

# Paediatric Teledentistry

Delivering oral health services to  
rural and regional children



**May 2014**

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## **Acknowledgements**

The authors would like to thank Google for their support of the project providing funding through the IBES Industry Partner Program. We would like to thank all the participants in this project and to acknowledge Dr Parul Marwaha, and Ms Susan Jury for assisting with coordination of the project and support in collecting data.

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ISBN 978 0 7340 4919 3

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## Executive Summary

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Many rural, remote and outer suburban areas receive inadequate oral health care services. This is due to workforce shortages, particularly specialist services, and often results in poor oral health outcomes. Teledentistry allows local service providers to seek advice from specialists without the patient having to leave the local practice.

This publication reports on a field trial, supported by Google, that used teledentistry to deliver specialist consultation to children in Victoria and pave the way for the application of teledentistry for paediatric patients. Improving the oral health of children and adolescents is a priority area in Australia's Oral Health Plan. Teledentistry can deliver affordable and timely oral health care to patients thereby addressing the chronic dental workforce shortage and improving health outcomes.

Three Victorian general dental practitioners in Rosebud, Shepparton, and Geelong were trained to use teledentistry to conduct consultations between their clinics and the Royal Children's Hospital in Melbourne. Throughout the trial 43 patients aged from 2 to 18 were involved in teledentistry consultations with cleft lip and palate specialists and orthodontists.

Parents of patients responded positively to the study with the vast majority seeing it as a positive experience and a beneficial way to obtain dental services. Many were impressed by the ability of the local dentist and specialist to conduct the consultation obviating the need for travel.

The success of the trial provides early evidence on how teledentistry is transforming access to specialist care within the community and improving oral health outcomes. Teledentistry delivers tangible results including improved access to services in rural and regional Australia and reduced travel for patients and their families. Practitioners, patients and their parents found that teledentistry is an appropriate substitute to face-to-face consultations.

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# 1 Introduction

Many rural, remote and outer suburban areas receive inadequate oral health care services resulting in poor oral health outcomes. These communities face time consuming and expensive travel to access services provided in metropolitan centres. Teledentistry is an emerging set of technologies and practices that increase the availability of specialist oral health care therefore improving health and quality of life. Teledentistry allows local service providers to seek advice from specialists without the patient having to leave the local practice. The enhanced access and reduced costs that teledentistry delivers improves health outcomes in the community by overcoming socio-economic, geographic, and cultural barriers.

All children like to see their teeth on screen.<sup>1</sup> Teledentistry is particularly well suited to children and receives greater cooperation by younger children and toddlers, as no instruments need to be inserted into their mouth. Being able to provide oral health care services closer to the family also reduces absences at school and work due to travel.

This publication reports on a field trial that used teledentistry to deliver specialist consultations to children in Victoria and paved the way for the application of teledentistry for paediatric patients. The project was supported by Google and conducted by the Oral Health Research Centre at the Melbourne Dental School, the Royal Children's Hospital and the Institute for a Broadband-Enabled Society (IBES).

The report provides an overview of teledentistry considering the technical and clinical features of an installation. The report then discusses the benefits of teledentistry for child oral health followed by a discussion of the project and the results from the field trial. Finally, the report turns its attention on to policy, social and clinical lessons learned from the trial.

