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Decision-making in the management of TMJ disc displacement without reduction: A qualitative study

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ABSTRACT

Objective: Patients with disc displacement without reduction (DDwoR) may suffer sudden-onset painful/limited mouth opening and immediately seek care from clinicians at the frontline. Currently, there is a lack of understanding of frontline, and specialist, clinicians' decision-making processes when encounter DDwoR patients. Understanding these processes and what influences them is an essential first-step towards the development of an evidence-informed behavioural intervention to improve first-line care of DDwoR patients. The objective of this study was to examine clinicians' decision-making processes in managing DDwoR and influences upon them.

Methods: A qualitative study informed by the Theoretical behaviour change Domains Framework (TDF) was conducted. The TDF-based topic guide was utilised in semi-structured interviews with a purposive sample of medical and dental frontline and specialist clinicians who might encounter patients with DDwoR. Interviews continued until data saturation across the theoretical domains was achieved (n = 21) and were analysed using the TDF to structure coding alongside framework analysis.

Results: The results highlighted the complexity of decision-making process and demonstrated the influences of all the domains on clinicians' decisions. Of the influential factors identified, the frontline clinicians placed most emphasis on their lack of: 'knowledge', 'skills', and 'experience' with DDwoR management.

Conclusion: The clinicians at the frontline showed high degree of diagnostic and management uncertainty and preferred to refer DDwoR patients early. The frontline clinicians displayed lack of knowledge, experience, and training to diagnose and treat DDwoR. There is a need to enhance the clinicians' knowledge and skills in managing DDwoR at the first-point of contact.

Clinical significance: The frontline clinicians showed unfamiliarity with DDwoR presentation and inability to diagnose and, consequently, treat DDwoR. This indicates that DDwoR patients may, currently, receive sub-optimal first-line care in the UK. Designing a behaviour change intervention informed by the identified theoretical domains can support the clinicians' decisions and improve patients' care.

1. Introduction

Patients with any type of Temporomandibular Disorders (TMDs) may seek care from a wide range of sources within both dental and medical specialities [1] and those with the subtype temporomandibular joint (TMJ) disc displacement without reduction (DDwoR) are no exception [2]. Acute DDwoR with limited mouth opening (closed lock) is, however, one of the most acute and objective presentations of all the types of TMDs often presenting suddenly without any warning and causing severe functional limitation and moderate to severe pain [3]. Acute DDwoR may, therefore, cause significant concern to those affected and understandably patients with acute DDwoR often immediately attend a primary care clinician or local emergency service ("frontline" clinicians) for management of a perceived significant problem [4]. Patients with acute DDwoR can be diagnosed clinically based on any combinations of the following characteristic signs and symptoms: history of clicking followed by sudden-onset TMJ pain and limited mouth opening (locking without clicking), impaired mandibular lateral movement towards the opposite 'unaffected' side, and deviation towards the same 'affected' side during mouth opening [3]; however, magnetic resonance imaging (MRI) may be required to confirm the clinical diagnosis [5]. Currently, the best available evidence suggests

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that patients with DDwoR should be treated promptly with non-invasive conservative interventions including simple self-management instructions and early mandibular manipulation [4,6,7] and most will have a good prognosis with increasing mouth opening and decreasing pain intensity over time [8,9]. There is, however, a lack of understanding of how clinicians make management decisions, and what factors influence these decisions, when patients present with acute DDwoR at the frontline of clinical care.

Clinical decision-making is a complex process involving a multitude of factors all of which can interact and lead to variability in the resultant decision [10,11]. Qualitative research can be used to examine the complexity of this process allowing the exploration of both the explicit and implicit aspects of decision-making and thereby generating an understanding of the process that is grounded in the clinicians' perspective [12,13]. The use of atheoretical frameworks in qualitative research may not reveal all aspects of decision-making process and may overlook important factors influencing clinicians' decisions, so called 'behavioural determinants' [14]. The Theoretical Domains Framework (TDF) is a framework based on a wide range of psychological theories that can be implemented in qualitative research to unpick and identify determinants (i.e., barriers and facilitators) of a clinical behaviour and to inform designing behaviour change intervention [15,16].

In utilising the TDF, the aim of this theoretically-informed qualitative study was to examine the decision-making processes of those healthcare professionals most likely to encounter acute DDwoR and to identify any factors influencing those processes.

2. Methods

2.1. Study design

This study is reported in accordance with the recommended Standards for Reporting Qualitative Research (SRQR) [17]. It employed a theory-informed generic qualitative health research approach to investigate and explore the decision-making process and influences on clinicians' decisions [18–20].

2.2. Ethics

Ethical approval prior to conduct the study was obtained from the Faculty of Medical Sciences Ethics Committee at Newcastle University, UK (FMS: EC 00632).

2.3. Sampling

The sampling strategy used was purposive, criterion-based, maximum variation sampling to ensure diversity in several characteristics and thereby gaining a depth and breadth of viewpoints from differing groups of healthcare professionals across various practice settings as follows:

- Frontline clinicians including General Dental Practitioners (new 'NGDP' < 5 years and experienced 'EGDP' ≥ 5 years), General Medical Practitioners (GMP), Emergency on-call General Dental Practitioners (ERGDP), and Accident and Emergency (A&E) junior, middle grade, and senior doctors.
- Oral surgery and MaxilloFacial Surgery (OMFS) junior, middle grade, and senior doctors.

The clinicians were identified from the relevant professional register and were invited to take part in the study using a standard invitation letter, with supplemental information provided via a participant information sheet. If individuals were interested in participating, a mutually convenient time was arranged for interview, with written consent being obtained prior to the interview commencing. Recruitment continued until data saturation across the theoretical domains was achieved (n = 21); that is, when no new determinants of decision-making behaviour across the theoretical domains were identified with further data collection.

2.4. Data collection

Semi-structured one-to-one interviews were utilized to collect the data using an interview topic guide structured around the TDF [15,16]. The topic guide was developed by the first author (MA) and its content validity was assessed (clinically and methodologically) by two authors (JD and VAS), in order to ensure that the questions adequately covered all the 15 theoretical domains of the TDF (the fourteen domains in the validated framework [16] plus the nature of behavior domain in the original framework [15]) around DDwoR management. The study took inductive and deductive iterative approaches to collect and analyze data and, accordingly, the topic guide evolved concurrently as interviews progressed.

