

SYSTEMATIC REVIEW

The evolution of the teledentistry landscape in Australia: A scoping review

Brianna Poirier MSc¹  | Emilija Jensen DCLinDent(Paed)^{1,2} | Sneha Sethi PhD¹

¹Adelaide Dental School, The University of Adelaide, Adelaide, South Australia, Australia

²Department of Paediatric Dentistry, Women's and Children's Hospital, Adelaide, South Australia, Australia

Correspondence

Brianna Poirier, Adelaide Dental School, the University of Adelaide, Level 10, Adelaide Health and Medical Sciences Building Corner of North Terrace and, George St, Adelaide, South Australia, Australia.
Email: brianna.poirier@adelaide.edu.au

Abstract

Introduction: There has been a recent surge in the use of teledentistry services in Australia that has paralleled the COVID-19 pandemic. Due to the limited published literature reflecting on this transition, this article employed a systematic scoping review methodology.

Objective: The objective was to explore the role of teledentistry in the provision of clinical dental services in Australia.

Design: Two independent reviewers searched PubMed, Embase, Scopus, Web of Science and grey literature sources to identify literature eligible for inclusion. The search was restricted to Australia and service delivery. Data were categorically synthesised by modalities and reported benefits and limitations; findings were cross-referenced with the COVID-19 pandemic timeline.

Findings: The systematic search identified 758 articles, of which 25 met the inclusion criteria. Results highlight a range of service providers and definitions of teledentistry. A shift in modality from asynchronous towards synchronous teledentistry pre- and post-COVID-19 pandemic is detailed.

Discussion: Whilst highly useful during the COVID-19 pandemic, teledentistry provides a unique opportunity to continue to increase the accessibility of dental services, especially for patients in rural areas or those who are immunocompromised.

Conclusion: Clinicians and researchers must consider opportunities to merge existing research with the recent clinical uptake of teledentistry for patients that would benefit from teledental services beyond the COVID-19 pandemic.

KEYWORDS

Australia, health services, oral health, rural health, teledentistry, telehealth

1 | INTRODUCTION

Telemedicine is defined as 'the remote diagnosis and treatment of patients by means of telecommunications technology'.¹ For several decades, telemedicine has

contributed to overcoming the inequitable distribution of health services by expanding the provision of care to previously unreachable populations.² The evolution and acceptance of telemedicine into health systems is a great step forward in ensuring the dissipation of time-sensitive

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and regular health surveillance, irrespective of physical location. Dental services, similar to other health services, are often inaccessible or inconsistently available to people living in remote areas.³ Despite the long history of teledentistry dating back to the 1990s, as well as the centrality of technological advances in the field of dentistry, the integration of teledentistry into mainstream dental services has been slow,⁴ until recently.⁵

Teledentistry is considered a subspecialty of telemedicine and is defined as ‘the provision of real-time and offline dental care such as diagnosis, treatment planning, consulting and follow-up via electronic transmission from different sites’.⁶ Through the use of medical records, information and communication technology, and Internet networks, teledentistry aims to provide care to patients from a distance.⁷ In the Australian context, approximately seven million people (28% of the total population) live in rural or remote regions.⁸ In addition to limited access to primary health care services, individuals in remote areas have higher rates of injury, death and hospitalisation and are more likely to engage in health-risk behaviours such as smoking and consuming alcohol. As such, the prevalence of chronic and immunocompromising conditions is higher amongst rural populations in Australia.⁹

The impacts of the COVID-19 pandemic have extended to personal, professional, societal and institutional levels. Health services have arguably been the most severely impacted and burdened during this time, primarily due to hospitalisation rates but also due to the restriction of normal activities in an attempt to limit the transmission of COVID-19.¹⁰ In Australia, state governments instituted directives to limit elective dental services and aerosol-producing treatments, amongst others, during lockdown periods. At varying points in time, states were temporarily mandated to only provide emergency dental services, creating major obstacles to accessing preventive or regular dental services.¹¹ The COVID-19 pandemic forced many dental practitioners to consider alternative modes of service delivery, which is reflected in the uptake and integration of teledentistry into routine dental practice.¹² The perception and use of teledentistry pre-pandemic was limited in scope to people living in remote locations or vulnerable populations, such as residential aged care facilities, with inaccessible or impractical dental services. Many teledentistry projects pre-pandemic were under development or in proof-of-concept stages, which may have contributed to the low integration of teledentistry modalities into regular dental practice.⁴ Due to the pandemic, the fear of contracting COVID-19 or the possibility of transmission to immunocompromised individuals resulted in a shift amongst dental services, where routine examinations, post-operative reviews and new patient consultations were conducted via teledentistry.

