Teleconsultation/Telediagnosis using Teledentistry Technology: a Pilot Feasibility Study

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Abstract—This study assessed the feasibility of a teledentistry model for teleconsultation and telediagnosis in Residential Aged Care Facilities. Study feasibility was defined by the ability to develop remote treatment plans. Reliability of the remote assessments was assessed by comparing with those performed by traditional face-to-face oral examinations. An intraoral camera was operated by trained teledentistry assistants with the aim of screening residents for oral diseases and pathological conditions. The model was supported by traning and an instructional kit for the introral camera operators. The structure, content and delivery of the program, was evaluated. Residents' views about the structure, content and delivery of the program were also evaluated. A total of 50 residents participated in this assessment. Results indicated that the proposed teledentistry approach for oral health screening is feasible and reliable as an alternative to traditional oral health examination. Residents expressed high levels of satisfaction with the teledentistry service. This study provides an innovative solution towards closing the service delivery gap in the provision of sustainable oral health care services to underserviced populations (e.g., nursing homes, rural areas).

Keywords - oral health, teledentistry, intraoral camera, nursing homes

I. INTRODUCTION

Improvements in oral health in Australia over the past 50 years have translated into a greater proportion of older individuals retaining more of their natural teeth, increasing the prevalence of caries and periodontal disease. Older people living in Residential Aged Care Facilities (RACFs) have been identified as a significant risk group for oral diseases in Australia. In addition, the changing demography and oral health needs of older Australians will present many challenges for the dental profession over coming decades. As an initial stage to address these challenges, a project was organized to test whether improvements in accessibility and appropriateness of oral health services can be achieved by utilizing advanced ICT techniques to screen for oral disease in older people living in RACFs [1].

In 2005 more than 41,000 residents in the state of Victoria, Australia lived in high or low-care residential facilities on a permanent basis; with just over half being dentate and having high dental treatment needs [2][3]. Significant barriers to accessing dental services exist. Residents are often physically and cognitively impaired, medically compromised and dependent on others to maintain their oral hygiene.

Face-to-face patient examinations are regarded as the

most accurate method for correct oral health diagnosis. However in Victoria only 11% of aged care facility residents have seen a dentist in the past 12 months, as there are few dentists available to provide dental care for residents [4][5]. In fact, only half of Victorian dentists reported providing care to residents of RACFs, and those dentists spent on average only one hour per month providing care in this setting [5].

As the capability of information and communication technology (ICT) has risen, the use of ICT for data collection has increased. Expanded use of ICT has provided clinicians with alternatives to the traditional face-to-face oral examinations. This shift in focus has resulted in a vast increase in the number of published articles that include some form of either synchronous (real-time) or asynchronous (delayed image examination), teleconsultation/ telediagnosis [6].

Teledentistry can be successfully implemented in different oral health settings to deliver improved health outcomes and positive health professional-patient experiences [1][6]. Teledentistry has the potential to reduce the number of inappropriate referrals by screening patients to ensure that only those who need to see a specialist go on waiting lists. This ensures efficient use of scarce health resources, increasing access to specialist care, improving specialist productivity and supporting enhanced oral health across society.

Potentially, teledentistry could benefit an expanding segment of the population in relative and absolute terms; namely, older people living in RACFs and rural areas. According to the 2006 Australian Census, 55-64 year-olds made up 11.8% and those 65 years and over 13.7% of the total Victorian population [7].

Older people are proportionately over-represented in rural and regional Australian communities and these communities are ageing more rapidly than their metropolitan counterparts. Therefore, a teledentistry approach could potentially target a rapidly expanding segment of the population with special oral health needs. Other parts of the world have similar demographic and geographical problems making this study equally relevant to them.