All 21 interviews were carried out within a seven-month period in a clinical or academic setting, by a trained researcher (MA) who had no professional or personal relationships with the interviewees. Most interviews were conducted face-to-face (n = 18) with a minority conducted by telephone at the request and convenience of those participants. The interviews were recorded using a digital voice recorder and the audio files were anonymized using study numbers and transcribed *verbatim* by a professional company. To ensure the accuracy of transcription, each anonymized transcript was cross-checked against the original recording by the interviewer and then the audio recording was securely deleted.

2.5. Data analysis

Inductive and deductive iterative processes were used throughout data analysis following the principles of framework analysis [21] and guided by the TDF of behaviour change [15,16]. Framework analysis is a pragmatic, systematic, and flexible approach to analyse qualitative data inductively and/or deductively by multidisciplinary research teams and it is most appropriate for applied qualitative health research with a specific *a priori* question [22]. In this study, the TDF was used as the main coding framework and any emergent themes that were not adequately covered by the theoretical framework were assembled separately and the framework analysis was utilised to help organise the data and facilitate the analysis.

The interview transcripts were analyzed in seven stages: familiarization, line-by-line coding, matching codes into theoretical domains, generating the theoretical framework, identifying relevant theoretical domains, mapping the clinical decision-making processes of participants, and data interpretation [21,23].

All data collection and analysis procedures in this study were performed by the first author (MA) and cross-checked independently for validity at various stages by three authors (RG, JD, and VAS) thereby avoiding any potential bias in data interpretation. The study findings were then reviewed, discussed, revised, and finally agreed by all the study authors.

3. Results

Twenty-one clinicians (12 males and 9 females) practicing in diverse care settings across the Northeast region of England were interviewed in this study. The mean duration of the 21 interviews was 45.22 (± SD 14.86) minutes. The study sample involved 16 clinicians at the frontline, based in emergency or non-specialist community and primary care roles who might be the first-point of contact by patients having acute DDwoR and 5 clinicians based in oral and maxillofacial surgery specialist role who might be consulted for advice on, or be directly involved in, the management of an acute case of DDwoR. The characteristics of clinicians are detailed in Table 1 and can be cross-

Table 1
Characteristics of study sample.

Participants' characteristics*		Primary care			Secondary care	
Identification number	Range of years of experience	Emergency service Frontline clinicians	Community service		Emergency service	Specialist service OMFS clinicians
		ERGDP	GDP	GMP	A&E	
1	21-30	✓	✓			
2	11-20	✓	✓			
3	5-10	✓	✓			
4	< 5					✓
5	< 5		✓			
6	< 5				✓	
7	11-20			✓		
8	11-20			✓		
9	5-10			✓		
10	21-30		✓			
11	11-20					✓
12	11-20		✓			
13	> 30		✓			✓
14	< 5		✓			
15	< 5		✓			
16	5-10				✓	
17	21-30			✓	✓	
18	5-10		✓			
19	11-20					✓
20	11-20					✓
21	> 30					✓

Abbreviations: ERGDP: Emergency on-call General Dental Practitioner, GDP: General Dental Practitioner, GMP: General Medical Practitioner, A&E clinicians: Accident and Emergency clinicians, OMFS clinicians: Oral and MaxilloFacial Surgery clinicians.
*The sample included diversify in several characteristics: gender, qualification, dental school, time since graduation 'experience', practice setting, and practice region.

referenced to the references in parentheses following each quotation reported in the results section.

The clinicians' decision-making processes will first be presented in narrative form with illustrative supporting quotes starting chronologically from patient's presentation, through diagnosis, to treatment or referral and then the influences on these processes will be summarised by each theoretical domain.

3.1. Narrative of clinicians' decision-making processes

Patients with acute DDwoR, as for any other sudden-onset acute condition, may present to any clinician at the frontline care services, but the frontline clinicians in the study sample (GDP, GMP, and A&E clinicians), regardless of their working experience, generally felt *"uncomfortable"* (EGDP10) and appeared *"not familiar"* (EGDP18) with this presentation. In contrast, most specialist clinicians, regardless of their working experience or professional grade, reported being familiar with DDwoR presentation, *"that's a fairly frequent"* (OMFS11) and appeared relatively less concerned.

> *"I feel quite vague on it. I don't feel very knowledgeable on closed lock*[2] *specifically"* (ERGDP3).
> *"Usually these [DDwoR] patients have…a long-standing history of a clicking jaw and then one day it doesn't click, it just locks"* (OMFS11).

Interestingly though, when asked about the presentation of other acute TMJ problems (TMJ dislocation), many frontline clinicians appeared more comfortable with their knowledge and understanding of it, despite this is also being a rarely encountered presentation.

> *"No [I didn't encounter a TMJ dislocation case] but I know about the management of it… you have to put your thumbs on the occlusal surface of the lower molars and then manipulate the mandible backwards into place"* (ERGDP3).

This difference may be due to the focus of the curriculum in the UK dental schools, or to the existence of several conditions causing limited mouth opening [24] making its differential diagnosis challenging.

> *"I don't think we have been taught well [about DDwoR] but I think…if you're talking about the jaw locking there's always a lot of focus on the fact that oh it's most likely if it's kind of a really wide open lock then it's most likely to have been a dislocation"* (OMFS20).

An important disparity was also identified in diagnostic processes among the clinicians. The frontline clinicians expressed a high degree of diagnostic uncertainty and concern, whilst most OMFS clinicians suggested being able to initially diagnose DDwoR.

> *"Well you want to check their [DDwoR patients] background, their systemic history, you want to make sure they've not got something like quinsy or something. If that's ruled out and it does seem like TMJ and they can't open their mouth I'd be quite uncertain actually" (GMP9).*
> *"Well there may be clues in what they tell you that they may have had problems for a number of years, they may have had a clicking joint initially and then it stopped clicking and then they started to have problems opening"* (OMFS19).