What is already known on this subject:

- Teledentistry is a subset of telemedicine which endeavours to provide real-time and offline dental care through the utilisation of medical records, information and communication technology, and Internet networks
- In Australia, approximately seven million people live in rural regions, where access to primary health care services, including dental services, is often intermittent

What this paper adds:

- COVID-19 forced dental services to increase utilisation of teledentistry technologies, to accommodate public health restrictions on health services
- Existing technologies and research enabled rapid uptake of teledentistry in mainstream dental services, with the Australian Dental Association advocating for teledentistry modalities and the addition of a teledentistry item number for dentists
- Increased practitioner utilisation and acceptance of teledentistry provides a unique opportunity for widespread uptake that benefits rural and immunocompromised patients

There is limited peer-reviewed literature regarding the modalities and experiences of practitioners and patients accessing teledentistry care. Therefore, a scoping review methodology¹³ was used for this project to enable the identification of grey literature sources that would reflect recent changes in teledentistry use. This systematic scoping review aimed to explore how teledentistry is currently being used for the provision of clinical dental services in Australia. Secondary aims of this review included the identification of the impacts of COVID-19 on teledentistry use, the comparison of teledentistry use pre-pandemic and post-pandemic, and the exploration of the benefits and limitations associated with the use of teledentistry.

2 | MATERIALS AND METHODS

Systematic reviews are conducted for a range of purposes and across many fields; they are considered the highest level of evidence and are often used to inform both policy and practice.¹⁴ Despite the usefulness of systematic reviews in uncovering international evidence, identifying future areas of research, investigating conflicting results,

confirming current practices and guiding decision-making, there are instances where systematic reviews are unable to meet research objectives.¹⁵ Scoping reviews are a subset of systematic reviews that are ideal when determining the coverage of literature on a given topic, particularly for emerging evidence.^{15–17} This scoping review was conducted to identify key characteristics related to the concept of teledentistry in Australia.

An initial search of PROSPERO, PubMed and the Joanna Briggs Systematic Reviews register revealed no comparable published or underway reviews. This scoping review has been registered with the Joanna Briggs Systematic Reviews register, and in accordance with Joanna Briggs Institute's methodological recommendations for scoping reviews,¹³ the protocol was made publicly available¹⁸ with the Center for Open Science.¹⁹ This review was conducted and reported in alignment with the scoping review extension of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

2.1 | Identifying articles for inclusion

Four databases were searched in October 2021 using keywords and index terms related to 'Telehealth', 'Dental' and 'Australia'. The search strategy was first developed for PubMed and then adapted as per the design of Embase, Scopus and Web of Science (Appendix S1). The database search was restricted to literature published from database inception until October 2021, and by Australian context, to identify all data available regarding key characteristics of the use of teledentistry in Australia. The search was not restricted by study design or language. Grey literature was also searched to account for information not yet published in peer-reviewed journals. Specifically, all state-based and national Australian Dental Association (ADA) websites were searched with terms related to 'Telehealth' and 'Teledentistry' (Appendix S2).

