Perceptions of community healthcare workers on the use of teledentistry for seniors in Singapore: A qualitative study

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Abstract

Objective: This study aimed to identify barriers and facilitators surrounding the implementation of TDOCS from Community Health Workers (CHW)'s perspective before TDOCS implementation.

Methods: A descriptive qualitative study was conducted through semistructured interviews with a purposive sampling of CHWs from partner nursing homes and home care teams. A French framework outlining barriers to asynchronous oral tele-consultation adoption was used to develop the topic guide for this study. Then, the Consolidated Framework for Implementation research (CFIR 1.0) was used to guide coding and analysis.

Results: A total of 43 CHWs from participating institutions were interviewed prior to receiving teledentistry training. Perceived barriers included low awareness about the importance of dental care, limiting conditions to T-DOCS participation among beneficiaries, limited understanding of T-DOCS, perceived low self-efficacy among CHWs, manpower shortages, perceived low priority of dental care, competition with other nursing duties and restricted access due to COVID-19. Facilitators included existing relationships between CHWs and beneficiaries, receptivity towards participation, CHWs' motivation to upskill and improve dental care for seniors, prior experience with other telemedicine technology, perceived need for change, supportive management, colleagues and existing impediments to access dental care.

Conclusion: This study identified barriers and facilitators to implementing T-DOCS from the CHWs' perspectives. We recommend for targeted CHW training, programme champions, workflow integration and incentivisation schemes. Addressing challenges like manpower strain and resource limitations through efficient scheduling and capacity building is vital for sustainability. Policy-level support, including legal frameworks, funding and regulatory structures, is essential for integrating teledentistry into mainstream healthcare.

Keywords

Teledentistry, seniors, community health workers, oral health, digital heath

Background

Oral health care in Singapore

Oral health is crucial for seniors' overall well-being, as maintaining good oral hygiene prevents diseases that impact quality of life.[1] In Singapore's aging population, oral healthcare is provided by both public and private

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sectors. While dental care is prioritised in geriatric settings, unmet dental needs remain high.[2,3] However, a high level of unmet dental health needs among seniors remains.[4] The 2019 Singapore national adult oral health survey revealed that 12.5% of community-dwelling seniors (>60 years old) had complete tooth loss and 64.3% had fewer than the 21 teeth required for adequate function.[5] Regular dental screenings are key for early detection and better outcomes[6,7] yet service utilisation among seniors is low due to disability, perceived inconvenience and lower prioritisation of oral health.[8,9]

Over the years, community- based geriatric care services including home care services, nursing homes (NHs) and centre-based services have grown significantly in Singapore. As of 2021, 2.5% of Singaporeans seniors reside within NHs.[10] Nevertheless, dental services remain poorly integrated into healthcare, forcing homebound seniors and NH residents to rely on off-site dental care. This poses significant challenges due to physical and resource consuming logistical constraints.[4] As a result, 41% of NH residents were reported to have complete tooth loss and 59% suffer from tooth decay cause by poor hygiene and ill-fitting dentures.[11] Dental care in NHs is often inconsistent, relying on unsustainable volunteer efforts. Despite basic dental protocols, staff non-compliance – due to limited skills and knowledge, along with financial and facility constraints, further exacerbate the significant gap in dental care for seniors.[8]

Teledentistry: a potential to address oral health gaps in Singapore

Teledentistry, a subfield of telehealth focusing on dentistry has been demonstrated to be effective for making dental referrals, treatment planning and monitoring dental treatments.[12,13] It leverages on information technology to facilitate remote dental care, advice, education or treatment rather than direct face-to-face communication.[14,15] Introduced in 1994, it operates through two common modalities; (i) synchronous (real-time) and (ii) asynchronous (store-and-forward) assistance. The synchronous modality involves a live interaction between the provider and the patient, caregiver or practitioner via audio-visual communication. Using asynchronous assistance modality, patient data, images or videos, is sent for later review and diagnosis, reducing the need for real-time interaction between provider and patient.

In geriatric settings, teledentistry has been shown to be highly feasible with excellent accuracy for the diagnosing dental diseases, assessing chewing ability and rehabilitation status among NHs residents.[16,17] Furthermore, It reduces waiting times, travel and costs for high-risk seniors while enhancing dental education for staff and families.[16] Successfully adopted in Australia,[18] United States[19,20]

and France,[21] teledentistry offers significant opportunities for improving oral care access in Singapore.

Tele-dentistry supported oral care for seniors (T-DOCS) programme

The T-DOCS programme trials teledentistry to improve oral care access for vulnerable seniors, including those homebound or in NHs with mobility and cognitive challenges in Singapore. Over two years, it builds the capacity of CHWs through training and support. Using an intraoral camera with fluorescence technology, trained staff capture oral images, upload them to the secure e-DENT platform and enable remote dentist assessments for diagnosis and treatment planning. The platform also tracks follow-ups. CHWs received training through lectures and workshops to perform oral scans and provide daily assisted oral care for NH residents, while home medical teams trained caregivers of homebound seniors. Participants were monitored every six months and given oral hygiene and denture care packs. Community partners included three NHs and one home medical service provider.