A three-stage study was designed to address priorities established by Australia's National Oral Health Plan 2004-2013 for 'Older People' targeting older people living in RACFs, (an underserviced, high-risk population and one with major oral health needs) [8]. This project was conceived in an effort to promote affordable, timely oral health care and to test an oral health care model in which ICT is used with the aim of extending clinical care to residents who are physically separated from the examining oral health professional. This study was also a response to serious dental workforce shortages in caring for this group and provides opportunities to supplement traditional methods of oral diagnosis, care delivery and health promotion.

The study builds on a University of Melbourne Institute for a Broadband Enhanced Society (IBES), Project Seed Grant, which tested the technology under laboratory conditions (proof-of-concept) and developed the instructional material for non-oral health professional operators [9]. That study demonstrated that the proposed teledentistry approach for oral health screening using an intraoral camera was feasible and reliable as an alternative to traditional oral health examination. The long-term goal of the project is to test whether improvements in accessibility and appropriateness of oral health services can be achieved by utilizing advanced ICT techniques to screen for oral disease in older people living in RACFs. Stage 2 of this three-stage study involved the field testing of this teledentistry technology and is the subject of this article.

In the last few years, economic evaluations (EE) have acquired greater importance in decision-making in health. Health service managers, programmers and planners are required to select the interventions with the highest impact, based on evidence and prioritizing of high-risk groups. Analyses of this type assist decision-makers in determining which intervention (or combination of interventions) maximizes outcomes, given the available resources. Despite this, apart from one example of economic evaluations in teleorthodontics [10], the use and application of economic evaluations in teledentistry remains limited [5].

This paper is organised in six sections. The first Section provides the foundation for understanding the need for teledentistry in this particular population. Section II is concerned with the aims and objectives of the paper. Section III describes the methodology used in this field trial of teledentistry. Section IV presents the results of the trial, including interviews with personnel and patients involved in the program. Sections V and VI discuss the results of the trial and conclude on its findings, respectively. Further steps are also discussed in last section.

II. AIMS AND OBJECTIVES

This paper outlines the results of the second stage of this project, which aimed to assess, on a small scale, but under real conditions, the safety of the procedures, their feasibility, as well as patients' and health practitioners' experiences with the technology. A comparison was conducted between face-to-face-examinations and remote examinations using an intraoral camera.

The specific objectives of this study were to:
1) assess the feasibility of using teledentistry to screen for oral diseases and conditions and to develop treatment plans for older people living in RACFs;
2) identify barriers to the adoption of a teledental approach. These included: a) general staff workload; b) professional culture and acceptance (e.g., morale, motivation, resistance to change, etc.); and c) availability of appropriate equipment,
3) test the utility of an instructional training kit,
4) assess the residents' views of their experiences during delivery of the program, as well as feedback and information provided during the teledentistry consultation.

However, in order to assist in the development of a consensus statement about the costs of oral health interventions, and the need for economic data which can be

used as a reference for national programs, this study aims to determine the costs of implementing a teledentistry program to develop treatment plans for rural RACF residents in Victoria, Australia.

III. METHODS

Three RACFs within Victoria, Australia, were successfully approached to participate in this stage; two in metropolitan Melbourne (suburbs of Brunswick and South Morang) and one in rural Victoria (Stawell). These clinics worked in partnership with the University of Melbourne's Melbourne Dental School, which acted as the central co-ordination and examination site.

Five non-oral health professional teledental assistants (e.g., registered nurses - RN) in these facilities were trained to manipulate an intraoral camera and use existing and introduced ICT infrastructure to transmit video images for remote examination and diagnosis. Video was streamed over the open Internet to enable the service in the first instance, as it would otherwise be necessary to overcome firewall issues at the RACF's where it can be difficult to enlist the aid of local IT support to change port settings for such short-term trials. If ongoing services were established in the future then VPN's (Virtual private Networks) could be used to ensure the security of patients' data. An oral health professional at the Melbourne Dental School performed a 'virtual dental examination', recorded findings and developed a treatment plan for a group of selected residents

Purposive sampling was used to recruit participants. To participate in this teledentistry study, the resident was required to have the ability to understand and to provide independent informed consent, the ability to communicate with the health professional and to undergo a 15-20 minute oral examination. They could be dentate or edentate. However, because of the nature of this trial, special care was taken to select residents who had some of their natural dentition.

