

Dysphagia Management via Telerehabilitation: A Review of the Current Evidence

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INTRODUCTION

The assessment and management of dysphagia is a mainstay of adult speech pathology practice. Unfortunately though, there are a number of factors which impact negatively on health services and their ability to ensure all patients with dysphagia receive appropriate and timely care. As such, it is recognized globally that there is a need to explore alternate models of care, such as telerehabilitation, to enhance the provision of dysphagia services.

Distance is a common health service barrier, as it impacts directly on the ease to which patients have access to services. However, distance is also a relative term, and it is important to recognize that the challenges of "distance" are not only experienced by individuals living in regional, rural or remote locations. For many of our patients, the co-presence of moderate to severe levels of physical disability can make any travel, even over short distances to local services, difficult.

Lack of sufficient human and physical resources also places challenges on dysphagia services. This shortfall of human resources has many layers. At its most basic, the absence of sufficient numbers of available speech pathologists causes a critical lack of services. However, simply having access to a speech pathologist, may not necessarily mean that that local clinician will have the required skills for dysphagia management. This issue is exacerbated when patients are seeking specialist dysphagia services, such as instrumental assessment or management of areas of advanced practice such as tracheostomy or post head and neck cancer care^[1]. Lack of physical resources to conduct instrumental assessments can be a further barrier. These factors can pose significant barriers to the provision of care, particularly in those areas of the world where speech pathology services are in the early stages of establishment.

In addition to access issues, patient factors are important drivers of telehealth services. A recent study of the uptake of eVisits in four

ABSTRACT

Dysphagia is a common symptom of a wide range of medical conditions. Accurate assessment, diagnosis and management of dysphagia requires the expertise of a skilled speech pathologist with access to a range of clinical resources. Unfortunately, not all services are easily accessible by patients, and many services face challenges of insufficient staffing, limited access to necessary equipment for instrumental assessments and/or a lack of clinicians with specialist expertise in dysphagia assessment and management to meet current service demands. Telerehabilitation is a model of care, which has the potential to address some of these barriers to improve patient access to dysphagia services. This paper details the evidence base for dysphagia assessment and management conducted via telerehabilitation available to date. It discusses the issues involved with evaluating telerehabilitation services and highlights important considerations for future service development. Overall the evidence base in this field is in its infancy and there are multiple questions which require further research. Despite this, the current evidence is largely positive, supporting the potential for telerehabilitation to serve as a viable clinical modality for the delivery of dysphagia management in the future.

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medical practices in the United States, highlighted the potential for eVisits to attract a younger population of users who chose to use these services for convenience reasons^[2]. Hence, it is conceivable that in time, some dysphagic patients may select to have their regular review assessment via telehealth simply for the convenience. Health economics will also prove to be an important driver in telehealth service development. As noted by Coyle^[3], dysphagia management via telehealth has the potential to enhance patient survival and reduce health care costs associated with admissions for aspiration pneumonia. Although actual hard data to support these beliefs is yet to be collected, there is great potential to use telehealth to keep dysphagic patients well managed at home and out of hospital.

IMPLEMENTATION OF TELEHEALTH SERVICES IN SPEECH PATHOLOGY

Clinicians using telehealth services report multiple benefits, including improved access, better time efficiency, greater client focus, enhanced caseload management and cost efficiency^[4]. However, despite a recognized need and the potential advantages, the translation of telehealth models of care into routine clinical practice is still suboptimal. Data collected over a decade ago in the United States reported that at that time, only 9% of the 825 clinicians surveyed were using telehealth, and this was largely for counseling and follow-up services, with only some for treatment and screening^[5]. Whilst this figure was low, 47% expressed interest in its potential use in the future. Similar low implementation results were found in a survey of rural, remote and regional clinicians in Australia, where only 16% of the 51 surveyed clinicians reported using telehealth^[6].