Despite the potential of teledentistry, successful implementation of teledentistry is complex[15,22]. Integration of teledentistry into mainstream dental health system is noticeably slow,[23] influenced by stakeholders' perception of 'implementability' – the likelihood of an intervention to be adopted into routine practice and consumer behaviours across setting and timing.[24] Therefore, assessment of implementability is essential to identify care gaps, optimise resources and develop strategies to improve patient dental car.[24] Additionally, understanding contextual factors allows for necessary adaptations to ensure that an intervention fits well into its specific environmental context.[25]

As Singapore's first community-based teledentistry programme, T-DOCS lacks context-specific insights for its effective implementation. Therefore, assessing implementability and relevant contextual is crucial. This study aimed to identify barriers and facilitators surrounding the implementation of TDOCS from CHW's perspective before TDOCS implementation.

Methods

Study design and conceptual framework

A descriptive qualitative study was conducted between January 2021 and January 2022, prior to the commencement of TDOCS. Pre-implementation assessment is expected to provide valuable insights to navigate challenges, improve communication and increase the likelihood of successful implementation.

A French framework outlining barriers to asynchronous oral teleconsultation adoption was used to develop the topic guide for this study (unpublished). This framework

described barriers related to financial, technical, time, psychological, social, legal, organisational and change processes that were identified through semi-structured interviews, document reviews and non-participant observation of teleconsultation activities and project meetings.

The Consolidated Framework for Implementation research (CFIR 1.0) was used for guiding coding and analysis. The CFIR was designed as a practical guide to systematically determine factors that influence the implementation of any intervention at various level. The CFIR was adopted as a guiding framework for analysis as it nicely covers the aspects of questions listed on the topic guide and has been widely used in assessing determinants of implementations across a range of healthcare interventions[26–30]. Comprised of 5 domains – participant characteristics, innovation characteristics, inner settings, outer setting and processes and 39 constructs, CFIR has been found to be associated with effective implementation. Annex 1 provides the adapted definition of the domains and constructs of CFIR 1.0 used in this study as codebook. In addition to coding and analysis, CFIR was used to categorise results and implementation lessons learnt.

Table 1. Mapping of interview questions to CFIR domains and constructs.

Interview guide question	CFIR domain	CFIR construct
What do you think about the project?	Characteristics of CHWs, Innovation Characteristics	CHWs' Knowledge of T-DOCS, CHWs' motivation, Relative advantage of T-DOCS
How do you think patients will react to this device? Do you think you will prepare them anyway?	Characteristics of Beneficiaries, Characteristics of CHWs	Beneficiaries' relationship with CHWs, CHWs' self-efficacy
Which are the disadvantages in your opinion? For you, for the facility, for the patient	Characteristics of CHWs, Innovation Characteristics, Inner Setting	CHWs' Knowledge of and Attitude towards T-DOCS, CHWs' self-efficacy, Implementation climate, Compatibility of intervention with existing context
How do you see this project compared to your traditional profession? Your tasks? Your role?	Characteristics of CHWs, Inner Setting	CHWs' Knowledge of T-DOCS, Implementation climate, Compatibility of intervention with existing context
Would you say that this type of project is favoured in your organisation or not? Rewarded? In what way?	Inner Setting, Innovation Characteristics	Implementation climate, Culture of organisation, Relative priority of T-DOCS

Study participants

A purposive sampling of CHWs from the participating community partners were included in this study. Sample size was initially estimated based on the number of CHWs identified by each partner institute and eventually determined by saturation. CHWs identified as the staff to be involved in T-DOCS were invited to participate in an interview through their respective centre managers and programme leads. Upon referral, participant eligibility was confirmed by study team members. Only those who speak English and able to provide informed consent were recruited. While invitations were extended to potential respondents through their respective leaders, interview sessions were arranged independently by the study team.

Data collection

Qualitative data was collected through a one-time semi-structured interviews with CHWs who were identified as key actors to be involved in implementing T-DOCS from partner NHs and home care teams. All eligible CHWs who were invited agreed to participate in the interviews. An interview guide was developed based on the French framework which investigated the factors influencing the adoption of telemedicine in dentistry.[31] Written informed consent was obtained from every participant before the initiation of interviews. During every interview, CHWs' perceptions of T-DOCS and its feasibility of implementation in their respective organisations were explored. Researcher/innovator with experience in conducting interviews related to teledentistry, RP (Male, PhD) led and assisted by a dentist, CPCS (Female, BDS) in the conduct all interviews through Zoom platform before commencement of CHWs' training. Interviews were conducted with no other party involved, lasted between 20–70 min and were audio recorded. Notes were also taken during interviews. Interviewers were not mutually acquainted with participants however participants were aware that CS is a part of T-DOCS. To maintain rigor, regular meetings were held for debriefing and refining questions based on insights

gained from previous interviews. Data saturation was achieved and used to guide the eventual sample size. Recordings were transcribed verbatim and transcripts were checked for accuracy by the study team before coding and analysis. Transcripts were not returned for participants for checking nor did participants provided feedback on study findings.

Data analysis

MN, EH, RP and CPCS coded data using NVivo (California) guided by the CFIR 1.0 as the primary coding framework. Initially, to ensure the suitability of CFIR1.0 and identify relevant CFIR domains and constructs to include in the initial codebook, each interview question was mapped to applicable domains across CFIR as illustrated in Table 1. Initial codebook was tested and refined based on trials on 4 transcripts before being fully applied across all transcripts. Analysis was conducted in two steps. First, transcripts were coded deductively according to constructs defined by CFIR. Then, using content analysis as typically adopted in analysis guided by CFIR,[32–34] quotes were rated by MN and EH as barrier or facilitator based on a modified rating rule[26]. Constructs identified

Table 2. CHWs' characteristics (n = 43).