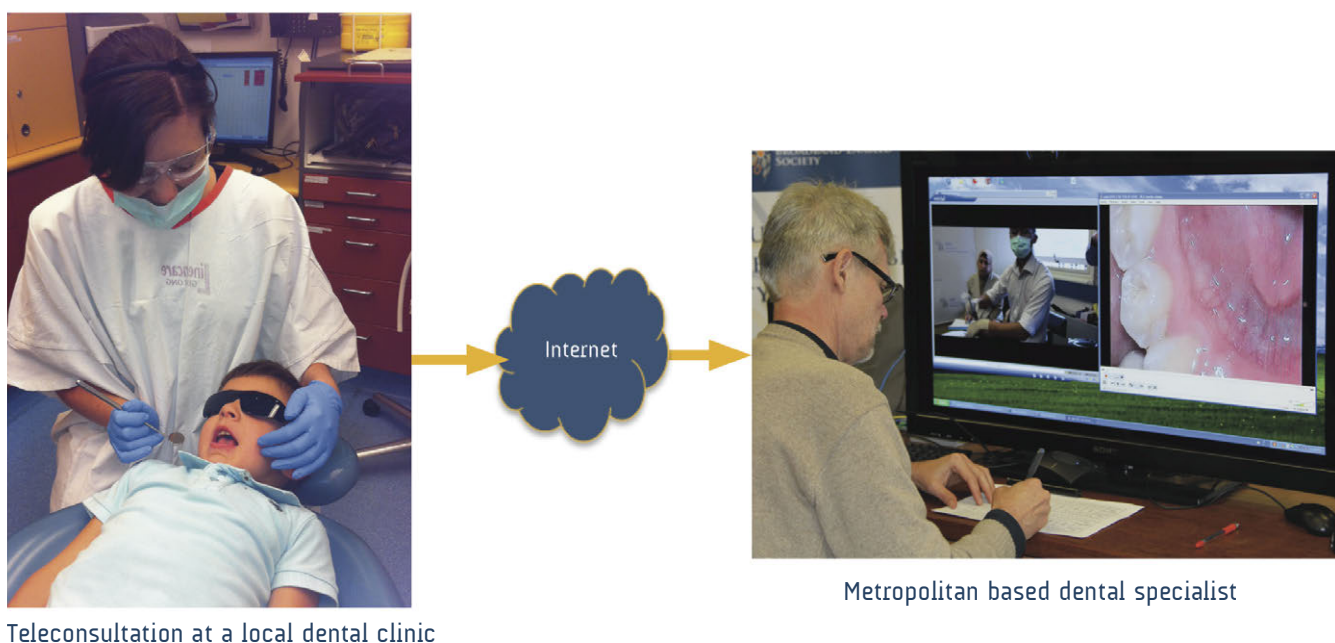


Figure 1: Teledentistry Set-up

## 2 Teledentistry

Teledentistry is broadly defined as a body of knowledge that uses information and communication technologies for the organisation, management and distribution of information in support of dental education, practice, research and administration. Given the breadth of the definition, teledentistry has a wide number of beneficial applications across the fields listed above and is firmly embedded within the broader area of telehealth. Table 1 below outlines the variety of services available.

Category	Description
<b>Tele-consultation</b> <b>Tele-diagnosis</b> <b>Tele-treatment</b>	The patient with the local health professional consults a specialist. The specialist delivers assessment and/or monitors treatment.
<b>Tele-education</b> <b>Tele-training</b>	Continuing Professional Development and training for oral health professionals
<b>Tele-monitoring</b>	Regular monitoring of physical and/or biochemical parameters in chronically ill patients (i.e. dialysis and cardiorespiratory), in intensive care or emergency care settings.
<b>Tele-support</b>	Support to remote health facilities located in isolated areas, remote places, or in areas affected by natural disasters or armed conflict.
<b>Tele-administration</b>	The use of communications technology for purely administrative work (for example scheduling and managing appointments).
<b>Consumer medical and health information</b>	Websites used for both clinical and educational purposes, combine different applications ranging from merely informative (static) pages to completely interactive applications.

Table 1: Major areas of telehealth<sup>4</sup>

Teledentistry can benefit oral health care by enhancing early diagnosis, facilitating timely treatment of oral diseases, reducing isolation of practitioners through communication with peers and specialists, and by improving access to specialist care. Increased collaboration between practitioners also supports a professional learning environment to support clinical decision-making.

Clinical uses of teledentistry support a wide range of applications with benefits to patients and practitioners. A teledentistry consultation from an oral health professional to a dental specialist can improve diagnosis and support clinical treatment. Teledentistry technologies support the sharing of clinical materials such as radiographs, periodontal and dental charting, photographs and treatment notes allowing the remote specialist to construct an informed treatment plan.

Teledentistry reduces 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.

Teledentistry works by delivering practical solutions. Reports on teledentistry trials have proved that teledentistry can be successfully implemented in different oral health settings to deliver genuine health outcomes and positive health professional-patient experiences.<sup>3</sup> There is currently no active teledentistry

service in operation delivering private or public clinical care. The aim is that all the fragmentary trials occurring across the world will provide the basis for fully funded service provision.

## 2.1 Consultation methods

Teledentistry, as in any telehealth model, can work according to two consultation methods: real-time and store and forward.

