CORRECTION

Telehealth services in rural and remote Australia: a systematic review of models of care and factors influencing success and sustainability

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A B S T R A C T

Introduction: With the escalating costs of health care, issues with recruitment and retention of health practitioners in rural areas, and poor economies of scale, the question of delivering people to services or services to people is a dilemma for health authorities around the world. People living in rural areas have poorer health outcomes compared to their urban counterparts, and the problem of how to provide health care and deliver services in rural locations is an ongoing challenge. Telehealth services can efficiently and effectively improve access to healthcare for people living in rural and remote areas of Australia. However, telehealth services are not mainstream or routinely available in many rural and remote locations. The barriers to integration of telehealth into mainstream practice have been well described, but not the factors that may influence the success and sustainability of a service. Our aim was to collate, review and synthesise the available literature regarding telehealth services in rural and remote locations of Australia, and to identify the factors associated with their sustained success.

Methods: A systematic literature review of peer-reviewed and grey literature was undertaken. Electronic databases were searched for potentially relevant articles. Reference lists of retrieved articles and the grey literature were also searched. Searches identified 970 potentially eligible articles published between 1988 and 2015. Studies and manuscripts of any type were included if they described telehealth services (store-and-forward or real-time videoconferencing) to provide clinical service or education and training related to health care in rural or remote locations of Australia. Data were extracted according to pre-defined criteria and checked for completeness and accuracy by a second reviewer. Any disagreements were resolved with discussion with a third researcher. All

articles were appraised for quality and levels of evidence. Data were collated and grouped into categories including clinical speciality, disciplines involved, geographical location and the role of the service. Data relating to the success or sustainability of services were grouped thematically.

Results: Inclusion criteria were met by 116 articles that described 72 discrete telehealth services. Telehealth services in rural and remote Australia are described and we have identified six key factors associated with the success and sustainability of services: vision, ownership, adaptability, economics, efficiency and equipment.

Conclusions: Telehealth has the potential to address many of the key challenges to providing health in Australia, with its substantial land area and widely dispersed population. This review collates information regarding the telehealth services in Australia and describes models of care and characteristics of successful and sustainable services. We identified a wide variety of telehealth services being provided in rural and remote areas of Australia. There is great potential to increase this number by scaling up and replicating successful services. This review provides information for policy makers, governments and public and private health services that wish to integrate telehealth into routine practice and for telehealth providers to enhance the sustainability of their service.

Key words: access, Australia, models of care, sustainability, telemedicine.

Introduction

Australia is a vast country with a comparatively small population density of just three persons per square kilometre (compared with 35 in the USA, 265 in the UK and 421 in India)[1]. One-third of Australia's 23 million people live in rural or remote locations. These people live in towns, communities and isolated locations that have limited access to services and small population counts (<10 000)[2]. People living in rural and remote locations of Australia experience disadvantages because of their location and generally experience poorer health outcomes compared with their urban counterparts[3]. National census data for people living in rural areas estimates mortality for people aged less than 65 years is double and life expectancy 4 years shorter compared to urban areas[4]. This may be attributed to poorer access to health care and sporadic use of health services. Equity of access to health care in rural locations is compromised by geography, time and distance. Consequently, health needs are less likely to be met; the coordination and continuity of care is more difficult to achieve and the monitoring of health outcomes unlikely due to the intermittent nature of health service delivery in these locations[5].

With the escalating costs of health care, issues with recruitment and retention of health practitioners in rural areas, and poor economies of scale, the question of delivering people to services or services to people is a dilemma for health authorities around the world. The problem of how to provide health care and deliver services in rural locations is an ongoing challenge[5,6]. One solution to help address these problems is the use of telehealth to provide health care at a distance. Telehealth is defined as 'the delivery of health care services, where distance is a critical factor, by health care professionals using information and communication technologies (ICT) for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities'[7]. Telehealth services may be delivered using real-time (live) or store-and-forward techniques, such as videoconferencing and email respectively.