Although sample size calculations are not strictly necessary for a pilot study [11], a sample size of 50 residents was considered to be adequate to meet the general aims of this study. A 20% attrition rate was expected over the six month duration of the field component of this study therefore 62 residents were recruited initially.

Patients were introduced to the study by the local RN. When the patients, or their primary carers, expressed interest in participating, each received a Plain Language Statement describing the study and a Consent Form. Once informed consent was obtained, patients underwent an oral health assessment.

A SOPROLIFE® intra-oral camera was used to capture video via a custom video streaming software platform designed for the project [12]. Simulations were conducted in the IBES test-bed facility [13]. The intra-oral camera was connected via a USB cable to a laptop or mobile tablet used for bed side evaluations, containing the software that compressed and encoded the 25 frame-per-second video into an mpeg4 video stream of at least 3Mbit/sec bandwidth, and preferably a 5Mbit/s stream if network conditions allowed. This bandwidth was found to give the clinician sufficient

quality to interpret the images received and removed blurring due to the motion of the camera [8].

The clinician viewed the incoming video via a PC connected to a large monitor. A large screen facilitated simultaneous viewing of both the intra-oral camera video as well as that from a second web-cam, a high definition Logitech model C920 model, capturing the overall interaction between patient and the intra-oral camera operator. This was also streamed as an mpeg4 video of minimum 3Mbit/sec bandwidth. Mpeg4 audio was also transmitted at 128kbit/s along with the images via the use of Clear One Chat 50 model microphone/speaker units also connected via USB cables. This allowed excellent quality audio communications between patient and clinician ends. For test sites that could not accommodate a 3Mbits/s stream reliably a Store and Forward version was developed that enabled the Mpeg4 file to be stored on a central server for asynchronous download by the dentists. Each examination lasted approximately 15 minutes and each minute of video created a file of approximately 1GB. Thus, the video files were large (i.e., 15 minutes produces a 15 GB file).

Using a teledentistry installation each participant received a 'virtual' oral examination, including dental and oral mucosal assessments conducted with the assistance of a trained RN at the RACF using an intraoral camera operated in communication with a remotely located oral health professional.

Intraoral camera operators should be trained in the use of the hardware. In the present study, this training took a variety of formats including seminars, simulation activities, demonstration modules, and self-training. A sixty-six page training manual including diagrams, with content organized in five modules was also prepared for these purposes.

Intraoral camera operators training consisted of six hours delivered by a dentist from the Melbourne Dental School, University of Melbourne. The first three-hour session was an introduction to teledentistry, and on oral and dental anatomy. The second three hours was a demonstration of how to operate and manipulate the intraoral camera and send files over the Internet. After these sessions, the trainees were asked to have 10 hours of self-practice with an intraoral camera in their own time

The remote oral health professional was able to communicate in real-time with both the resident and the intraoral camera operator (i.e., the RN) via a video link to assist in taking a history, and to direct the RN where necessary in the use of the intraoral camera. To have communication in real time we used Skype® and Vidyo®. However, there were several problems with Vidyo due to firewall settings.

The information obtained from this examination was recorded and transmitted to a server for review of the 'virtual dental examination' to be performed remotely at a later time. Information was registered on a conventional Dental Health Services Victoria chart for the generation of treatment plans by qualified clinicians at the Melbourne Dental School, University of Melbourne.

On completing the virtual oral examination the residents were asked to complete a seven-item teledentistry

assessment questionnaire to assess his/her views on the approach. As a further verification of the approach, the ability to understand communications between the oral health professional and the resident was determined both for the conventional face-to-face and remote communications. The evaluation form consisted of statements that participants rated on a five 5-points Likert scale, depicting their level of agreement with the statement (1 'Strongly agree'; 3 'Neutral'; 5 'Strongly disagree'). The summary evaluation also contained four open-questions, so participants could include their thoughts about their experience and critiques.

