NHSBSA, 2022). Trained and calibrated assessors evaluate five completed cases per performer using full records (including pre- and post-treatment study models, radiographs, photographs and FP17DCO form) and an Orthodontic Case Assessment form. A report is generated based on three categories:

- Clinical records
- Treatment need (using IOTN)
- Standard of treatment

Standard of treatment is not assessed in this case using the PAR index. Instead, NHSBSA use the British Orthodontic Society and Department of Health (BOS/DH) "Orthodontic Treatment Protocol" (Department of Health, 2005). Neither PAR nor the "Orthodontic Treatment Protocol" captures the experiences of patients during their treatment. Patient-reported outcome measures (PROMs) and patient-reported experience measures (PREMs) would more adequately assess this, but none have been used to date to assess the effect of the utilisation of OTs within the orthodontic workforce.

1.4.3 Working practices of orthodontic therapists

One study has assessed the working practices, experiences and career expectations of OTs in the UK (Onabolu et al., 2018). Questionnaires were sent to 417 OTs, with 200 responses received (48%). The questionnaire was an adaptation of the Gallagher Motivation Instrument, including open and closed ended questions around motivation, current working practices, job satisfaction, career aspirations and demographics.

Of the respondents, 94.4% were female with a mean age of 39. A total of 189 were actively working as OTs, with 73.2% working in a mixed NHS/private practice as their primary place of work. Of the remainder, 21.7% worked solely in the NHS and 3.5% only in private practice. The average number of hours worked was 32 per week, but 18.2% also had a secondary role, such as dental hygienist, dental therapist, or practice manager. In response to the questions about motivation, the most popular reasons given for pursuing a career within dentistry were a 'desire to work with people', 'job security', a 'desire to work in healthcare', 'academic knowledge' and 'scientific knowledge'.

Regarding treatments, respondents reported that most clinical procedures were carried out unsupervised, but under a written prescription from the supervising orthodontist (Onabolu et al., 2018). Over 70% of respondents stated that they would fit separators, place orthodontic brackets and bands, and take impressions without direct supervision if it had been prescribed. On the other hand, only 1.5% reported

that they would fit bonded retainers and adjust arch wires unsupervised and without a written prescription. Due to the anonymous responses to the questionnaire, the authors were not able to follow up respondents who reported working outside their scope of practice, but this has also been reported amongst dental therapists in separate research (Gibbons et al., 2000).

Using a 7-point Likert scale to determine levels of job satisfaction, 71.2% of respondents rated themselves as 'very satisfied' or 'extremely satisfied' (Onabolu et al., 2018). The main influences on satisfaction were 'your colleagues and fellow workers', 'amount of variety in job', 'physical working conditions', 'hours of work' and 'opportunity to use your abilities'. Interestingly, the two main influences on being dissatisfied were remuneration and a lack of recognition for good work. When making decisions about career, financial stability, work/life balance, gaining professional experience and working towards achieving career goals were the most influential reasons given.

Perhaps the largest piece of research into the working practices of OTs was published in two parts in 2018 by a team from Manchester (Ahmed et al., 2018; Dugdale et al., 2018). This examined the scope of practice and levels of supervision of OTs in the UK through cross-sectional surveys of both OTs (Ahmed et al., 2018) and orthodontists (Dugdale et al., 2018). For OTs, questions were finalised following a focus group with two orthodontic consultants and two registrars, before being piloted with 10 OTs (Ahmed et al., 2018). A postal questionnaire was deliberately chosen instead of an electronic format, citing higher response rates (Shih and Fan, 2009). The content validity of the questionnaire was shown to be good using the CH Lawshe method (Lawshe, 1975), and readability was determined as high using Flesch-Kincaid readability tests (Kincaid et al., 1975). The questionnaire had 16 questions, largely multiple choice, but with a free text 'comments' section at the end. Postal details were acquired from the ONG and GDC registers.

Amongst the OTs, a response rate of 74% was achieved (211/284), with 3% returning blank questionnaires indicating that they did not wish to participate (Ahmed et al., 2018). As found in the previous study (Onabolu et al., 2018), the results found that OTs

work an average of 33 hours per week with most working within the NHS and the private sector. Their results showed that an OT worked in primary care 85% of the time and 15% of the time in secondary care. Regarding the scope of practice, most OTs performed 16 of a possible 20 clinical procedures, with every respondent saying they took impressions, bonded brackets and changed arch wires. The least common treatments provided by OTs were fitting/removing headgear, lingual appliances, facebow recordings and insertion or removal of temporary anchorage devices (TADs). A small number of respondents (7.6%) reported that they would change a treatment plan if they felt it was appropriate to do so.

Regarding levels of supervision, the responses indicated that OTs usually perform clinical procedures 'unsupervised and from a written prescription' (58%), whereas 19% reported that they worked 'unsupervised without a written prescription', which was mostly when carrying out emergency procedures or giving oral hygiene and diet instructions (Ahmed et al., 2018). The remaining level of supervision was 'direct', mostly related to fitting or removing headgear. OTs commonly reported taking patient consent and being happy to do so.

OTs could report their frequency of supervision as being 'every visit', 'every other visit', '2-4 visits', or 'very rarely' (Ahmed et al., 2018). The modal frequency was '2-4 visits' (36%), closely followed by 'every other visit' (35%). Supervising at every visit was reported by 26%, with 3% responding that they were 'very rarely' supervised. OTs reported that their supervising orthodontists would usually see their own patients whilst supervising (91.5%). A high percentage of OTs (90.1%) felt that prescriptions were clear, and a less than half (40%) of prescriptions would include the date for review by the orthodontist.

The authors highlighted several flaws in the study, starting with the sample (Ahmed et al., 2018): not all OTs are members of ONG, so identifying the sample using this method introduced selection bias. However, at the time of the study, the authors stated there was no other method of obtaining details for all OTs. Recall bias is also a risk with any questionnaire, but they report that to investigate the scope of practice and levels of supervision using other methods, such as clinical observation, would carry

a much greater burden for the research team. The reproducibility of the questionnaire was also not assessed (Ahmed et al., 2018). Regarding the responses, the authors noted a central bias tendency in some of the questions and highlighted the possible difficulty in gaining honest responses about the potentially sensitive topic of supervision levels.

The questionnaire about OT scope of practice and supervision levels was also sent via post to orthodontists (Dugdale et al., 2018). Like the questionnaire sent to OTs, it was designed to fit on a single piece of A4 paper, to reduce the burden on participants. The 16 questions were devised following a literature review and a focus group including two orthodontic consultants and two specialty registrars, before being piloted with 20 orthodontic specialists working from primary and secondary care settings.

The sample of orthodontists was the entire register of specialist orthodontists (n=1252), having been identified via the GDC specialist list (Dugdale et al., 2018). The authors set a target response rate of 60-65% to limit financial outlay, in accordance with previous dental and orthodontic population sampling. Non-specialist dentists with a special interest in orthodontics were excluded as this sample could not be identified using the GDC register. The two separate mailshots were supported by reminder emails sent from the BOS.

A response rate of 59.7% of orthodontists was achieved (747 responses), with 56% of respondents working in primary care, 19% solely in secondary care, and 25% in mixed primary and secondary care (Dugdale et al., 2018). Around half (52%) of the participants reported that they worked with an OT, and this cohort of questionnaires were the focus of further analysis. Most OTs were employed (81%), with the average full time OT working 37 hours per week compared to 19 hours per week for part-time workers. A total of 57% only treated patients in the NHS, whereas 2% saw patients solely on a private basis. Around half of respondents reported that the OT would see the same patient from start to finish for each course of treatment.

Regarding the clinical output of orthodontic care, 75% of orthodontists responded that the introduction of OTs had led to an increase in clinical output, with 61% reporting that this had allowed more time for treatment planning (Dugdale et al., 2018). The

clinical autonomy of OTs was also questioned, with 66% of orthodontists responding that they would not wish for OTs to have greater clinical autonomy, compared to 30% replying that they would prefer greater autonomy for OTs. Responses regarding scope of practice were similar to the OT answers, with facebow records, placing and removing TADs, and fitting headgear less frequently delegated to OTs.

Again, the authors offered several limitations to the questionnaire sent to orthodontists (Dugdale et al., 2018). They reported that a risk of bias was introduced from both recall and non-response, having not reached their target response rate of 60-65%. They highlighted issues regarding a lack of clarity in questions, leading to a range of interpretations, such as answers to the same single best answer question not being mutually exclusive. The authors also felt that ‘supervision’ should have been better defined, conforming with the BOS viewpoint that the orthodontist is present without needing for the procedure to be directly observed.

1.5 Choice of methodology

1.5.1 What methods are available?

This research aimed to determine the current working practice of OTs in the UK, and the barriers and enablers to effective patient care between OTs and orthodontists. Data could have been gathered in several ways. Straightforward questions, such as "How do you divide your time between primary and secondary care?", could be asked through a questionnaire or interviews with clinicians. To understand the current working practice of OTs across the UK, a greater sample size will be more representative, and the participants would ideally be the entire UK population of OTs and orthodontists. A questionnaire is the obvious choice in this regard, given the unfeasibly high research burden if using an interview method.

There are several reasons why using interviews would be a more effective research method for more nuanced questions, such as "What do you feel works well with your working relationship with your supervising orthodontist?". During an interview, participants can more readily ask for clarification and allow for more elaboration (Harris and Brown, 2010), and further questioning can be used to generate richer qualitative responses. However, interviews also have disadvantages, including data that may be poorly generalisable due to either being specific only to the context of the interview (Lincoln, 2005), or due to smaller sample sizes (Bryman, 2016). Participants may also have a tendency to change their responses to appease others in the interview (Richman et al., 1999).

Other questions relating to the delivery of orthodontic care, such as "What is the average number of clinicians supervised by your supervising orthodontist?" could be answered in one of two ways. The first involves asking clinicians directly, whereas the second involves a researcher observing routine working practices and interactions in that specific clinical setting. Again, observing a large sample size can make the research extremely burdensome, making a questionnaire a more favourable research method (Ahmed et al., 2018).

However, there are several factors that can limit the quality of data collected. These include a poorly designed survey, inadequate sampling, poor response rates, misunderstanding of questions, ambiguity between answers, and inaccurate interpretation during data analysis (Oppenheim, 2000). Despite between able to reach a large number of potential participants, questionnaires generally have low response rates with the associated bias this introduces (Oppenheim, 2000). A more comprehensive approach to understanding this research topic would be to start with surveying a large sample, before undertaking more focused research within clinical settings to undertake clinician interviews and observe working relationships.

1.5.2 What makes a good survey?

There are several factors that need to be considered when designing a questionnaire. In order to interpret the results of a questionnaire, it is imperative that the development of the questionnaire is described in sufficient detail (Rattray and Jones, 2007). It must be clear at the outset what the questionnaire is trying to measure, such as behaviours, emotions, understanding or beliefs. Multiple factors need to be considered when designing questions, including wording, layout and response options (Rattray and Jones, 2007).

Care must be given to ensure items are worded and ordered appropriately as this may otherwise bias responses (Rattray and Jones, 2007). It is important to ensure questions avoid unnecessary abbreviation or technical terms, are not too long or ambiguous, and avoid asking questions that are too onerous or taxing (Oppenheim, 2000). The same author also draws attention to avoiding leading questions or loaded words, which may be particularly relevant when asking about the sensitive topic of OT supervision, given that reporting poor supervision would admit not following national guidelines (British Orthodontic Society and Orthodontic National Group, 2017).

Including free text responses can increase the likelihood of gaining more in-depth responses, but this comes with the disadvantage of more complex data synthesis and analysis (Polgar and Thomas, 2011). Once synthesised, data are more likely to be categorical in nature, limiting the number of more powerful statistical tests that can be performed (Polgar and Thomas, 2011). Finally, open-ended free text responses are

likely to be more burdensome for participants to complete than closed-ended multiple choice responses, perhaps increasing the risk of non-response. Despite this, the advantages of gaining a greater level of understanding about more exploratory questions often outweigh the risks of including free text responses.

The reliability and validity of questionnaires should be assessed during their development. Reliability encompasses the repeatability and internal consistency of the questionnaire (Jack and Clarke, 1998). For questionnaires that are broadly divided into sections, consistency between questions in each section can be tested using Cronbach's α statistic, whereas determining the test-retest reliability can demonstrate the stability of the questionnaire over time (Jack and Clarke, 1998). Validity refers to whether the questionnaire is measuring what it is intended to measure (Rattray and Jones, 2007). The content validity of questions can be improved following a literature review, engagement with stakeholders and experts before a thorough pilot (Bowling, 2014). The convergent validity can only be determined by comparing the new questionnaire with established measures to help prove its value (Rattray and Jones, 2007).

Consideration also needs to be given to using a postal or digital questionnaire, and the effect this has on response rates and non-response bias. A meta-analysis conducted in 2000 found that email surveys had around a 20% lower response rate than postal questionnaires, but found that rates were comparable in college populations more familiar with email and frequent internet use (Shih and Fan, 2009). Since then, widespread internet usage has made email and online questionnaires viable alternatives, when considering the internet-based advantages of shorter response times, reduced research cost (if using established survey software), and increased capability of rapidly reaching a wide sample (Shih and Fan, 2009). Web-based questionnaires further benefit from reducing 'don't know' answers by formatting required responses and improving data synthesis by minimising incorrect coding of data (van Gelder et al., 2010).

1.6 Aims

This research aimed to establish how orthodontics was co-delivered by OTs and supervising clinicians (SCs), and to explore clinicians' perceptions of these working arrangements.

This was determined by establishing:

- The working arrangements of OTs with SCs.
- Clinician perceptions of their contribution to patient care.
- Clinician perceptions of the barriers and enablers to co-delivery of treatment by orthodontists and OTs.

2 Materials and Methods

2.1 Study Design

Cross-sectional survey using an online questionnaire. Ethical approval was sought and approved by the University of Leeds Dental Research Ethics Committee on 1st March 2023 (Ref: 230123/JS/362, see appendix).

2.2 Population

All supervising clinicians (SCs) and OTs/trainee OTs working in the UK.

Eligibility criteria:

- Practising dentists (who supervise OTs), orthodontists and consultant orthodontists registered with the GDC.
- Practising OTs registered with the GDC, including qualified and trainee OTs.

2.3 Questionnaire

2.3.1 Summary of content

The questionnaire had a small introductory page informing participants why they were being asked to take part, and what the research aimed to determine. The questionnaire was divided into three sections.

1. Demographics, working structure:

The first section of the questionnaire asked about the current structure of the orthodontist/OT workforce. This included demographic questions and working arrangements.

2. Treatment delivery:

The second section asked questions around the day-to-day provision of treatment. This included questions about appointment times, supervision levels and any differences between the GDC's Scope of Practice and the actual procedures routinely completed by OTs (General Dental Council, 2013a).

3. Outcomes:

The final section asked questions about participant perceptions of the contribution of OTs to patient care, and whether they feel the skill set and competence of OTs is most efficiently used.

2.3.2 Development process and testing

The structure and content of the questionnaire was developed over several months (Figure 1). Initial development stemmed from the literature review and advice of the project supervisors. Once general ideas had been identified for the questionnaire, stakeholder input was sought through virtual meetings with OTs and orthodontists to further develop the questionnaire into its pilot form. Formal piloting then took place followed by any necessary modifications.

2.3.2.1 Stakeholder Meetings

Aim

The aim of the stakeholder meetings was to meet with members of the target population (orthodontists and OTs) to discuss the overall aims of the research and ideas to develop the questionnaire further. Compared to piloting, this was intended to offer broader advice about the research, as well as input about the questionnaire design itself. Advice was sought across a range of areas related to the development of the questionnaire, such as formatting and structure, type and wording of questions, and effective recruitment.

Method

The intention was to include clinicians from a range of clinical roles and perspectives as the questionnaire would be answered by orthodontists and dentists working across all clinical settings. These varied clinical backgrounds included working in the NHS and private sector, primary and secondary care, alongside a wide range of clinical experience. Importantly, the intention was to include participants in both the stakeholder meetings and pilot who had experience with orthodontic questionnaires in the past.

As some of the survey questions relate to appointment lengths and management of clinician diaries to enable effective supervision, consideration was given to including a dental practice manager in the stakeholder meetings. Their role is normally to arrange the day-to-day running of the practice, including rotas and staffing. However, after discussing this with other members of the target population, it was felt that this was not necessary over and above including orthodontists and OTs in the stakeholder meetings.

On 14th September 2022, the first stakeholder meeting took place with two orthodontists and on 22nd September 2022, four OTs were included in the second stakeholder meeting. Both meetings were virtual and lasted around 30 minutes. During the meetings, the questionnaire was shared in its draft form on OnlineSurveys, which was not altered between the meetings. The meetings were recorded with the consent of the participants to allow comprehensive notes to be made.