There is growing evidence, including many systematic reviews, to support the use of telehealth for patients and healthcare providers with outcomes: showing reduced length of stay; reduced demand on emergency services; improved access to health care; improved quality of services; improved clinical outcomes; decreased costs; reduced inconvenience; improved management of chronic and complex conditions; and provision of peer support, networking and education[3,8,9]. Despite the obvious benefits of telehealth, the actual uptake and integration of telehealth into mainstream practice has been slow and fragmented[10-12]. The scale and pace of adoption of telehealth has not developed as quickly as anticipated and many pilot programs have not migrated into sustained services[13]. The barriers and challenges associated with telehealth in Australia have been well described and include clinician preference for face-to-face consultations, ethico-legal concerns, change management practices, resources (including time), funding models, service coordination and administration personnel[13-15]. These observations are not limited to Australia. Internationally, the uptake of telehealth has not been consistent with the rapid advances in health and communication technologies and the subsequent opportunities to apply these in the context of service delivery at a distance[16-18].

Recognising the potential of telehealth to support Australians living in rural and remote areas, the Australian Government in 2011 introduced an important policy on telehealth funding. This policy led to the introduction of specific funding opportunities through Medicare, Australia's publicly funded healthcare scheme. The Medicare Benefits Schedule (MBS) lists the scheduled fee for consultations, procedure and diagnostic tests that the government considers appropriate and that it reimburses to healthcare users or providers when that item is claimed[19]. The intention of the new Medicare funding items was to encourage the use of telehealth, to improve access to specialist health services for patients in remote areas and enhance engagement between clinicians working in rural areas and specialists in major cities. For example, with the introduction of new telehealth Medicare item numbers, a specialist medical practitioner who provides a consultation by videoconference could claim additional payment from Medicare of up to 50% of the standard scheduled fee for providing the consultation face-to-face. Similarly a general practitioner or nurse supporting the patient end of a video consultation can also claim payment through Medicare for the same consultation.

The Medicare telehealth items have created a much -needed incentive for clinicians to deliver telehealth, and from a national perspective telehealth activity is steadily increasing[10]. In response to these funding opportunities, many professional societies and colleges including the Australian College of Rural and Remote Medicine, the Royal Australasian College of Physicians, the Royal Australian College of General Practitioners and the Royal College of Nursing Australia have developed specific guidelines and standards to support the use of telehealth[20-23]. Currently, MBS items for telehealth are only available for real-time (video) consultations involving a medical specialist. Under certain conditions, reimbursement for medical officers, nurses and Aboriginal health workers is available if they accompany the patient during a telehealth consultation with a medical specialist[19]. However, funding opportunities for general medical and allied health practitioners for the provision of telehealth services are very limited or non-existent, as are funding opportunities for store-and-forward telehealth applications.

For telehealth to reach its full potential, it is important to not only understand the barriers and challenges, but also to identify the factors associated with successful services. Success of a service may be defined as the sustained integration of telehealth into routine clinical practice, which is unlikely to occur by good chance[24]. There are few opportunities to learn from other services with little systemic knowledge about the range of existing services in Australia. Identification of what services are available, in which locations, and what elements have contributed to their success may help develop appropriate policy directives and support other health services to better integrate telehealth into practice. Thus, the aim of this study was to synthesise the literature regarding telehealth services operating in rural and remote locations of Australia, and to identify the reported factors associated with success and sustainability.

Methods

We conducted a systematic review of the literature according to established methodology. The study protocol was registered with PROSPERO number CRD42015015090 and adheres to the PRISMA checklist for preferred reporting items in systematic reviews[25]. We undertook the review in five phases: planning, searching, screening, appraisal and synthesis.

Planning and searching

In the planning phase, the research team agreed upon the tasks and responsibilities of each researcher. The research questions were developed, revised and agreed upon as a team:

- What are the characteristics of the telehealth services available in rural and remote Australia?
- What methodologies have been used to evaluate these services?
- What are the facilitators or enablers of successful services?
- What other factors are associated with successful or sustainable services?

The search terms were developed with the research team and a university librarian scientist. A three-step search strategy was utilised. First, an initial limited search was undertaken of MEDLINE using the terms *telemedicine* AND '*rural Australia*'. Analysis of text words contained in the resulting titles and abstracts, and of the index terms used to categorise the article, helped to inform the final search terms. The second step involved searching electronic databases with the search terms related to telemedicine or telehealth, rural and remote and Australia. The search was undertaken in November 2014 and updated in July 2015. We searched peer-reviewed electronic databases MEDLINE, Embase, CINAHL and sources of grey literature (Trove, Mednar, government and university websites) using the terms *telehealth, telemedicine, video consultation, rural, remote, Australia* as well as each state and territory in Australia. Terms were searched for as

medical subject headings (MeSH), in titles or abstracts and with Boolean operators 'AND' and 'OR'. A snowballing strategy was used to identify other relevant articles in the retrieved articles' reference lists. Articles were included if they met the criteria defined in Table 1.