	N (%)
Gender	
Female	31(72.1%)
Male	12 (27.9%)
Role	
Staff Nurse	13 (30.2%)
Enrolled Nurse	9 (20.9%)
Nurse Manager	8 (18.6%)
Nursing Aide	6 (14%)
Healthcare Assistant	3 (7%)
Nurse Clinician	2(4.7%)
Doctor	2(4.7%)
Setting	
Nursing Home	36 (83.7%)
Home Medical Care	7 (16.3%)

by majority of CHWs (>50%) to have either positive or negative influence over the implementation of T-DOCS were considered as facilitators and barriers respectively. Findings were categorised into the four CFIR domains: (1) characteristics of individuals, (2) innovation characteristics, (3) inner setting and (4) outer setting. As data was collected prior to the implementation of T-DOCS, the domain of 'process' was not examined. The French framework was not explicitly applied during the analysis because CFIR includes the domains addressed by the French framework, offering a more comprehensive approach for analysis. To ensure rigor, regular meetings were conducted to discuss emerging themes and reach consensus on coding.

Results

A total of 43 CHWs from participating institutions were interviewed prior to receiving teledentistry training. As described in Table 2, majority of these CHWs (76.7%) were involved in nursing care at varying levels of seniority (e.g. healthcare assistants, nursing aides, enrolled nurses, staff nurses, nurse clinicians). Majority (83.7%) of CHWs were from NHs, while the remaining CHWs were from the home medical care services. We did not find any differential impact of participants' roles on identifying barriers and facilitators.

We identified 12 CFIR constructs to be relevant to implementability of T-DOCS and related contextual factors. Figure 1 provides a summary of our study findings, which are organised into four CFIR domains, described below.

Individual characteristics

Within this domain, we sub-categorised our findings into CHWs' and beneficiaries' characteristics.

Characteristics of CHWs

Community healthcare workers were found to have a mixed view about T-DOCS. CHWs' limited understanding about T-DOCS and perceived low self-efficacy were found to be potential challenges for implementation. Meanwhile, CHWs' receptive attitudes towards teledentistry and motivation were identified to be beneficial for implementation.

Barrier: limited understanding of T-DOCS and perceived low self-efficacy. Community healthcare workers highlighted their feelings of apprehension towards the commencement of T-DOCS. Although they were nominated to receive T-DOCS training and would subsequently oversee implementation within their respective settings, many of them expressed little or no understanding as to the nature or objectives of T-DOCS, other than the fact they were to be involved in it. This caused them to feel worried on
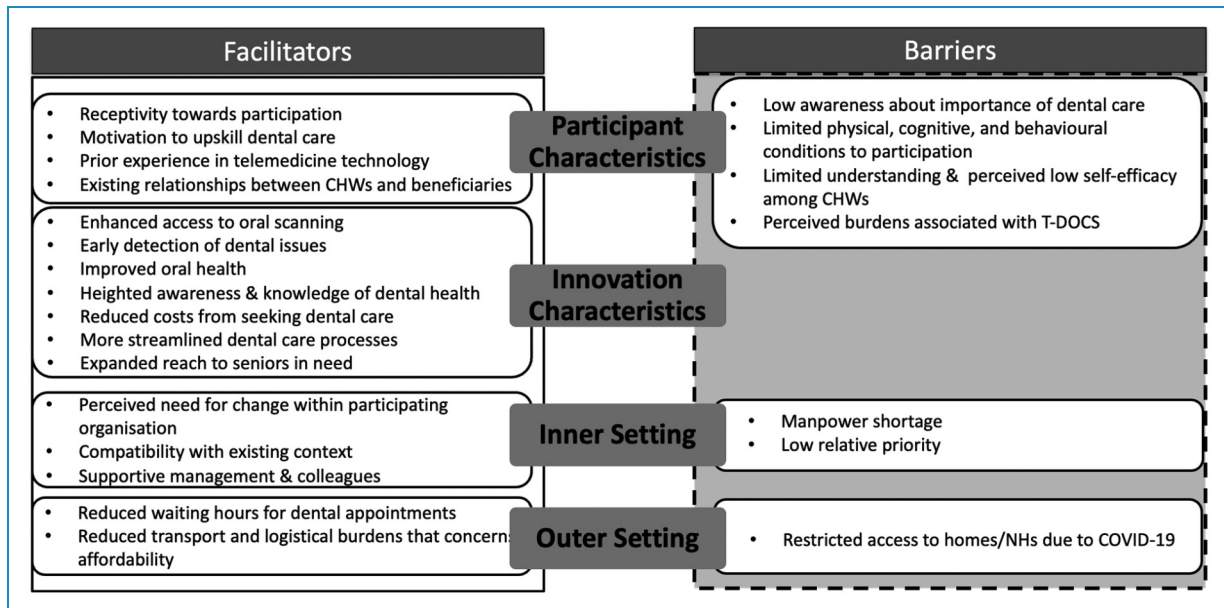
Figure 1. Facilitators and barriers surrounding the implementation of T-DOCS from CHW's perspectives.

whether they have sufficient required knowledge. Furthermore, this anxiety was compounded by the fact that many CHWs lacked exposure to dental care, even more so about teledentistry. Being expected to engage in an unfamiliar field, as well as handling what was perceived to be complex, state-of-the-art dental equipment, was deemed 'challenging' and something that was beyond CHWs' capabilities.