Ten residents received a second oral examination by a different oral health clinician. This was a traditional face-to-face examination (the clinician present in front of the patient) with findings recorded on a conventional dental chart.

Furthermore, we wanted to explore how the introduction of teledentistry was experienced by those in charge of teledentistry on site. RNs who collected the information for this project completed a questionnaire to assess their initial attitude to, and acceptance of the practice, and their overall experience with the teledentistry approach. The utility of the instructional training kit and any other issues associated with the project were also assessed.

Due to the small sample size, only descriptive analysis was used to illustrate the participants' views about the format, content and delivery of the teledentistry program. In some cases, categorical and ordinal data were analyzed utilizing Chi square analysis (χ^2) to compare results between different oral conditions and the distribution of socio-demographic and outcome variables were performed. The level of inter-examination reliability for the degree of consistency of the two sets of examinations was assessed using the kappa statistic.

To complement this analysis, and to obtain a better understanding of the usefulness of teledentistry approach, an economic evaluation was conducted. The form of economic evaluation used in this study was cost description. A cost description is the most basic type of economic evaluation, which is a partial form of economic appraisal because it looks only at the costs of a program and provides no information on the health outcome of interest [14]. It answers the most commonly asked question when considering introducing a new program: "how much will it cost?", and provides decision makers with important information on the resources needed to introduce or expand a service. It also allows program managers to determine a unit cost or cost per unit of service (i.e., for a treatment plan).

Teledentistry, as in any telehealth model, can work according to two consultation methods: real-time and store and forward. Both methods require the same basic infrastructure connected to telecommunications networks with sufficient bandwidth. However, as low-speed, high-latency connections are more typically found in rural and remote regions, this may impact the ability to perform real-time consultations. Therefore, practitioners without adequate bandwidth would have to rely upon the store and forward modality to send data to the specialist for later review. Store and forward provision can be just as effective at presenting cases as the real-time modality.

Thus, this analysis calculated the cost per unit of a treatment plan under Australian conditions. The program or intervention under evaluation in this study involved:

1) Oral examination data recorded at the RACF using an intraoral camera operated by a trained RN who transmitted the files to a remotely located dentist for asynchronous review and treatment planning (asynchronous model).

2) Remote real-time oral examination and treatment planning with the assistance of a trained RN at the RACF using an intraoral camera operated in communication with a remotely located oral health professional (real-time model).

The question being examined was: "what would be the cost of implementing an asynchronous and a real-time teledentistry model per resident if we provide a treatment plan for a cohort of 100 residents?"This figure was based on capacity of the largest RACF in Stawell.

The costs of running the program were based on this study, expert opinion, together with other relevant sources. A micro-costing approach, or direct cost measurement from a healthcare perspective, was applied to quantify and value all resources in this program, except where costs are small and unlikely to make any difference to the study results. Costs were grouped under three main categories:

1) Training. Calculations under this heading were done under the following assumptions. It was assumed that the asynchronous and the real-time models require a trained RN to manipulate the intraoral camera. Training of the intraoral camera operator involved six hours of direct contact and ten hours of practice examinations.
   Transportation. The Australian Tax Office travel reimbursement schedule for a 2.2 litre engine was used to quantify travel cost [15]. Average distance between the aged care facilities located in Stawell and the Melbourne Dental School, Univeristy of Melbourne was applied to determine the travel costs of the dental clinician to train the RNs.

2) Salaries. The salary of oral health personnel involved in the oral examination was based on the Dental Health Services Victoria scales [16]. The RNs' salary was based on Australian Department of Health and Aging recommendations [17].
   Each examination in the asynchronous model (store and forward) was calculated as lasting 15 minutes, whereas examination time in the real-time model was 20 minutes. It was assumed that in the real-time model there would be more commmunication with the remote examiner to prepare and finalise the treatment plan.