This disparity between frontline and OMFS clinicians was seemingly mirrored in their reported initial treatment strategies for DDwoR patients, as OMFS clinicians could generally formulate a treatment plan, in contrast to those clinicians at the frontline:

> *"I was quite lost when she was locked. I was quite lost exactly what to do because she was in so much pain and…I couldn't physically do anything for her… I did feel a bit lost that I couldn't take her pain away"* (ERGDP2).
> *"Generally, I don't tend to find them [DDwoR patients] difficult to manage because I do have a sort of… set of measures that generally help*

[2] During the interviews, the terms 'closed lock' and 'DDwoR' were used colloquially indistinguishably but the clinical condition was explained to the interviewee as the symptomatic acute DDwoR associated with TMJ pain and limited mouth opening.

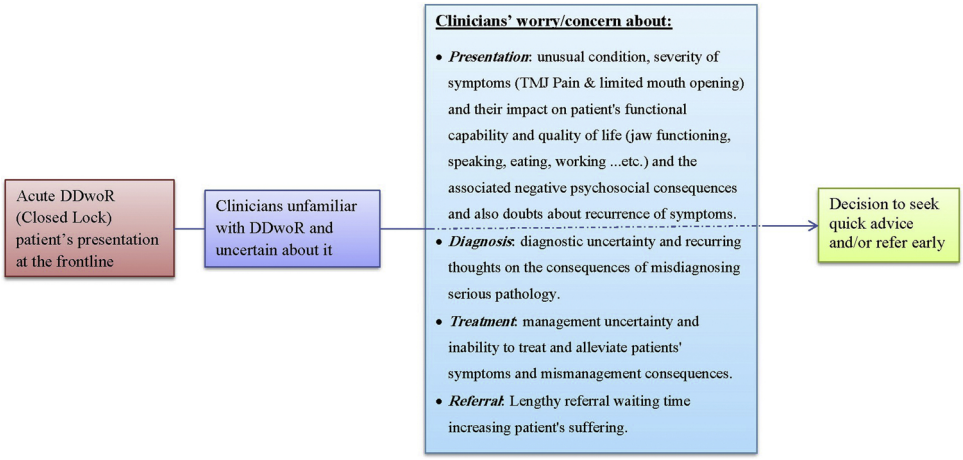

Fig. 1. Frontline clinicians' early referral decision process and its reasons.

people so I think when they first attend it's fairly straightforward to manage them" (OMFS4).

Instead, the frontline clinicians reported seeking phone advice and referring DDwoR early/urgently to secondary care setting to get direct support from a more experienced clinician. This referral urgency was seemingly mediated or influenced by clinicians' concern over the severity of pain and limited mouth opening symptoms and consequent patient suffering and negative impact on functional capability and quality of life.

"If there was something significant, erm particularly the patient couldn't translate [jaw] to something like thatwith the limited opening those would be the ones I would be most concerned about, the ones I would need to refer more quickly" (EGDP12).

All the expressed worries and concerns that led the frontline clinicians to make an early referral decision of DDwoR to secondary care are summarised in Fig. 1.

3.2. TDF-informed analysis of influences on clinicians' decisions

All 15 theoretical domains of TDF, in addition to the new theme emerged 'experience', identified as influences on frontline clinicians' decisions and a summary of the findings by domain is tabulated in Table 2 with the rows representing the findings by each of the domains and the columns representing data in these domains by phase of the clinical decision-making: diagnosis, treatment, and referral decisions. Of all the domains emerged as influences on clinicians' decisions, the TDF-based analysis revealed three 'core' barriers influencing the provision of initial management of DDwoR in frontline clinical care: clinicians' knowledge about disorder, experience with it, and skills required to diagnose and treat it.

4. Discussion

This qualitative study, to the research team's knowledge, is the first study that has used the TDF to explore clinicians' decision-making process in the diagnosis and management of DDwoR. The decision-making process varied among clinicians and appeared to be related to the individual clinician's familiarity with the clinical condition which, in turn, varied according to their role.

It has been suggested that the practice of decision-making improves the clinicians' performance over time [25] and therefore "experienced clinicians perform better than novices" [11]. From the analysed data, important disparities in decision-making processes between clinicians at the frontline of care (A&E, GMPs, and GDPs) and those providing a specialist (OMFS) care service are demonstrated which seem to be linked to differences in professionals' knowledge, skills, and experience with DDwoR. These differences appear to shape decision-making and care for patients with DDwoR and, consequently, the two groups of clinicians seemingly utilised completely different approaches in decision-making. The 'experienced' OMFS clinicians appeared to be able to recognise the pattern of DDwoR early and target particular information to diagnose 'DDwoR' by the pattern recognition decision-making approach [26]. In contrast, given their high diagnostic uncertainty and concerns regarding misdiagnosing a serious pathology, the 'inexperienced' frontline clinicians seemed to approach clinical decision-making by ruling out worst-case scenarios [27] or by using all the available resources in order to ascertain a diagnosis by an exhaustive decision-making approach [27]. The expectations of 'worst case scenarios' probably led the 'inexperienced' clinicians at the frontline of care to refer the undiagnosed perceived 'significant' condition early before establishing a definitive 'DDwoR' diagnosis. This 'rule of thumb' approach is simple heuristic decision-making, but it might not be the best decision and is known to be prone to bias in conditions of uncertainty [28].

This study has highlighted the complexity of factors shaping decision-making processes. All theoretical domains of the TDF we used, in addition to theme 'experience', emerged as influences on clinical practice, but of those, three in particular appeared qualitatively to be highly influential on clinicians' decisions at the first point of contact. These were primarily related to frontline clinicians' lack of knowledge, training, and experience in this less common disorder specifically.

Clinician knowledge is one of the key determinants of clinical decision-making process [29,30]. The lack of knowledge about DDwoR specifically among the majority of the clinicians at the frontline, including the GDPs in the study sample, can be potentially attributed to multiple reasons, including: the limited undergraduate teaching and training on the subject in the UK dental schools as compared to their European counterparts [31]; the use of the term TMD as a 'catch-all' diagnosis [32,33]; and the low incidence of DDwoR [34]. Interestingly, although the incidence of DDwoR is low it is comparable to that of TMJ dislocation [35,36] which many respondents reported knowledge in diagnosing and managing.