The primary outcomes of interest for this review were the number, types and characteristics of telehealth services in rural Australia reported in the literature. Characteristics of services included the people, clinical aspects, location and purpose of the service.

Secondary outcomes of interests were: findings or important insights related to the success and sustainability of services,methods used to evaluate services, and outcomes that were measured, ie health-related outcomes (eg. quality of life, hospitalisation, clinical outcomes etc.); costs and resource utilisation; and process measures (eg. quality of care, adherence to standards, training and education and satisfaction). As satisfaction with processes is commonly measured, it was categorised separately.

Screening and appraisal phase

Two study authors (NB, LC) independently screened the titles and abstracts of all articles identified by the searches. Where there was any doubt, the article remained in the list for review by a third reviewer. At full text screening stage, one reviewer (NB) with content knowledge in the area reviewed the full text of each article and recorded a decision to include or exclude the article for full review and data extraction based on the inclusion/exclusion criteria and relevance to the research question. A second author (LC) reviewed the list of articles to be included and excluded and consensus was obtained. All articles that met the inclusion criteria were included in the review. Data extraction was undertaken systematically by one study author (NB) using a pre-specified list of variables and questions and was documented in a database developed for this study. The data extraction form was piloted on 10 articles and refined following discussion with all study authors. Extracted data included:

- author; year of publication; purpose of article (study, guideline, descriptive)
- geographical setting: rural; remote; state in Australia
- clinical specialty
- service details: purpose; clinicians; target clients; type of telehealth used
- methodological approach: data source; study design
- reported outcomes: categorised into health-related outcomes; costs; resource utilisation; process measures and satisfaction
- other outcomes: examples of evidence; study-author-identified facilitators of success; study-author-identified factors influencing sustainability.

A second reviewer (LC) completed independent data extraction for a random selection of 12 (10%) of articles. The results of data extraction by both reviewers were checked for accuracy, completeness and consensus. Discrepancies were resolved by discussion with all study authors. One reviewer (NB) appraised each article for the level of evidence according to the Joanna Briggs Institute (JBI) criteria[26]. The quality of each article was also appraised by the same reviewer using a modified tool developed for a systematic review of primary healthcare services in rural Australia[5]. The quality criteria assessed in this tool was deemed appropriate as it covered a range of important aspects pertaining to services rather than appraised the methodology used to evaluate services, and thus was relevant to the objectives of our review. Ten items were included; each item achieved scored 1 and items not achieved scored 0. Items included article informed by a literature review, explicit need for the service, transferability, clear aim, population representative of rural/remote, characteristics of service explained, methods accord with objectives, conclusions consistent with findings, limitations acknowledged. No articles were excluded on the basis of the level of evidence or quality assessment.

Synthesis phase

Data were categorised according to clinical speciality, discipline, geographical location and service details. Using an inductive approach, extracted data relating to the success or sustainability of services were grouped thematically to identify recurring elements in relation to the research questions. The research team met frequently to discuss consensus of findings. Data were synthesised into a narrative account summarising the overall evidence by comparing and contrasting the data.

Results

Selection of articles

Searches identified 970 potentially eligible articles. A total of 116 articles published between 1988 and 2015 were included in the review. The results of the screening and selection processes are shown in Figure 1. The majority of excluded articles did not meet the inclusion criteria of reporting an Australian service. Other articles reported feasibility or pilot studies that were not intended as services and were also excluded.

Characteristics of services

The 116 articles included in the review described 72 discrete telehealth services. Fifty-one services were reported individually and 21 in two or more papers each. Forty nine (68%) services operated from tertiary public hospitals into regional hospital facilities. The remainder of services were made up of either urban-based specialists (n=19, 26%), general practitioners (n=3, 4%) and community nurses (n=1, 4%) who provided telehealth to other locations including the patient's home. There has been a marked increase in the number of services reported over time (Fig2). The characteristics of the services were summarised and grouped into 22 different clinical specialities across Australia. The service purpose and discipline are described (Table 2). Full details of included articles can be found in the supplementary table, available in the online version of this article.