> … about this T-DOCS, [it] is my first time to hear [about it]. I think few weeks ago, one of our enrolled nurse just informed me to be part of the team…But honestly, I don't have any idea about [it]. (Nursing Aide, Nursing Home)

> … I'm not competent enough to do because I really don't know what they're going to do. We haven't been trained. So, yah, so I'm not very sure. (Assistant Nurse Clinician, Home Care)

Facilitator: receptivity towards participation. Despite these concerns, CHWs were generally receptive towards participating in T-DOCS and expressed a sense of acceptance that they would just have to 'adapt and learn'.

> not all of us are technology savvy [but] as long as we are taught on how to do, maybe we will be able to adapt and learn. (Staff Nurse, Nursing Home)

Facilitator: CHWs' motivation to upskill and improve dental care for seniors. Community healthcare workers demonstrated eagerness to engage in T-DOCS, with some

willingly volunteering. The primary motivation for most CHWs stemmed from the anticipated positive outcomes of T-DOCS for the oral healthcare of seniors under their supervision. At a professional level, they viewed participation in T-DOCS as an opportunity to acquire 'new knowledge and skills' that could potentially help to advance their careers. Collectively, these factors contributed to their motivation.

> as doctor[s] and nurses, we always [think] for the benefit of the patient so when we know that the patient is going to benefit from these, I think we'll be happy to do it… especially our homecare nurses because they enjoy this work, that's why they are in the community (Doctor, Home Care)

> The upside is with teledentistry, nurses will learn new skills in terms of oral assessment and using the imaging technology. They will learn a lot of knowledge about oral health. Generally, they are nurses who are trained in everything but not specialist in oral health (Senior Nurse Manager, Nursing Home)

Facilitator: prior experience with other telemedicine technology. We observed a variable range of self-efficacy levels among CHWs, influencing their attitudes towards T-DOCS. Numerous CHWs interviewed conveyed uncertainty about their ability in conducting intra-oral scanning, citing a lack of prior knowledge and experience with teledentistry platforms. Conversely, some CHWs embraced T-DOCS with confidence, drawing on their past experience

with other telemedicine technologies, which they equated to the T-DOCS platform.

> Because the speech therapist also doesn't come in the nursing home; we are doing teleconsult also. So, I think it's like same also in doing the T-DOCS. (Enrolled Nurse, Nursing Home)

Characteristics of beneficiaries

From providers' perspectives, we found (i) knowledge and beliefs about T-DOCS and (ii) individual stage of change associated with limiting conditions of beneficiaries to be significant barriers to implementation of T-DOCS. Meanwhile, existing relationship between beneficiaries and CHWs was as expected, identified to be beneficial for the implementation of T-DOCS.

Barriers: low awareness about the importance of dental care among beneficiaries. According to CHWs interviewed, a notable lack of awareness regarding the importance of dental care among beneficiaries and their next-of-kin (NOK) was observed. Compared to physical health, oral care was perceived to be of less importance among beneficiaries and their NOKs, leading to a lower priority being placed on dental care. This lack of prioritisation is expected to pose challenges for obtaining consent from individuals to participate in T-DOCS.

> … I seldom hear them saying that, you know, they are going for a dental treatment… some of the family members, when you ask them, they will like, "I think it's not necessary"… As long as there is no pain, they will just leave it. (Nurse Manager, Nursing Home)

Barriers: limiting physical, cognitive and behavioural conditions to T-DOCS participation. The implementation of T-DOCS was expected to face challenges due to individual stage of changes associated with illness-related limitations of beneficiaries. As many seniors are bed-bound and non-communicative, CHWs anticipated difficulties in getting them to open their mouths for scanning. Additionally, the prevalence of dementia among seniors, often accompanied by cognitive decline and behavioural issues were identified to likely pose challenges in communication and securing cooperation from this group. Community healthcare workers reported encountering obstacles in getting beneficiaries to cooperate due to unpredictable fluctuating moods and previous resistance to dental care while attempting to establish oral hygiene practices. Furthermore, the advanced age and physical frailty of seniors were expected to make it challenging to have them keep their mouths open for an extended period of time.

> … a lot of our residents, personally, from my personal opinion, they are not keen for us to do our dental hygiene for them…. Sometimes they don't want the taste the solution we are using. That's why after that, they're not cooperative to have the dental hygiene… Sometimes they fight with us. (Nursing Aide, Nursing Home)

> It really depends on residents' behaviour, because not all the time, they are in good mood, sometimes, their behaviour can easily changed… Even when situation seems fine, suddenly they get these outbursts behaviour and erratic behaviour that cannot be controlled. So I think this is one of the reason that can hinder the implementation of TDOCS (Staff Nurse, Nursing Home)

Facilitator: existing relationships between CHWs and beneficiaries. Existing family-like relationships between CHWs and beneficiaries were considered to be enablers for effective recruitment of participants for T-DOCS. This is because familiarity was expected to help beneficiaries feel at ease. It was emphasised that knowing beneficiaries' respective personalities was an advantage, knowing how to approach beneficiary was identified as key to securing their cooperation.

> … because a nursing home is like a home for them. So, we are like family… (Staff Nurse, Nursing Home)

> Nurses are the ones that are the closest to the residents… [so they] understand the residents much, much better… They are able to coax the patient… [when] it can be quite intimidating to have something in their mouth…. (Nurse Manager, Nursing Home)

Innovation characteristics

As data was collected prior to the implementation of T-DOCS, only one relevant CFIR construct namely 'relative advantage' was perceived to have influence over the implementation of T-DOCS under this domain.