Feedback from orthodontists was intentionally sought separately to OTs after several discussions with both orthodontists and OTs whilst preparing for the meetings. It was felt that meeting as a larger group would cause members of either group, but particularly OTs, to be reluctant to discuss certain aspects of their working relationships, especially if they had any negative opinions.

Results

Of the four orthodontists invited, two were available for the stakeholder meetings, compared to four OTs. The professional backgrounds of the orthodontists and OTs who participated in the stakeholder meetings are summarised in Tables 5 and 6.

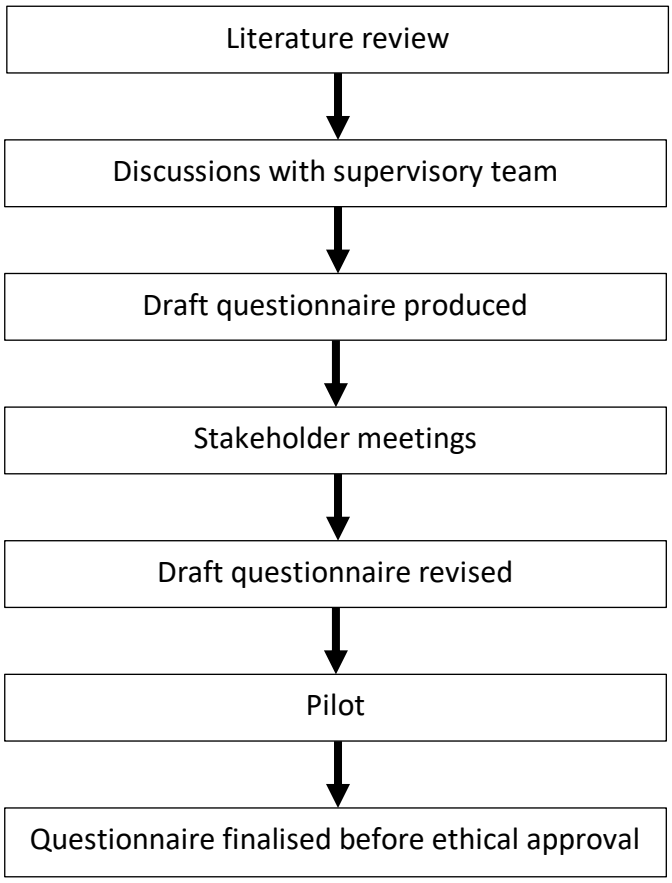


Figure 1: Flow diagram of the questionnaire development process.

Table 2: The professional backgrounds of the orthodontists who participated in the stakeholder meetings.

Orthodontist initials	**NHS or private**	**Primary or secondary care**	**Years since MOrth**	**Expertise**
CD	Both	Both	7	Author of questionnaire-based research into OTs in 2017.
RJ	Both	Primary	20+	Chair of the BOS Orthodontic Specialists Group Committee.

Table 3: The professional backgrounds of the OTs who participated in the stakeholder meetings.

OT initials	**NHS or private**	**Primary or secondary care**	**Years since Diploma in OT**	**Expertise**
SD	Both	Primary	10+	Chair of ONG whilst working in primary care.
JG	NHS	Secondary	10+	Experience of working in secondary care and OT training.
KK	NHS	Primary	10+	Experience of working in primary care.
TM	NHS	Secondary	8	Web and social media officer of ONG whilst working in secondary care.

The points raised by the stakeholders led to multiple changes to the questionnaire and recruitment. These can be summarised over six key areas:

1. Enrolment

    - Ideally aim for a 60% response rate, although subsequent discussion with supervisors underlined that this is a very high target.
    - The ONG mailing list would not capture the full list of OTs. The OT stakeholders recommended posting the survey to Facebook groups as well.

2. Structure

    - There should be a screening question for orthodontists who do not work with OTs.

3. 'Clinical role' question

    - CD found in her research that she could not filter out OTs working outside of their scope of practice as it was unclear if they were jointly qualified as a dental hygienist or dental therapist. This clarification should be identified in the 'About you' questions.

4. 'About you' section

    - It is essential to differentiate between 'working with' an orthodontist and 'being directly supervised by'.
    - All stakeholder OTs agreed with the suggestions of asking questions about OT salary and employment.

5. 'How is treatment delivered between clinicians' section

    - In the scope of practice question, ask if OTs complete attachment placement, aligner appointments, bonded retainers, teeth whitening, making changes to arch wires, and supra- and sub-gingival scaling.

6. 'How do you feel about your working relationship' section

- Possibly include the question to OTs, 'do you feel you should have greater autonomy?'.
- Reduce the burden of the amount of free text questions on this page.

All points were raised with the supervisory team and appropriate changes were made to the questionnaire before piloting. A small number of suggestions from the stakeholder meetings were not implemented, such as asking whether the introduction of OTs has changed opportunities for orthodontic specialty training, since it was not felt that this was directly related to the aims of this research.

A financial incentive of around £250 was initially considered for both groups to improve the response rate. This idea was positively received by the OTs in the stakeholder group, who also gave the suggestion of providing free tickets to the British Orthodontic Conference. Amongst orthodontists, it was unanimously agreed that a financial incentive would be very unlikely to increase participation, and this was not pursued further. Ultimately, a financial incentive was not offered to OTs either as it would compromise the anonymity of responses. Overall, it was considered that anonymity was a greater incentive to complete the survey than a financial reward.

2.3.2.2 Pilot

Aims

The purpose of the pilot was to test the questionnaire in its more final form, including across a range of devices and web browsers. It was expected that feedback and comments would be more detailed. Again, clinicians with a broad range of clinical experience were invited.

Method

There were two broad options to piloting to balance the time available to the research team whilst optimising the level of feedback:

1. To distribute the questionnaire electronically to a greater number of participants, before analysing pilot results on OnlineSurveys.

2. To observe a smaller number of participants completing the questionnaire in individual meetings.

Overall, the richer feedback expected to be generated by observing a smaller number of participants complete the pilot questionnaire was considered the better option. The formal pilot used a 'think aloud' approach (Eccles and Arsal, 2017), where two OTs and three orthodontists completed the pilot over five separate meetings. Three of these were virtual, and two were face-to-face, each lasting 20-30 minutes. Table 7 summarises the clinical background of the clinicians involved in the pilot and details about the meetings.

Results

In total, three orthodontists and two OTs took part in the pilot. There were no problems with using OnlineSurveys on any device. Many comments led to subtle changes in the wording or order of questions and altering answer options. Both OTs felt it fundamental that the questionnaire defined "supervised": does a specific clinical procedure being "supervised" mean the supervisor does the procedure for the OT, directly watches the OT do it, or prescribes it before letting the OT complete it without direct supervision?

A key area of feedback led to making it more obvious that the questionnaire should be completed from the perspective of a single clinical setting, as two orthodontists started the pilot and stated they were unsure whether to answer from the perspective of their primary or secondary care roles. This was despite written instructions on the introduction page stating that the survey should be completed from the perspective of a clinician's *main* place of work, with an option to repeat the questionnaire from another clinical perspective.

Two concerns about the questionnaire prior to piloting were the structure and number of questions requiring free text responses. The structure of the pilot questionnaire had simple, closed, demographic questions at the start, with more complex open-ended questions at the end of the survey, risking a reduced response rate to the final questions. However, participants of the pilot commented that this structure should be

maintained, with the more straightforward questions allowing time for participants to formulate clear thoughts about working as/with an OT, before being asked to provide more nuanced opinions at the end.

With regards to the number of open-ended questions, one pilot participant strongly recommended minimising the number of free text responses. This was to both simplify data synthesis and analysis, and to increase the response rate to questions necessitating this style of question. When answering the final section of the main page of the questionnaire which was made up of entirely open-ended questions ('How do you feel about your working relationship?'), one OT and two orthodontists commented that it may be beneficial to have some multiple-choice options alongside the free text box. They suggested that this would give participants some ideas about possible ways to respond to these more difficult questions, as well as providing a way to gather at least some data if participants chose not to write anything else.

This feedback was discussed carefully with the supervisory team, but after careful reflection no changes were made to this page of the questionnaire. It was agreed that to provide some multiple-choice options would make the questions on this page too leading, and a smaller number of organic and nuanced free text opinions was better than a larger number of multiple-choice answers alone. Providing multiple-choice options may also decrease the incentive to fill in the free text responses, which were the most important part.

Tables 5, 6 and 7 summarise the wording and types of questions in the final questionnaire and the rationale for them being included, alongside the type of data expected to be collected for each question.

Table 4: The clinical backgrounds of participants and meeting details of the pilot.

Participant Initials	**Clinical role and years since qualifying**	**NHS or private?**	**Primary or secondary care?**	**Expertise**	**Virtual or face to face?**	**Device/web browser used**
HJ	OT – 10+ years	Both	Both	Extensive experience in primary and secondary care.	Face to face	Hospital Windows computer
RS	OT – 10+ years	NHS	Primary	Extensive experience in primary care.	Virtual	Personal computer
ASh	Orthodontist – 10+ years	Both	Both	Wide range of clinical practice, with experience supervising research using questionnaires.	Virtual	Personal smartphone
ASu	Orthodontist – 10+ years	Private	Primary	Extensive experience in primary care orthodontics supervising OTs.	Virtual	Personal computer
CSB	Orthodontist – 10+ years	Both	Both	Wide range of clinical practice, supervising OTs in primary and secondary care.	Face to face	Personal Mac computer

Table 5: The final questions, the rationale for including them and the type of data expected from section one of the questionnaire.

About You

Question	Type of question	Data type expected	Why was the question asked?
Where in the UK are you based?	Single-answer multiple choice	Nominal	Demographic information.
Do you have any other dental registrations?	Multi-answer multiple choice	Nominal	Having other dental registrations changes the potential scope of practice of a respondent.
When and where did you complete your diploma/MOrth?	Open-ended	Nominal (where) Discrete (when)	Demographic information. Are there trends between level of experience and responses?
How is your week divided between primary and secondary care?	Open-ended (%)	Discrete	Is the working relationship between OTs and SCs different between primary and secondary care?
How many OTs work in your clinical setting?	Open-ended	Discrete	Provide information about the size of clinical teams and clinics.
How many orthodontists work in your clinical setting?	Open-ended	Discrete	
How many dental chairs in your clinical setting are typically in use for orthodontics?	Selection list	Discrete	
What percentage of orthodontics do you carry out on the NHS/private?	Open-ended (%)	Discrete	Is the working relationship between OTs and SCs different between NHS and private care?
Do you feel your salary appropriately reflects your contribution to patient care? - Are you employed or self-employed? - Please write your salary here	Single-answer multiple choice Open-ended	Nominal Continuous (£)	Asked to OTs only. How does salary relate to the type of clinical practice and employment?

Table 6: The final questions, the rationale for including them and the type of data expected from section two of the questionnaire.

How is treatment delivered in your practice?

Question	Type of question	Data type expected	Why was the question asked?
What is the standard length (in minutes) of your appointment times for the following procedures?	Single-answer multiple choice	Discrete	How do appointment times compare between OTs and SCs?
How frequently does the supervising orthodontist see patients?	Single-answer multiple choice	Ordinal	Are BOSONG guidelines for OT supervision followed?
Are you provided with an overall treatment plan in the patient notes?	Single-answer multiple choice	Nominal	What level of guidance is provided to OTs from their SC?
Are you provided with a visit-by-visit treatment prescription? - if yes, how often is this updated? - does the visit-by-visit treatment prescription include… - Do you have a standard operating procedure for orthodontic appliances in the absence of a supervisor?	Single-answer multiple choice Multi-answer multiple choice Dichotomous (yes/no)	Nominal Ordinal Nominal Nominal	What level of detail is provided in prescriptions to OTs by their SC, and how frequently?
Does the same OT complete the same patient's treatment from start to finish?	Single-answer multiple choice	Ordinal	Is there continuity of care for patients being seen by an OT?
Which of the following clinical procedures do you/the OTs you supervise carry out?	Matrix/grid question	Nominal	To what extent do OTs undertake clinical procedures within their scope of practice?
Do you feel your/your OT's skills are being utilised appropriately?	Dichotomous (yes/no)	Nominal	What are the attitudes of OTs and SCs to the current scope of practice of OTs?
Are there any other clinical procedures that you think should be included in your/your OT's scope of practice?	Dichotomous (yes/no)	Nominal	

Do you wish you/your OT were able to make more decisions about treatment?	Dichotomous (yes/no)	Nominal	
Are there any procedures that are only performed by the orthodontist?	Multi-answer multiple choice	Nominal	
What is the average/maximum number of clinicians (including OTs and dentists) supervised by you/your supervising orthodontist? - What do you feel is a sensible number of clinicians that should be supervised by a single dentist who is/is not treating their own patients at the same time?	Single-answer multiple choice	Discrete	How many OTs do dentists currently supervise, and how does this relate to what respondents perceive to be a sensible supervision ratio?
Do you/your SC ever supervise remotely?	Single-answer multiple choice	Nominal	Is remote supervision common?
Do you/your supervising orthodontist perform any separate clinical activity whilst supervising?	Single-answer multiple choice	Nominal	Do SCs tend to just supervise or see their own patients at the same time?

Table 7: The final questions, the rationale for including them and the type of data expected from section three of the questionnaire.

How do you feel about your working relationship?

Question	Type of question	Data type expected	Why was the question asked?
How do you feel about your own contribution to the quality of patient care and treatment efficiency? E.g., treatment outcome, patient satisfaction, number of visits, appointment availability.	Open-ended	Free text	Asked to OTs only. What do OTs feel is their contribution to clinical care?
What positive or negative effect does the contribution of OTs you work with have on the quality of patient care and treatment efficiency? E.g., treatment outcome, quality of finish, patient satisfaction, number of visits, appointment availability.	Open-ended	Free text	Asked to dentists only. What do dentists feel is the contribution of OTs to treatment quality and treatment efficiency? This relates both to the quality of finish and outcomes of individual cases, as well as the overall efficiency of the practice/clinic.
What do you feel works well with your working relationship with your supervising orthodontist(s)? E.g., communication, supervision. - What do you feel could be improved to maximise the working relationship?	Open-ended	Free text	Are there common topics between OTs and dentists about the good and bad aspects of working relationships?
What effect does working with an OT have on your own clinical practice? E.g., number of patients seen, more/less stressful.	Open-ended	Free text	Asked to dentists only. Do dentists working with OTs see more patients overall? Is this more or less stressful?

2.4 Methods

2.4.1 Recruitment

2.4.1.1 Identification

Orthodontists were identified and invited through the BOS emailing list, as most orthodontists are members of the BOS. Permission was requested from the BOS in advance using the survey administration request process, and the recruitment email was sent via an administrator. As of October 2023, there were 1390 orthodontists on the GDC specialist list (General Dental Council, 2023c). There are over 1800 BOS members on the BOS mailing list (British Orthodontic Society, 2023), as there are some BOS members who are not orthodontists currently working in the UK.

OTs were identified and invited through the Orthodontic National Group (ONG); however, proportionately fewer OTs are members of the ONG compared to orthodontists being members of the BOS.

To maximise the number of participants, social media was also used for recruitment using:

- Posts in 'Orthodontic Therapist Network UK' Facebook group, with 910 members in October 2023. Permission was granted by the group administrator.
- Posts in 'Orthodontic Mastery Group' Facebook group, with 11459 members in October 2023. Permission was granted by the group administrator.

2.4.1.2 Invitation to Participate

Clinicians were provided with information about the research in the invitation email and participant information sheet (PIS). The PIS was attached as a document to social media posts, explaining that participation was voluntary and anonymous. An electronic version of the Research Participant Privacy Notice was also made available. A summary of this information was provided on a shorter introductory page at the start of the questionnaire itself.

2.4.1.3 Enrolment and Consent

Participants were provided with sufficient information during the recruitment process to allow them to make an informed decision about whether to participate. As such, participants self-enrolled and consent to participate was implied by completing the questionnaire. This was supported by a simple statement at the start of the questionnaire where participants confirmed that they had read the information about the study and were happy to take part. Due to the anonymous nature of responses, it was not possible to withdraw from the study once answers had been submitted.

2.4.2 Data Collection

Data were collected through the completion of an online questionnaire hosted by OnlineSurveys. This website followed strict data security standards (ISO27001) and was GDPR compliant, with data collected over encrypted connections (Jisc, 2023).

2.4.3 Data Management

Data were stored electronically within OnlineSurveys, which backed-up data daily. Once data collection was complete, data were exported in a Microsoft Excel spreadsheet for analysis by the researcher. Data were stored on a password protected University of Leeds computer in the M: drive, in accordance with the guidance set out by the University of Leeds for data protection and GDPR.