Recent survey research which examined a cohort of speech pathologists who were active users of telehealth, indicated that most were providing services in regional areas, with clinicians typically using telehealth for up to a third of their caseload, though a small proportion (7%) used it with 90-100%^[4]. This survey also provided the first indication of current clinical use of telehealth for the provision of dysphagia services. Data revealed small numbers of clinicians working with both adult and paediatric caseloads were using telehealth for dysphagia management^[4].

When asked, clinicians cite a number of barriers limiting the uptake of telehealth services. These include problems with technology and connectivity, issues with technology support, limitations of current technology for certain clinical uses, lack of appropriate reimbursement and funding, lack of training in the use of telehealth, and the lack of evidence of its effectiveness^[4,6-8]. It is the aim of the current review to address just one of these issues by detailing the current evidence base for conducting dysphagia management via telehealth. This review specifically will involve discussions of current viable technology, the evidence supporting conducting a clinical swallow examination (CSE) via telehealth, the emerging evidence for conducting instrumental procedures remotely, current management options, as well as data from consumer perceptions. In each section, areas for further research will also be highlighted.

SYSTEM ARCHITECTURE

Recent research has highlighted that clinicians who use telehealth are relying on a wide range of technological solutions to deliver services including telephone, email, and videoconferencing (via either hardware systems, computer based software, or web-based software)^[4]. As a clinical specialty area, the implementation of dysphagia services via telehealth also encompasses the potential to use a wide range of

different technological solutions, depending on the purpose and need.

Due to its increasing accessibility, videoconferencing is a common tool being used by clinicians to deliver telehealth services^[4] and is an integral part of conducting online clinical assessments of dysphagia^[9-13]. Whilst traditionally videoconferencing was limited to purpose-built hardware videoconferencing systems, there are now multiple ways people can conduct videoconferencing via a range of mobile health devices (e.g. electronic tablets/smart phones) and using an array of computer-based or web-based software (e.g. Cisco Jabber, Polycom CMA Desktop, Skype). The low cost and easy availability of mobile devices to the general public affords health services the opportunity to communicate directly with the patient at any point in time, deliver therapy, monitor health status and provide information to support education, self-management and disease prevention via videoconferencing.

However, there are important data safety and security issues which must be considered when using these different types of videoconferencing systems within health services. Purpose built and commercial videoconferencing systems and software are based on international communication standards and therefore have greater capacity to deliver a controlled and secure network. Alternatively free or inexpensive web-based software (e.g. Skype) have limited security or privacy, and as they are shared with other users, bandwidth cannot be controlled^[7,14]. For this reason, the videoconferencing technology used in most of the published research to date have used either purpose built computer based systems incorporating security measures^[9-13] or commercial hardware systems running through protected hospital networks^[15].

Bandwidth, a measure of the capacity of a communications channel to carry information, is an important consideration when using videoconferencing to conduct dysphagia assessments, as images need to be of a high quality for accurate diagnosis and treatment planning. Variation in bandwidth and connectivity can impact on a range of audiovisual difficulties including audio drop-outs, pixilation of images, as well as cause total session disruption^[16]. In much of the early research conducted into conducting clinical dysphagia assessments online, relatively low bandwidths (e.g. 128 kbit/s) have been tested^[9-13]. The authors report that such low bandwidths were specifically selected as they represented the minimum speed available for residents and the health service within the regional area at the time^[9-13]. However, at these low bandwidths, issues with pixilation, audio delays and occasional drop outs were noted to disrupt some sessions^[9-13]. For these reasons, capacity to use high bandwidths wherever possible is recommended. Recent work using a hardware videoconferencing unit combined with a medical camera system was tested at much higher bandwidths (minimum of 1M bit/s), due to necessary high image quality required for assessing tissue health (e.g. granulation tissue) in the head and neck patient population^[15]. At these speeds, excellent visual quality and high quality audio signal was ensured.