Making decisions in the face of acute clinical problems, however, does not rely solely on knowledge but also on clinicians' training and experience with these situations [37]. When encountering a new clinical condition, the clinicians often use their past clinical experiences in their decision-making process by comparing and matching the present encountered situation to previous experienced situations held in their memory in order to make a decision [25,37]. Most frontline clinicians in the study sample, however, had barely encountered a patient with acute DDwoR due to the low incidence of the condition.

Table 2
Summary of the influential factors, and their representative quotes, on frontline clinicians' decisions in DDwoR management.

Theoretical Domains and descriptions [a]	Quotes [c] representing the influential factors (theoretical domains) on clinicians' decisions in DDwoR management			Summary of findings
	Clinical decision-making process [b]			
	Diagnosis decisions	Treatment decisions	Referral decisions	
1. Knowledge: *The professionals' knowledge about DDwoR and its management.*	"Certainly, I don't know the difference between erm the subgroups of TMD so maybe that would be something and maybe how to treat each one slightly differently" (NGDP14). "I don't know if it's happening because of muscle spasm or because there is an internal derangement. That's where I'm not sure" (EGDP12). "I suppose it's a matter of er if something that the patient might say might trigger you into thinking oh maybe it's this and I'll ask a few more questions about this erm, you know, some of them might say 'I initially had a click and now I don't have a click anymore' and so that might make you feel that, you know, they've got disc displacement without reduction now" (OMFS19).	"I think again it's just the knowledge of it [DDwoR]. I think the main difficulties clinicians face is just they don't really know what treatment to provide for the different [TMD] conditions" (NGDP15). "I would generally try and give them a little explanation, erm maybe with some really terrible diagrams I draw and erm then we have a skull to hand so to try and explain the anatomy really and erm but if it was just a muscular thing maybe to discuss with them the things that they might be doing to erm them making the problem worse" (OMFS19).	"I don't understand what that term [DDwoR] is. I don't have insight into what that is and why that would be a subgroup of TMJ disorder" (GMP7). "I managed just to see her [a DDwoR patient] and with her I had to actually ring up the SHO on-call for maxfax [senior house officer in oral and maxillofacial surgery] to ask their advice because I was a bit lost on exactly what to do" (ERGDP2).	Most OMFS clinicians recounted knowledge about DDwoR management, whilst most frontline clinicians seemingly had no, or very limited, clinical knowledge about DDwoR and its management. This lack of knowledge exerts a major negative influence on frontline clinicians' decisions.
2. Skills: *The professionals' skills and competencies to manage DDwoR.*	"The one patient I did see, …had quite bad trismus and restricted movement so I wasn't sure whether it was [disc displacement] without reduction or with reduction" (ERGDP3). "The history from the patient and then examination findings have reduced it to a sizeable distance. I'd anticipate er there'd be some tenderness over the jaw joint, I'd anticipate a deviation towards the affected side on opening which may then erm correct itself on late opening but they would be the typical findings I'd expect to find" (OMFS11).	"I just feel we haven't really – I haven't been to any training that would, you know, that instantly tells me what to do if a patient had that [DDwoR]" (EGDP18). "With the closed lock, erm I think it would be – essentially I'd reassure them, I'd encourage them to continue with soft diet if they had muscle pain or if they had pain over the joint or the muscles I'd encourage them to use an Ibuleve or a topical non-steroidal gel on the joints and the muscles on the affected side. Erm and I suppose that would be my suggestion to them and because there may well be spontaneous resolution just with erm I think it's probably the time as much as anything else which may encourage that to settle" (OMFS11).	"This is [DDwoR] out of my area of expertise. I would refer them" (A&E/GMP17). "I think once you're getting down to the delivery of erm surgical therapy, be that minimally invasive in the form of arthroscopy or arthrocentesis or even joint replacement, I think it needs to be sort of 1 or 2 er individuals who have developed that as a special interest within their practice who manage it and it's for them to make the ultimate decisions if they think that's appropriate and erm to deliver that treatment. I think it's better that it's someone with a sub-specialist interest that does that" (OMFS11).	Most OMFS clinicians seemingly had the skills to initially diagnose and treat DDwoR, but most frontline clinicians seemingly did not possess diagnosis and treatment skills and this was linked back to lack of knowledge, experience, and training. This lack of diagnostic and treatment skills exerts a major negative influence on frontline clinicians' decisions.
3. Experience: *A 'conscious event' that is lived through, or undergone (rather than imagined or thought about), that stimulates the acquisition of knowledge and/or expertise/skills.*	"I've worked here [general practice] for…[> 5] years and we haven't come across anyone with that problem [DDwoR]" (EGDP18). "If it's either painful for them or they can't seem to open their mouth very wide then erm… I have come across those patients which haven't given it that name [DDwoR]" (GMP8).	"It's probably one of those ones like say I haven't come across a case like that [DDwoR] so erm my experience of it is limited and I would imagine even if you have come across a case like that in your career it's going to be one or two…so there's probably not going to be a whole lot of experience in it [to manage]" (NGDP5). "This is [TMJ dislocation] less common than the closed lock I would say" (OMFS11).	"From my point of view I've never seen it [DDwoR] so it's…difficult to then say 'oh this is what we do' and rather than to start with we can box it sometimes speaking to an experienced practitioner or [oral and] maxillo[facial surgeon]. and either send them in" (ERGDP1). "It's a condition [DDwoR] I have to admit I've never come across" (A&E16).	Most OMFS clinicians reported frequent experience with DDwoR, whilst most frontline clinicians seemingly had no, or very limited, experience with it. This lack of experience exerts a major negative influence on frontline clinicians' decisions.
4. Social/ Professional role and identity: *The professionals' perceived role, identity, responsibility, and limits or boundaries in managing DDwoR.*	"Well because you're the first, because you're in primary care, I think it is important that the [DDwoR] patient is aware of what's going on, that you're	"Yes [it's important to manage DDwoR in primary care] because I think, even though I haven't seen it in my day to day job, you know, I think we are going to get people	"That's probably the sort of patient [DDwoR] I'd ring the maxfax [oral and maxillofacial surgery] on-call about and just get advice as to whether it's something I	The OMFS clinicians perceived a responsibility to manage DDwoR, but those at frontline reported differing perceptions regarding their role and responsibility to manage DDwoR.