Barrier: perceived burden associated with T-DOCS. Respondents voiced apprehensions regarding the increased burdens and responsibilities associated with participating in T-DOCS. As T-DOCS equipment looked expensive to CHWs, they expressed concerns about their liability should patients damage the equipment.

> of course, [the staff] are worried if anything, like, you need to compensate, maybe a tooth is broken, or I don't know, patient break the equipment or something… [because] this is something new in Singapore and we're the first one. (Doctor, Home Care)

Moreover, CHWs considered T-DOCS as an 'additional workload,' complicating their existing daily tasks. This was particularly challenging for the home medical care team, as implementing T-DOCS required them to transport the equipment along with the medical supplies already carried for each home visit.

> I think it will be hectic for us… the first thing that will go on [my colleague's] mind is it is an additional work. (Staff Nurse, Nursing Home)

> … [I heard] we have to carry some device - to check the patient at home…we already have one big luggage with us… So, carrying an extra device will be challenging when a nurse go to the patient's house alone… (Doctor, Home Care)

Furthermore, CHWs with some knowledge of the programme expressed concerns that a teledentistry mediated dental assessment might be of inferior quality compared to the traditional, in-person examination.

> … if [the doctor] saw directly the resident, they [can] just identify it, so what happened, what type of infection they got… [but when they] do the teleconsult… it's not effective, they never saw the patient face-to-face. (Senior Nursing Aide, Nursing Home)

Compared to existing practices in which residents had to visit a dental clinic for oral examination, T-DOCS was perceived as relatively advantageous for beneficiaries and CHWs. The perceived advantages included enhanced access to oral screening, early detection of dental issues, improved overall health, heightened awareness and knowledge of dental health for both beneficiaries and CHWs, reduced costs associated with seeking dental care, more streamlined dental care processes and an expanded reach to seniors in need.

> If this project can take off and it's very practical, I think it will add a lot of benefits to my residents, specially to increase their oral care. I think this eventually also prevent them from getting aspiration pneumonia when you got a good hygiene. (Senior Nurse Manager, Nursing Home).

> It will be a good help for NH residents because many of them do not know that they have problems. Also, they will also learn that this is the right process/way to do their dental care. So we can instruct them properly on how dental hygiene should be done. (Enrolled Nurse, Nursing Home)

Visits to the dental clinics were infrequent among seniors with limited mobility due to logistical challenges and anxiety associated with movement, which is often accompanied by significant costs. T-DOCS was seen as a potential solution to overcome these challenges. Implementing T-DOCS within the familiar surroundings of beneficiaries was expected to create a sense of comfort while alleviating logistical and financial burdens for NOKs.

> Because if they go clinic, they see all the instruments and everything, so it cause more panic for them. So, if it is in the video call, maybe they feel much better…. the environment there cause more anxiety in the dental clinic. (Enrolled Nurse, Nursing Home).

Community healthcare workers believed that increased access to dental care provided by T-DOCS would contribute to overall health improvement for beneficiaries. For instance, poor oral hygiene often leads to pneumonia, a common complication among the elderly in long-term and residential care. Consequently, CHWs saw T-DOCS' goal of enhancing oral health as likely to reduce the probability of developing pneumonia.

> …I think this eventually will also prevent them from getting aspiration pneumonia, when you got a good hygiene… (Senior Nurse Manager, Nursing Home)

Moreover, beneficiaries were expected to gain heightened awareness and knowledge of oral care through T-DOCS. The availability of professional advice provided by the remote dentist was anticipated to positively influence health-seeking behaviour among beneficiaries, as dentists' advice might be perceived as credible by both beneficiaries and their next-of-kin (NOKs).

> … if we get a professional to evaluate this screening result… [and] professional help is provided by the dentist, I think health-seeking behaviour might change over a period of time. (Doctor, Home Care)

Additionally, it was acknowledged that beneficiaries and their NOKs would benefit from the cost savings associated with remote dental screening. The reduction in transportation-related costs, particularly for seniors with limited mobility, was seen as a significant advantage of T-DOCS.

> …the teledentistry programme may provide easier access for the residents because they don't need to go outside or takes time for them to queue… [they] can do here already at our home. (Nursing Aide, Nursing Home)

At the professional level, CHWs believed that their involvement in T-DOCS would enhance their knowledge

of oral care through exposure to teledentistry. They also perceived the workflow of T-DOCS as more efficient compared to the current practice of transporting patients from their residences to a dental clinic. Not only did the existing approach incurred significant financial costs but also required for additional manpower as a staff chaperone was always needed. Moreover, this improved efficiency of oral screening was expected to expand the number of people whom the remote dentists can reach. This was particularly significant for seniors receiving home medical care services, whom would have otherwise not be able to get their oral health assessed.

> For me as a doctor, I can see only maximum six patients a day, when I go from one patient's house to another patient's house… but if nurses are gathering the data and giving them to the dentist, I think it will be more efficient… because dentists have to just focus on only the specific dental condition and that tooth from the remote area, from their own office. So, in that case, they will be able to see much more patients… (Doctor, Home Care)

Inner setting

Within this domain, (i) insufficient available resources and (ii) low relative priority for T-DOCS were identified as potential barriers. Meanwhile, tension for change and leadership engagement were expected to contribute to the success of T-DOCS implementation.