### 2.1.1 Real-time

Real-time teledentistry involves a videoconferencing session that allows oral health professionals at different locations to communicate with each other. A typical set-up involves high-definition webcams combined with hands-free microphone/speaker units so that the users can see and hear each other. For this type of consultation, both parties arrange a meeting time and information is exchanged in real-time between sites. A real-time consultation has the following advantages:<sup>4</sup>

- **Saves time:** as consultants do not have to write a letter to the dentist, who simply makes notes during the session.
- **Provides comprehensive patient information:** as consultants are able to access patient information along with complete case notes, radiographs and sketches before and during the session, for review.
- **Builds professional practice:** by giving the oral health professional the ability to ask questions as they arise and discuss case notes directly with the consultant.
- **Supports professional education:** via real-time interactive videoconferencing that is more effective than web-based self-instruction as it generates immediate feedback between instructor and student.<sup>5</sup>

### 2.1.2 Store and forward

Store and forward teledentistry has an oral health professional seeking advice from a remote specialist over a specified period of time. Communication is asynchronous. The oral health professional collects all the necessary information, such as video clips, photographs and scans, storing them in a file. This file is sent to a specialist. The consultant specialist retrieves the file at a time of their convenience and examines the contents. Recommendations are provided to the oral health professional in the same manner.



## 2.2 Equipment

The technology required for teledentistry is not complex, comprising hardware, software and Internet connectivity. The hardware comprises a computer, or tablet, that has reasonable hard drive storage (greater than 250 GB) and a substantial amount of RAM coupled with a processor able to handle real-time video processing along with a web-camera for video-conferencing and a specialist intraoral dental camera to capture images. Video-conferencing software is required, this project used Citrix GoToMeeting, however other video-conferencing software can also be used. Finally, sufficient bandwidth is required to support the desired consultation model: real-time or store and forward.