3) Teledental device. The investments necessary to conduct the teleconsultations were the intraoral camera with an integrated USB dock to connect to a computer. Camera costs were computed at market value [18]. Digital images obtained by the camera can be used to

support real-time or store-and-forward teledentistry consultations.

The life span of the intaroal camera and its direct USB Camera dock was estimated at 10,000 hours (about 5 years) of normal use as per its handbook [19].

All costs were computed in Australian dollars (AUD) (1.00 AUD =0.70 EUR) at 2014 price levels. No cost discounting applied to this short-term study.

Data collection extended between October 2012 and June 2013. Ethical approvals to conduct this study were sought and obtained from the University of Melbourne.

IV.   RESULTS

At the end of data collection, 50 residents from three RACFs participated in the trial from the 62 initially recruited; with 58% being female. Three RNs conducted the examinations. Twenty-two examinations were conducted in Stawell, twenty-one in Brunswick and another seven in South Morang. The majority of participants (70%) had, at least part of their natural dentition, while fifteen residents (30%) had no natural teeth. By location, nine edentulous residents were from Stawell, and six were from Brunswick (See Table I).

A teledentistry installation enabled five trained intra-oral camera operators (registered nurses) to record, use and transmit video images for the generation of treatment plans by qualified clinicians at the Melbourne Dental School, University of Melbourne. Information from the remote examination was compared with a real-life dental examination. The intra-examiner agreements for dental examination parameters determined by the Kappa index reflected an 'Excellent' agreement (Kappa=0.83) [20].

When residents were asked to rate their satisfaction with the examination, the majority of the residents were either very satisfied: (46%) or slightly satisfied (38%) with the format of the remote dental examination.

TABLE I.   RESIDENTIAL AGED CARE FACILITIES RESIDENTS' SOCIODEMOGRAFIC CHARACTERISTICS

	Residential aged care facilities		
	Brunswick n (%)	*South Morang n (%)*	*Stawell n (%)*
Sex			
Male	10 (47.6)	3 (42.9)	8 (35.4)
Female	11 (52.4)	4 (57.1)	14 (63.6)
Dentate Status			
Dentate	15 (72.4)	7 (100.0)	13 (60.0)
Edentulous[a]	6 (28.6)	- (0.0)	9 (40.0)
Total	21	7	22

a.   total absence of natural dentition

The majority would also recommend (strongly: 46%; or slightly: 46%) a remote dental examination to other people of their age and background. When asked about the reason for not recommending this assessment, the comments were related to the lack of provision of oral health services, in particular preventive care (See Table II).

TABLE II.   RESIDENTS' RESPONSES TO TELEDENTISTRY ASSESSMENT QUESTIONNAIRE (%)

1. How satisfied were you with the remote dental examination?[a]				
Strongly satisfied	Slightly satisfied	Neutral	Slightly Dissatisfied	Strongly dissatisfied
46.0	38.0	14.0	2.0	-
2. If remote examinations were available for patients, would you recommend them to other people?				
Strongly recommend	Slightly recommend	Neutral	Slightly not Recommend	Strongly not recommend
46.0	46.0	4.0	2.0	2.0
3. How appropriate was the format of the remote dental examinations?				
Very appropriate	Slightly appropriate	Neutral	Slightly Inappropriate	Strongly inappropriate
46.0	46.0	6.0	2.0	-
4. How satisfied were you with the review of your dental needs by the remote dentist?				
Strongly satisfied	Slightly satisfied	Neutral	Slightly Dissatisfied	Strongly dissatisfied
46.0	32.0	6.0	16.0	-
5. Were instructions from the examiner in the face-to-face exam clear and easy to understand?				
Very easy	Slightly easy	Neutral	Slightly Difficult	Very difficult
86.0	12.0	2.0	-	-
6. Were instructions from the examiner in the remote examination clear and easy to understand?				
Very easy	Slightly easy	Neutral	Slightly Difficult	Very difficult
46.0	46.0	4.0	2.0	2.0

a.   n= 50

When asked about how satisfied they were with the review of oral health needs, although the majority was either satisfied (46%) or slightly satisfied (32%), three residents (6%) were neutral and, more importantly, 16% were slightly dissatisfied. Asked about the reason for this dissatisfaction, most residents' comments were related to the lack of immediate feedback on the examination.