Table 1: Study inclusion and exclusion criteria

| Criteria	Inclusion criteria	Exclusion criteria
Time period	No restriction	
Language	English	
Place of study	Australia	International/not Australia
Geographical delimitation	Rural or remote	No relevance to rural or remote
Aspect of health care	Primary, secondary or tertiary level health care	
Study design	All study designs (qualitative/quantitative) including case studies and review and descriptions of services	Feasibility or pilot studies that do not intend to result in services
Type of technology and service	Any use of technology (store-and-forward or real-time video interaction) used to provide clinical services, or targeted clinical education and training or supervision of rural and remote clinicians	Any use of technology for administrative purposes only, or for general education programs, eg in-service, grand rounds presentations. Telephone-only services
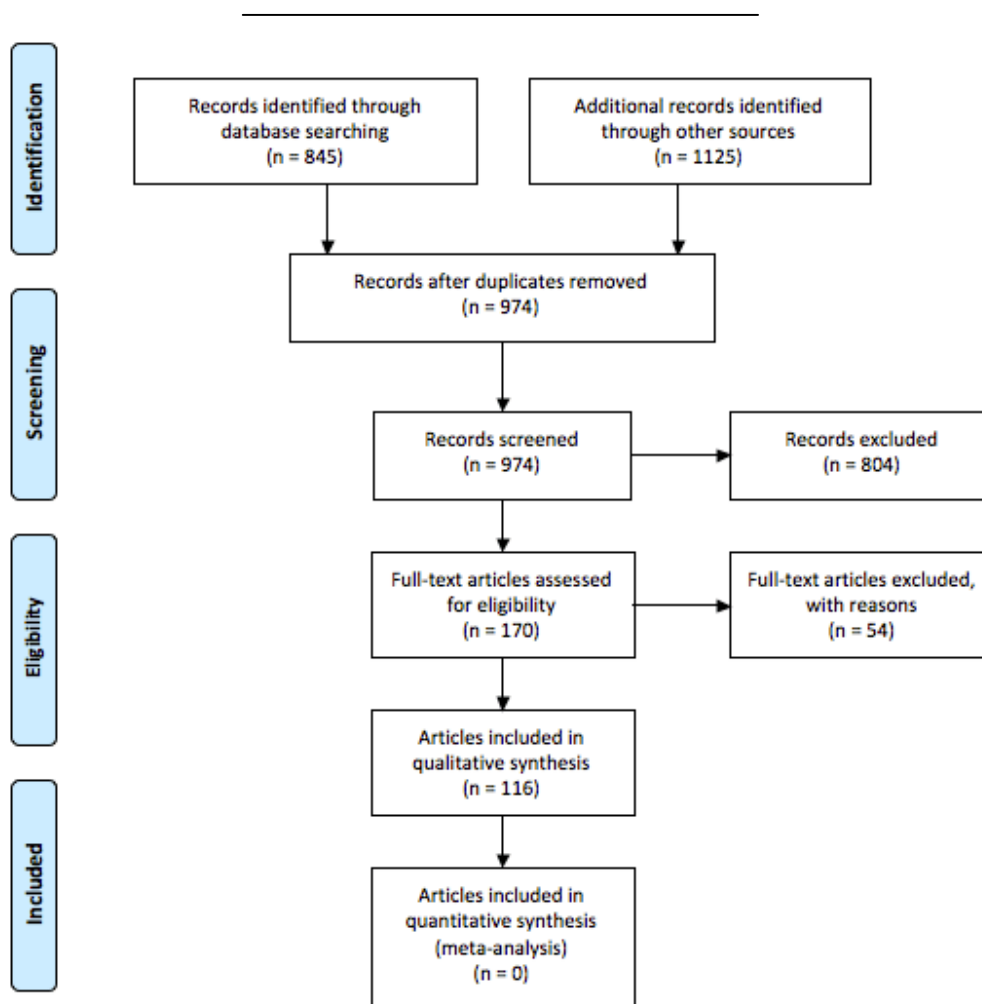
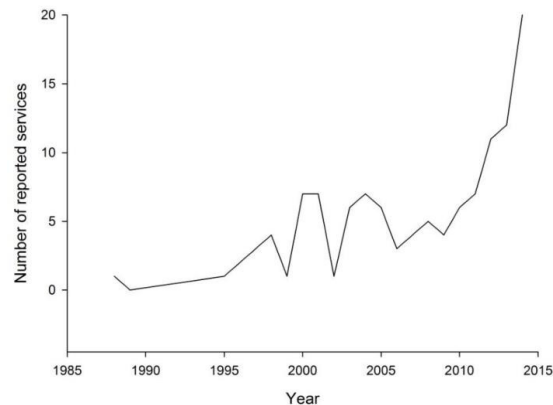**Figure 1: Flow chart of search strategy.**