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Table 2 (*continued*)

Theoretical Domains and descriptions [a]	Quotes [c] representing the influential factors (theoretical domains) on clinicians' decisions in DDwoR management			Summary of findings
	Clinical decision-making process [b]			
	Diagnosis decisions	Treatment decisions	Referral decisions	
	reassuring them that there's nothing serious wrong" (NGDP14). "I think genuinely it would strike me as being such an unusual presentation [DDwoR] that actually, you know, a differential list of things that it may or may not be would be even less and I fear to say would be beyond my understanding of the situation such that I'd be saying 'listen I don't know what it is, that's the plan to somebody in secondary care'. So it's less missing diagnosis, it's more not having any idea what it is" (GMP7).	coming to us as their first port of call and I think we should be able to do something to them, be able to help them" (ERGDP2). "It's [DDwoR] a sort of specialist area which would need access to specialist investigations…and specialist treatments and so not the primary care" (EGDP13). "I am in a position where people refer to me for advice about what to do" (OMFS4).	should be referring on that day or what to do about it" (GMP9). "I think it's important that we then pick up the kind of [DDwoR] patient afterwards so obviously like with any area when you refer a patient they still come back to you on the practice isn't it, so we still need to understand it and reinforce whatever the specialist may say but as far as I'm aware I don't know anything specific that you could do in primary care but certainly like with any conditions we would then sort of review the patients afterwards and just see, you know, how they are managing" (GMP8). "I find that most of them are coming from almost tertiary referrals,…they've probably been seen by the general practitioner in the first instance then somebody else, then me" (OMFS21).	Frontline clinicians mostly perceived their role as 'generalists' and as such felt comfortable to treat the general, most common, mild TMD pain in primary care and refer acute DDwoR to be treated in secondary care and then be involved in continuing care, perhaps reflecting the way those frontline clinicians were trained to act; although a minority also expressed a desire to be able to institute simple initial management to help with symptoms relief at the first-line of care. This disparity in professionals' perceived role indicates that this domain can exert a positive or negative influence on frontline clinicians' decisions.
5. Beliefs about capabilities: *The professionals' perceived self-confidence and beliefs about their abilities to manage DDwoR.*	"I'm not sure what the subgroups are all called. I know that it all falls under the one umbrella of TMD but I'm not sure which subtype to put it under. So to diagnose TMD I'd be fairly confident erm but to put it into a subcategory I'd be less confident, yeah" (NGDP14). "I tend to usually carry out an MRI before I feel really confident [in DDwoR diagnosis] but I feel erm yeah that there are significant amounts of patients that I think that's what's happening, or I'm pretty sure that's what's happening, yeah" (OMFS19).	"I did feel a little bit helpless but there was very little I could actually do to physically help him [a potential DDwoR patient] at the time that that happened" (EGDP12). "I don't feel confident that I'd know what I'm doing" (EGDP10).	"[We refer DDwoR early] because we don't know much about it, erm and it's a limited experience in treating it. Erm so I guess it's the lack of confidence treating it really" (EGDP18).	Most OMFS clinicians were seemingly more confident in their ability to diagnose and treat DDwoR, whilst most frontline clinicians suggested they lacked belief in their ability to diagnose and treat DDwoR. This lack of confidence exerts a major negative influence on frontline clinicians' decisions.
6. Beliefs about consequences: *The professionals' beliefs about potential consequences of their clinical decisions as well as the disorder progress.*	"Obviously the first thing I would want to make sure is there's no pathology, it's not related to a dental pathology in bizarre conditions which you'll get trismus and I want to illuminate that before [saying] something like that [DDwoR] or TMD problem" (ERGDP1). "The initial presentation [of DDwoR]… could be any number of things that I would think are more important. I don't know how important, this sounds probably quite serious" (GMP9). "Erm you may do an MRI scan just to reassure yourself that there's nothing abnormal there" (OMFS4).	"I have, you know, dislocated jaws before erm [while] extracting teeth and I have been able to re-manipulate them but to do that on a patient that was already in pain erm I don't know. I would be very worried about making something worse" (EGDP12). "I think…you have to make people aware of the fact that it's erm not really an ultimate success having this sort of surgery. You have to make sure that they're very well aware of the pitfalls and the possible complications and they've got to go in with their eyes open" (OMFS21).	"I think it's probably important [to manage DDwoR in primary care]… because if they're going to be in an acute situation coming to me with limitation of opening and I'm going to be sending them away saying 'I'm not really sure what's going on here' and then they're going to have that huge 3-month wait to be seen, 2 to 3 month (s) it is" (EGDP10). "I think I've always had the view that a majority of patients with TMJ disorders can be managed conservatively but there will always be a minority that may require some surgical treatment and I think that basic philosophy has always underpinned my attitude towards it" (OMFS11).	Most OMFS clinicians were seemingly less concerned about managing DDwoR relative to frontline clinicians who articulated several concerns about consequences of their decisions: prognosis of DDwoR if not managed early; misdiagnosis; mismanagement; delayed referral. These concerns can exert a major negative (to refer early) or positive (to manage early and avoid lengthy waiting time of referral) influence on frontline clinicians' decisions.
	None [d]	"I think I will probably in the explanation make more reference to the disc and to what	"Obviously if somebody comes in with a locked jaw or erm, you know, really acute	Some frontline and OMFS clinicians seemed less optimistic regarding DDwoR patients'

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Table 2 (*continued*)