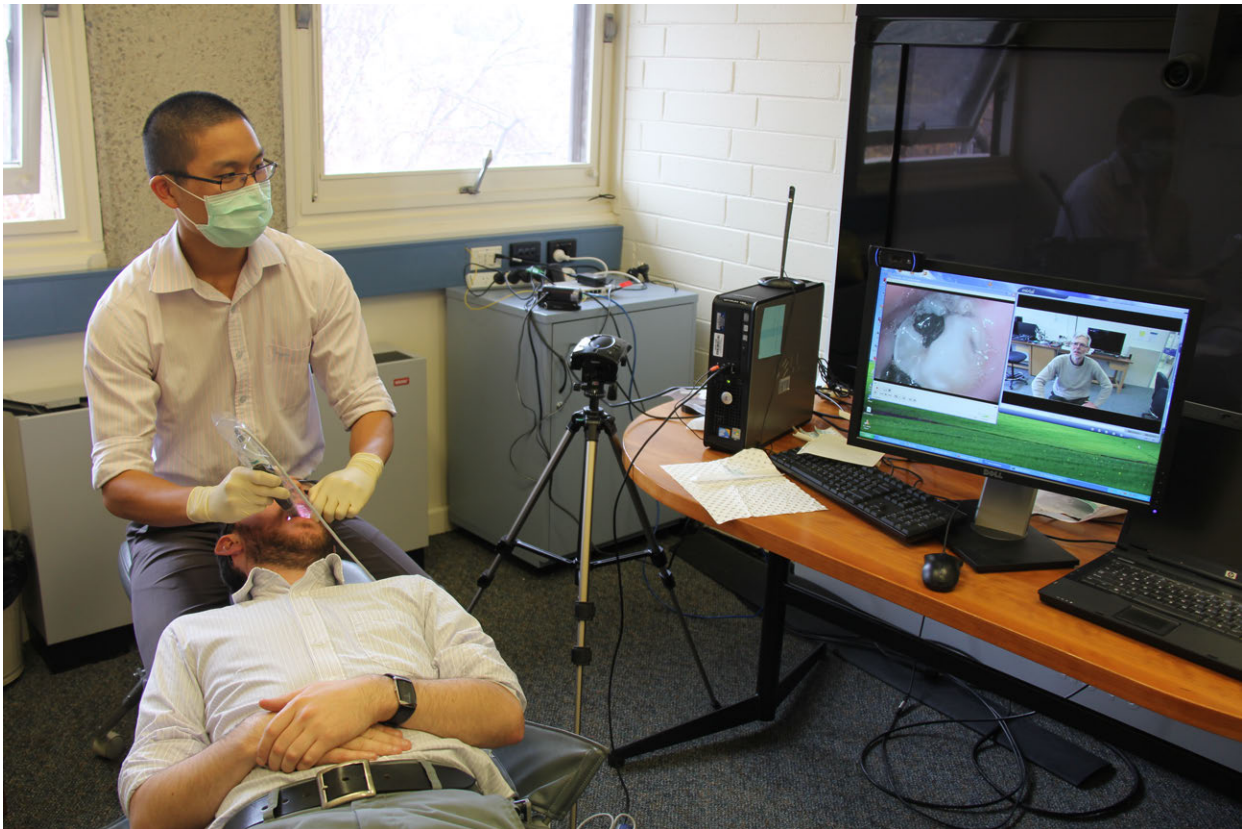


Figure 2: Teledentistry set-up for a remote clinic comprising intraoral camera, webcam, computer and Internet connection

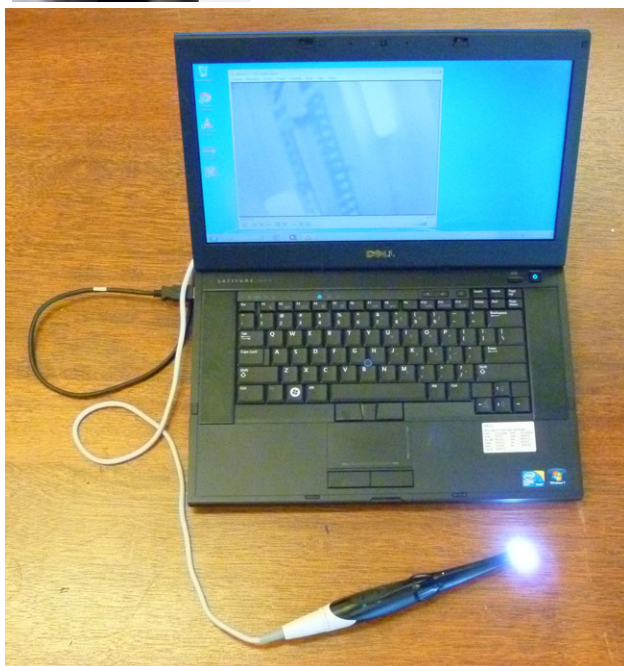


### 2.2.1 Intraoral camera

The essential dental capture technology is the intraoral camera, which produces images that are as good, or superior to, conventional real-time visual/tactile oral examination. The use of intraoral cameras has improved diagnosis of oral diseases, especially dental caries.<sup>6</sup> Digital images obtained by the camera can be used to support real-time or store and forward teledentistry consultations. Additional benefits of the camera include the lower impact upon the patient compared to traditional methods of gathering information, reducing the stress of vulnerable patients such as children. This project used a SOPROLIFE intraoral camera pictured below.



Camera head containing camera  
LEDs for white and blue illumination



Camera in operation  
connected to a computer

Figure 3: Sopro Life intraoral camera

## 2.2.2 Bandwidth

Before settling on the choice of appropriate consultation mode, the priority is to consider the nature and quantity of the information to be transmitted between sites.<sup>7</sup> This factor is essential in determining bandwidth requirements, service availability and ultimately the kind of equipment required. Additionally, it is imperative that parties connected to the teledentistry service have compatible technologies. If the technologies in the collaborating practices are not compatible there will be problems with data transfer.<sup>8</sup>

Both real-time and store and forward models require the same basic infrastructure connected to telecommunications networks with sufficient bandwidth. Low-speed, high-latency connections, which are typically found in rural and remote regions, impact the ability to perform real-time consultations. Therefore, practitioners without adequate bandwidth would have to rely upon the store and forward technique, which can utilise lower quality network connections – within reason – to ‘trickle’ data to the specialist for later review. Store and forward provides excellent benefits for a wide range of applications, and can be just as effective at presenting cases as the real-time modality.

This project assessed the capabilities of the proposed technical solution in the IBES Lab before deploying the technology in the field. The software compressed and encoded the 25 frame-per-second video into an MP4 (Mpeg-4 multimedia file) video stream of a minimum of 3Mbit/sec data transfer rate – and preferably using 5Mbit/s bandwidth if network conditions allowed. These bandwidths gave the clinician sufficient resolution quality to interpret the images received and also removed image blurring due to camera motion. Based on the results of these tests it was ascertained that clinicians had sufficient video quality to interpret the images received based upon the expected bandwidth available at the remote sites.<sup>9</sup>

## 2.2.3 Training

Reliability is essential to ensure uptake and usage of teledentistry. The integration of hardware and software in this and previous projects has been workable for clinicians and specialists. However, integration requires close attention to ensure reliability and ease of use. Users should be trained in the use of the hardware and have access to technical support to troubleshoot any difficulties.