2.4.4 Data Analysis

Mainly quantitative data were gathered with a limited amount of qualitative data in the form of free text answers. Open-ended questions with free text responses, such as what clinicians perceive to be the barriers and enablers to co-delivery of care, generated qualitative data. Free text responses were categorised, and topics identified where appropriate.

Below, questions from the questionnaire have been mapped to the research objectives, describing the plan for statistical analysis.

1. The working arrangements of OTs with SCs.

a. Descriptive summary statistics, including response rates (%) and frequencies, to summarise:

- Respondents' main clinical role (Q2).
- The country of the UK in which respondents work (Q3, Q37).
- Working splits between primary/secondary care, and NHS/private provision (Q6-7, Q13-14, Q39-40, Q46-47).
- Whether OTs are employed/self-employed (Q15b).

b. Measures of central tendency, dispersion (range and standard deviation) and some histograms to describe:

- The number of OTs and orthodontists working in the respondent's clinical setting (Q8-11, Q41-44).
- The number of dental chairs in use for orthodontics (Q12, Q45).
- OT salaries (Q15c)
- Appointment lengths (Q16-22, Q48-55).

c. Descriptive summary statistics, including frequency tables and bar charts, to describe responses to questions about supervision:

- How frequently the SC sees patients (Q23, Q56).
- Provision of an overall treatment plan, and visit-by-visit treatment prescriptions (Q24-25, Q57-58).
- Average, maximum, and 'appropriate' number of clinicians that are supervised by a single dentist (Q32, Q65).
- Remote supervision (Q33, Q66).

d. Descriptive summary statistics, including bar charts and pie charts, to describe:

- Which clinical procedures OTs perform (Q27, Q60).
- Which clinical procedures are only performed by the SC (Q31, Q64).

2. Clinician perceptions of their contribution to patient care.

a. Categorisation of free text responses to identify details and context, possibly including bar charts depending on common topics identified, about:

    - Whether OTs feel their salary reflects their contribution to patient care (Q15).
    - Whether the skills of OTs are appropriately utilised (Q28, Q30, Q61, Q63).
    - Whether OTs should have other skills included within their scope of practice (Q29).
    - How OTs feel about their contribution to patient care and treatment efficiency (Q35).
    - How SCs feel about the contribution of OTs to quality of patient care, treatment efficiency and their own clinical practice (Q68-69).

3. Clinician perceptions of the barriers and enablers to co-delivery of treatment by orthodontists and OTs.

a. Categorisation of free text responses to identify details and context, possibly including bar charts depending on common topics identified (Q36, Q70).

2.5 Other materials

The following materials were used for this research:

1. Recruitment emails (27.2.23 v3)
2. Social media invitation (16.1.23 v2)
3. Participant Information Sheet (16.1.23 v2)
4. QR code
5. Questionnaire

2.5.1 Recruitment Emails

Two separate recruitment emails were produced for participants invited through the BOS and ONG. These were checked by members of the target audience. Emails were almost identical, with the wording changed to address OTs or SCs directly as appropriate. A link to the online questionnaire was embedded within the text of the email. The BOS regularly emails members with requests to participate in research, and so emails were deliberately kept to a succinct but informative invitation to participate in the research. To prevent excessive amounts of information being included in the main text, the PIS was included as an attachment to the emails.

The recruitment emails were checked by a member of the target audience and permission was sought from the BOS committee, with approval granted to survey the entire BOS membership. The emails were distributed by a member of the BOS administrative team at an appropriate time to minimise overburdening the BOS/ONG memberships to optimise response rates. Reminder emails were sent at the start of the second and third months of data collection.

2.5.2 Social Media Invitation

Facebook posts were published in the Orthodontics Mastery Group (targeting orthodontists and dentists) and Orthodontic Therapist Network UK (targeting OTs and trainee OTs). Permission was sought from an administrative member of each group and checked by a member of the target audience. To maximise engagement with the posts, text was kept more concise than the recruitment emails, with the main detail included in the PIS. This was uploaded as an attachment to the posts. Again, the link to the questionnaire was embedded within the text of the Facebook post.

Reminder posts were published at the start of the second and third months of data collection. As a member of Orthodontics Mastery Group, the lead applicant was able to directly post these invites. The administrative group member of Orthodontic Therapist Network UK agreed to post on behalf of the lead applicant.

2.5.3 Participant Information Sheet (PIS)

The PIS was produced using the guidance provided by the University of Leeds in their template PIS and 'easy-read' PIS (University of Leeds, 2023). The order of the PIS was amended slightly following the recommendations of the Dental Research Ethics Committee. In its draft form, the PIS was sent to the participants of the stakeholder groups and pilot for feedback, therefore being checked by members of the target audience. The finalised PIS was attached to the recruitment emails and social media posts.

2.5.4 QR code

During the three months of data collection, the OT Training Day (organised annually by the BOS) took place in May 2023. To try and improve the response rate, one of the orthodontists speaking on the day was contacted to ask if they would be happy to display a QR code at the end of their presentation. With their approval, a brief PowerPoint slide including a QR code directly linking participants to the online questionnaire was displayed.

3 Results

3.1 Survey responses

Data collection was undertaken from 30.3.23 to 30.6.23. A total of 161 responses were received, from 89 supervising clinicians (SCs) and 72 OTs. The response rate is difficult to exactly quantify due to the varied methods of recruitment and use of social media, but if the total sample size is taken as the number of recipients of the email invitations sent to the BOS and ONG mailing lists, this would indicate a response rate of 6.0% for SCs (89 out of 1483) and 34.8% for OTs (72 out of 207), with a combined response rate of 9.5%.

Throughout the results, comparisons are made between the grouped responses from OTs and SCs. SCs and OTs have not been paired with each other, so direct comparisons are not necessarily being drawn between an OT and their specific SC, and vice versa.

3.2 Respondent characteristics

Most respondents were based in England, with similar variation between OTs and SCs as demonstrated in Table 8.

Table 8: Geographical split of respondents across the UK.

	SCs (n=89)	**OTs (n=72)**
England	83% (n=74)	86% (n=62)
Scotland	11% (n=10)	6% (n=4)
Wales	4% (n=4)	6% (n=4)
Northern Ireland	1% (n=1)	3% (n=2)

Figure 2 shows the main clinical roles for respondents who completed the questionnaire. For both OTs and SCs, the largest proportion of respondents reported that their main clinical role was in primary care, followed by district general hospitals and dental hospitals. The number of non-specialist dentists supervising OTs was small, making up only 7.9% (n=7) of all SCs, but most worked in dental hospitals (n=4).

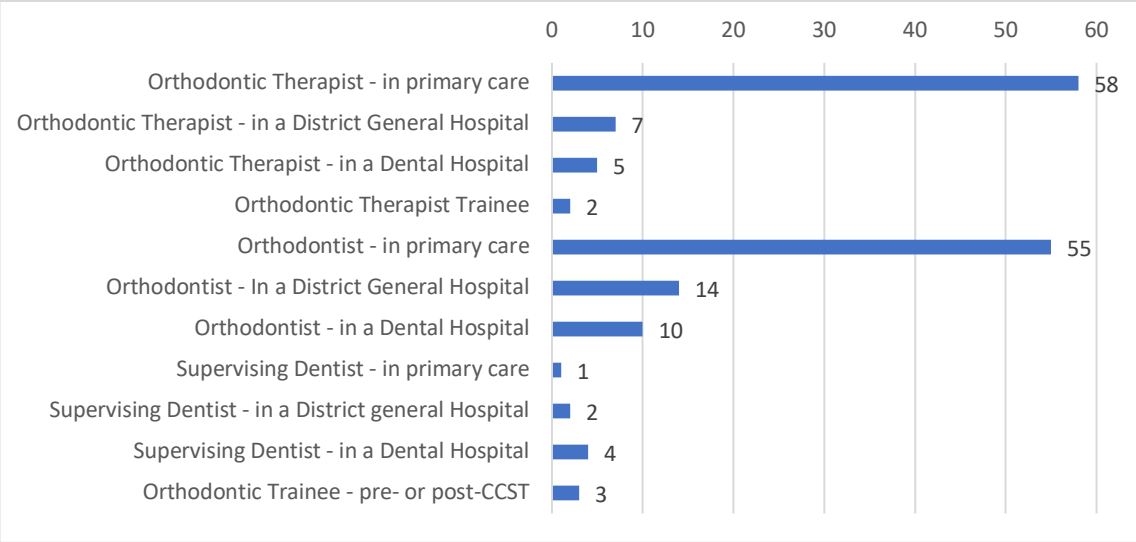


Figure 2: The main clinical role of all respondents.

Of the 161 total respondents, only seven (4.3%) opted to complete the questionnaire for a second time from a different workplace perspective. The secondary clinical roles were two OTs in primary care, four orthodontists in primary care and one orthodontist in a district general hospital. For the purposes of the results, from section 3.1.2 onwards, these responses from the perspective of a secondary clinical role are treated as new respondents, including when calculating averages.

Table 9 summarises the data collected regarding the training of SCs and OTs. For orthodontists who provided the year they completed their specialist training (n=65), completion years ranged from 1991-2022, with nearly half completing their training between 1996 and 2005. The year in which OTs completed their Diploma in Orthodontic Therapy is included for those that provided these data (n=50). All institutions offering the Diploma in Orthodontic Therapy were represented in the results, although only one respondent qualified from Edinburgh Dental Education Centre.

Table 9: Training summary of orthodontists and OTs.

How many years of experience did orthodontists and OTs have?		
	Orthodontists (n=65)	**OTs (n=50)**
	N (%)	**N (%)**
<5 years	7 (11%)	10 (20%)
5-10 years	9 (14%)	17 (34%)
10-15 years	9 (14%)	23 (46%)
15-20 years	16 (25%)	
>20 years	24 (37%)	
Where did OTs undertake their Diploma in Orthodontic Therapy? (n=47)		
		N (%)
Yorkshire Orthodontic Therapy Course		18 (38%)
Orthodontic Team Training (Formerly University of Warwick)		9 (19%)
University of Bristol		7 (15%)
University of Central Lancashire (UCLan)		5 (11%)
The School for Dental Care Professionals (DCPs), University Dental Hospital of Manchester		4 (4%)
King's Health Partners		2 (4%)
Edinburgh Dental Education Centre (EDEC)		1 (2%)

Of the OT respondents who provided their additional registrations (n=68), most were also registered as dental nurses (n=31; 46%) or dental nurses with additional skills (n=29; 43%). A smaller number were registered as dental hygienists (n=5; 7%), therapists (n=2; 3%), and technicians (n=1; 1%).

3.3 Working patterns of respondents

When asked how their week was divided between primary and secondary care, 91 SCs and 56 OTs responded, with just over half working solely in primary care as their main clinical role (Table 10). The split between working in primary care, secondary care or both was broadly similar between SCs and OTs.

Table 10: The split between working in primary care, secondary care, or both for SCs and OTs.

	N (%)	
Clinical Role	**SCs (n=91)**	**OTs (n=56)**
Primary care only	46 (51%)	34 (61%)
Secondary care only	17 (19%)	8 (14%)
Primary and secondary care	28 (31%)	14 (25%)

Data were also collected comparing the provision of orthodontics within the NHS and privately. Comparisons of the split between private, NHS and mixed practice have been drawn for respondents whose main clinical role was in primary care and for those who stated that they work solely in primary care (Table 11). For those clinicians who provide NHS and private orthodontics, the average NHS:private split has been calculated. These data were not normally distributed.

Data about the number of dental chairs in use for orthodontics were provided by 161 respondents. Due to the use of open plan teaching bays in most teaching hospitals, results have been split for primary and secondary care separately (Figure 3). For SCs and OTs whose main clinical role was in primary care (n=118), the median number of chairs was 4.0, compared to 6.3 for those whose main role was in secondary care (n=46). The highest option in the selection list was 11+ chairs: this option was not selected by anyone with a main role in primary care, compared to 6 respondents in secondary care.

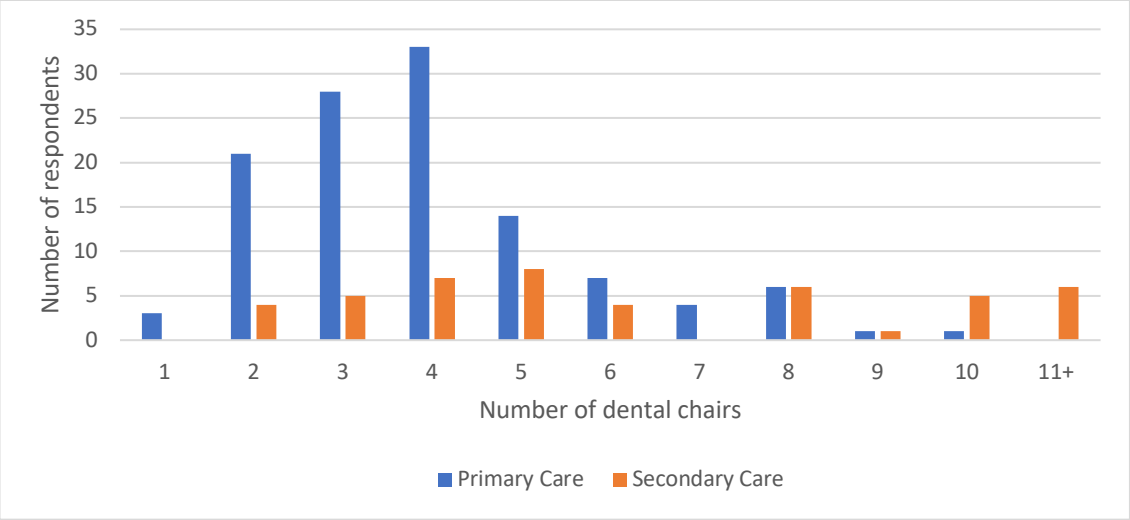


Figure 3: The average number of dental chairs in use for orthodontics in primary and secondary care settings.

Table 11: The split between NHS, private and mixed practice for SCs and OTs working in primary care. Secondary care has been excluded as all secondary care orthodontics is provided within the NHS.

	Role	N (%)			Average NHS:private split for mixed
		100% NHS	100% Private	Mixed	
SCs	**'Main clinical role' is in primary care (n=59)**	11 (19%)	6 (10%)	42 (71%)	Median – 85:5
	Working only in primary care (n=46)	9 (20%)	4 (9%)	33 (72%)	Median – 80:20
OTs	**'Main clinical role' is in primary care (n=58)**	5 (9%)	9 (16%)	44 (76%)	Median – 85:10
	Working only in primary care (n=36)	4 (11%)	7 (19%)	25 (69%)	Median – 80:20

Participants were asked how many orthodontists and OTs worked in their clinical setting, including themselves (Table 12). These data were not normally distributed. Three SCs reported more than 15 part time orthodontists working at the same clinical setting (n=16, n=16, n=27); all three were based in secondary care and reported 11+ chairs were in use for orthodontics at any one time. SCs reported working alongside a greater median number of part time OTs than full time OTs, and more part-time than full-time orthodontists were reported as colleagues in primary and secondary care.

Table 12: The number of colleagues working with SCs and OTs.

		Number of colleagues [Median (range)]			
		Part time OTs	**Full time OTs**	**Part time orthodontists**	**Full time orthodontists**
SCs	**Primary**	2 (0-6)	1 (0-6)	2 (0-9)	0 (0-5)
	Secondary	2 (0-4)	1 (0-3)	4 (0-27)	1 (0-7)
OTs	**Primary**	1 (0-10)	1 (0-5)	1 (0-7)	0 (0-3)
	Secondary	1 (0-4)	1 (0-1)	2 (0-10)	0 (0-5)

Participants were asked about the standard length of their appointments for various common scenarios. The median and range of these responses is provided in Table 13, comparing SCs and OTs. Data were not normally distributed. Broadly, there is little difference between the groups, with OTs reporting slightly shorter appointments for adjusting fixed appliances and placement of aligner attachments. Aligner check appointments were the shortest for both SCs and OTs, whereas placement/removal of dual-arch fixed appliances and placement of aligner attachments were the longest appointments.

Table 13: Appointment lengths in minutes for SCs and OTs.