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	Clinical decision-making process [b]			
	Diagnosis decisions	Treatment decisions	Referral decisions	
7. Optimism: *The professionals' optimism/pessimism about DDwoR management.*		might be going on…and I would usually say that 'I think that we try this sort of conservative management first and we'll see it may be that we'll need to do some further treatment following it' whereas I think I'd try and be a bit more optimistic with the other [TMD] patients. I'm not sure if I'd do anything else at that initial stage of treatment planning but I guess I might have a lower expectation of improvement maybe myself… Just that [because] they've kind of got a definite physical problem [DDwoR] that can be difficult, very difficult to sort out" (OMFS19).	pain and sever trismus it can be very difficult. There's no magic quick fix that you can suddenly give them to improve that" (EGDP12).	response to conservative management in comparison to other common subtypes of TMD and this was linked back to their previous experience. This view seemingly exerts a negative influence on frontline clinicians' decision-making process in DDwoR management. That said, this domain seems unlikely to change the frontline clinicians' decisions to manage DDwoR because the majority had limited, if any, experience with DDwoR.
8. Reinforcement: *The professionals' perceived incentives or rewards, whether self-reward, social reward, material reward or health-system 'CPD' reward associated with managing DDwoR.*	"If I was working in a general practice I certainly want to be paid for it. Not that money's the be all and end all but when you've got UDA [Units of Dental Activity] targets to meet I think a lot of GPs are very guilty of 'I've only got 10 minutes to talk about this…at the end of an examination' because…realistically a general practitioner isn't going to bring that patient back for a review" (NGDP14).	"If you were a practitioner working in the NHS [National Health Service] there is no funding, you will be doing charity work if you got involved in these cases. It will be of no benefit. In fact, it would be detrimental financially to a practitioner to treat such cases" (EGDP13).	"There's no particular incentive. It's just I would want to treat them as I would any other patient. The incentive, I mean I do prefer not having to refer a patient so and obviously it's much better for the patient as well if we can manage them here [at the general practice] and they don't have to, you know, go through a long waiting list, so yeah I mean there's a lot of incentives, you know, that you don't have to refer a patient and you can treat them at the practice" (EGDP18).	Different forms of reinforcement were identified in this study that positively influence clinicians' decision-making behaviour, for example, social desire to help patients and resolve their complaints. Nevertheless, all the clinicians working in the NHS primary dental care reported a lack of financial incentives to manage patients with DDwoR, whilst this was not an issue for those working in secondary care. This lack of remuneration to compensate for the time required to manage DDwoR seemed to exert a negative influence on NHS primary dental care providers' decisions.
9. Intentions: *The professionals' intentions and intrinsic motivation to improve their knowledge and skills in order to manage DDwoR.*	"I think if I had a patient with the condition you mentioned earlier, disc displacement without reduction, I think if I saw more patients like that then that would influence me to increase my knowledge myself and try to manage them better" (NGDP15).	"I like doing practical manoeuvres. If it works for the patient the patient thinks it's wonderful, the doctor's a magician, he just did this and I was better, you know, and so learning practical manoeuvres that could help are very helpful" (A&E/GMP17).	"I mean I would quite prefer a bit more experience… I guess we should be trained on it a bit more and it would prevent needing that referral" (EGDP18).	Many clinicians had the intentions and intrinsic motivation to improve their knowledge and skills in managing DDwoR at the frontline and avoiding referrals. This intention exerts a positive influence on their decision-making process in DDwoR management. That said, this domain, seems unlikely to change the frontline clinicians' decisions to manage DDwoR because the majority were already motivated to manage the patients but their limited knowledge and skills were main barriers identified.
10. Goals: *The professionals' goal setting and action planning associated with the priority of importance for DDwoR management.*	"To relieve them of their pain and monitor them for progression or not" (ERGDP3).	"To get the patient sort of symptom free and to manage the condition" (GMP8). "I suppose, absolute success if I've got somebody who is free of pain, erm can eat what they like, can open as wide as they want and don't have a click. I suppose that's it in simplistic terms" (OMFS21).	"Obviously, we want to get the patient out of pain and…resolve that pain as quickly and effectively as possible" (NGDP5). "[The patient may] benefit from an earlier surgical intervention" (OMFS11).	Many clinicians set a goal of improving patients' symptoms within a specific time-frame and the majority prioritised the importance of early management for patients with DDwoR at the first-point of contact. Setting these goals exerts a positive influence on their decision-making process in DDwoR management. That said, this domain seems unlikely to change the frontline clinicians' decisions to manage DDwoR because most of them already aimed to manage and improve

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Table 2 (*continued*)