Barriers: manpower shortages and competition with other nursing duties. Community healthcare workers highlighted the perennial concern of manpower shortages as a potential barrier to T-DOCS. This was especially prominent among the NH CHWs. Given that staffing resources were already constrained, providing the available resources for T-DOCS such as taking staff away from routine care duties for T-DOCS activities including training and conducting intra-oral scanning was seen as an additional burden among CHWs.

> … if there's any problem here in the ward, for example, we need to attend one of the residents, we will not be able to focus on T-DOCS procedure if they are on the same time…. (Enrolled Nurse, Nursing Home)

Barrier: low relative priority. Organisations represented in our study were said to place limited importance on oral healthcare. Oral health care was often relegated to a lower priority to accommodate for physical care. Unsurprisingly, the lack of emphasis on oral care was considered the prevailing norm. Allegedly, there were no measures in place to ensure adherence to oral hygiene practices.

Such perceptions contributed to a sense that oral care was given a low priority throughout the organisations.

> maybe here at the nursing home, dental care is not in the top priority. (Enrolled Nurse, Nursing Home)

Facilitator: perceived need for change. Our study participants from both NHs and the home medical care service acknowledged that T-DOCS would fill a much needed gap in long-term and residential care by improving provision of dental care.

> [Care for] dental hygiene is really need[ed]… we are not really taking care of dental hygiene for the residents. (Staff Nurse, Nursing Home)

Facilitator: compatibility of intervention with existing context. Despite CHWs emphasising resource limitations, they recognised the potential of integrating T-DOCS with existing processes that are familiar to CHWs. For example, some pointed out that patients under their care were already receiving a basic level of oral care through scheduled dental examinations. Moreover, CHWs were familiar with a mobile dental clinic that visited various long-term care institutions to offer dental screenings for seniors with mobility issues. These initiatives were seen as beneficial for improving CHWs' receptivity, providing a contextual point of reference to understand what T-DOCS involved. To achieve optimal integration, it was suggested that T-DOCS be incorporated into time periods when care duties were less intensive.

> We do a home visit every, few months, at least once in three months. So, at least once in three months, I make a routine assessment to do an oral examination of the patient, but not thoroughly like which could be done through your camera and the oral prop; it is not so thorough, so we just use a tongue depressor and torchlight to see (Doctor, Home Care)

> … it is better than in the morning [for the residents], because morning they have activities, so they are still quite active… in the afternoon, they have the nap time. So, this timing also they are sleeping. So, when we go and do the assessment, right, at this timing and they are sleeping, it will be difficult for them… on our part, as the nurses, er, in the morning, we have, er, other activities that we need to attend to. (Staff Nurse, Nursing Home)

Facilitators: supportive management and colleagues, top-down approach, empowering leadership style. Community healthcare workers also felt that their respective organisational cultures were conducive for T-DOCS implementation. Generally, there was a sense that T-DOCS was well

supported by senior management and had received a mandate from the 'top'.

> I think the nursing managers are quite supportive of this project, which is why we are asked to do this. And they also, er, eager to help the residents with this additional tool… (Staff Nurse, Nursing Home)

This was reinforced through discussions with CHWs in managerial roles, who indicated that participation in T-DOCS was not merely encouraged but designated as a 'mandatory project' for staff, enhancing the perceived legitimacy and importance of T-DOCS among healthcare CHWs.

> … it's one of the components that we are, I mean, we have a lot of other projects going on. So, is one of the other projects, so we actually locate a few staff nurses for this project to lead this project. So, we have made it like one of their mandatory projects that they have to take on. (Nurse Manager, Nursing Home)

Simultaneously, CHWs emphasised the importance of empowering CHWs by allowing a certain degree of flexibility in project management. This approach aimed to instil a sense of ownership and responsibility for projects among staff, which was seen as a facilitator for T-DOCS implementation.

> … [When staff] see the changes, they feel more engaged, it will be more successful. I always let the staff run… it should not come from me… [but] engagement, ownership of the whole thing so that it becomes a success … in terms of specialised training and appreciation for their efforts and pat on the back kind of thing is to encourage them towards that thing. So, they don't feel like this is something that I chose to them. For me, I always pitch it as part of their development as nurses and those kind of things. (Senior Nurse Manager, Nursing Home)

Furthermore, CHWs highlighted a supportive culture among staff, emphasising the willingness of colleagues to provide assistance when needed. This support extended to various aspects, including communication in local languages, creating a collaborative environment that contributed to the successful implementation of T-DOCS.

> I can ask someone to translate in Mandarin. I mean, I have some colleagues who can talk to them. So, we can explain to them properly, then they can cooperate also. (Enrolled Nurse, Nursing Home)

Outer setting

This CFIR domain relates to interactions of the project or organisation with the broader political or economic context that may have implications for implementation. Within this domain, CHWs identified existing impediments to accessing dental care and COVID-19 related restrictions to be facilitator and barrier respectively.

Facilitators: existing impediments to accessing dental care – long waiting periods for dental appointments, transportation and logistical burdens, concerns about affordability.
During our conversations, CHWs painted a picture of existing patient needs that would enhance their receptivity towards T-DOCS. For patients in long-term and residential care, accessing dental care was problematic due to the long waiting times of several weeks or months for appointment in the two national dental centres providing geriatric dental services. In addition to consultation fees, caregivers also incurred high transportation cost for seniors with mobility issues, which added to the concerns about affordability of seeking dental care. T-DOCS was considered appealing as it addresses existing challenges associated with dental care for seniors through the convenience it offers and also its current charging mechanism.