On comparing residents' opinions on the clarity of the communications received with the face-to-face examiner (i.e., the RN), 86% of the respondents found it "Very easy", and another 12% "Easy" to understand. Residents also found it generally easy to understand remote communications (46% "Very easy" and 46% "Easy"), and another 4% were neutral about it. Nonetheless, the remainder 4% found it "Difficult" or "Very difficult" to understand remote communications, but comments were related to the foreign accent of the oral health professional that provided feedback on the examination, rather than the technology used.

Over one quarter of the residents (28%) commented that the most valuable element of the remote dental examination was its convenience. For example, by taking video images in

the RACF, residents could avoid the disruption, difficulty and cost of arranging travel to visit a dentist.

Three of the five RNs that had been recruited and trained conducted intraoral examinations with the RACF's residents. Despite having written instructions and being able to successfully transmit files during the training sessions, most of the intraoral examinations (n = 28) required an oral health professional to manipulate the intraoral camera. In another eight examinations the RNs were assisted, either remotely or at the RACF, by an oral health professional on how to properly manipulate the intraoral camera and transmit the video images. The RN's performed the examination and transmitted the videos unsupported in only 14 examinations (See Table III).

TABLE III.   NUMBER OF TELEDENTAL EXAMINATIONS COMPLETED BY INTRAORAL CAMERA OPERATOR

	Residential aged care facilities		
	Brunswick	*South Morang*	*Stawell*
Nurse no supervision	6	4	4
Nurse under supervision	4	0	4
Oral health professional	11	3	14
Total	21	7	22

a.   Residential aged care facility

The three participating nurses provided feedback on the training material presented (i.e., a hard-copy, on-line manual and demonstrations). There was general agreement that the material presented was clear and relevant to the purposes of this project. RNs also agreed that the length of the material was right. Nonetheless, they considered that the information about oral health in older adults was too long and less relevant to their work.

Estimated unit costs of the proposed oral examination and treatment planning for a RACF's resident population, including current training costs, instrument cost and staff time are presented in Table IV. The cost of training is common between the two options while costs related to intervention delivery were different. The average cost of a 16 hour training session was AUD 8.88 per resident (ranged from AUD 8.59 to AUD 9.18 per resident). The intervention delivery cost of the Storage and Forward model was AUD 54.93 per resident with the estimated range of AUD 44.88 - AUD 66.11. The total cost per resident of the real-time oral model was AUD 54.42 (ranged from AUD 44.01 to AUD 63.86).

Staff time costs accounted for 80% of the total intervention delivery cost in both options. The staff time cost of Storage and Forward option is slightly higher than the real-time mode because of a small increase in time a nurse spent on recording the video. The average oral examination time in the Storage and Forward model was 20 minutes, whereas the nurse took 15 minutes for the real-time oral examination.