Figure 2: Number of reported Australian telehealth services over time

Methodologies used to report and evaluate services

The methodologies used to report or evaluate services are summarised in Table 3. Further details of included articles are provided in Appendix I. Of the 116 articles included in this review, the majority were qualitative or quantitative descriptive accounts of services (n=85, 73%). These articles presented data or information regarding the service with little or no analysis. Half of the included articles presented a review of service activity (n=57, 49%), and used observational methods to document the processes used in the service. Use of interviews or questionnaires to collect data occurred in 13 (11%) and 32 (27%) articles. As such, most studies (n=83, 72%) were rated on the JBI level of evidence scale as a 4 (observational or descriptive studies)[26]. Two studies used an experimental or quasi-experimental design with a control group achieving a JBI level of evidence rating of rating of 1 or 2. The remainder undertook an analytical approach when describing or evaluating their service. A total of 22 (19%) studies used quantitative statistical methods in their analysis and 10 (8%) studies used qualitative analytical methods. Most articles (n=90, 78%) reported process measures related to the service, for example numbers of consultations, efficiency, technical skill or requirements. A large proportion of studies (n=38, 33%) measured either staff or patient satisfaction, with smaller numbers of studies reporting health-related outcomes (n=27, 23%), or costs (n=23, 20%).

Factors influencing success and sustainability

Factors influencing success and sustainability of services were identified from our analysis and grouped into six categories: vision, ownership, adaptability, economics, efficiency and equipment (Table 4). Services reported one or more of these factors being associated with the success and sustainability of the service (Table 5).

- *Vision* related to having a clear, realistic goal defining the purpose of the service.
- *Ownership* related to the clinical need, motivation and purposeful development of the service; success required both clinicians and management to be 'on board' and supportive of the initiative.
- *Adaptability* related to the recognition of the requirement to adapt the service model in response to the needs of patients, clinicians and health services, often going through several iterations before establishing a suitable model.
- *Economics* referred to the need for the service to offer value that was transparent, in terms of cost or time savings, with comparable clinical benefits to face-to-face services.

- *Efficiency* related to the development of procedures and processes. Successful and sustainable services did not always have high activity levels, but needed to be efficient with processes.
- *Equipment* related to consideration of infrastructure. Services did not require expensive equipment; many relied on low-cost alternatives. Services did however need to have processes in place to manage technical issues.

In our systematic review, we identified a total of 72 telehealth services reported in 116 articles in the literature. The majority of the reported services involved the public health system. This is likely to reflect only a small proportion of the actual number of telehealth services in Australia, since many are not likely to have been published. Indeed, reports on government health websites indicate telehealth is a priority for all states in Australia, and work is being undertaken to integrate telehealth into mainstream practice[143,149]. Therefore, we can be confident that a broad variety of telehealth services exist and that successful implementation of telehealth services is possible. There are many examples of sustained services; however, as costs savings to the health system are as yet unproven, the sustainability of services is not assured.

The literature has highlighted numerous barriers and challenges to the uptake of telehealth services both in Australia and internationally[13,24,150]. Since there appears to be a positive growth in the amount of telehealth work being reported, it may be that some barriers are being overcome and more services are being developed and subsequently reported. In this review we found evidence of factors associated with successful and sustained telehealth services in Australia. These factors were distilled from the services reported and present a concise overview of areas to consider when developing services. Many factors are congruent with similar studies internationally[151-153]. However, our findings highlight the importance of adaptability and efficiency, which have not been reported previously. The need to adapt and modify the service model in response to need was a frequently reported factor for the success of services.

Similarly, making a service more efficient by streamlining processes such as coordination of clinician time, room bookings, maintenance of equipment, sharing of test results and documentation, and troubleshooting technical problems, were also frequently reported as important factors for successful services.

Funding models to support clinicians who provide telehealth services are an important consideration for the government and health services. As the cost of travelling to access health care is often borne by the patient, the impetus of services to use telehealth as an alternative is reduced. Also, there is no clear understanding of the cost shifting involved in undertaking telehealth in the public hospital system. For telehealth to become integrated into the health system there needs to be a clear understanding of how services are funded, from what budget source, where the savings are generated, and how they are distributed back into the health system. We found a considerable number of services provided by allied health and multidisciplinary teams that are not eligible for MBS reimbursement. These services are likely to be operating within public hospitals or obtaining a fee for service in private practices. For providers charging a fee for service, review of MBS item numbers to support their services may be warranted. Incorporating the findings from this review will be an important 'evidence into policy' initiative for health services and governments to consider.