> [It's] not easy to get [an] appointment for [a] dentist. It could be months. (Enrolled Nurse, Nursing Home)

> … our staff will be deducted because one of the staff will need to accompany [the resident for their dental appointment] so the manpower in the ward is already been deducted, because one already went outside. (Staff Nurse, Nursing Home)

> … when it comes to sending the patient out of the house, it is quite challenging… because most of the patients are homebound and some of them can't even sit on the chair, they need to be transferred on the trolley….And it also involves cost of transferring the patient, cost of leaving their work to send their loved one to the hospital, and also the cost of treatment. (Nurse, Home-care)

Barrier: restricted access to NH due to COVID-19 regulations.
The COVID-19 pandemic coincided with T-DOCS training resulting in many delays and complications. Due to new safe distancing regulations imposed on long-term and residential care institutions, the T-DOCS team faced multiple challenges in implementation the programme. For instance, to minimise disruption from COVID-19 infections, NHs staff were allocated into separate groups that could not mingle. This reduced the number of available staff that could be involved in training sessions and thus delayed T-DOCS implementation.

[T-DOCS] was moving quite well before this whole COVID situation started and then we had to put kind of a stop to it because, you know, no visitations… minimising all these crossing overs of residents and all….hopefully things would get a little bit better in terms of consent taking [and]… screening of the residents. (Nursing Manager, Nursing Home)

Discussion

This study examined perceived barriers and facilitators for the implementation of T-DOCS before its commencement from the CHWs perspectives. Across four CFIR domains, 12 relevant constructs were perceived to be important for implementation of T-DOCS.

Under the domain of 'individual characteristics', we identified limited awareness/appreciation of the importance of oral health and dental services among seniors and their NOKs to potentially hinder implementation of T-DOCS. The perceived lack of importance was expected to lead to low motivation and potentially resistance to enrol into the T-DOCS programme. This finding aligns with a scoping review which identified a positive correlation between the perceived importance of care and dental healthcare utilisation among the elderly.[35] Furthermore, it was found that Singaporean seniors lacked an understanding of the oral-systemic relationship, contributing to lower dental care utilisation[9] As motivation for preventive care is known to be generally low after acute dental issues are resolved, it is important to continuously engage seniors to keep them motivated.[36] Another potential strategy to overcome challenges associated with individual resistance change could be the identification and recruitment of champions among seniors. Seniors who have positive experience of T-DOCS could be given the opportunity to share their experience as champions so as to provide confidence to other seniors.

Consistent with previous findings, CHWs expected seniors to be less anxious about teledentistry in settings where familiar support staff are available.[37] This points towards a facilitator in which TDOCS can leverage on to foster a greater sense of comfort and security, which could increase participation and lower resistance.

As reported in the literature,[38] age-related functional and cognitive decline were identified as potential barriers to implementation. The lack of cooperation was anticipated for seniors with cognitive impairments. They were expected to bite on the intra-oral camera head, face difficulty in keeping their mouth open and refuse to co-operate during the intraoral scanning process due to their unpredictable fluctuating mood. This concern is consistent with previous studies which revealed absence of positive attributes with relatively good adherence to teledentistry among those with cognitive impairments.[21,31] This highlighted the need

for conducting the scanning when seniors are likely to be in a good mood or conducting scan in 2 sessions to reduce time required for seniors in every session, particularly for high-risk seniors who struggle to keep their mouths open for prolonged period of time.

A variable level of self-efficacy was observed among CHWs. Those with prior experience with tele-medicine expressed a higher level of confidence whereas CHW's limited oral health literacy and experience in oral health care was found to contribute to low self-efficacy. It is important to address this issue as limited self-efficacy were reported to affect staff's performance, taking longer to complete the necessary scans or needing to redo them to meet the requirements for dentist reviews. Additionally, low self-efficacy also impacted their motivation to continue with T-DOCS, especially when they were already burdened with other work responsibilities. To improve self-efficacy, dynamic training tailored to CHWs' training needs has been recommended.[39] As both NH and home medical care staff work under different contexts, it would be essential to tailor the training based on their respective needs and availability.

Community healthcare workers' knowledge about oral health was found to be associated with greater willingness to deliver oral health care to their patients.[40] Clear communication of programme-related information including instructions, roles and responsibilities and expected benefits have been shown to be beneficial for the successful implementation of healthcare programmes.[41] Therefore, it is necessary for CHWs to have a clear understanding about the programme through educational meetings and regular programme updates. Identification and recruitment of programme champions within each site have also been identified as an effective strategy to enhance CHWs' knowledge and commitment to T-DOCS. For this reason, instead of having an external specialist dental organisational to continue to train CHWs, trained CHWs could be empowered to train other new CHWs and advocate for the successful implementation of the T-DOCS programme within their respective work setting.

Apprehension regarding the increased burden and responsibilities associated with participating in T-DOCS among CHWs was a potential barrier that was identified to likely affect adherence to T-DOCS. While the T-DOCS programme was well funded and T-DOCS potentially can bring about cost savings, it is well acknowledged that the implementation of T-DOCS will still take some time, create additional workloads and may place pressure on existing services as what have been observed in other similar settings.[23] Changes in physical structure, equipment and access to new funding were proposed as strategies to overcome issues related with limited existing resources. While equipment and funding were made available for the implementation of T-DOCS, the strain in manpower was not anticipated and accounted for. Thus, to improve

the situation, an efficient deployment of dedicated manpower may be required to support the implementation of the T-DOCS programme in the long term.