Procedure	**SCs**		**OTs**	
	Median (mins)	Range (mins)	Median (mins)	Range (mins)
New patient assessment	20	5-30		

Records	20	10-30	20	5-45
Treatment planning/consent	20	5-30	20	5-45
Placement of dual-arch fixed appliances	45	15-60	45	20-60
Adjusting fixed appliances	20	10-30	15	10-30
Removal of dual-arch fixed appliances	30	10-60	30	15-60
Aligner check (without attachment placement/IPR)	15	5-30	15	10-30
Placement of aligner attachments	40	15-60	30	15-60

3.4 Employment of orthodontic therapists

OTs were asked details regarding their employment and salary. Of the 75 responses, 65 (86.7%) were employed compared with 10 (13.3%) who were self-employed. When asked whether they felt their salary appropriately reflects their contribution to patient care, 72 responses were received, with 26 (35.1%) reporting 'Yes', 42 (56.8%) 'No', and 6 (8.1%) 'Other'; the difference between those who were employed compared to self-employed was negligible. Those who answered 'No' and 'Other' were given the opportunity to leave a free text comment. Most comments expressed that the salary did not reflect their contribution to patient care:

> *"NHS pay is poor"* [OT in secondary care with two years' experience]
>
> *"It did but with cost of living and inflation not anymore"* [OT in primary care with seven years' experience]
>
> *"I do a lot more and sometimes see more patients than the specialty doctors/orthodontists"* [OT in secondary care with three years' experience]

If they felt comfortable to do so, OTs were also asked to provide their salary (Table 14). Of the 57 responses to this question, 35 gave their hourly rate and 22 gave their salary. Of those who disclosed their salary, some indicated this was for less than full-time and where this information was provided, the salary has been converted to a full time

equivalent to aid comparison. Hourly rates were converted to a full-time salary using the assumption of a 37-hour full-time working week. There is potential inaccuracy using this assumption, as it seems unlikely a minimum full-time salary would be as low as £18,000.

Table 14: Self-reported salaries for OTs, with comparisons between primary and secondary care, employment and self-employment, and OTs who reported that their salary did and did not reflect their contribution to patient care.

	Mean Salary (£)	Standard Deviation (£)	Minimum Salary (£)	Maximum Salary (£)
All respondents (n=57)	48,940	10,242	18,000*	73,744
Primary care (n=33)	51,089	9,513	18,000*	73,744
Secondary care (n=2)	40,755	4,241	35,392	46,061
Employed (n=35)	48,071	10,307	18,000*	73,744
Self-employed (n=7)	56,492	4,789	46,061	59,644
OT feels salary reflects contribution (n=17)	53,327	12,621	18,000*	73,744
OT feels salary does not reflect contribution (n=38)	47,763	7,687	30,000	59,644

*Unlikely this is full time salary but data unclear

3.5 Supervision arrangements

Respondents were asked about how often the SC sees the patient. Out of the total 166 responses, 61% (n=101) reported this happening “every other visit”, 20% (n=34) “every visit”, and 14% (n=4) “every 3-5 visits”. Supervision occurring “prior to debond only” was only reported once, and 4% (n=6) reported that supervision took place “rarely”. Figure 4 compares the responses from SCs and OTs. A similar proportion of majority “every other visit” responses were seen in both groups, however, 33% (n=30) of SCs reported supervising patients “every visit”, but OTs reported this to be 5% (n=4). The number of SCs seeing patients “every 3-5 visits” was 8% (n=7), whereas OTs reported this to be 23% (n=17).

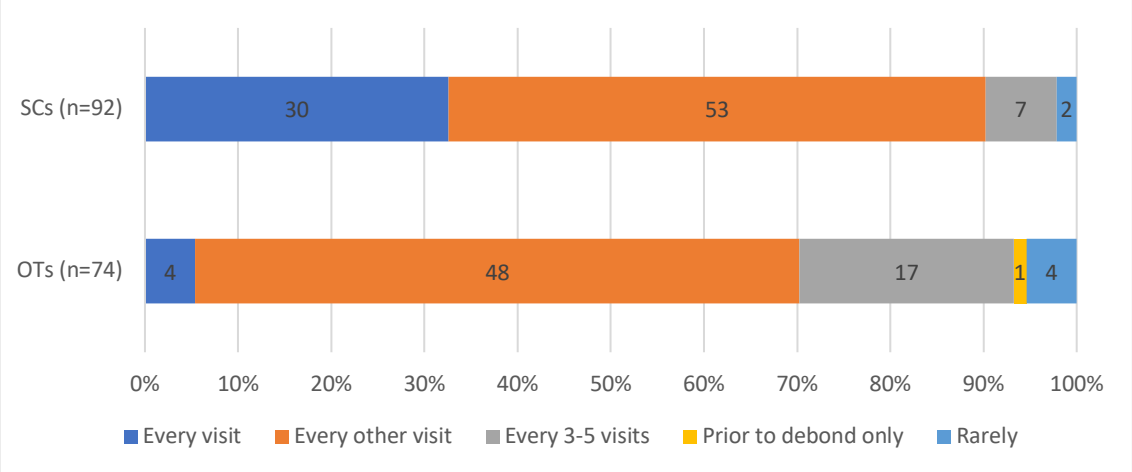


Figure 4: A comparison between the frequency of supervision reported by OTs and SCs working across primary and secondary care.

When the frequency of supervision was separated between primary and secondary care, a greater proportion of respondents in secondary care reported supervision “every visit” or “every other visit” than in primary care. All OTs in secondary care reported supervision at least “every other visit”, compared to 65% (n=39) of OTs in primary care. Supervision “every 3-5 visits” or less was reported by 12% of SCs in primary care (n=7), compared with 6% (n=2) of SCs in secondary care.

Participants were asked details about their supervision, including whether an overall treatment plan is included in the notes, whether a visit-by-visit prescription is provided, and, if so, how often this is updated. Table 15 compares the responses given by OTs and SCs. More SCs than OTs reported that an overall treatment plan was provided in the

notes. Most OTs (82.4%; n=61) reported that they did receive a visit-by-visit prescription of some kind, and most SCs (97.8%; n=90) reported that they provide this. Responses from both OTs and SCs indicated that the visit-by-visit prescription is usually updated "every visit" or "every other visit". However, more OTs (23.5%; n=15) than SCs (7.8%; n=7) reported that updates occur "every 3-5 visits" or "rarely".

Table 15: Comparing the responses from OTs and SCs about whether an overall treatment plan is in the notes, whether a visit-by-visit treatment prescription is provided and how often it is updated.

	OTs	**SCs**
Is the overall treatment plan in the notes?		
Yes	82.4% (n=61)	96.7% (n=89)
No	2.7% (n=2)	3.3% (n=3)
Sometimes	9.5% (n=7)	0% (n=0)
Varies between supervisors	5.4% (n=4)	0% (n=0)
Do you have a visit-by-visit treatment prescription?		
Yes - verbally	14.9% (n=11)	27.2% (n=25)
Yes- written in notes	31.1% (n=23)	60.9% (n=56)
Yes - verbally and written in notes	36.5% (n=27)	9.8% (n=9)
No	17.6% (n=13)	2.2% (n=2)
How often is the visit-by-visit prescription updated?		
Every visit	23.4% (n=15)	48.9% (n=44)
Every other visit	53.1% (n=34)	43.3% (n=39)
Every 3-5 visits	17.2% (n=11)	5.6% (n=5)
Rarely	6.3% (n=4)	2.2% (n=2)

Participants were asked what was included in the visit-by-visit prescription. The most common response was "details regarding desired appliance mechanics", followed by "individual recall intervals with supervising orthodontist" and the "date/stage of treatment to reassess with supervising orthodontist". Participants who selected "other" (n=4) or 'none of the above' (n=14) had the opportunity to leave free-text comments. All four of the comments left by SCs and one of the two comments left by an OT related to providing a plan for desired appliance mechanics at the next visit, such as:

> *"Loose prediction of what will be done NV. e.g., step up AWs, or continue space closure, or show orthodontist NV."* [SC in primary care with 22 years' experience]

Another SC detailed their specific protocol for supervision:

> *"I tend to either see the patient and give verbal instructions every time (e.g., I am not physically treating but I look and give direct instructions) or if the patient is booked for a visit that I am not there for I write an instruction for the next visit. I therefore do not have a set time frame for when I next see the patient. I would say that my patients are treated with additional support from [a] therapist but is 100% under my supervision."* [SC in primary care with 18 years' experience]

The final comment left by an OT showed dissatisfaction with their supervision, criticising the frequency of supervision, as well as a lack of clear prescriptions:

> *"Continually ask for prescriptions. When they are there [they are] very vague. Often end up seeing patients that haven't seen [an] Orthodontist for 4 visits - only seen other OTs. I try to ensure every other visit but difficult when seeing other OT patients."* [OT in primary care]

Participants were asked whether a Standard Operating Procedure (SOP) was used within their clinical setting, regarding the supervision of OTs. Over half of OTs (n=43; 58%) and SCs (n=49; 54%) reported having a SOP and most provided free text comments providing details, with 44 comments left by SCs, and 38 comments from OTs. Common topics were identified in the comments, and these are presented in Table 16.

Table 16: Topics identified from free text comments in which SCs and OTs described the details of SOPs to be used in the absence of the SC. More than one topic was identified in some comments.

Topics of free text comments	Explanation	Number of comments	
		SCs	OTs
Mechanics/archwire sequence	SOP details specific mechanics for specific clinical scenarios, including preferred arch wire sequences	12	13
Make safe/emergencies	Only treatment needed to relieve pain or repair an appliance should be done without a prescription.	9	8

Follow prior prescription only	SOP details that only treatment previously prescribed should be completed without SC present.	9	4
Retie	If there is no prescription and no SC present, retie the appliance only.	8	13
Discuss with SC in advance	SC/OT should discuss cases in advance when it is known the SC will not be present.	3	0
Contact SC	During the appointment, contact the SC via phone/video call for a prescription.	3	2
Approach another SC	Ask another SC present in the clinical setting for a prescription.	3	0
Take photographs	Take photographs to discuss with the SC for a prescription ahead of their next appointment.	1	2

The largest number of comments related to following a specific archwire sequence:

> "*Usually pre-prescribed. I have standard arch wire changes that I use but there are certain cases where camouflage cl 3-this will differ which I will highlight in notes. Repairs etc are not pre-prescribed but therapist was trained in-house (three orthodontists in two practices) so procedure pretty standard.*" [SC in primary care with 18 years' experience]

> "*Wire sequence [and] stage of bonding of 7s have been detailed in initial notes to therapists*." [SC in primary care]

Several comments discussed how SCs can provide advice and prescriptions when not present at the appointment with the OT, including via virtual assessment:

> "*Available via phone/facetime*" [OT in primary care with one year experience]

> **"***Follow written prescription. If circumstances have changed, ask other orthodontist present to assess. If not possible, call "covering" orthodontist. If not possible, make safe, comfortable and rebook asap when supervising orthodontist available***."** [SC in primary care with 27 years' experience]

> *"…we use DentalMonitoring, so although the supervisor doesn't physically see the patient every visit or every other, I always have a written prescription which*

is written using their scans as a basis." [OT in primary care with nine years' experience]

A comment from one SC provided a detailed description of their SOP and administrative arrangements, providing a clear example of good practice:

"Therapists work to the therapist protocol which is updated annually but regular meetings are carried out to discuss any additional scenarios or queries that either myself or my therapists wish to discuss. In addition, my OTs regularly approach me if they have any queries. We also use a Teams spreadsheet to monitor queries, photos to be checked, letters that need to be written to GDPs or the hospital, follow ups that need to be made, e.g., if we haven't heard from the hospital and should have done, etc. These I check on a daily basis." [SC in primary care with 21 years' experience]

Table 17 compares the responses from all OTs and SCs about whether the same OT treats the same patient throughout their course of treatment. When considering responses exclusively from participants whose main clinical role was in primary care, the responses were very similar to those shown in Table 17, due to the greater overall number of responses from primary care (n=121) compared to secondary care (n=45). When only considering secondary care, ≥90% of both SCs and OTs reported that the same OT sees the same patient "always" or "mostly".

Table 17: OT and SC responses about whether the same OT treats the same patient for the duration of their course of treatment.

	OT (n=74)	**SCs (n=92)**
Yes - always	9.5% (n=7)	26.1% (n=24)
Yes - mostly	43.2% (n=32)	54.3% (n=50)
Sometimes	16.2% (n=12)	0% (n=0)
No	31.1% (n=23)	19.6% (n=18)

Participants were asked questions about their current supervision ratios between SCs and OTs, as well as their perception of a 'sensible' number of clinicians to be supervised at the same time by a single SC. Responses were not normally distributed.

There was general agreement between OTs and SCs, with the same median response for a 'sensible' number of OTs to be supervised if the SC was treating their own list of patients concurrently (two OTs), compared to if they were not (four OTs). When discussing their current supervision arrangements, OTs and SCs reported that the maximum median number of OTs supervised by a single SC was three. According to SCs, the median number of OTs routinely supervised by a single SC was two, whereas OTs reported this to be three. Figures 5 to 8 compare the same data in more detail.

Participants were asked about remote supervision of OTs. A majority of SCs (73%) reported that they do not supervise remotely. However, more than half of OTs (63%) reported being supervised remotely at least sometimes (Table 18).

Table 18: Responses from SCs and OTs about whether they remotely supervise/are remotely supervised.

	SCs (n=91)	**OTs (n=73)**
Yes	2% (n=2)	11% (n=8)
Sometimes	25% (n=23)	52% (n=38)
No	73% (n=66)	37% (n=27)

Participants were also asked to provide comments regarding remote supervision, with 23 comments left by SCs and 32 comments left by OTs. Most SC comments (n=17) and smaller number of OT comments (n=9) specifically described that this was not undertaken routinely:

> "*When I am off sick or on holiday and I can remotely log onto the practice server to access patients' clinical notes, photos, and X-rays*." [SC in primary care with 19 years' experience]

> "*Very rarely. If no other orthodontist present due to illness, I have had video call discussions*." [SC in primary care with 27 years' experience]

> "*He has occasionally given advice over the phone when needed but this has been unplanned*." [OT in primary care with six years' experience]

> "*In an emergency I can contact the prescribing orthodontist. I can also contact any of the other orthodontists if this is not possible*." [OT in primary care]

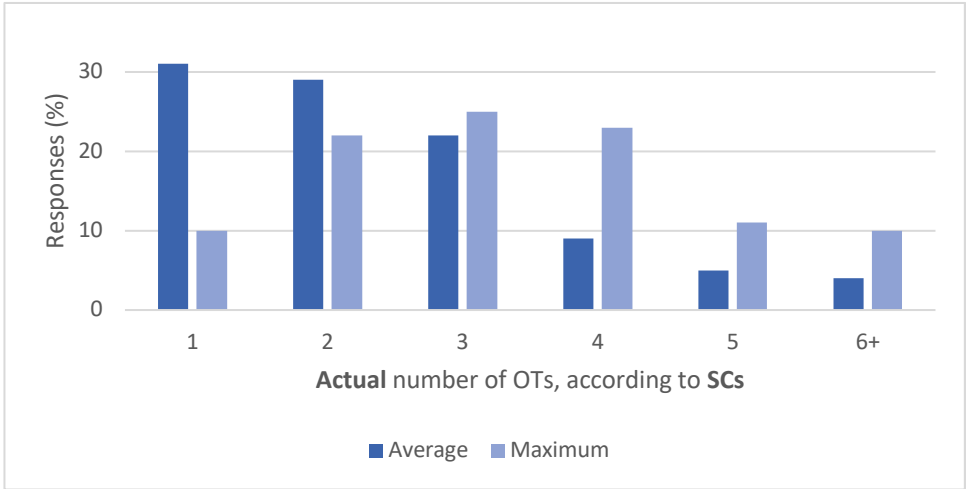


Figure 5: The number of OTs routinely supervised by a single SC, as reported by SCs.

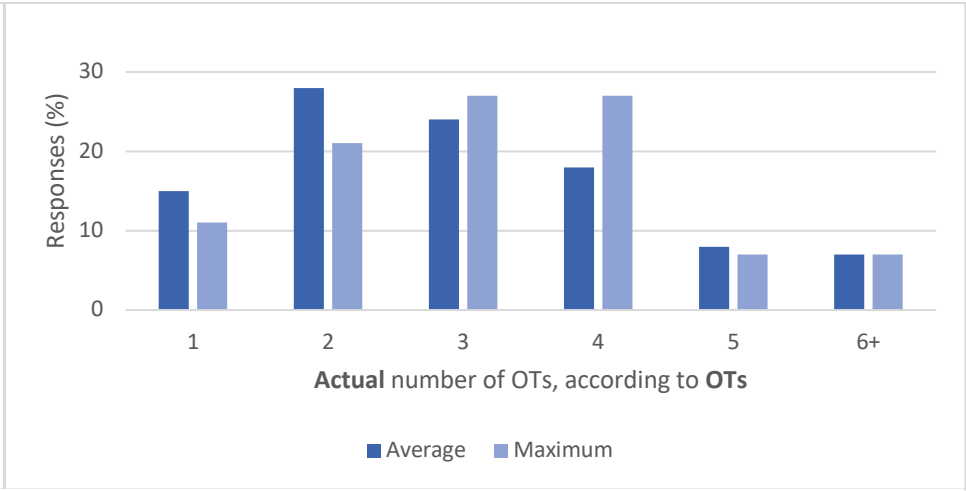


Figure 8: The number of OTs routinely supervised by a single SC, as reported by OTs.