Concerns within government, health services and industry that telehealth is not being used to its full potential still remain[11,154]. In 2014, the Queensland Parliament reported on an inquiry into telehealth services – to appraise a $31 million investment into telehealth services in Queensland[155]. One of the findings in the report was the need for a more deliberate approach to planning the implementation of telehealth. According to the report, a more common understanding of plans to increase the use of telehealth was needed within the health service to promote telehealth adoption as well as greater collaborations between health services so that best practice approaches and lessons learnt were more accessible[155].

Table 2: Characteristics of Australian telehealth services (*n*=72)

Characteristic	Number of services	%
Specialty		
Mental health	16	22%
Oncology	5	7%
Dermatology	4	6%
Emergency medicine	4	6%
General medicine/practice	4	6%
Geriatrics	4	6%
Wound care	4	6%
Hearing and language	3	4%
Ophthalmology	3	4%
Palliative care	3	4%
Rehabilitation	3	4%
Cardiovascular (stroke)	2	3%
Endocrine	2	3%
Genetic counselling	2	3%
Infectious disease	2	3%
Neonatology	2	3%
Orthopaedics	2	3%
Otolaryngology	2	3%
Paediatrics	2	3%
Burns	1	<1%
Community care	1	<1%
Cardiac	1	<1%
Type of technology		
Videoconferencing	61	85%
Store-and-forward	11	15%
State/territory in Australia[†]		
Queensland	29	40%
New South Wales	11	15%
Western Australia	11	15%
Victoria	10	14%
South Australia	6	8%
Northern Territory	3	4%
National	3	4%
Australian Capital Territory	1	1%
Tasmania	0	0%
Discipline		
Medical	41	57%
Multidisciplinary team	16	22%
Allied health	9	13%
Nursing	6	8%
Target client group		
Adults	47	65%
Children	16	22%
Older adults	4	6%
Health practitioners	3	4%
Indigenous children	2	3%
Indigenous adults	0	0%

Table 2: cont'd

Characteristic	Number of services	%
Service purpose[†]		
Increase accessibility	49	68%
Build workforce capacity	14	19%
Cost–benefit	8	11%
Care cwoordination	3	4%
Health workforce education	2	3%

[†]Totals greater than 100% because some services in multiple states and reported multiple roles.

Table 3: Methodologies used to report or evaluate Australian telehealth services

Methodology	Number	%
Study design		
Qualitative – descriptive	54	46%
Quantitative – descriptive	31	27%
Quantitative – analytical	22	19%
Qualitative – analytical	9	8%
Method of data collection		
Review of service activity	57	49%
Observation	53	46%
Questionnaire	32	27%
Interviews	13	11%
Outcomes reported[†]		
Process measures	90	78%
Satisfaction	38	33%
Health-related outcomes	27	23%
Costs	23	20%
Levels of evidence		
4 Observational/descriptive	83	72%
3 Observational/analytic	29	25%
5 Expert opinion	2	2%
2 Quasi-experimental design	1	1%
1 Experimental design	1	1%

[†]Totals greater than 100% because multiple methods of data collection, roles and outcomes reported.

The intention of this review was to identify telehealth services in Australia. Our focus was not on the critique of methodological quality of articles. In this review, the majority (86, 73%) of studies found were descriptive reports. The majority of outcomes reported were process measures such as patient or clinician satisfaction rather than specific clinical outcomes or economic measures. Whilst process measures are important for demonstrating feasibility and factors associated with service development, specific clinical outcomes and cost measures are likely to have an important influence on the justification and uptake of telehealth[24,156].