### 3 Paediatric teledentistry

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In the state of Victoria, general dental services are provided by either private practitioners, or if eligible via public dental services. There are strict eligibility criteria for accessing public services, which are based on age, income or social situation. Waiting times to access this service can be up to 18 months.<sup>10</sup> Access is even more limited in remote areas where there are often long waiting lists for both consultation and treatment, especially for specialist care.

This project aimed to address this gap through the provision of a paediatric teledentistry service by connecting patients and their local oral health professional to a centralised paediatric dentistry specialist.

The project aimed to connect patients who require specialist attention in three areas:

- **Cleft lip and palate:** supporting the timely management of patient conditions through consultation with a paediatric specialist.
- **Dental trauma:** providing management of oro-facial trauma in rural or remote health centres and isolated practices by connecting to a paediatric dental consultant to allow for rapid diagnosis and the development of an appropriate treatment plan for presenting patients.
- **Orthodontics:** identifying and developing treatment plans for malocclusions that remain untreated due to lack of access to specialist services.

### 3.1 Clinics

Three community dental health clinics in regional Victoria participated in the trial. The clinics were located in Geelong, Shepparton and Rosebud, south of Frankston. The clinics worked in partnership with the Melbourne Dental School and the Royal Children's Hospital. The Royal Children's Hospital acted as the central site, providing specialist services to the clinics.