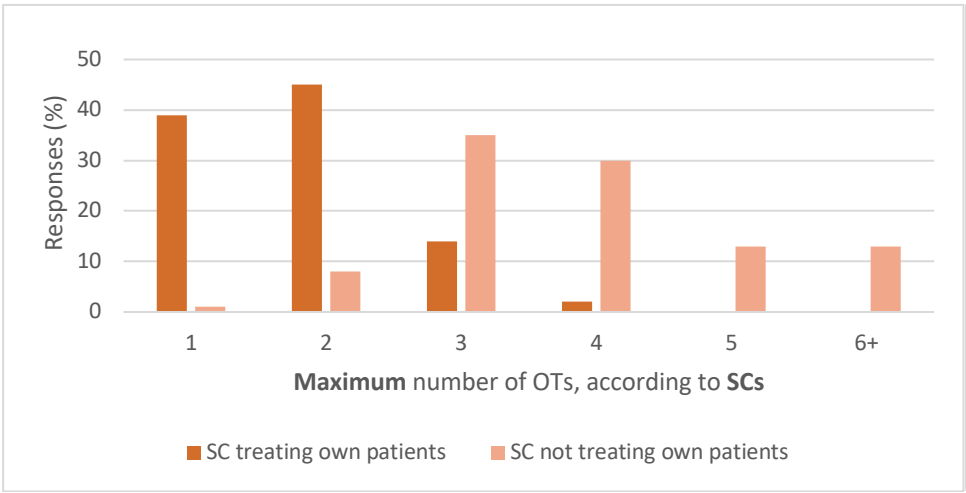


Figure 7: The maximum number of OTs supervised by a single SC, as reported by SCs.

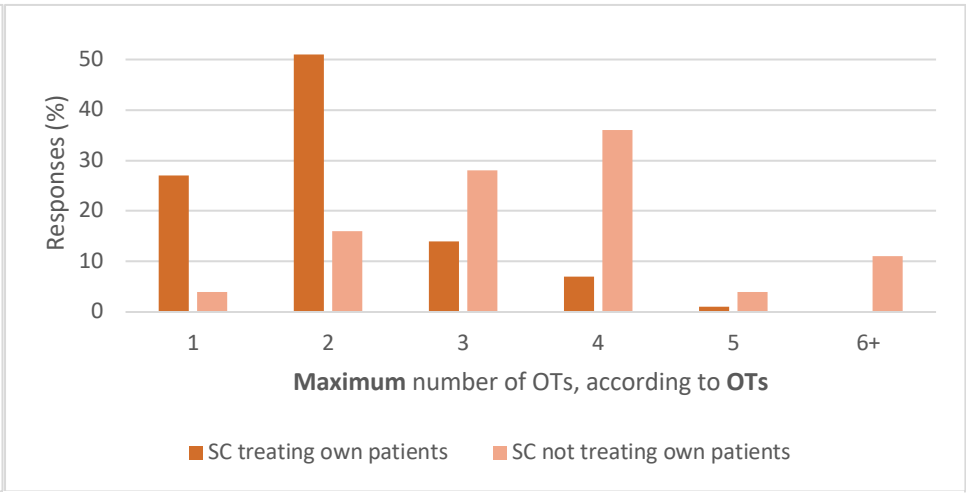


Figure 6: The maximum number of OTs supervised by a single SC, as reported by OTs.

A smaller number of comments (three from SCs and three from OTs) suggested that remote monitoring was more routinely undertaken in their clinical setting, with six comments mentioning the use of DentalMonitoring.

> "*Sometimes and increasingly. About to pilot a new…system.*" [SC in primary care with 25 years' experience]

> "*We use photo reviews combined with clinical reviews to supervise treatments. Photos are used for routine prescription updates but where photos cannot show what is relevant or at predetermined points, as requested by myself or thought necessary by my OT, a clinical review is used*." [SC in primary care with 21 years' experience]

> "*I write a prescription for every patient but if there is a question, my OT would take a photo and I can dial into the system and change the prescription. I also use DentalMonitoring with all patients undergoing treatment with aligners and now with a few patients undergoing treatment with fixed appliances."* [SC in primary care with 16 years' experience]

> "*Using DentalMonitoring; also photos sent for him to review when carrying out IOTN screenings*." [OT in primary care with nine years' experience]

One comment from a SC recommended that future BOS guidelines around OT supervision should take remote supervision, especially via Dental Monitoring, into account:

> "*With Dental Monitoring becoming a possible feature in managing orthodontic patients it is likely that remote supervision will become more acceptable, and this should be factored and future-proofed into any BOS guidelines*…" [SC in primary care with 26 years' experience]

Participants reported that the vast majority of SCs perform some kind of clinical activity when supervising, with only 4% of SCs (n=4) and 5% of OTs (n=5) stating that no other clinical activity was undertaken during supervision. Treating or assessing their own patients was the most common activity for SCs whilst supervising as reported by

60% of SC respondents (n=56) and 85% of OT respondents (n=63). Completing clinical administrative tasks during supervision was reported by 33% of SCs (n=31) and 9% of OTs (n=7).

3.6 Scope of practice

OTs and SCs were asked about the scope of practice for OTs (Figure 9). The five procedures most frequently performed by OTs *with* supervision were:

1. Consent appointments
2. Making changes to archwires
3. Fitting functional appliances
4. Activating components on removable appliances
5. Debonding

The five procedures most frequently performed by OTs *without* supervision were:

1. OHI, diet advice
2. Emergency appointments
3. Fitting removable retainers
4. Clinical photography
5. Impression/intra-oral scanning/changing elastomeric and ligature ties

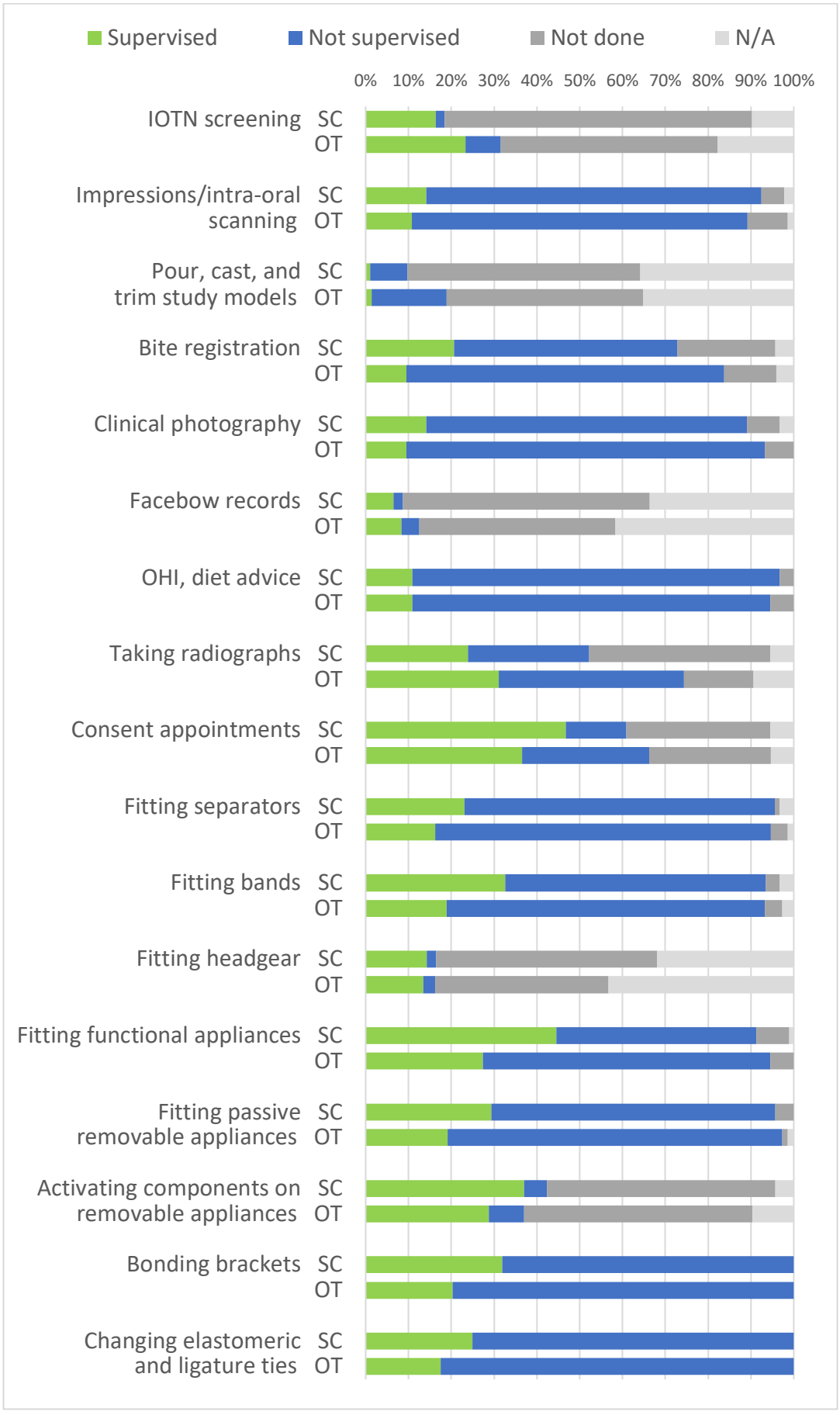
The five procedures most frequently *not performed* by OTs, instead performed by someone else in the same clinical setting, were:

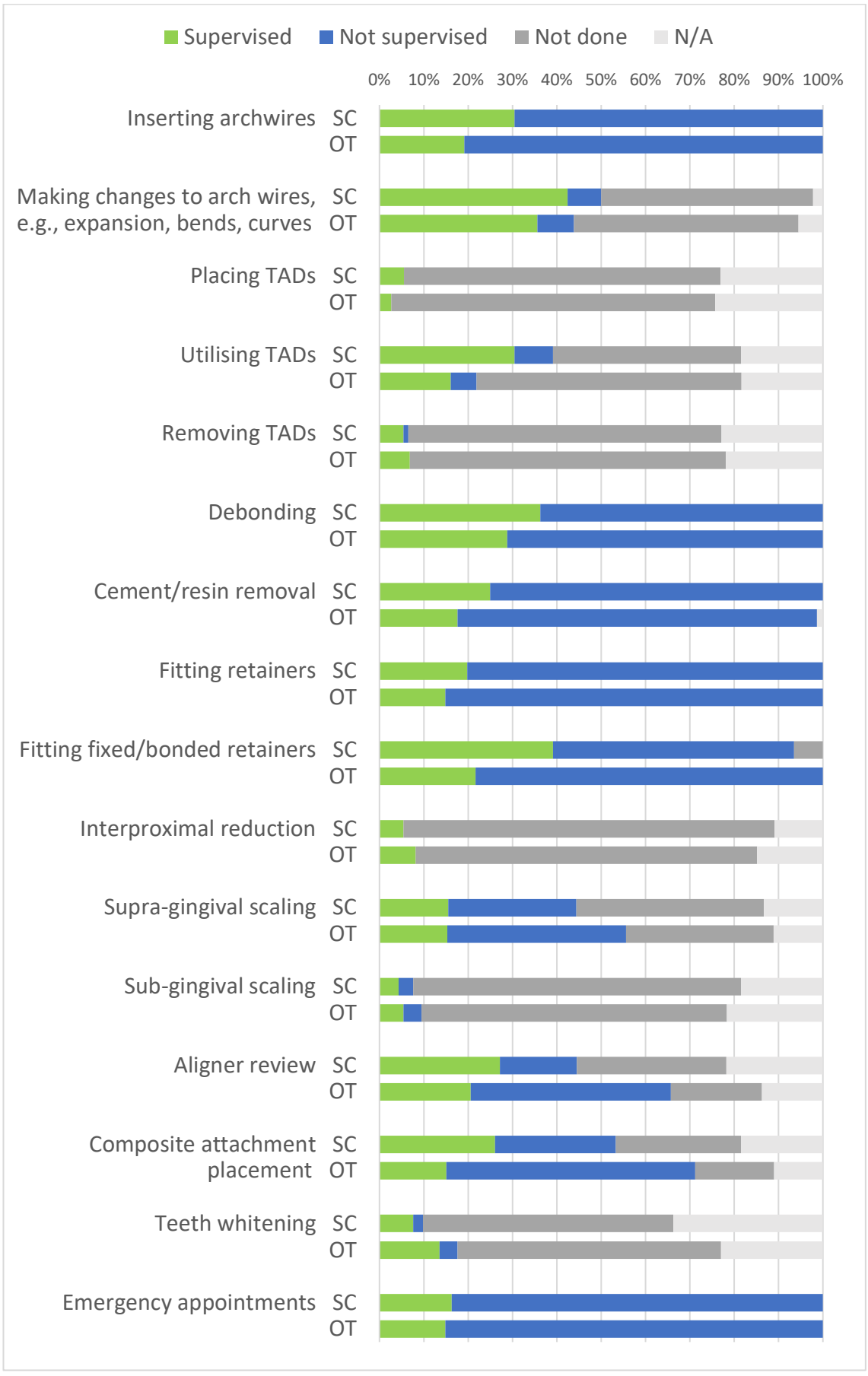
1. Interproximal reduction
2. Sub-gingival scaling
3. Placing TADs
4. Removing TADs
5. IOTN screening

Other procedures exclusively performed by SCs included:

- Activation of expanders, e.g. quadhelix
- Fitting headgear, including protraction facemasks
- Activate removable appliances
- Archwire bends/expansion
- “Twin blocks”
- Treatment planning discussions
- “Laser surgery” (no further clarifying information provided by respondent)

Figure 9: Procedures performed by OTs, as reported by SCs and OTs.




Supervised
Not supervised
Not done
N/A
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Inserting archwires
SC
OT
Making changes to arch wires, e.g., expansion, bends, curves
SC
OT
Placing TADs
SC
OT
Utilising TADs
SC
OT
Removing TADs
SC
OT
Debonding
SC
OT
Cement/resin removal
SC
OT
Fitting retainers
SC
OT
Fitting fixed/bonded retainers
SC
OT
Interproximal reduction
SC
OT
Supra-gingival scaling
SC
OT
Sub-gingival scaling
SC
OT
Aligner review
SC
OT
Composite attachment placement
SC
OT
Teeth whitening
SC
OT
Emergency appointments
SC
OT

Procedures performed by OTs working in primary care were broadly similar to those in secondary care, with a small number of more clear differences. In primary care, OTs reported taking more radiographs, completing more aligner reviews, placing more composite attachments, and performing more IOTN screenings. In secondary care, OTs described undertaking more consent appointments and fitting headgear more often. Subgingival scaling, tooth whitening and interproximal reduction are outside the scope of practice of OTs, and performed by a minority of OTs, but all of these were in primary care, with none completed in secondary care.

When asked whether the skills of OTs are being appropriately utilised, a majority of SC (90%; n=83) and OT (74%; n=55) participants responded "Yes". However, the proportion of OTs who did not feel that their skills are being appropriately utilised or answered "Other" (26%; n=19), was almost three times higher than the corresponding SC responses (9%; n=9). Participants were invited to leave comments if responding with "No" or "Other", and four comments were received from SCs and five from OTs. Three comments highlighted that OT skills were appropriately used for the most part, but some relatively minor changes to the scope of practice of OTs would be beneficial:

> "*Largely yes but they could be given additional responsibilities like activating components on URAs*." [SC in primary care with four years' experience]

> "*Mostly but there are some erroneous rules. Like not being able to activate a URA*." [SC in primary care with 21 years' experience]

> "*I feel that we should be able to place simple activation in archwires, i.e., to coordinate a wax bite, to expand or constrict archwires or to sweep in a simple reverse curve*." [OT in primary care with 13 years' experience]

Two comments from experienced OTs pointed to a more limited utilisation due to the constraints of the current scope of practice:

> "*As a therapist who has been qualified for 15 years, I feel very restricted. There should be opportunities to increase scope*." [OT in primary care with 15 years' experience]

> "*As an experienced OT I could be used a lot more but due to scope or practice limitations this is not possible*." [OT in primary care with seven years' experience]

Two SC comments discussed a lack of confidence in OTs being able to efficiently perform clinical procedures:

> "*It's a difficult one as sometimes…they will not be great at something and it's faster if you do it*." [SC in primary care with 22 years' experience]

> "*OT is under skilled. Not trained by me. OT not particularly receptive to further training to improve the quality of her work so there are many procedures I avoid her doing which is poor use. Selecting the right ortho nurse with the right skills and training your own [OT] is important*." [SC in secondary care]

When asked directly whether OTs should be able to perform other clinical procedures as part of their scope of practice, 75% (n=69) of SCs responded "No", whereas 68% (n=50) of OTs responded "Yes". Free text comments were also invited following this question if the participant answered "Yes", with 24 comments left by SCs, and 49 left by OTs. Table 19 shows how frequently additional procedures were reported. In addition, four procedures were discussed at least twice, which are all permitted within the current scope of practice of OTs:

1. Supragingival scaling
2. IOTN screening
3. Fluoride varnish application
4. Band placement

Comments provided in response to this question gave further details about additional procedures. The extent of wire bending was frequently quantified by both SCs and OTs:

> "*I think that OTs…should be able to place small bends in archwires <0.75mm rather than repositioning the bracket as it has the same clinical effect as*

repositioning and has a very low risk of harm…" [SC in primary care with 26 years' experience]

"*Wire bending but checked by orthodontist before placing it*." [SC in primary care with six years' experience]

"*Archwire expansion*" [OT in primary care with 13 years' experience]

"*Placing step bends*" [OT in primary care with 12 years' experience]

"*Placing reverse curves in archwires*" [OT in primary care]

One OT commented that they would like "some kind of post-certificate style qualifications", and two OTs wanted to work more independently:

"*Treatment planning for under IOTN 3 and less*" [OT in primary care with seven years' experience]

"*Simple treatments with less supervision*" [OT in primary care]

Table 19: Additional clinical procedures that should be included in the scope of practice of OTs according to SC and OT respondents.