After the removal of duplicates, two independent reviewers screened the titles and abstracts of articles identified in the systematic search in Endnote (Clarivate Analytics), with articles considered relevant by either reviewer progressing to full-text review. Full-text articles were subsequently screened against the inclusion criteria, which included: Australian-based teledentistry programmes focused on clinical dentistry provision. Exclusion criteria included non-Australian contexts, the use of technology in training dental professionals, SMS text reminders for dental appointments and anticipatory guidance programmes delivered via the telephone. Any disagreements or uncertainties were resolved through discussion amongst the two reviewers. In accordance with scoping review methodologies, the critical appraisal

was not performed on studies included in this review because the aim was not to produce critically appraised findings but to generate an understanding of the existing evidence.¹⁵

2.2 | Data extraction and synthesis

Data were extracted into a piloted extraction form by three reviewers. Three articles were performed by all reviewers to ensure inter-rater reliability and reduce the introduction of selection bias. The data extracted included author name, year of publication, geographical location of study, study aim, study design, population characteristics, definition of teledentistry used, teledentistry terminology used, practitioner providing services, services provided, COVID-19 relevance, benefits and limitations of teledentistry described. Extracted data were categorically synthesised and tabulated according to teledentistry modalities described in the included literature pre- and post-COVID-19, as well as reported benefits and limitations of teledentistry.

3 | RESULTS

The systematic search identified 758 articles, of which 337 were duplicates, leaving 421 unique articles eligible for inclusion. Ninety-seven articles were retrieved for full-text review; during this process, 72 were removed, primarily due to a non-Australian context. A total of 25 articles were included in this systematic scoping review (Figure 1). The literature included in this review was published between 2014 and 2021, with 32% of the studies addressing teledentistry at a national level^{5,12,20–25} and 40% focusing on the Western Australia context^{26–33} (Appendix S2). Included literature ranged in study design, from grey literature^{5,12,21,22,24,32,34} to observational cross-sectional studies,^{29,35} cost analysis,^{23,25,36} proof of concept,^{31,37–39} retrospective analyses³³ and commentaries.²⁶ Service providers of teledentistry included dentists,^{12,20–22,24,26,34,35,38} non-specified dental practitioners,^{5,27,30,32,33} dental specialists (including oral medicine²² and oral and maxillofacial surgeons³⁹), oral health therapists^{20,25,28,29,31,37,40} and registered nurses.^{36,41} A range of terms was used throughout the different articles including the following: telehealth,^{12,33,34} teledentistry,^{5,20,21,23–32,35–38,40–42} teleoral medicine²² and surgical telepresence.³⁹ Two approaches to teledentistry were described in the included articles, synchronous (real time) and asynchronous (store and forward).⁵ Synchronous teledentistry was described as video (or telephone) consultation (or diagnosis) between a patient and a dental practitioner in real time. Asynchronous teledentistry