TABLE IV.   COST DESCRIPTION OF TELEDENTISTRY

	Average AUD[b]	*Minimum AUD*	*Maximum AUD*
TRAINING COST			
3-hour introduction at RACF[a]			
a) trainer			
training preparation & delivery	4.99	4.99	4.99
travel cost	0.22	0.22	0.23
b) trainee time cost	0.37	0.31	0.42
3-hour demonstration			
a) trainer			
training preparation & delivery	1.50	1.50	1.50
travel cost	0.22	0.22	0.23
b) trainee time cost	0.37	0.31	0.42
10-hour self-practice			
Trainee time cost	1.22	1.04	1.40
Total	8.88	8.59	9.18
Option 1 Storage and forward			
Intraoral camera and USB dock	0.34	0.31	0.38
STAFF TIME COST			
Nurse time	27.45	21.03	34.70
Dentist time	18.25	14.96	21.85
Total	*45.70*	*35.99*	*56.55*
Grand total	54.93	44.88	66.11
Option 2 Real-time			
Intraoral camera and USB dock	0.26	0.23	0.28
STAFF TIME COST			
Nurse time	26.03	20.23	34.70
Dentist time	18.25	14.96	21.85
Total	44.28	35.19	54.39
Grand total	54.42	44.01	63.86

b.   Residential aged care facility

c.   Australian dollars (1.00 AUD =0.70 EUR)

V.   DISCUSSION

The present study both tested and proved the technical feasibilty and acceptance, by both users and residents, of an alternative model to the traditional face-to-face oral health examination using a teledentistry installation. The observed concordance of remote and face-to-face exams was high and residents expressed acceptable levels of satisfaction with the teledentistry model.

The 'virtual dental examination' can provide general and specialist oral health care support to local aged care facilities. It can assist in providing regular and timely oral health checks using trained non-oral health professional assistants in the first instance.

Additionally, there is anecdotal evidence from RACF staff that the stress imposed by travel to a dental surgery can lead to complete non-compliance with the dental examiner, to the point where attempts at oral examination are abandoned. This leads to further travel and dentist re-

booking costs and often reluctance on the part of resident and practitioner to repeat the process. By using the teledentistry approach, the RACF avoids the disruption and difficulty of arranging travel for the patients for dental treatment.

A successful translation of this technology into clinical practice would extend the provision of health care/oral health care to remote and difficult-to-serve locations, and improve access for care to additional patient populations at reasonable cost. The ability to view examination results at their desk will enable oral health professionals to see and screen more residents per time unit in their catchment area. Further development of the procedures is warranted to allow for high-care resident assessment. Specialist dental services can subsequently be provided when the required treatment is identified.

Oral health professionals will also be able to triage and prioritize appointments, rather than travelling to each home without knowing beforehand what treatment each resident will require. Visiting domiciliary oral health professionals will be aware of the exact nature of the oral problem before they arrive. The oral health professional will also be able to plan a visit to treat other residents in the area, improving efficiency and meaning that more residents can be treated over the course of the year. The oral health professional can better identify older adults who require a diagnostic examination by a dental specialist.

Furthermore, by performing an in-RACF examination, the confidence that both the residents and their families have in the RACF will increase. From the health care system and societal perspective, a key impact will be in the satisfaction of knowing that residents have been well looked after, and that scarce resources are being well utilized. Additionally, the case for extension of funding would be bolstered. It will improve oral health for underserviced communities through education, diagnosis, treatment, health promotion and disease prevention.

Data collected from this project could also be useful as a starting point for a large oral health record repository, which would combine a digital record with 2-D and 3-D stills and video images, as well as radiographs.

Additional research should explore and address some technical and training aspects of this study, as a means to further verify this approach. Firstly, when the interaction during the conventional face-to-face exam and remote communications was examined, residents indicated levels of dissatisfaction. The face-to-face seems to provide a more effective mean to achieve clarity and easy to understand communication between the oral health professional and the resident. King and his collaborators [21] reported diminished quality of communication with videoconferencing. However, in the present study it appears that this was due to language and not technical aspects, but this was not explored. Secondly, it was expected that after a while the RNs would be able to operate the intraoral camera and send the files. However, despite having adequate training, written instructions, and receiving material compensation, some RN's still failed to fully engage with the study. This is despite the successful use of RNs in other areas of dentistry [22][23].