	SCs		OTs	
	n=	%	n=	%
Interproximal reduction	9	10	19	26
Archwire bends	7	8	13	18
Teeth whitening	3	3	13	18
Activating removable appliances	5	5	10	14
Composite bonding	0	0	5	7
Quadhelix expansion	0	0	3	4
Incisal edge enameloplasty	0	0	3	4
Temporary restoration placement	0	0	1	1
Treatment planning	0	0	1	1
Mouthguards	0	0	1	1
Prescribe fluoride toothpaste/mouthwash	0	0	1	1
Prescribing radiographs	0	0	1	1
New patient assessment	0	0	1	1
PAR scoring	1	1	0	0
Subgingival scaling	1	1	0	0

Participants were asked whether OTs should be able to make more decisions about treatment. A majority of both SCs and OTs answered "No", but around four times as many OTs (37%; n=27) responded "Yes" than SCs (8%; n=7). Free text comments were left in response to this question by seven SCs and 22 OT. The vast majority of comments left by SCs and OTs centred around it being sensible for OTs to work through a specified archwire sequence:

> "*I feel that aligning archwire progression can be a skill taught to OTs with little clinical risk. OTs should be given the option of NOT progressing to the next wire if they feel the current NiTi archwire has not expressed enough i.e. the prescription is the upper limit of their treatment scope*." [SC in secondary care with eight years' experience]

> "*I would like to be able to make decision within an already written treatment plan. For example, early wire changes whilst aligning*." [OT in primary care with nine years' experience]

> "*Would be good to have an overall treatment plan and work through a pre-set series of arch wires etc without necessarily needing the prescription for every visit*." [OT in primary care with nine years' experience]

> "*If it's a simple wire change then I believe we should be able to choose the next…wire, but when a stage of treatment is complete, I believe we should then have input- i.e. level and alignment complete*." [OT in secondary care with four years' experience]

One SC felt that OTs should be able to make more decisions around treatment mechanics, and justified this through their level of training:

> "*I train my OTs to a very high standard and do audits on the knowledge they learn during training and ongoing post qualification to be able to prove that they understand mechanics decision making based on our documented rules-based knowledge online platform which is continuously available to them to*

refer to… I think OTs should be able to make more decisions in treatment mechanics." [SC in primary care with 26 years' experience]

Beyond this, two comments from OTs again indicated a desire to treatment plan:

"*Basic treatment planning*" [OT in primary care]

"*Offer extra training for OTs to become orthodontic specialists*." [OT in primary care with 13 years' experience]

3.7 How did orthodontic therapists and supervising clinicians feel about working with each other?

3.7.1 What are the positive and negative effects of working with orthodontic therapists?

OTs were asked to provide free text responses to discuss how they felt about their contribution to the quality of patient care and treatment efficiency. Examples offered in the questionnaire were areas such as treatment outcome, patient satisfaction, number of patient visits and appointment availability. Of the 65 comments received, 85% (n=65) were generally positive. When SCs were asked how patient care and treatment efficiency were affected by working with OTs, a total of 82 comments were received, with similar positive topics identified. Some comments were succinct, focusing on one single issue, whereas some comments included up to five separate topics.

Table 20 compares the positive topics identified in comments received from SCs and OTs, where each topic had at least two responses from either group. Individual responses from SCs also reported improved job satisfaction as a supervisor and a positive effect on the career aspirations of the dental nursing staff:

"*We orthodontists have a more enjoyable and fulfilling work day as the routine appointments can be delegated. Therapists enjoy their involvement in patient care and the rewards it brings…*" [SC in primary care with 25 years' experience]

Table 20: The number of times positive topics were mentioned in SC and OT responses, when asked about the effect of OTs on patient care and treatment efficiency.

Topic	Number of mentions in 82 SC comments	Number of mentions in 65 OT comments
More appointment availability	35	4
More patients seen	14	0
Good rapport with patients	11	0
More efficient	11	0
Good quality of care	9	7
Improved patient satisfaction	8	8
Good outcomes	7	12
Better use of skill mix	4	0
Continuity of care	4	2
Reduced treatment duration	2	0
Better delegation	2	0
Improved outcomes	2	0

Although not directly related to the patient care and treatment efficiency, six OT comments reported a good relationship with their SC and three mentioned feeling valued as a member of the clinical team:

> "*I am currently very satisfied with my clinical routine. I feel I am an appreciated member of the team who produces good treatment outcomes and patient satisfaction*." [OT in secondary care with 10 years' experience]

> "*I love my job and I have a brilliant relationship with my orthodontist*." [OT in primary care with seven years' experience]

A smaller number of negative perspectives were also identified in responses from OTs and SCs in response to the effect of working with OTs on patient care and treatment efficiency. Six OTs reported that their contribution was hindered by poor appointment availability and appointments that are too short:

> "*I don't feel that it is more efficient seeing us as we don't get a prescription given. The orthodontist still has to see the patient as well and can sometimes take up to 40 minutes for the supervisor to come and tell us what they want us to do. It would be more efficient if the supervisor saw the patient every other*

visit and wrote a clear prescription for treatment…" [OT in secondary care with eight years' experience]

"*Our chair time with patients is limited so I try very hard to provide [any] information necessary but often run late which puts everyone under pressure. Work feels like a conveyor belt, unfortunately*." [OT in primary care with 13 years' experience]

Only two negative topics were mentioned more than once in SC comments:

1. Increased treatment duration (n=6)
2. Poorer outcomes (n=4)

"*More visits as OT generally less confident to progress treatment*." [SC in primary care with 32 years' experience]

"*I really enjoy working with them, but find I relate to the patients less, and that can sometimes impact on treatment time lengthening, especially for bracket positions as our therapist is just out of training so still learning how we all like it! Great help for appt availability and increasing our capacity*." [SC in secondary care with 21 years' experience]

A longer comment left by a SC provided their view of both the negative and positive effects of working with OTs, including the challenge of explaining the different clinical roles to patients:

"*Patients in general like the more relaxed appointments with a therapist than seeing 'the boss', they also have wider appointment choices. Occasionally patients who I start their treatment, e.g., when starting with a twin block I see them until they need the fixed phase, they have occasionally felt 'dumped' onto someone with less expertise, obviously this needs to be carefully explained to them about skills and training. Treatment outcome is I feel overall similar to when I didn't have a therapist, as I can concentrate on the tricky cases which I see myself. The 'flip' side of this is that my treatment sessions are often full of complex cases, and you don't get the 'rest' of a simple case!! Patient*

satisfaction is overall good, but parents give 'thank you' gifts less often when 2-3 clinicians are involved in their care than always seeing the same clinician. This is anecdotal. Number of visits is probably 10-20% higher for treatments done by an OT than solely by the orthodontist." [SC in primary care with 25 years' experience]

Another response provided several positive and negative perspectives, and explained the difference between working with a "well trained" and "poorly trained" OT:

"With the right team with a good working relationship then it can function extremely effectively and efficiently treating patients to a high standard. [If OTs or trainees are poor or underperform, it] takes a lot longer per visit and overall treatment duration and quality of finish can be compromised especially if not closely supervised. However, having scope to give patients appointments to do routine adjustments at earlier stages and debonds is very helpful in managing the diary so orthodontist can focus on treatments that are essential to allow treatment to progress effectively and efficiently. A well-trained therapist is an asset but a poorly trained one is a burden." [SC in secondary care]

3.7.2 How does working with orthodontic therapists affect the clinical practice of supervising clinicians?

SCs were asked to provide free text responses about the effect of working with an OT on their own clinical practice. Examples included in the question included the number of patients seen, and levels of working stress. Table 21 shows the positive and negative topics identified in the 82 comments received.

Table 21: The positive and negative topics identified from SCs, when asked how working with OTs affects their own clinical practice. Some may consider 'SC can focus on complex care' as a negative, and some may consider 'less wet-fingered dentistry' as a positive.

Positive topics	Frequency	Negative topics	Frequency
More patients seen	44	More stressful	27
Less stressful	25	Poorer quality of care	3
More appointment availability	8	More clinical admin	2

More efficient	5	More organisation required	2
Reduced waiting list	4	Less wet-fingered dentistry	2
More enjoyable	4	Increased responsibility	1
SC can focus on complex care	4		
More profitable	3		
Fewer patients for SC to treat	2		
SC can delegate the less desirable tasks	2		
Better service	1		
Improved quality of care	1		

A similar number of comments mentioned that working with OTs can make their own clinical practice both more and less stressful. Many comments explained why and when it is more stressful, particularly when concurrently seeing their own patient list whilst supervising. Other comments explained why this higher working stress was deemed acceptable, usually due to the ability to see more patients and delegate treatment:

> "*I do sometimes see my own patients with supervision responsibilities which does increase stress levels but when solely supervising, I feel working with OTs (especially with prescriptions) is incredibly effective*." [SC in secondary care with eight years' experience]

> "*More stressful if OT is very busy, or if supervising many OTs with own busy list*." [SC in primary care with four years' experience]

> "*Very stressful supervising and trying to see own patients*." [SC in primary care with 18 years' experience]

> "*Generally I enjoy working with OTs, they work hard and get on well with patients. Can be more stressful if you don't know the patients because you don't have a handle on the plan and progress. Need the OT to have good notes and be able to tell you what has happened to date. Our OTs have longer appointments but overall think it still probably means more patients are seen*." [SC in secondary care with nine years' experience]

> "*It is definitely EASIER when the OT is not there, and my day is much less stressful - BUT I am able to deliver more patient care and devolve seps and impressions and simple re ties to the OT ensuring my clinical time is spent doing more productive consents and complex mechanics*." [SC in secondary care with 26 years' experience]

One SC gave a detailed comment explaining why their stress is not affected by working with OTs, but criticised funding within NHS orthodontics and the threat this may pose to working with OTs:

> SC: "*It means a single specialist orthodontist can see up to three times more patients improving access for patients however from a financial point of view this is not translated into profit as NHS work is almost profitless at present when done to a high standard and so the future of OT delivered practices may be in doubt should the NHS service become uneconomic and collapse. This is the biggest threat to OT working viability. Having OTs may reduce clinical stress but then you have increased stress from the people management of a larger team. For this reason, the Orthodontist stress levels are not affected by OT use*." [SC in primary care with 26 years' experience]

3.7.3 What works well in the working relationship between supervising clinicians and orthodontic therapists?

All participants were asked what they felt works well, and what could be improved in their working relationship. Table 22 compares what SCs and OTs felt works well, where topics were present in at least two comments.

Table 22: The frequency that topics were mentioned in SC and OT responses, when asked what works well in the working relationship between SCs and OTs.

Topic	Number of mentions in 77 SC comments	Number of mentions in 64 OT comments
Communication	42	34
Supervision	19	16
Rapport	10	0

Defined roles	6	5
Teamwork	5	4
Teaching/Feedback	6	0
SC approachability	4	2
Effective SOP	3	0
Empowerment of OTs	3	12
Trust/Respect	3	12
Delegation	2	0
SC availability	0	8
Prescriptions follow scope of practice	1	3
Awareness of SC's preferred way of working	0	5

Communication and supervision were most frequently mentioned as being effective by both OTs and SCs:

> "*We have very good communication, and they are able to come to me at any point during the day, they know they can interrupt when I am seeing patients myself if they have any concerns rather than just booking patient back with me for the next visit which helps reduce overall treatment times*." [SC in primary care with seven years' experience]

> "…*We are usually available in an adjoining surgery, or our offices, as well as written prescriptions in the notes. Face to face, email, and messages within notes all work well for communication*." [SC in secondary care with 21 years' experience]

> "*Excellent communication, discussing with rather than dictating to so I am always thinking and learning*." [OT in primary care]

> "*Mostly good communication and able to ask questions if needed. Available when needed for prescription appts and when not in practice appts booked with prescription that do not need supervision*." [OT in primary care with 10 years' experience]

Several comments described the benefits of training existing members of staff as OTs, and working with OTs that were trained by the same SC:

"*Good communication as they have all been trained by our practice. All have the same ethos*." [SC in primary care]

"*I have very good working relationships with my OTs as I selected them on personality and intensively trained them, so they became very good. It's a pleasure to work with such professionals. I have no issues with communication or supervision because they are trained so well and selected for their personalities*." [SC in primary care with 26 years' experience]

"*All my therapists are trained by myself, so we have a very good working relationship*." [SC in primary care with 19 years' experience]

"*Training your own staff to be your OTs. Massively more trust and understanding than if you advertise and bring in an unknown OT*." [SC in primary care with 21 years' experience]

Empowering OTs was a common perspective in OT responses and was also mentioned in three SC comments.

"*I have regular meetings with my orthodontists to discuss any matters arising. Communication and supervision are good, and my supervisors always trust my initiative if I find I have a query within a prescription etc*." [OT in secondary care with 10 years' experience]

"*We communicate very well. Either working from a written prescription or seeking a verbal one. I feel valued and my opinions respected*." [OT in secondary care]

"*My orthodontist knows that I have many years' experience working in ortho and puts her trust in me, she still likes me to feed back to her my thoughts of what I am thinking we should do next and will then either agree with me or advise on a different approach*." [OT in primary care with 13 years' experience]

"*I hope that we work well as a team. My aim is to ensure that my OT wants to come to work to see the patients but to also enjoy her day and not feel part of a*

machine churning out stuff – I feel I do more teaching in this setting as we are just 2 of us together." [SC in primary care with 26 years' experience]

3.7.4 What could be improved in the working relationship between supervising clinicians and orthodontic therapists?

When asked what could be improved in the working relationship between SCs and OTs, comments were grouped in four general categories (Table 23).

Table 23: The frequency that topics were mentioned in SC and OT responses, when asked what could be improved in the working relationship between SCs and OTs.

Topic		Number of mentions in 64 SC comments	Number of mentions in 50 OT comments
Supervision	More SC availability	0	9
	Not keeping OT waiting	0	8
	More detailed prescriptions	3	4
	More time to supervise	6	0
	More supervision	0	3
	SC seeing fewer patients on their own lists	0	3
Training	Feedback	3	3
	Training existing staff members to be OT	3	0
	More case-based discussions	2	0
	Regular post-qualification training days	2	0
	Better OT training	2	0
OT working practice	Increased autonomy	0	5
	Fewer patients/Longer appointments	2	3
	Expansion of scope of practice	0	3
	More non-clinical responsibility for OT	2	0
	Maintain OT job satisfaction	2	0
Other	Communication	0	5
	Functioning secondary care IT systems	2	0
	Better treatment plans	0	2

The most frequent responses regarding supervision were from OTs, highlighting a need for increased availability of the SC and to not keep the OT waiting when they are with a patient:

> "*With some orthodontists it would work better if they weren't seeing their own patients at the same time as supervising. Sometimes I am left waiting a long time for them and running late because of this*." [OT in primary care with seven years' experience]

> "*Prescribing orthodontist being on time in the morning*." [OT in primary care with seven years' experience]

> "*… he's very busy so can't see patients when they are in, so we take photos and he leaves a note for next visit prescription. I feel this prolongs treatment time for the patient*." [OT in primary care with 14 years' experience]

Having more time to supervise was the most frequently mentioned topic amongst the 64 SC comments. To some extent, this overlapped with having time for feedback, the pressures of busy clinical practice, and being able to have longer appointments:

> "*More time to explain to therapist your mechanics & better prescriptions for bond up & adjustment prescription for next visit*." [SC in primary care with 19 years' experience]

> "*Being less busy yourself*!" [SC in primary care with 16 years' experience]

> "*More time - but that doesn't get the UOAs [Units of Orthodontic Activity] done*!" [SC in primary care with 26 years' experience]

> "*Better UOA values would allow more time to devote to one-to-one weekly informal discussion of what's gone well or not so well this week*." [SC in primary care with 25 years' experience]

Feedback was also mentioned in some OT comments:

> "*More feedback and monthly cash ups to chat about changes or problems*." [OT in primary care with five years' experience]

An increase in autonomy, or expansion of the scope of practice, was highlighted as a possible improvement in eight OT comments:

> "*Being more autonomous as a clinician with 10 years' experience. Changes to OT scope of practice so we can do more*." [OT in primary care with 10 years' experience]

> "*Allowing OTs to perform IPR would improve the workflow*." [OT in primary care with seven years' experience]

> "*Give a little more responsibility in early archwires with straight forward cases, knowing that I would seek advice if I felt necessary*." [OT in primary care with 13 years' experience]

> "*The ability to see patients more regularly without supervision. Allowing more regular appointments not controlled by the specialist being on site*." [OT in primary care with seven years' experience]

Although communication was a common area of good practice, five SC comments specifically reported that elements of communication could be improved as well. These comments focused on the OT gaining a greater insight for the reasons behind clinical decision making:

> "*Discussion on treatment planning decisions and methodology maybe at assessment of patients in my care*." [OT in secondary care with 10 years' experience]

> "*Meetings to discuss things in more detail*." [OT in primary care with 13 years' experience]

4 Discussion

4.1 Key Findings

This study is one of a small number to investigate the use of OTs in the UK, but one of the first to also determine the opinions of OTs and supervising clinicians (SCs) about working together. This research has highlighted several key findings.