Theoretical Domains and descriptions [a]	Quotes [c] representing the influential factors (theoretical domains) on clinicians' decisions in DDwoR management			Summary of findings
	Clinical decision-making process [b]			
	Diagnosis decisions	Treatment decisions	Referral decisions	
11. Memory, attention, and decision processes: *The professionals' memory for, and attention to, DDwoR and their decision processes in DDwoR management.*	"The anatomical malalignment as they [DDwoR patients] open their mouth erm would make me think this is significant, I need to do something about this. Now whether I would remember which side it [jaw] deviated to or not that I couldn't tell you" (A&E/GMP17). "I suppose it's a matter of er if something that the patient might say might trigger you into thinking oh maybe it's this and I'll ask a few more questions about this erm, you know, some of them might say 'I initially had a click and now I don't have a click anymore' and so that might make you feel that, you know, they've got disc displacement without reduction now" (OMFS19).	"There's probably…different [TMD] conditions so there's with reduction and there's the one disc displacement without reduction. Erm gosh I'm trying to think of the name now… Erm there's with and without limited opening so there's 2 different types and then there's obviously all the arthritic problems as well" (NGDP15).	"I would need to ask advice [about DDwoR] and if I'm told to do something I will do it then I will remember it for next time. So, if that were the case then if it were possible I could remember it and do it next time" (A&E/GMP17).	DDwoR patients early at the frontline of care but their limited knowledge and skills hinder them from achieving these goals. Most OMFS clinicians were seemingly able to memorise and identify pathognomonic signs and symptoms of DDwoR when diagnosing it; but given their lack of training and very low exposure to DDwoR, all the frontline clinicians seemingly had difficulty recalling and identifying the pathognomonic signs and symptoms of DDwoR, which was reflected in their decision processes. This exerts a major negative influence on frontline clinicians' decisions.
12. Environmental context and resources: *The availability, accessibility, and functionality of resources as well as the environmental barriers and facilitators for DDwoR management.*	"I think clinicians just need to be taught better understanding of TMD conditions just generally and then a bit more specifically about…diagnosing the different conditions but I think the NHS contract doesn't allow time for clinicians to spend time doing all the different criteria that they do in a hospital" (NGDP15).	"I think it just depends if they [patients] pay… because if they don't want to pay for a soft splint then it's difficult to manage them to your full potential" (EGDP18).	"Often you need a lot of time spent just listening to them [patients] and often a GP doesn't have that time" (NGDP14).	Time and funding were reported as the main environmental barriers of primary care, and to a lesser extent secondary care, for DDwoR. These environmental factors exert a negative influence on primary care providers' decisions.
13. Social influences: *The social influences (social support or pressure) from other clinicians, patients, or organisations on professionals' decisions when managing DDwoR.*	"I'd probably have a go at making a [DDwoR] diagnosis given that I'd been guided by the dental hospital… I would have a go at the diagnosis but erm under guidance" (EGDP10). "[I] need to be confident on the [DDwoR] diagnosis and that again can be discussed on the telephone…[and] if I'm given clear instructions I will do what I'm told to do and if it works that's great and if it doesn't then I'll send them in" (A&E/GMP17).	"It's more getting advice [from secondary care about a DDwoR patient]. Erm, you know I'm very willing to give anything a go if the advice on the phone is right I want you to do this or do this or do this" (ERGDP2). "Most of the time people are pushing me to have something more done because they're fed up of it" (OMFS21).	"We have a forum here where we discuss patients we wish to refer and that inevitably triggers a bit of discussion about whether you've done everything before referring for a second opinion" (GMP7). "If there was something erm out of the ordinary that I was concerned about yeah, I would [discuss it with colleagues], especially with the people erm that work within the practice" (EGDP12).	Social influences from other clinicians, patients, or healthcare organisations were reported to provide either support or pressure and thereby encourage or discourage the management of DDwoR at the frontline of care. The professionals and patients' social influences and interactions can exert a positive (e.g., support from an experienced clinician) or negative (e.g., repeated patient attendance with continuing problems despite treatment) influence on the frontline clinicians' decisions.
14. Emotions: *The professionals' emotional responses (positive or negative), stress, fear, or burnout when managing DDwoR.*	"I was concerned that there was something seriously deranged in the joints, that was my biggest fear and that's why I wanted him [a possible DDwoR patient] to be seen erm because his joint was not moving, you know, as it should have been" (EGDP12). "I would be worry in the fact that I was uncertain of the [DDwoR] diagnosis and I would never sort of want to be sending somebody away with something like that if I didn't know what was going on" (A&E16).	"The amount of pain killer I gave I would be very wary about. Again, like I said with the patient with the jaw dislocation that had a reaction to the morphine… I'd be very worried about doing something like that with the patient with reduced mouth opening because of the difficulty there with intervention erm if they had issues" (A&E16).	"I think if…they're [patients] quite distressed about the condition, very worried erm that might push me a little bit more to refer…a bit sooner" (ERGDP2). "Actually, my first worry would be that they'll be [DDwoR patients] in a lot of discomfort and a lot of pain, affect their eating and, you know, general day to day things" (EGDP18).	Most OMFS clinicians appeared to be less affected by the severity of symptoms of acute DDwoR, whilst many frontline clinicians appeared to be affected by acute DDwoR's severity of symptoms. This difference seems related to interaction between the frontline clinicians' own emotions and self-doubt on how to act and the patient's associated pain and emotional manifestations leading them to refer early. This emotional effect exerts a major negative influence on frontline clinicians' decisions.

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Table 2 (*continued*)

Theoretical Domains and descriptions [a]	Quotes [c] representing the influential factors (theoretical domains) on clinicians' decisions in DDwoR management			Summary of findings
	Clinical decision-making process [b]			
	Diagnosis decisions	Treatment decisions	Referral decisions	
15. Behavioural regulation: *The professionals' self-regulatory processes that aim to change their behaviour as a result of specific behaviour change techniques (e.g., feedback) and that could lead to change or improve DDwoR management.*	"It's helpful [to receive a feedback from secondary care] to know if a diagnosis has been made erm and I need so that from my learning experience that, you know, matching the symptoms to what the final diagnosis was" (EGDP12).	"Definitely [important to receive a feedback from secondary care], yeah …to know the treatment that they are providing, so that might help in the future to manage the patient who is having the treatment there, so it would be helpful to know what to do in a primary care setting in terms of long-term management of that patient or just to know what to do if it happened again or you came across someone else that it happened to" (EGDP18).	"I think if it's possible [to get the feedback] yeah [it's important]. Both for my own education so I can remember next time to refer earlier, later, try something else first, but also just in terms of continuity of care, to know what the patient's being told and those sorts of things" (A&E/GMP17).	Many OMFS clinicians showed experience in dealing with DDwoR patients due to their frequent exposure to cases of DDwoR, but those at the frontline showed lack of experience due to relative rarity of DDwoR patients' presentation. All the frontline clinicians, however, had the motivation to receive feedback from secondary care about their referred patients and how they are progressed and managed for their own-learning or self-education and the majority had also intrinsic motivation to change and improve their practice. This can exert a positive (e.g., receiving feedback on patient progress and potentially increasing knowledge) or negative (e.g., not getting this feedback, aligned with a lack of growing experience effect to shape knowledge and develop skills) influence on frontline clinicians' decisions.
16. Nature of behaviour: *The nature of professionals' behaviour in DDwoR management.*	"I think in my head it seems a more serious condition [DDwoR]. Erm I think it's affecting the patient's day to day life a lot more rather than the former [TMD]" (NGDP14). "[For] the other [TMD] conditions people are in pain but they're not in as much pain. Generally, on a scale they're on a scale of about five out of ten as a kind of pain, the ones we see in practice but this lady [referring to a DDwoR patient] she was ten out of ten, she was an absolute agony" (ERGDP2).	"[I am] not as confident [to manage DDwoR] as other forms of TMD…with normal opening just with pain… Erm if there's somebody with a closed lock it's almost like the condition has gone just that one step further erm so I think I would be more inclined to refer those patients sooner rather than later into hospitals, into secondary care" (NGDP14).	"I mean obviously if they've got painful mouth opening and like an affected ability to eat and erm make the pain worse…it would probably make me want to refer them earlier than just someone with TMJ pain but with normal mouth opening… Erm just because I feel that I can offer something to TMJ, you know, in terms of pain relief and so on whereas this is sort of pain as well as not being able to open their mouth so I just feel that I can't offer anything so, you know, then I would refer earlier" (GMP8).	The nature of the specific set of behaviours that clinicians had to perform in order to manage the presentation of DDwoR seemed to differ considerably depending on clinicians' familiarity with the type and severity of clinical situation thereby impacting on their decision-making processes. Most OMFS clinicians seemed able to diagnose and treat, at least initially, a patient who presented with acute DDwoR. Most frontline clinicians seemed to try to diagnose and treat, at least initially, a patient who presented with the more common 'chronic' and mild TMD subtypes before making a referral decision, but they appeared to experience a high degree of uncertainty if they encountered a patient with the less common acute and severe DDwoR and reported they were more likely to seek an urgent advice and make an early referral decision.