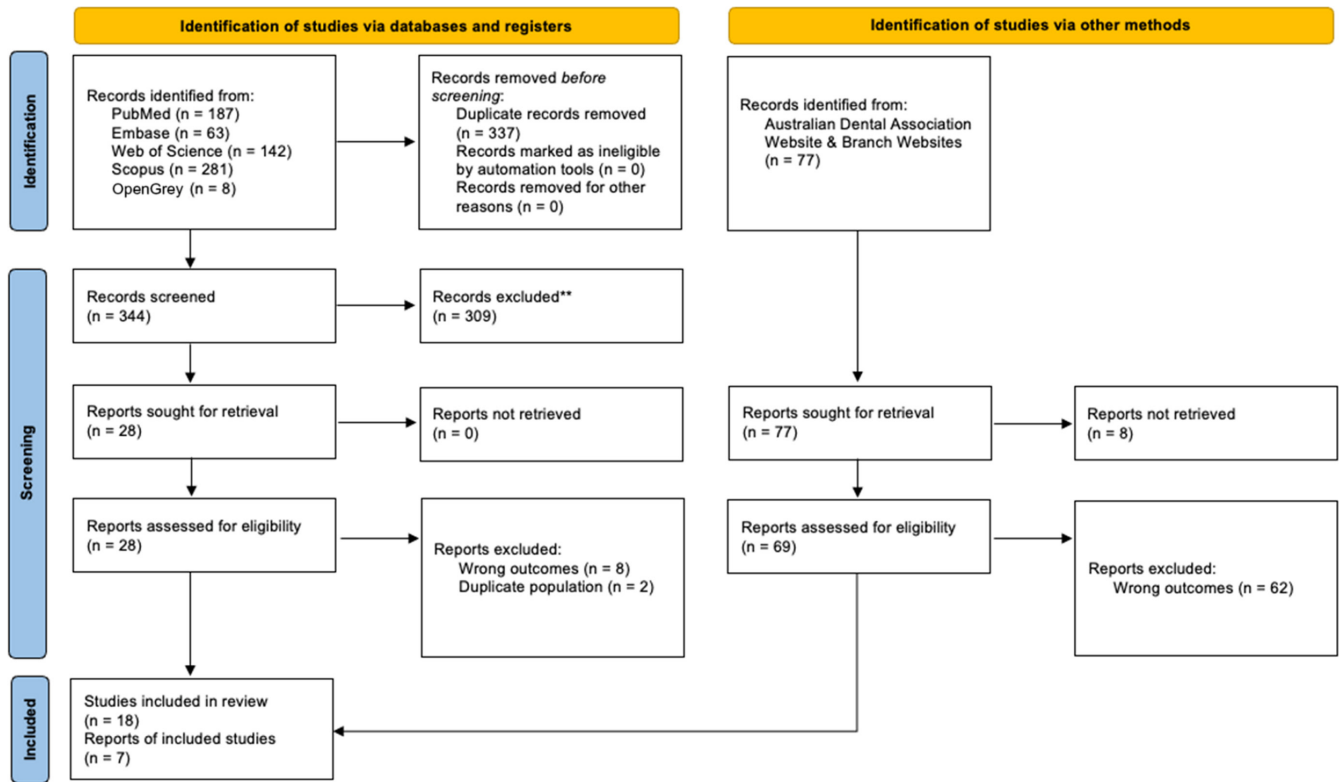
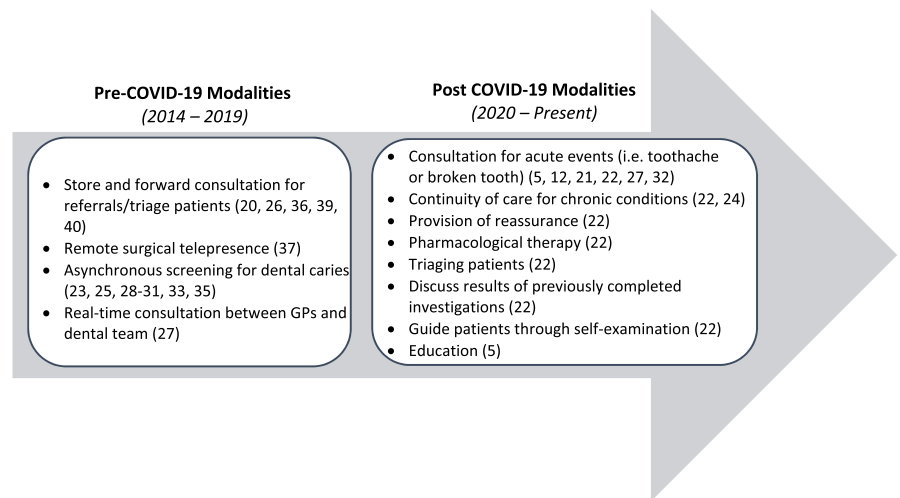


FIGURE 1 PRISMA flow diagram

FIGURE 2 Variation in teledentistry modalities in the context of COVID-19



often included collected clinical data (radiographs, smartphone images and intraoral camera photographs) stored on a device forwarded electronically (by email or through an application) to a dental practitioner for consultation or diagnosis.²²

3.1 | Modalities of teledentistry before and after the COVID-19 pandemic

Six articles discussed both synchronous and asynchronous use of teledentistry.^{5,24-27,36} Majority of the articles

that discussed synchronous use of teledentistry were published in 2020 and included a discussion of the impacts of the COVID-19 pandemic in the delivery of dental care.^{12,21,22,32,34} Prior to 2020 and the onset of the COVID-19 pandemic, articles related mainly to asynchronous teledentistry and cost-analysis, development of applications and network requirements, delivery to rural patients and validity and reliability of teledentistry for diagnosis of dental disease. Pre- and post-COVID-19 teledentistry varied not only between asynchronous and synchronous technology, but also for the modality of teleconsultations and telediagnoses (Figure 2).