4.1.1 The utilisation of orthodontic therapists and their working patterns

4.1.1.1 Utilisation of orthodontic therapists

Due to the low response rate, particularly of SCs, it is not possible to accurately comment on the contribution of OTs to orthodontic delivery in the UK. Despite this, it is likely that the 6.0% of SCs from the BOS mailing list who reported working with OTs is a significant underestimation of their utilisation, not least due to the increasing numbers of OTs on the GDC register (General Dental Council, 2023c). The geographical split in respondents across the UK showed the large majority were from England. However, this split is broadly representative of the split in population between the UK devolved nations (Office for National Statistics, 2021).

As was also shown in the largest questionnaire of OTs (Ahmed et al., 2018), responses to this survey showed that OTs provided orthodontic treatment in primary and secondary care settings, with most OTs in this survey working in primary care (Table 10). In this study, although most primary care OTs were providing both NHS and private treatment, more were providing treatment solely privately than solely within the NHS. This may reflect the increasing demand for adult and private orthodontics in general, accelerated by the "Zoom boom" of video conferencing and remote working since the Covid-19 pandemic (British Orthodontic Society, 2021).

OTs and SCs described several clear benefits to the utilisation of OTs within the orthodontic workforce. However, it is an unexpected finding that the benefits described by SCs do not align with those of OTs. The three most frequently described benefits reported by OTs were "good quality of care", "improved patient satisfaction" and "good outcomes". In contrast, SCs most frequently mentioned "more appointment availability", followed by "more patients seen", "more efficient" and "good rapport

with patients". Rather than focusing on patient outcomes, SCs appear to favour the increased efficiencies of working with OTs. Some SCs aligned with OTs and mentioned "good outcomes", but appointment availability was five times more likely to be reported. This difference in focus is perhaps partly explained by SCs being responsible for the delivery of their contract, focusing attention on the time between appointments and the efficiency of each course of treatment.

This was emphasised by the comments received from SCs about the effect working with OTs has on their own clinical practice, which focused on three main topics. Again, the ability to see more patients was most frequently mentioned, followed by a group of SCs describing working with OTs as more stressful, and an almost identical number of SCs describing it as less stressful. The prioritisation of patient throughput by SCs is apparent, even at the expense of a potentially more stressful working environment. This increase in clinical output following the introduction of OTs was also described by most orthodontists in a large previous national survey of orthodontists (Ahmed et al., 2018).

It was a surprising finding that the appointment lengths were very similar between OTs and SCs. The median appointment lengths for common procedures were almost identical, at times shorter with OTs, with the range of appointment lengths also comparable. One argument which supports longer SC appointments is that they are likely to see more complex cases themselves, preferring to delegate treatment for more straightforward cases. Similarly, they may choose to personally see a patient for time-consuming appointments, such as the finishing and detailing stages of fixed appliance therapy.

The majority of SCs reported seeing their own patients at the same time as supervising OTs and it may be the case that SCs are factoring this additional time demand into their appointment lengths. However, the opposite argument may be true for OTs, who may be lengthening their own appointment times in anticipation of having to wait for their SC to see a patient to provide a prescription. It is interesting that the median appointment time for adjusting fixed appliances was five minutes shorter for OTs than

SCs, despite the assumption that OTs are perhaps most likely to request chairside supervision during these appointments.

Across primary and secondary care, most respondents reported that the same OT mostly or always sees the same patient for the duration of their treatment. The importance of continuity of care in dentistry and orthodontics is poorly researched, although a synthesis of qualitative research in medicine demonstrated that a relationship built over time with a single trusted healthcare professional is key when patients consider the overall continuity of care (Jeannie et al., 2013). SCs were more likely to report that the same OT sees the same patient, with only 20% of responses indicating that this does not usually happen, compared to 47% of OTs. This discrepancy could be due to different working practices between the participant groups, given OTs and SCs were not matched. It could also be explained by SCs overestimating the continuity of care.

Patients being seen in secondary care were reportedly more likely to see the same OT throughout treatment, with less than 10% of responses indicating that this did not usually happen. Less continuity of care in primary care settings may be explained by chance differences between the groups, a reduced frequency of SC supervision in primary care, and reduced appointment availability in primary care.

4.1.1.2 Employment status and salary

Most (87%) OTs in this study were employed, aligning closely with previous research that has reported on this (Hodge et al., 2015; Dugdale et al., 2018). The average full-time salary of OTs in this survey was £48940, with one respondent reporting a salary as high as £73744, and both figures were deemed realistic by the research team. In contrast, the smallest full-time salary of £18000, less than the UK National Living Wage, appears incongruous (HM Revenue & Customs, 2023). These data underline potential inaccuracies in the reporting of salaries, since it was not possible to determine when part-time participants were providing full-time or pro rata earnings.

More than two-thirds of OTs (69%) felt that their salary did not accurately reflect their contribution to patient care. It is important to recognise that this survey was

conducted during a period of increased cost of living expenses in the UK, as was highlighted by one OT (Parliament. House of Commons, 2023). Although the question related OT salaries to their contribution to patient care, this rising demand on salaries is likely to have confounded responses. Nevertheless, if the findings of this study are used to determine how to improve working relationships between OTs and SCs, that most OTs in this survey do not feel their salary represents their clinical impact is important to note.

4.1.2 Supervision

4.1.2.1 Supervision frequencies and ratios

The wide variation in the frequency of supervision seen in this study has been a finding of larger surveys (Ahmed et al., 2018). Across all respondents, the findings in this survey showed appointments with OTs were most often supervised every other visit (61%), followed by every visit (20%). When these data were separated between OTs and SCs, the most common frequency remained every other visit for both groups. However, SCs reported supervising patients every visit 33% of the time, with 5% of OTs reporting the same frequency. On the other hand, only 8% of SCs reported supervising every 3-5 visits compared to 23% of OTs.

This discrepancy is interesting but perhaps not surprising: in the two largest surveys of OTs and SCs, OTs reported appointments being most commonly supervised every 2-4 visits, whereas SCs most frequently answered “every visit” (Ahmed et al., 2018; Dugdale et al., 2018). Equally, the figure of 10% of SCs in this study reportedly supervising less often than every other visit was comparable to the finding of 14% by Ahmed et al. (2018). The BOS guidelines recommend that the SC should see the patient at least every other visit, and also remind SCs that the GDC states that they are able to delegate the responsibility for tasks but not the accountability (General Dental Council, 2013b; British Orthodontic Society and Orthodontic National Group, 2017). It is therefore possible that SCs are susceptible to cognitive biases when recalling this information, and more likely to underreport less frequent supervision if it is not considered good practice.

Supervision ratios between SCs and OTs have not been previously investigated. In this study, OTs and SCs agreed that two OTs is a "sensible" number to supervise if the SC if concurrently seeing their own patients, or four if not. When considering that 71% of all respondents reported that they/their SC see their own patients at the same time as supervising, a*ctual* supervision ratios were slightly higher than what was perceived as "sensible": as a median, SCs and OTs reported a maximum of three OTs being concurrently supervised, and a median of two or three OTs being routinely supervised according to SCs and OTs respectively. This aligns with previous anecdotal evidence of SCs supervising two OTs if concurrently seeing their own patients, or three OTs otherwise (Hodge et al., 2015).

Hodge (2010) has previously reported on the risk of overreliance on OTs, particularly within the financial constraints of NHS contracts, which may partly explain the difference between "sensible" and actual supervision ratios in these data. The argument that the time and financial pressures of NHS primary care orthodontics may affect supervision could also be supported by the finding in this survey of reduced supervision frequency in primary care, with all OTs in secondary care reporting supervision at least every other visit, compared to 65% of OTs in primary care. It is also true that remote supervision, discussed further below, was much more widely reported in primary care orthodontics, and this modality of supervision may potentially facilitate less frequent, but still effective, face-to-face supervision.

It is important to highlight that it was not a universal finding of this research of less adherence to good supervision practice in primary care. Several comments from experienced orthodontists drew attention to good practice enabled through the increased flexibility of practice management in primary care, using technology to manage OT queries, appointments, referral letters and minimise delays in treatment, alongside the use of SOPs and meetings to discuss additional clinical scenarios OTs may face.

4.1.2.2 Remote supervision

An unexpected finding of this survey was the prevalence of remote supervision, and the number of comments referring to this. A total of 27% of SCs reported that they supervise remotely sometimes, whereas 63% of OTs reported being remotely supervised at least some of the time. It is interesting that whilst SCs individually appear to supervise to a lesser extent, OTs cumulatively are more likely to be supervised remotely. This could be simply explained by the fact that the sample of OTs in this study work with SCs who are more likely to use remote supervision. Equally, given there are uncertainties around the effectiveness and legitimacy of remote supervision when compared to direct supervision, SCs may have underreported its use.

The use of technology to facilitate remote healthcare, or telemedicine, is not a new concept (Wallace et al., 1998). It has previously been broadly divided into two categories; real-time systems, or videoconferencing, where the patient and clinician are involved in a live remote consultation, and store-and-forward systems, where medical records are remotely viewed and actioned by clinicians (Wallace et al., 1998). Data in this survey provide examples from both categories, ranging from providing an orthodontic prescription via a phone or video call with an OT, to accessing work software away from the workplace to view patient records, to the use of AI driven platforms such as DentalMonitoring (Dental Monitoring, 2023).

Although the remote supervision of OTs does not eliminate the need for a face-to-face appointment with the OT, the environmental benefits of minimising travel of any staff members or patients to appointments are clear. Around 17% of the carbon emissions of the NHS have been attributed to patient and staff travel (The King's Fund, 2012). Teledentistry has been successfully used in orthodontics more than other fields of dentistry, and was used initially during the triage process for new patient referrals (Mandall et al., 2005). During the early 2000s, it was also used to provide remote consultations to patients via their GDP regarding interceptive orthodontic treatment, in cases where referral to an orthodontic specialist was not feasible (Berndt et al., 2008).

Remote supervision has not been a finding of other large surveys studying the supervision of OTs (Ahmed et al., 2018; Dugdale et al., 2018; Onabolu et al., 2018). This is likely due to the more recent expansion of virtual technology in orthodontics, with two main factors in this growth being COVID-19 and the increased provision of clear aligner orthodontic treatment. In March 2020, to reduce the spread of COVID-19, NHS England suspended all routine outpatient appointments and this was supported by the Chief Dental Officer, who recommended all routine dental appointments, including orthodontics, should be deferred until further notice (NHS England, 2020a; Stevens and Pritchard, 2020). The BOS issued guidance to primary care NHS and private orthodontic practices recommending the use of virtual consultations (British Orthodontic Society, 2020). Similarly, NHS England and NHS Improvement secured access to the videoconferencing software Attend Anywhere for secondary care clinical settings (NHS England and NHS Improvement, 2020).

The increased use of clear aligners in orthodontic treatment has also driven a rise in the use of remote technology for improvements in practice efficiency, monitoring of patient compliance, and to customise intervals between patient appointments. However, the efficiency savings of remote monitoring are perhaps greatest for patients using customised clear aligners, who do not need regular appointments other than to check their appliances remain well-fitting, in contrast to the regular appointments necessary with fixed appliances to check progress and adapt mechanics (Hansa et al., 2018).

Although this survey is cross-sectional, providing data from a single point in time, trends within the free comments appeared to point towards a clear and increasing appetite for the use of remote monitoring and supervision amongst some clinicians, and a belief that it offers an effective alternative to face-to-face supervision. While early research has pointed to general satisfaction amongst clinicians and patients when remote consultations were used during the restrictions of the COVID-19 pandemic (Byrne and Watkinson, 2021), their effectiveness for orthodontic supervision has not been fully researched and concerns have been raised about the quality of the AI learning of DentalMonitoring (Ferlito et al., 2023).

4.1.3 Scope of practice

4.1.3.1 Comparisons between primary and secondary care

Few differences were reported between the procedures completed by OTs working in primary and secondary care (p. 81). The differences that were found, such as more aligner reviews and composite attachment procedures in primary care, are readily explained since aligner treatment is nearly always part of private orthodontic treatment, which is not undertaken in secondary care settings. Similarly, the standalone radiography departments used by clinicians in secondary care likely explain why more radiographs were taken by OTs in primary care. IOTN screenings were reported to be performed less in secondary care, most likely influenced by the fact that cases that are on the borderline for treatment within the NHS are unlikely to be triaged for level 3b care by consultant orthodontists (NHS England, 2015).

It is interesting that OTs in secondary care reported undertaking consent appointments more frequently than in primary care. This could be due to the nature of appointments in secondary care, where patients often return for a standalone consent appointment. It may be the case that more first patient visits to primary care include an assessment with a SC, the gathering of orthodontic records with an OT, before the SC immediately discusses the proposed treatment plan and consent process, negating the need for primary care OTs to gain informed consent.

4.1.3.2 Expansion of scope of practice

It was an expected finding of this study (Figure 9: Procedures performed by OTs, as reported by SCs and OTs.) that some OTs reported undertaking, and some SCs reported prescribing, clinical procedures that are out with the GDC's defined scope of practice (2013b). For example, in 2017, with regards to such procedures, 7.6% of OTs in a large survey reported that they would change the orthodontist's treatment plan, and 3.5% inserted and/or removed TADs (Ahmed et al., 2018; Dugdale et al., 2018). In comparison, in this survey OTs reported undertaking insertion (3%) and removal (7%)

of TADs, IPR (8%), subgingival scaling (9%), and tooth whitening (18%), all of which are not in the scope of practice of OTs (General Dental Council, 2013a).

There are several possible explanations for OTs working, or being prescribed to work, outside of their scope of practice, including ignorance of or intentional disregard for regulations. Data showed a desire amongst a small minority of SCs, but a larger group of OTs, for an expansion in the permitted scope of practice of OTs. However, there was a clear distinction between OTs and SCs: 75% of SCs did not believe OTs should be able to perform any other procedures, whereas 68% of OTs felt that their scope should be expanded at least to a small extent. Similarly, more OTs felt that their skills were not being appropriately utilised when compared to the responses of SCs.

When asked about which specific additional procedures should be permitted within the scope of practice of OTs, 26 responses were received from SCs (the larger of the participant groups) compared to 72 responses from OTs. Four procedures were mentioned more than once by SCs: IPR, archwire bends, tooth whitening and the activation of removable appliances. Tooth whitening may be completed by dental hygienists and dental therapists to the prescription of a dentist, but not by OTs. Some SC comments clarified that any wire bends should be small and checked by the SC, and experienced clinicians in primary care suggested that not being able to activate removable appliances is “erroneous”. However, IPR would mark a more significant deviation from the current scope of practice to include an irreversible removal of tooth tissue.

When considering the additional procedures reported by OTs, four of the seven mentioned more than once were the same as those reported by SCs. The remaining three were incisal edge enameloplasty, composite bonding and activating quadhelices. Perhaps as a sign of the changing market in adult orthodontics, particularly with GDPs, four of the seven procedures listed above (IPR, composite bonding, enameloplasty and tooth whitening) form part of the “smile makeover” or “align/bleach/bond” treatments increasingly offered to adults in primary care (Ooi and Kelleher, 2021), with popular postgraduate courses providing teaching in this approach to dentists (IAS Academy, 2023).