The main aim of implementing teledentistry would be the improvement of the clinical outcome as well as achieving the satisfaction of residents and of those in charge of the program. The latter is important, as problems and even failures of the telehealth initiative may result from discrepancies in the expectations of health care stakeholders, as well as any limitations of the health care technology [24]. Possible changes due to introduction of new technology also need to be assessed [24].

In the present study, although RNs understood the capabilities of this technology, they questioned its effectiveness in the context of a RACF. They felt that the approach did not recognize the realities of the RACF. They did not acknowledge its use as an alternative to face-to-face examinations when used on high care residents. The perception that this technology is of limited use in RACFs could explain, at least in part, the unwillingness to take up this new technology [25]. In any case, it seems that barriers to implementation are largely due to human factors. Further training and analyses of how different types of constraints operate to support or undermine the adoption of a teledentistry model need to be explored and addressed. Nonetheless, while these are important concerns, this study was not designed to explore in depth the experience of RNs and patients with teledentistry, but to give some preliminary insights on its technical feasibilty,acceptance and cost. A longitudinal study would allow assessment of users experience over time.

Estimating the costs of teledentistry programs is crucial for efficiently allocating resources to provide oral health care services for underserved communities, such as RACF residents. While the economic analysis has inherent limitations as a result of its reliance on a range of assumptions, the results provide important information for further economic evaluation, and help local program managers to determine the average cost per examination under the conditions prevailing in Victoria, Australia. Findings suggest that, the cost of the teleconsultation / telediagnosis has an overall cost per resident ranging from AUD 44.01 to AUD 63.86, with no significant differences between real-time and the Store and Forward model.

VI.   CONCLUSIONS

Findings for this field trial indicate that using a teledentistry installation is an appropriate alternative to traditional oral health consultation, and could provide benefits to an expanding segment of the population in relative and absolute terms. This population comprises older people living in RACFs and older people living in regional, rural, and even outer-metropolitan areas.

An increasing proportion of older people are living in rural and regional Australia and these communities are demographically ageing more rapidly than their metropolitan counterparts. Teleconsultation / telediagnosis projects such as the present one have the potential to target this rapidly expanding aged segment of the population with special oral health needs. There is also potential for wider scale application for the provision of sustainable oral health care in rural areas. Nonetheless, involvement of a wider range of

stakeholders will be necessary, as they all influence adoption. A recent review of factors influencing the implementation of telehealth highlighted some challenges at different levels [24]. These challenges need to be specifically targeted.

This study will lead to third Stage of this project, which would involve a multi-State, community-based trial of the technology which could be extended as an integrated part of the general adoption of telemedicine / telediagnosis. The long-term goals of such a project will be to test whether improvements in accessibility and appropriateness of oral health services can be achieved by utilizing ICT techniques to screen for oral disease and delivering oral healthcare services for older people. The project would deliver specifications and toolkits for new products and services, and develop markets for teledentistry in the public and private health sector. However, this will require further research into the acceptability of teledentistry by participants, including the format, content and delivery of the program, as well as the relevance and appropriateness of the information provided. It will also need to explore the sustainability of oral health care services in underserved areas and provide evidence for a first cut business plan for national and state programs in oral health.

People living in rural or underserved areas are amongst the most in need of oral healthcare. Teledentistry may be especially useful in remote rural areas or in other areas where there are few dental practitioners. Teledentistry may enhance the quality of services provided and reduce costs. It can benefit oral health care by enhancing early diagnosis, facilitating timely treatment of oral diseases. It can provide patient health education and health promotion and early detection of disease [25]. Eventually, face-to-face examinations could be replaced by the collection of patient information and data remotely and integrating dentistry into other health care services provided locally.

Despite this, there is currently no active teledentistry service in operation delivering private or public clinical care. The aim would be that all the fragmentary trials occurring across the world will provide the basis for fully funded service provision. The impact of such a model needs to be assessed further. Further research will also be required to undertake economic analysis and modeling to determine the intervention's productivity compared to the traditional model of oral health examination.

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