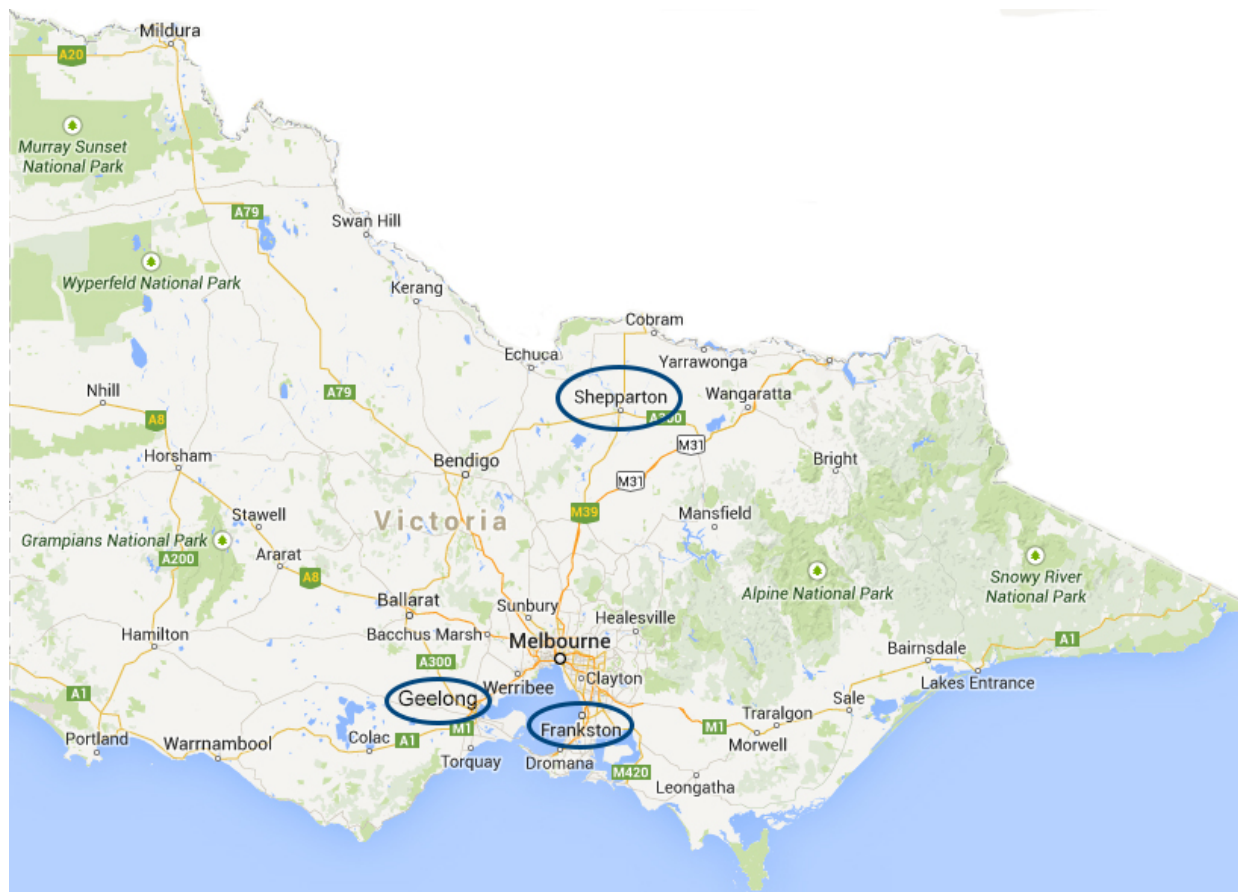


Figure 4: Location of trial teledentistry clinics in Victoria

### 3.2 Patients

Participants were recruited from the Royal Children's Hospital cleft lip and palate and orthodontics databases that lived in the aforementioned geographic regions. The local dental practitioner introduced patients and their parents to the study and conducted an oral health assessment. Parents were questioned about their satisfaction and acceptance of the teledentistry service.

### 3.3 Operation

Three general dental practitioners were trained in the use of the intraoral camera to conduct teledentistry consultations. Additional support was provided through an accompanying manual. The trained dental practitioner at the remote end used the intraoral camera on their patients. A paediatric dentistry consultant and an orthodontist located at the Royal Children's Hospital in Melbourne conducted a virtual dental examination of the patient. In collaboration with the local dentist they developed a treatment plan for each participant. The remote specialist assessed the patient's condition and provided advice to the local dentist about managing care. This entailed local treatment or the arrangement of a specialist consultation in Melbourne. Additionally, the specialist provided general advice to health staff or to the parents of the child.



Figure 5: Teledental consultation at the Royal Children's Hospital



## 4 Field Trial

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Forty-three remote assessments were conducted during the field trial. Patients presented with conditions in two specialist areas: cleft lip and palate (27 patients) and orthodontics (15 patients). One patient presented with Cohen's syndrome. Trauma was not assessed because there was no case of oro-facial trauma during the data collection period. Eighteen examinations were conducted in Shepparton, with 13 in Geelong and 12 in Rosebud. Participant ages ranged from 2 to 18 years old with the largest group (42%) being aged between 4 and 8. The majority (60%) of participants were males.

Fifty-seven percent of consultations resulted in the avoidance of travel to the Royal Children's Hospital in Melbourne. Half of the teledentistry patients were given a follow-up visit occurring in the next 6 to 12 months with a small minority requiring consultation within 3 months.

The teledentistry examination was often the initial consultation with the specialist. Therefore, for some consultations the specialist requested additional information that would be required, such as radiographs, or general dental treatment, before the speciality treatment could commence. This made the actual consultation with the specialist more efficient.

When asked about their overall experience, the majority of the parents were very satisfied or satisfied with either the remote dental examination, the review of the dental needs by the remote dentist or the format of the remote examination.

*I believe this is a valuable service for rural communities*

Parent (Rosebud)

Respondents considered it as appropriate as face-to-face consultations and would recommend the practice to other people.

*Amazing that they can consult this way*

Parent (Rosebud)

Ninety per cent of the parents found it easy to understand the instructions received from the remote examiner. Two thirds of the parents who answered this question commented that the most valuable element of the remote dental examination was the avoidance of difficult and expensive travel to visit a dental specialist reducing disruption to family routines.

*Not needing to take the day off to drive to Melbourne for 5 minutes appointment*

Parent (Shepparton)

*Apart from courteous examiners, the advantage of not having to travel to Melbourne is great, plus money saving*

Parent (Shepparton)



Overall people were satisfied with teledentistry.