Table 4: Factors influencing success and sustainability of Australian telehealth services

Factor	Key points to consider
Vision	• Clear, realistic vision of the purpose of the service
Ownership	• Deliberate and consultative service development with all stakeholders • Supportive management • Clinicians who champion the service by actively engaging and participating in service delivery
Adaptability	• Trial and modify the service model according to needs of patients and health service • Remain responsive to requirements of all stakeholders
Economics	• Deliver cost savings, or facilitate prioritisation of services for health services • Provide value for patients • Achieve comparable care with clinical benefits
Efficiency	• Have defined, efficient processes for managing activity • Quantity not necessarily the marker of success – high levels of activity are not required to be sustainable
Equipment	• Careful consideration of the equipment used and the technical requirements for support

Table 5: Clinical specialties of Australian telehealth services and factors influencing success and sustainability[27-142]

Specialty	Vision	Ownership	Adaptability	Economics	Efficiency	Equipment	N/A
Burns	[42]						
Cardiac		[43]			[43]		
Cardiovascular	[41]	[44–46]			[41]		
Community care		[50, 51]					
Dermatology		[49]			[48, 52–55]		[47]
Emergency medicine		[56–58]			[56–59]		[60]
Endocrinology			[61]		[61, 62]		
General medicine†	[66, 67]				[63]	[65]	[64]
Genetic counselling					[68, 69]		
Geriatrics			[71, 72]	[70, 73]			
Hearing and speech	[75]	[76, 78]	[74, 75]		[75]		
Infectious disease		[81]	[79, 80]			[79, 80]	
Mental health	[98, 99]	[84–88, 98, 99]	[89, 90, 93–95, 103, 104, 106]	[83, 89, 90, 97]	[82–88, 91, 92, 96, 98–102, 105–107]		
Neonatology¶				[110]	[108–110]		
Oncology		[112, 115–122]	[114–122]		[111, 112, 115–122]	[113]	
Ophthalmology					[123–127]		
Orthopaedics					[128–130]		
Otolaryngology	[131, 132]	[131, 132]			[131–133]		
Paediatrics	[140]		[12, 134–139]		[140]		
Palliative care				[142–147]	[142–148]	[141]	
Rehabilitation					[149–151]		
Wound care		[153]			[152, 154–156]		

† Includes genetic counselling
¶ Includes foetal ultrasound

Telehealth services are primarily intended to improve access to services by reducing the need to travel, both for the patient and the clinician. Other common reasons for telehealth services include cost efficiencies related to the service, improved processes, improved clinical outcomes and education for healthcare clinicians[4]. Thus, these are the appropriate outcomes to measure and report for the evaluation of services. In our review we also identified additional roles of services including capacity building and care coordination. These could be considered other aspects to

measure in service reports or evaluations. It is important that effort is extended to ensure the evidence regarding telehealth is strengthened by including well-defined outcome measures that are able to inform clinicians, health services and policy makers of both the direct and indirect benefits that telehealth can achieve.

Limitations

There may be other factors reported in the literature regarding success and sustainability of services that were not identified in this review. Additionally, there may be other reported services that we did not identify, despite our search strategy being comprehensive and covering a broad range of services across Australia. Data extraction was complicated by the variety of methodologies and reporting styles used. In this study, the data extracted relating to the success or sustainability of services was not generally presented in the results section but was integrated into discussion.

Conclusions

Telehealth has the potential to address many of the key challenges to providing health in Australia, with its substantial land area and widely dispersed population. We identified a wide variety of telehealth services being provided in rural and remote areas of Australia. There is great potential to increase this number by scaling up and replicating successful services. Consideration of the factors associated with the success and sustainability should be an integral part of developing services. This review identified factors associated with successful and sustainable telehealth services in rural and remote areas of Australia. Many of these have been previously reported. However, the success factors of adaptability and efficiency were newly identified by this review.

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Appendix I: Systematic review methods

The study aim was to review the available literature to identify the range of telehealth services in rural and remote Australia and to describe factors associated with the success or sustainability as a service. We conducted a systematic review according to established methodology. The study protocol was registered with PROSPERO number CRD42015015090 and adheres to the PRISMA checklist for preferred reporting items in systematic reviews.

We undertook the review in five phases: planning, searching, screening, appraisal and synthesis.

Planning phase

In the planning phase, the research team agreed upon the tasks and responsibilities of each researcher. The research questions were developed, revised and agreed upon as a team:

- What are the characteristics of the telehealth services available in rural and remote Australia?
- What methodologies have been used to evaluate these services?
- What are the facilitators or enablers of successful services?
- What other factors are associated with successful or sustainable services?

The inclusion and exclusion criteria were defined as per Table 1.

Types of studies

All types of study designs (qualitative/quantitative) including case studies, reviews and descriptions of services were included.

Types of participants

The population of interest was patients or healthcare providers in rural and remote location of Australia.

Types of interventions

The types of interventions included in this study were the provision of any healthcare intervention or service, to rural or remote locations of Australia, via telehealth.