Within the domain of 'innovation characteristics', most CHWs viewed T-DOCS to be advantageous for seniors and themselves. Not only was T-DOCS expected to improve oral health, it was also expected to enhance their knowledge about the importance of oral health, facilitate early detection of oral diseases for appropriate referral to specialists and improve seniors' general health by reducing the development of systemic-related complications associated with poor oral health. Compared to in-person dental visits, T-DOCS was expected to generate time and manpower resource savings by alleviating logistical challenges, shortening wait time to see the dentist and reducing the need for accompanying manpower. Such positive outlook of T-DOCS is expected to contribute towards the adoption and adherence to T-DOCS as performance expectancy has been shown to lead to successful adoption of teledentistry.[42]

Community healthcare workers regarded the existing or lack of oral health care within NHs and private homes to be suboptimal in meeting the needs of seniors. This sentiment was perpetuated by *existing impediments to accessing dental care due to long waiting periods for dental appointments, transportation and logistical burdens and concerns about affordability*. Despite emphasising resource limitations, they recognised the pressing need for change and the promising potential of integrating T-DOCS with existing processes that are familiar to CHWs. Acceptability of a programme among healthcare CHWs was facilitated by how well the programme fitted into the existing workflow and also the CHWs' knowledge and beliefs about oral health programmes. Incompatibility of the programme often stems from the lack of integration with the current workflow within the organisation.[43] Hence, it is necessary to ensure that the programme activities complement well with the CHWs' day-to-day responsibilities and existing care plans to ensure successful programme integration and buy-ins from the CHWs.[41,44]

Nevertheless, given many competing tasks with which CHWs had to juggle within the NHs and in the provision of home medical care, oral care was often not prioritised. While T-DOCS was well supported by management of the participating partners, there is uncertainty around its potential sustainability in the long term. It is acknowledged that implementation of teledentistry as a research project is not sustainable in the long term due to its lack of integration to existing practices.[22] While there is an increasing emphasis towards strengthening oral disease prevention and integrating oral health into general health care services in Singapore,[4,38] there is limited effort at the policy level to facilitate the implementation of teledentistry service. More effort needs to be put into developing the legal and regulatory frameworks, funding schemes and capacity-building

processes to support the adoption of teledentistry services into mainstream practice. In addition, an adequate scheduling of the programme activities can enable a smooth transition of the healthcare programme into the existing workflow[45] . Recognising the unique contexts associated with the various implementation sites, it is also important to assess readiness, facilitators and barriers before implementing T-DOCS and to put in place strategies to overcome these challenges at the organisational level. Furthermore, incentivisation schemes may be useful for setting an agenda on the priority list within respective organisations. Potentially, a reward system could be introduced to incentivise individuals or organisations to support the successful implementation of the T-DOCS programme.

Strengths and limitations

The strength of this study lies in the novelty of insights it generates related to teledentistry. To the best of our knowledge, this is the first study conducted in Singapore to examine the perception of CHWs on the teledentistry model prior to its implementation. Given the close partnership fostered between partner organisations and the dental team, coupled with a systematic flow of recruitment, we achieved high response rate to participation in interviews of 100%. Systematic development of a topic guide based on a similar study conducted in France supported the relevance of questions asked during the interviews. The CFIR provided useful guidance for the identification and organisation of themes into domains of factors that have been demonstrated to influence implementation effectiveness. Based on CFIR related resources that is available online, we could classify themes into barriers and facilitators readily. Involvement of multiple coders in the refinement of codebook, establishment of coding consensus and eventually coding transcripts provided rigor for this study. Measurement errors were minimised by ensuring consistency of coding guided by CFIR while reliability of findings was validated through regular discussions. Furthermore, the use of CFIR allowed convenient mapping for the purpose of identifying implementation strategies.

A major limitation of this study is the retroactive application of CFIR only for analysis. It would have been beneficial to use it for development of the interview questions so as to strengthen theoretical foundation, continuity and consistency across various stages of the study. Despite this, we managed to achieve alignment between interview questions and CFIR domains which allowed conceptually coherent data exploration and analysis. While recruitment of CHWs through their organisation lead was useful, we acknowledged that response bias might have been introduced. To minimise such bias, respondents were assured of confidentiality of interviews and that their responses would not adversely affect their performance rating. In addition, as much as we tried to be comprehensive in the

recruitment of CHWs, dentists involved in the programme were not recruited as they have yet to be identified at the times of interview.

Conclusion

This study explored the perceived barriers and facilitators to implementing T-DOCS from the perspective of community healthcare workers (CHWs). Key findings highlight that limited awareness of oral health importance among seniors, cognitive and functional impairments, CHW self-efficacy and additional workload concerns may challenge the adoption of T-DOCS. On contrary, the familiarity of support staff, potential cost and time savings and the perceived benefits of improving seniors' oral and overall health were identified as facilitators.

To increase the likelihood of successful implementation, strategies such as targeted CHW training, identification of programme champions, integration of T-DOCS into existing workflows and incentivisation schemes are recommended. Addressing organisational and contextual challenges – such as manpower strain and resource limitations – through efficient scheduling and capacity building will be crucial for long-term sustainability. Additionally, policy-level support in developing legal frameworks, funding mechanisms and regulatory structures is necessary to integrate teledentistry into mainstream healthcare.

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