3.2 | Benefits and limitations

The benefits of teledentistry described in the articles included in this review largely related to increased access to services, both for remote communities^{5,20,26,27,33} and during the COVID-19 pandemic^{12,21,22,24,32,34} (Table 1). One of the most widely cited benefits of teledentistry was reduced waiting times for patients.^{20,26,27,31,33,40} For patients living in remote areas, teledentistry offers a cost-effective alternative to lengthy travel times and accommodation costs associated with visiting clinical services,^{5,27,31,40} as well as a reduction in lost school days for children.²⁶ A strength of teledentistry highlighted in four of the articles was the ability of health workers to manage local dental needs, in correspondence with remote dental teams,^{23,33,39,41} which also provided an opportunity for workforce development.^{26,37} Participant well-being was also described as a benefit when using teledentistry due to the ability to access familiar services with familiar staff,^{30,40} decreased caregiver burdens²⁶ and decreased pain due to decreased waiting times.^{26,33}

Several limitations are related to the quality of imaging and videos,^{22,29,31,33,39} the potential unreliability of the necessary technology^{30,39} and the limited network availability in some remote areas.²⁶ The articles emphasised

that teledentistry was not a replacement for preventive health checks,^{5,12,21,22,26,41} as evidenced by the limited scope of some of the services provided, such as prescription provisions.²² Some of the limitations identified in the articles have been addressed since publication, such as the limited regulation of teledentistry protocols, and the lack of health insurance support for teledentistry services⁵; as such, these limitations were not considered during data synthesis as they no longer impact on the provision of teledentistry services.

4 | DISCUSSION

This systematic scoping review aimed to collate existing literature and explore the teledentistry modalities of clinical dental service provisions in Australia. The synthesis of evidence contrasted against the timeline of the COVID-19 pandemic has highlighted a shift in the teledentistry landscape, as well as identified opportunities for consideration in future clinical and research endeavours. Teledentistry is reported in the literature as largely benefitting patients, particularly those in rural and remote regions, primarily through expanded access to oral health care services. By limiting the systematic

TABLE 1 Benefits and limitations of teledentistry

Benefits	<ul style="list-style-type: none"> Expanded access to care^{5,20,24,26,27,31,34,36} Provision of services when in-person access is restricted^{12,21,22,32} Use of health care providers decreases resource burden^{23,33,39,41} and increases workforce capacity^{26,37} Cost reduction^{25,31,37,38,42} Reduced waiting lists^{20,26,27,31,33,40} Reduction in unnecessary referrals^{26,31} Increased efficiency of service provision^{20,26,27,31} Decreased pain associated with delayed treatment^{26,33} Enables patient monitoring and continuity of care^{26,32} Potentially less distressing for patients^{30,40} Valid and reliable way to screen for caries^{29,35} Strengthens communication between service providers and patients²⁶ Reduced carer burden²⁶ Benefits for rural and remote regions <ul style="list-style-type: none"> Increased access^{5,20,26,27,33} Decreased costs related to travel expenses^{5,27,31,40} Ability to perform surgeries/treatments remotely^{33,39,40} Minimised missed school days²⁶ Reduced isolation for dental team in remote areas^{26,33}
Limitations	<ul style="list-style-type: none"> Not a replacement for preventive health checks^{5,12,21,22,26,41} Poor imaging or video quality^{22,29,31,33,39} Need to ensure patient confidentiality^{5,26,32} Technological limitations or potential failures^{30,39} Perceived financial costs associated with technology^{26,27} Limited network availability in regional or remote areas²⁶ Need for strong coordination and communication between hubs²⁶ Loss of diagnostic details due to presence of saliva, blood, debris, etc.³³ Limited prescribing privileges²²

search employed for this review to Australia, the authors ensured clinical relevance of findings, in line with ADA policy recommendations.⁵ The increased relevance of teledentistry due to the COVID-19 pandemic highlights the expanding nature of the telehealth model in dentistry; therefore, a foundational recommendation arising from this review is the universal use of the terminology 'teledentistry', rather than telehealth or similar terms, to ensure the specific and standalone development of the teledentistry field.