Types of outcome measures

The primary outcomes of interest for this review were the number, types and characteristics of telehealth services in rural Australia reported in the literature. Characteristic of services included the people, clinical aspects, location and purpose of the service. Secondary outcomes of interests were:
- findings or important insights related to the success and sustainability of services
- methods used to evaluate services
- outcomes that were measured, ie health-related outcomes (quality of life, hospitalisation, clinical outcomes), process outcomes (quality of care, adherence to standards, training and education), costs and resource utilisation and satisfaction from the patient or clinician perspective.

Search phase

The search terms were developed with the research team and a university librarian scientist. A three-step search strategy was utilised. First, an initial limited search was undertaken of MEDLINE using the terms *telemedicine AND "rural Australia"*. Analysis of text words contained in the resulting titles and abstracts, and of the index terms used to categorise the article, helped to inform the final search terms. The second step involved searching electronic databases MEDLINE, CINAHL and Embase with the search terms related to telemedicine or telehealth, rural and remote and Australia.

As the 'black' literature cannot possibly catalogue all material, and there is bound to be valuable information in the grey or white literature, the search was 'snowballed' by examining other sources of data (eg government websites, Trove database, The University of Queensland library catalogue, and MedNar. Finally, the reference lists of identified articles were scanned for additional articles. All retrieved articles were catalogued and managed in an electronic bibliometric database (Endnote vX7) library.

Screening phase

The results of the screening phase were managed in the Endnote library. Duplicates of the articles were first removed. Two study authors (NB, LC) independently screened the titles and abstracts of all articles for relevance to the review. Where there was any doubt, the article remained in the list for review by a third author. At full text screening stage, one reviewer (NB) with content knowledge in the area reviewed the full text of each article and recorded a decision to include or exclude the article for full review and data abstraction according to relevance to the research questions. A second author reviewed the list of articles to be included and consensus was obtained regarding the articles to be included. All screened articles that met the inclusion criteria were included in this review.

Data extraction and appraisal phase

Data extraction was undertaken systematically by one study author (NB) using a pre-specified list of variables and questions, and was documented in an access database on a form developed for this study. The extraction form was piloted on 10 articles and refined following discussion with all study authors. A second researcher (LC) completed data extraction for a random selection of 12 articles (10%). The results of data extraction by both authors were checked for accuracy, completeness and consensus. Discrepancies were resolved through discussion with all study authors.

Extracted data included:

- author; year of publication; purpose of article (study, guideline, descriptive)
- geographical setting: rural; remote; state in Australia
- clinical speciality
- service details: purpose; clinicians; target clients; type of telehealth used
- methodological approach: data source; study design
- reported outcomes: categorised into health-related outcomes; process outcomes; costs; resource utilisation; satisfaction
- other outcomes: examples of evidence; study-author-identified facilitators of success; study-author-identified factors associated with sustainability.

Each included article was appraised for the level of evidence according to the Joanna Briggs Institute criteria by one reviewer (NB) The quality of each article was also appraised by the same reviewer using a quality assessment tool based on an instrument developed for a systematic review of primary health care services in rural Australia. The quality criteria assessed in this tool was deemed appropriate as it covered a range of important aspects pertaining to services rather than appraise the methodology used to evaluate services, and thus was relevant to the objectives of our review. No articles were excluded on the basis of the quality assessment or level of evidence.

Synthesis phase

Data were collated and grouped into categories according to clinical speciality, discipline involved, geographical location and service details. Data relating to the success or sustainability of services were grouped thematically. Data were then collated to identify key elements of articles in relation to the research questions. To aid readability, study methodological approach was summarised into one of four groups:

1) Quantitative – descriptive: studies reporting descriptive numerical activity data with little or no statistical analysis.
2) Quantitative – analytical: studies reporting numerical data and incorporating statistical analysis of data
3) Qualitative – descriptive: studies reporting largely qualitative data where services or outcomes are described with little or no analysis
4) Qualitative – analytical: studies reporting qualitative data where qualitative analysis techniques have been applied

The research team met frequently to discuss consensus of findings. Data were compared to identify common and contrasting elements, tabulated and finally synthesised into a narrative account to summarise the overall evidence.

This version of 'Telehealth services in rural and remote Australia: a systematic review of models of care and factors influencing success and sustainability' is published in correction of the original article www.rrh.org.au, first published on 17 October 2016. The authors refer readers to additions and corrections throughout the text.