[a]The rows represent the summary findings by each of the domains.
[b]The columns representing data in the domains by each of the three phases of the clinical decision-making: diagnosis, treatment, and referral decisions.
[c]The quotes in the table are representative of the qualitative data and other than the addition of words in squared brackets [] to help with context or clarity, or shortening of quotes indicated by "…" for the sake of brevity, no alterations to quotes have occurred and all still retain the same meaning as intended by the participant. At the end of each quotation, acronyms in parenthesis are used referring to practitioner's type and practice setting as well as participant's reference number as clarified in Table 1.
[d]Some domains did not express themselves as relevant at one of the decision-making stages.

The lack of frontline clinicians' experience with DDwoR coupled with their limited knowledge and training (i.e., skills) seemed to impact in an inter-related manner between theoretical domains leading to an early decision for referral when presented with a patient having acute DDwoR. The intimate relationships between the theoretical domains indicate that all the domains can have an influence on clinicians' decision-making processes when managing DDwoR, but that their influential strength on clinicians' decisions can vary.

This study, as with any other qualitative-TDF study, had limitations related mainly to study design, methods used, and sample recruited. First, the sample recruited was diverse and included key professional groups responsible for DDwoR management at the frontline and specialist services, but other specialities potentially involved in DDwoR care such as: oral medicine and restorative dentists, physiotherapists, and ENT physicians were not included which may bias the qualitative data as these specialities may have differing management ideologies to surgeons [38]. Second, sampling was restricted to the Northeast area of England which may limit the generalizability of study findings elsewhere; although there are no reasons to assume that training and practice are any different across the UK. Third, data collection was performed using two modes of interview: face-to-face and telephone. Nevertheless, this did not significantly affect the data collected and may have helped avoid sampling bias due to some advantages of telephone interviews [39]. Fourth, as this is a qualitative study, the findings from data analysis regarding the identified influences on decision-making represent only the participants' perceptions and views about what might influence their clinical decisions and may not always reflect the actual influences on their behaviour in clinical practice; for example, the reported ability/inability of clinicians to diagnose and manage DDwoR may, in reality, reflect the clinicians' level of interest in TMDs/DDwoR management and may not always mirror the clinicians' actual practice. Lastly, the use of TDF as a guiding theoretical framework for data analysis, despite its comprehensiveness and inclusiveness, may be criticized for restricting the emergence of 'free' themes and omitting other aspects of clinical practice and experience; to circumvent this, open (unrestricted) coding was performed initially, and after comprehensive analysis and comparisons of data, one new theme not covered by the TDF emerged. Other research methodologies and data collection methods can be also used, for example quantitative methods, but the semi-structured interview method enabled the research team to explore 'in-depth' the relevant factors influencing the clinicians' decisions. By using a framework based on a wide range of psychological theories, the method helped provide new information about influential factors on clinicians' decisions that may otherwise be overlooked if the TDF was not used.

In summary, this study provides understanding of decision-making process in DDwoR management and identifies general domains (i.e., behavioural determinants) influencing frontline clinicians' decisions. This initial work is an essential first-step to help inform the design of a behaviour change intervention. The identified factors, as informed by theoretical domains, can be linked to relevant behaviour change techniques [40] to be subsequently targeted and implemented in future intervention design in order to support frontline clinicians' decisions in DDwoR management and, ultimately, improve first-line care of DDwoR patients.

5. Conclusion

The clinicians' decision-making processes for DDwoR management varied among clinicians. The clinicians at the frontline, in contrary to those at the specialist service, showed a high degree of diagnostic and management uncertainty. The clinicians' decisions were influenced by numerous factors, but of the influential factors identified, the most emphasised by frontline clinicians were their lack of knowledge, training and experience in diagnosing and treating DDwoR. There is a need to enhance the professionals' knowledge and skills in diagnosing and managing DDwoR to circumvent limitations in professionals' experience. Nevertheless, all the factors identified represent theoretically-based targets for designing a behaviour change intervention that can support, and thereby improve, the clinicians' decisions around DDwoR management at the first point of contact.

Authors' contributions

All authors contributed to this project. RG, JD, JS, and VAS were theoretical, methodological, and clinical advisers of this project. Project idea and study design conceived by MA, JD, and VAS. Study protocol designed by MA and developed and revised by JD and VAS. Ethical approval process organized by JD and obtained by MA. Sampling and data collection accomplished by MA. Data analysis and interpretation conducted initially by MA and cross-checked independently by RG, JD, JS, and VAS. The manuscript drafted and prepared by MA and critically appraised and revised by RG, JD, and VAS. Those authors read the final version of the manuscript and approved it for publication and agreed for all aspects of the project.

Declaration of Competing Interest

The authors declare that there are no potential conflicts of interest with respect to the authorship and/or publication of this article.

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