Alongside an expansion of permitted procedures within their scope of practice, comments left by OTs pointed to a desire for more autonomy. At the most extreme, statements from two OTs suggested that they should be able to treatment plan. This may highlight a disconnect between their confidence and competence: diagnosis and treatment planning are fundamentally not part of the training or practice of OTs (General Dental Council, 2013a).

4.1.4 What do clinicians prioritise in the working relationship between supervising clinicians and orthodontic therapists?

When participants were asked about their opinions of their professional relationship, a fundamental finding was that OT and SC perceptions and priorities did not always align. Communication and supervision were both mentioned most often by SCs and OTs when asked what works well in the professional relationship. Having defined roles and teamwork were also shared values which were mentioned to a lesser extent but as frequently in each group. However, rapport and teaching/feedback were frequently mentioned by SCs, in 13% and 8% of comments respectively, but neither were mentioned in any OT comments. In contrast, empowerment, trust, and the availability of SCs were much more likely to be mentioned by OTs.

The availability of SCs was also more frequently mentioned by OTs when asked what could be improved in the working relationship, underlining an OT desire to minimise disruption and downtime during their clinics. More SC availability (18%), not keeping the OT waiting (16%) and communication (10%) were the criticisms most reported by OTs; none of these was specifically mentioned by SCs, although they agreed with a need for more supervision time, as reported in 9% of SC responses. The principle of not keeping OTs waiting perhaps ties into the desire of some OTs to expand their scope of practice to include procedures such as IPR. It is unlikely that performing such procedures would provide any additional direct financial benefit. It is perhaps more likely that the primary perceived benefit of having this within their scope of practice is that OTs would not need to wait for their SC to complete the procedure, streamlining the working day.

4.2 Limitations

4.2.1 Limitations within the research design

Whilst surveys have the advantage of reaching a large number of geographically spread participants, some common disadvantages of surveys were certainly features of this study, including poor response rates, ambiguity between some answers, and the risk of inaccurate interpretation of free text responses (Oppenheim, 2000). Surveys provide a snapshot of information about *what* current behaviours are, but usually provide little data about *why* this is the case (Mathers et al., 2009). The responses to this study provoke multiple follow-on questions, many of which would require more formal qualitative research with focus groups to satisfactorily investigate.

Data from free text comments have been collated and responses compared between SCs and OTs by identifying common ideas or repeated "topics". The methodology used to categorise these responses was a simplistic form of content analysis. The process was not standardised and was undertaken by the lead applicant, and is therefore at risk of human error and subjective interpretation (Elo and Kyngäs, 2008). Certain free text comments have been selected throughout the results to evidence points and inferences. Again, these were the subjective choice of the lead applicant, chosen as they were deemed to appropriately support arguments. It is possible that over-analysis of some comments may have led to unjustified interpretations, but this could be a risk of qualitative research more widely.

The survey was designed with a view that some of the more interesting findings would come from comparing the responses from OTs and SCs. As has previously been mentioned, although such comparisons have been drawn to a certain extent during data analysis, OTs and SCs were not paired. Therefore, there is a risk that such comparisons are not valid, particularly for direct questions around the working relationships of OTs and SCs. This could be exacerbated by the low response rates.

The development of this survey attempted to expand on the largest previous questionnaire-based research of orthodontists (Dugdale et al., 2018) and OTs (Ahmed et al., 2018). In comparison, responses from just 89 SCs and 72 OTs in this survey is disappointingly low, although lower response rates are in keeping with other recent online questionnaire-based studies targeting orthodontic professionals, several also using the BOS mailing list (Carneiro et al., 2022; Rehil et al., 2022; Meade et al., 2023; Ong et al., 2023; Prithiviraj et al., 2023).

Despite not achieving the target response rate, the limited resources of this project still favoured a survey instead of personal interviews, and the level of data gathered, particularly in the free text responses, have justified its use. Declining response rates to healthcare questionnaires have been noted more generally with concerns of an over-surveyed population (Cook et al., 2009). The BOS mailing list provides a very useful source of potential participants for orthodontic research, and is therefore regularly used for this purpose, but it is plausible recipients of these emails are increasingly less likely to respond and are an example of an over-surveyed population.

4.2.2 Limitations with specific questions in this survey

There were issues with some specific questions in the survey. The information collected around the employment and pay of OTs was both novel and interesting (p. 67). However, caveats and nuances cast some doubt over the accuracy of these data. For example, a respondent reporting that they were “100% primary care” does not make clear how many days per week they work, making it impossible to confidently approximate their full-time equivalent salary. This lack of detail is very likely the cause of some of the low salaries provided in this study, starting from £18000, which are more readily explained by clinicians working part-time. These errors could be avoided by asking participants about full-time equivalent working patterns and analysing pro-rata salaries where participants worked less than full time.

Incongruous data, or a lack of clarity in responses, also led to some data being discounted during the analysis. For example, when asked *when* SCs completed the MOrth qualification, multiple participants provided the location without the year. Percentage splits between NHS and private care, and likewise for primary and

secondary care, did not always total 100%. Finally, participants not uncommonly left at least one question unanswered, with one possible explanation for this being that the survey was too long.

4.3 Implications for future research

One of the major strengths of the questionnaire-based research of Dugdale et al. (2018) and Ahmed et al. (2018) was that despite aiming to only investigate the supervision and scope of practice of OTs, they were the first studies to examine more generally the self-reported working practices of OTs in the UK. Their research took place around eight years after the introduction of OTs to the orthodontic workforce in 2008. The landscape of orthodontic practice and the number of registered OTs has changed considerably in the seven years since the publication of their work, with the number of OT registrants more than tripling (General Dental Council, 2023c). Although research has since been published regarding the working practices and career aspirations of OTs (Onabolu et al., 2018), two major strengths of this survey are firstly the updated knowledge around the present employment, utilisation and supervision of OTs, and secondly the novel evaluation of the perceptions of both SCs and OTs about their working relationships.

However, it is certainly the case that the results of this survey generate more questions than answers, with this research forming the starting point for several different research avenues. Firstly, it is apparent that remote supervision of OTs is not uncommon, and this has developed without clear evidence that such an approach is safe and effective. The results of two early single-operator retrospective cohort studies have suggested that using DentalMonitoring for patients undergoing clear aligner treatment leads to a reduced number of appointments for a course of treatment when compared to face-to-face orthodontic reviews (Hansa et al., 2020; Hansa et al., 2021). However, both studies have a high risk of bias, do not involve OTs or their supervision, and only show a significant change in the overall number of appointments.

Most recently, a prospective study found a lack of consistency in repeated DentalMonitoring scans when recommending whether to proceed to the next clear aligner, and a lack of agreement between scans about which and how many teeth have issues with “tracking”, which refers to whether teeth are moving appropriately as the patient progresses through a series of aligners (Ferlito et al., 2023). Whilst this recent study focused on the current abilities of AI with remote monitoring technology, again it did not include the use of such technology when supervising OTs. There is clear scope and need for a body of research assessing not just the effectiveness, efficiency and quality of outcomes when using new technology that permits remote monitoring, but also the impact of using remote monitoring when supervising OTs.

Although SCs and OTs were not paired in this survey, it would be interesting to further explore the real or perceived differences in priorities of OTs and SCs in future research. It is not known what effect the alignment of goals and priorities between SCs and OTs would have on orthodontic clinical practice. It seems logical that it would lead to greater levels of teamwork and satisfaction amongst clinicians, perhaps leading to greater productivity. Organisational support theory research undertaken across the NHS has previously shown that greater levels of teamwork led to improved job satisfaction and engagement, which in turn positively impacted patient satisfaction (Ogbonnaya et al., 2018). Further research in this area could highlight the increased output possible through closely coordinating the aims of OTs and SCs. Similarly, it is possible that working relationships between SCs and OTs could be affected by interpersonal traits or other demographics. More formal qualitative research using interviews and focus groups of paired SCs and OTs would most effectively bridge this gap in knowledge.

Although the GDC will ultimately determine the limit of any expansion in the scope of practice of OTs, perceptions of the career progression available to, and desired by, OTs could also be qualitatively investigated. Alongside the limitations of their scope of practice, several experienced OTs reported feeling constrained in their career. As this avenue was not directly questioned further in this survey, it is not known whether this sentiment was more prevalent. It is possible that some OTs feel like they hit a professional cul-de-sac after a certain number of years, and qualitative research could

examine what OTs want from career progression. As suggested in this survey, career progression could relate to further clinical opportunities, but it is not known whether OTs also have interests in teaching and management.

In the postal survey by Onabolu et al. (2018), 80% of the 200 OT respondents considered the range of possible careers in dentistry to be an important influence for choosing a career within dentistry. As supported in the results of the current survey, they identified that orthodontic therapy provided an important avenue of career progression for dental nurses and highlighted that continuing educational opportunities may be necessary to maintain the generally high levels of job satisfaction of OTs at that stage. It is possible that dental nurses who train as OTs then wish to seek further professional development at a later stage, but struggle if there are currently no further options to formally progress after qualifying as an OT. Indeed, the final report of the Advancing Dental Care Review by Health Education England (2021a) recommended a need to improve the retention of all staff by offering, amongst other measures, “post-registration skills development opportunities”.

This links with a need for research into determining exactly what the NHS needs from the OT workforce. The Advancing Dental Care Review suggested that it would be good practice for OTs to be included in the multidisciplinary provision of orthodontics and devised a broad aim to determine how best to develop OT training roles to support efficient orthodontic services (Health Education England, 2021a). However, it is not known how many OTs are required in the future. Although the NHS Long Term Workforce Plan stipulates an increase in the number of training places for dentists and dental care professionals, specifically mentioning dental hygienists and dental therapists, references are not made to orthodontic therapists (NHS England, 2023). However, this may be due to the detailed dental development modelling outputs not yet being publicly available.

Finally, undertaking this survey several years after the initial studies by Ahmed et al. (2018) and Dugdale et al. (2018) has provided an important update into the current working practice of OTs. Given the relatively short history of OTs within the orthodontic workforce, it would be beneficial for surveys into the working patterns of

OTs to continue at similar intervals. This would not just determine shifts in the scope of practice and supervision of OTs, but also ideally identify discrepancies between existing demand and workload, and the ideal working practices of efficient orthodontic services, to allow more targeted training of OTs and continued professional development. Many of the implications for research mentioned above would favour qualitative approaches, but any research feeding into workforce planning would require reliable quantitative workforce data, notwithstanding the systematic problems of collecting such healthcare data in primary care (The King's Fund, 2015).

4.4 Implications for clinical practice

It is difficult to draw specific clinical recommendations from this questionnaire-based research, with the findings likely to feed into other more focused research questions which could then lead to new guidelines. Despite this, the finding that the priorities of OTs and SCs did not align is of relevance to those working in such professional relationships. It is likely to be beneficial for SCs and OTs who work together to have open discussions about what they feel is successful in their personal working relationship, and what could be improved. At the very least, this would coordinate the goals of colleagues in a clinical setting, which has the potential to improve the satisfaction and productivity of clinicians.

Comparing current practice against the average actual and 'sensible' supervision ratios reported in this survey may also be useful for SCs and OTs. If OTs felt they were not receiving adequate levels of supervision, and the number of OTs being supervised exceeded the median ratios reported by the respondents in this study, these results could provide a useful comparison and guide for them to discuss changes to their working practices. Conversely, if greater numbers of clinicians are routinely supervised in what all parties perceive as an effective working relationship, these examples of good practice could be analysed with a view to share learning with other clinicians providing orthodontic treatment.

The desire amongst some OTs and SCs in this study to expand the scope of practice of OTs should at least be reflected on during the development stage of any update to the GDC's scope of practice guidance (General Dental Council, 2023d). There appears to be a clear shift in the underpinnings of the draft of the new guidance (General Dental Council, 2023b). Whilst the current version focuses on providing the seven different professional dental titles with a near-exhaustive list of treatments and clinical procedures they are and are not permitted to complete, the draft guidance focuses on advising clinicians to complete procedures that are within their "professional competence" (General Dental Council, 2023b). According to the new document, competence can be developed pre- or post-registration, with post-registration training including:

- "*On-the-job training*"
- "*Mentoring or being mentored*"
- "*Gaining experience in practice, for example taking on new or different responsibilities under supervision*"

Therefore, the draft guidance states that the scope of practice for any dental professional will change over time, provided it stays within the "defined boundaries" of the professional title. Alongside continuing to work under the prescription of a SC, the only other stated boundaries of the OT role are that they:

> "*…do not undertake dental treatments that are not related to the provision of orthodontic treatment or carry out interproximal reduction*".

It could be argued that these more flexible boundaries could accommodate subtle changes in scope if new simple orthodontic procedures become available, without needing a full rewrite of the guidance. However, it is also true that if this new guidance was viewed cynically, it could be the case that clinicians wanting to push the boundaries of their scope may use this ambiguity as an opportunity to do so. For example, performing incisal edge enameloplasties could be interpreted as being related to the provision of orthodontic treatment. It is interesting that the only procedure which is specifically stated to not fall within the scope of OTs is IPR, possibly

acknowledging the push for this change from some clinicians, or the understanding it is already being performed by others.

5 Conclusions

Appointments with OTs were most likely to be supervised every other visit. However, SCs were six times more likely than OTs to report supervision being every visit, and OTs were more likely to report supervision every 3-5 visits. Most OTs (63%) reported being remotely supervised at least sometimes. In contrast, 73% of SCs reported that they do not supervise remotely. Some comments described the routine use of remote supervision and the use of AI-driven orthodontic monitoring software, raising questions about its safety, effectiveness, and efficiency in orthodontic supervision, which are largely unknown and warrant exploration.

Some procedures outside the GDC Scope of Practice (General Dental Council, 2013a) were completed by OTs. Most OTs felt that they should be permitted to perform additional procedures whereas most SCs reported that they should not. OTs felt SCs should be more readily available, should improve communication and that OTs should have more autonomy. SCs instead commented on preferring more time to supervise and provide prescriptions. OTs reported improved patient satisfaction as the main consequence of their utilisation, whereas SCs described improved clinical efficiency.

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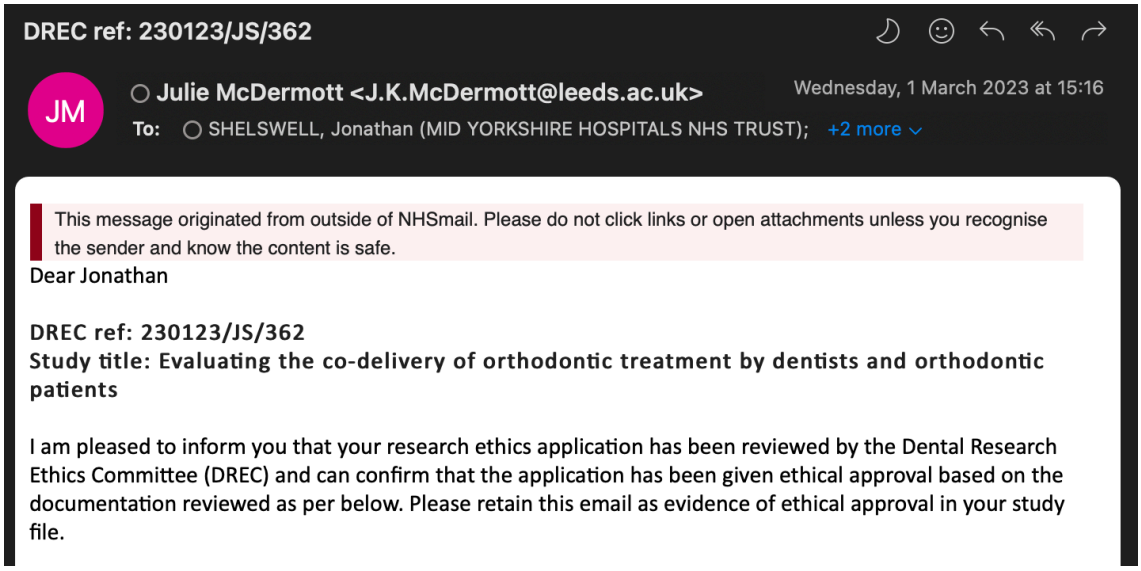
7 Appendix

7.1 Copy of ethical approval



DREC ref: 230123/JS/362

JM

Julie McDermott <J.K.McDermott@leeds.ac.uk>

Wednesday, 1 March 2023 at 15:16

To: SHELSWELL, Jonathan (MID YORKSHIRE HOSPITALS NHS TRUST); +2 more

This message originated from outside of NHSmail. Please do not click links or open attachments unless you recognise the sender and know the content is safe.

Dear Jonathan

DREC ref: 230123/JS/362
Study title: Evaluating the co-delivery of orthodontic treatment by dentists and orthodontic patients

I am pleased to inform you that your research ethics application has been reviewed by the Dental Research Ethics Committee (DREC) and can confirm that the application has been given ethical approval based on the documentation reviewed as per below. Please retain this email as evidence of ethical approval in your study file.