*They did give us instructions on hygiene and checked up on our upcoming appointment at the RCH. This was our first experience and we were very impressed*

Parent (Shepparton)

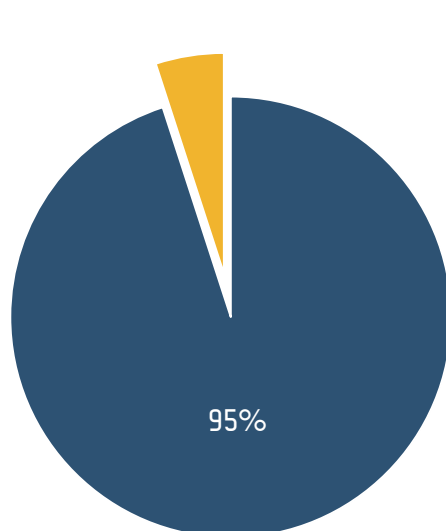


Figure 7: Percentage of parents satisfied with teledentistry service

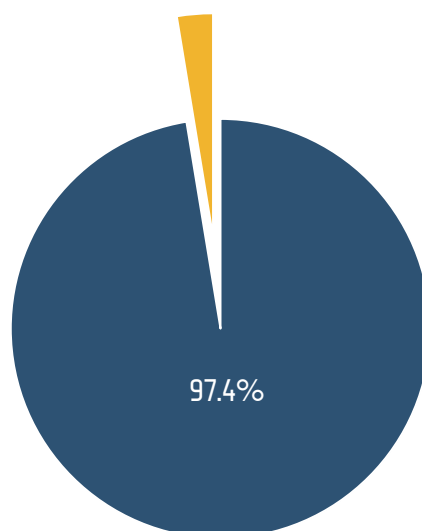


Figure 8: Percentage of parents who would recommend teledentistry

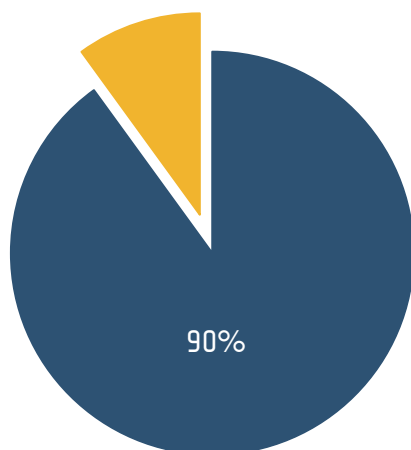


Figure 9: Percentage of parents who found the instructions transmitted during teledentistry easy to understand

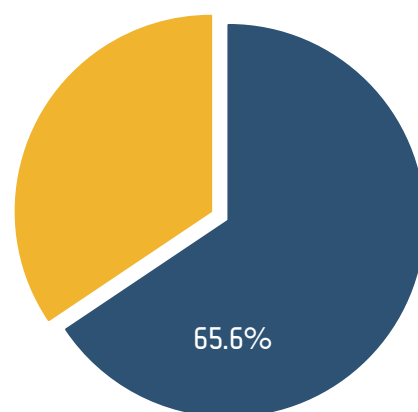


Figure 10: Percentage of parents who valued the travel reduction made available by teledentistry