The synthesis of evidence in this review emphasised a recent change in Australia's teledentistry landscape. However, it is important to consider the various modalities of teledentistry that were employed prior to the COVID-19 pandemic. These largely research-focused projects explored and piloted technologies related to the uptake of teledentistry and theorised the potential for their use, rather than focusing on immediate clinical implications. Merging the recent increase in acceptance and uptake of teledentistry modalities amongst clinicians with the existing research on technologies, such as mobile applications and store and forward technologies, provides a unique opportunity to continue to provide the most appropriate form of care for patients. Looking beyond the pandemic, teledentistry offers an opportunity to modify dental care provision in circumstances that benefit patient well-being. For immunocompromised patients or patients living with dementia, teledentistry offers a lower risk service pathway compared to visiting a clinic in person.

The benefits of teledentistry explored in this review highlight the potential to overcome widely cited barriers to accessing dental care in Australia, especially for those in remote regions.^{5,20,26,27,33} Reduction in costs associated with travelling for service delivery,^{5,27,31,40} as well as decreased carer burden²⁶ and fewer missed school days,²⁶ means that the benefits of teledentistry extend beyond an individual patient and have the potential to positively influence the well-being of their entire family. At a system level, teledentistry can increase workforce capacity^{26,37} and decrease costs associated with service provision.^{25,31,37,38,42} It is important to note that teledentistry will never be accepted as a replacement for face-to-face service provision, particularly considering the critical nature of trusting dental-patient relationships which requires regular interactions.⁴³ Additionally, there are limitations to which dental procedures would benefit from the use of teledentistry. For example, dental extractions, restorative work and surgical treatments cannot be done via teledentistry; one of the largest benefits of teledentistry lies in its ability to triage patients, provide post-treatment follow-ups and determine treatment plans. Importantly, there remain many individuals

without consistent access to dental services in Australia, for whom teledentistry could change oral health-related outcomes.³

4.1 | Limitations

Whilst the authors made all attempts to limit publication bias, there were limitations in this review. The majority of articles included in this systematic scoping review came from the same few research groups, which could have led to the over-representation of ideologies or beliefs surrounding the use of teledentistry in Australia. There were no articles from South Australia, the Northern Territory (NT), Tasmania or the Australian Capital Territory (ACT); this could be in part because the NT, ACT and Tasmania do not have a state-specific ADA website. Many terms are used when referring to teledentistry, such as telehealth, telemedicine and mHealth; although the authors employed a wide search strategy to account for all of these terms, it is possible that articles employing alternate terminology could have been missed.

5 | CONCLUSION

This systematic scoping review presents the range of opportunities that exist for the future of teledentistry in Australia. The incorporation of grey literature paralleled with the consideration of impacts of the COVID-19 pandemic makes this a timely and clinically relevant piece of research. Although teledentistry will never replace face-to-face service provision, vulnerable populations such as immunocompromised individuals and those living with dementia as well as individuals in remote regions without consistent access to dental services will benefit from the continuation of teledentistry. It is critical for clinicians and researchers alike to consider opportunities to merge existing research and technology with the recent clinical uptake of teledentistry that is tailored to patients that would benefit from teledental services beyond the COVID-19 pandemic.

AUTHOR CONTRIBUTIONS

BFP: conceptualization; data curation; formal analysis; investigation; methodology; project administration; software; visualization; writing – original draft; writing – review and editing. EJ: conceptualization; data curation; formal analysis; methodology; project administration; software; writing – original draft; writing – review and editing. SS: conceptualization; formal analysis; methodology; software; writing – original draft; writing – review and editing.

ETHICAL APPROVAL

No ethics was received because of the scoping review of existing literature methodology used.

ORCID

Brianna Poirier  <https://orcid.org/0000-0002-8257-6104>

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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