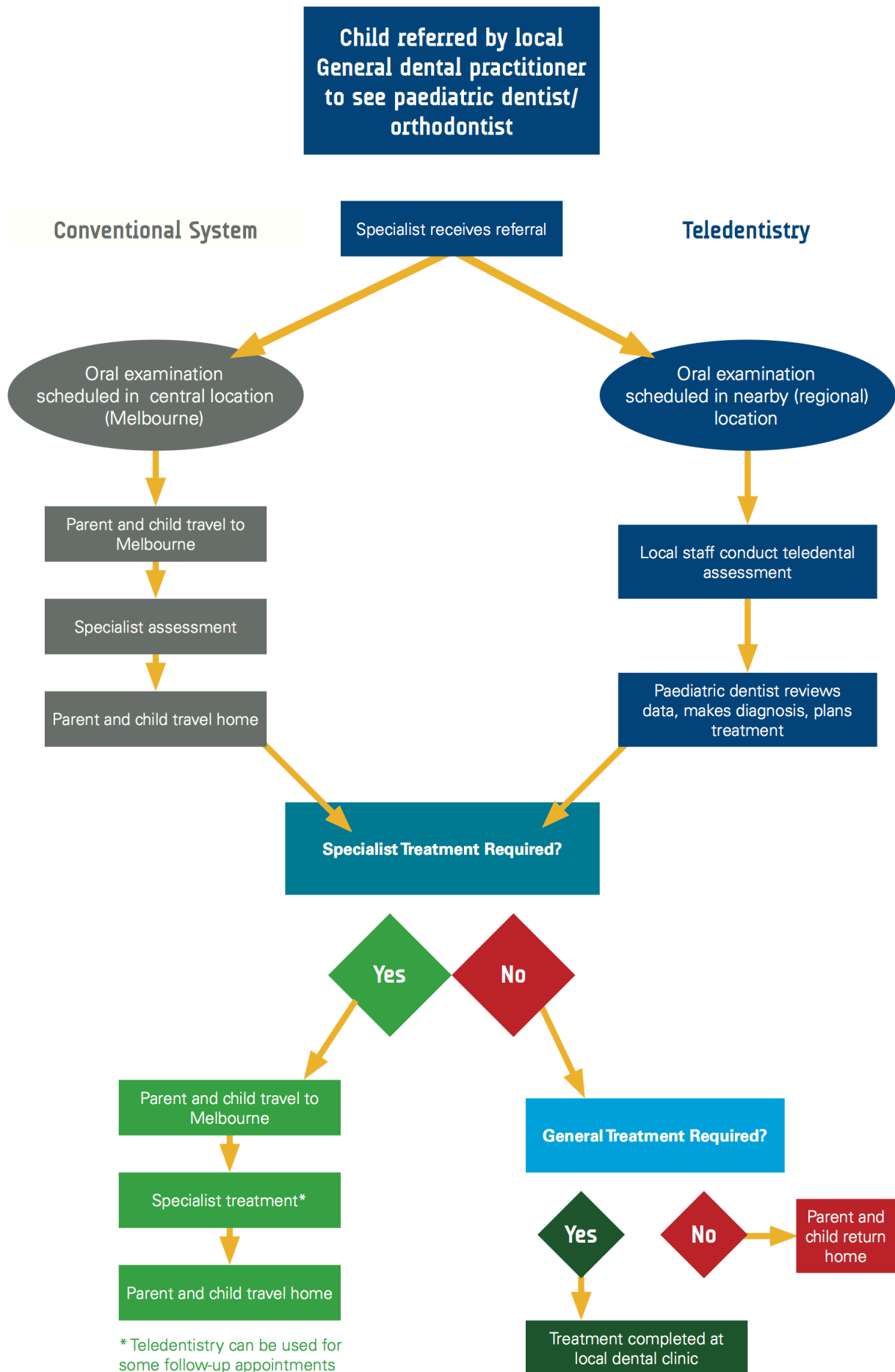


Figure 11: Comparison of current system and using teledentistry for paediatric Specialist oral health care

## 5 Conclusions

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The major outcome from the teledentistry field trial was the successful delivery of alternative models for paediatric oral health services provision in regional Victoria. This demonstrates that teledentistry can be a highly effective mechanism for enhancing early diagnosis and referral for patients who otherwise might not receive care.

A significant shortcoming of the current oral health care system is the failure to take advantage of innovations in health promotion and in information and communications technology. This failure is impacted by the lack of research information supporting oral health practices and identifying innovative ways to use e-health to increase access to preventative care and improve the delivery of dental interventions across Australia.

The teledentistry model provides a platform for expansion as the underlying technologies and practices can be extended and integrated into a broader suite of telemedicine services. Teledentistry reduces the amount of travel to health care facilities by patients located in rural and regional Australia. Participants in the trial found this a major benefit of teledentistry, as it had a direct impact on their lives – saving them time and money. Additional economic modelling is required to fully assess the impact of teledentistry and inform the development of sustainable business models.

More advanced teledentistry implementations would involve a larger number of dentists and patients from a wider geographic area with additional technologies being included in the teledentistry kit including: digital impression, 3D printing to develop dental models, saliva testing and advanced assessment tools.

Future trials are expected to increase demand for access to local oral health care services, while increasing the level of general oral health in the community. This could be achieved in remote areas with an appropriately equipped and financed mobile unit, which could also service other underserved segments of the population, such as the elderly. The proposed model provides an alternative entry point into the oral health care system by incorporating a team of oral health professionals who would use a fully equipped mobile dental unit to provide onsite oral health care services. Deployable nodes providing targeted interventions and treatment to address the oral health demand in rural, regional and remote Australia would support the mobile dental unit.

Finally, to improve oral health, the development of health promotion material is essential to reinforce the benefits arising from teledentistry. The development of an oral health care model that combines health promotion, remote oral examination, triage and the development of treatment plans would improve oral health across the community.

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