A growing array of peripheral devices (e.g. medical cameras, pulse oximeters) and software applications can also be combined with teleconferencing equipment and mobile devices to enhance information gathering for dysphagia management. In research conducted to date, additional webcams with zoom capabilities^[10-13,15], free standing web cameras which can be positioned relative to the patient^[10-13], and high quality medical camera systems^[15] have been used to help provide enhanced visual images for clinical assessments of swallowing during live videoconferencing. Additional lighting sources have also been found to be critical for intra-oral cavity assessments^[10-13,15] and both free

field and lapel microphones have been used to enhance the audio information available during the assessment^[11-13]. While not reported in any published research yet to date, the potential for additional add on tools, such as a digital stethoscope, accelerometers and pulse oximeters, to be incorporated into purpose built systems may help to further enhance the clinical information available to the online clinician during a real-time dysphagia assessment.

EVALUATING TELEHEALTH SERVICES

Although the potential benefits of telehealth are easily understood by many, it is important that any form of clinical practice offered via a telehealth modality has been systematically evaluated against the current standard of face to face (FTF) care. This ensures that the clinicians who deliver the service, the patients who receive it and the services which provide it are all appropriately informed of what is similar and/or different to traditional FTF services. Furthermore telehealth service evaluation also requires multi-layered consumer evaluation and most importantly, economic analysis which will be discussed separately later in the review. To date, the evidence supporting the clinical accuracy and reliability for conducting dysphagia assessments via telehealth is only just emerging and a significant body of work is yet to be done.

The service evaluation process involves multiple stages of analysis, beginning at equipment design and testing (see Perlman & Witthawaskul^[17] and Ward *et al*^[9] as examples). Determining what capabilities are needed in a system and how these can be achieved is the necessary first step, and its importance cannot be underestimated. As identified by Ward *et al*^[9], systematic equipment testing can highlight technical limitations which necessitate revision and enhancements, leading to the development of a better system.

Following equipment testing, studies typically progress to cohort testing using a non-inferiority study design^[9-13,18]. A non-inferiority or equivalence study design is a method used to determine that a treatment (e.g. telehealth), is at least not worse than another (e.g. traditional FTF care)^[19]. To achieve this, participants complete both forms of assessment, typically in either an asynchronous or simultaneous testing methodology and then the results of both assessments are compared^[19]. Ideally, there should be a high level of agreement between the assessment conducted online and FTF. Both simultaneous and sequential testing methods have been used to date to evaluate dysphagia assessments conducted via telehealth, and both have different forms of bias which must be acknowledged.

A sequential or serial methodology involves performing the online and FTF assessments separately, one after the other, sometimes after a period of time. As such, natural variability can exist between the results obtained in the online assessment compared to the FTF assessment, as they are performed at separate times. Particularly when using this methodology for evaluating dysphagia, issues of swallow-to-swallow variability^[20], the impact of patient fatigue and potential changes to patient state between assessments^[18,19] can introduce differences between the results of the two assessments. Consequently, it can be difficult in some instances to determine if low levels of agreement are due to the inferior performance of the tele environment or the influence of these other factors^[18]. This approach also raises an ethical issue when used with the dysphagic population, as a sequential model requires patients to be exposed a second time to consistencies known to cause aspiration.

Unfortunately, simultaneous assessment methods (when both online and FTF assessment are conducted simultaneously) can also introduce bias. This method typically involves the online clinician leading the patient assessment while the FTF rater completes

a simultaneous assessment of the patient. As such, it is argued that the FTF clinician has the benefit of their own observations plus observations of the interactions/decision making of the online clinician. While researchers have tried to minimize this by ensuring the online clinician did not discuss their decision making aloud during the assessment^[9-13], it is a factor which could lead to artificially inflated levels of agreement. To date, much of the work in the area of dysphagia assessments via telehealth has employed a simultaneous testing protocol^[9-13]. When using either methodology, researchers need to ensure they have controlled for potential bias as best as possible and acknowledge the possible impact of bias in the interpretation of their results^[19].

TELEHEALTH AND THE CLINICAL SWALLOW EXAMINATION

The CSE is a critical first step in the assessment process. It provides valuable information on the patient's capabilities, their potential risk for aspiration, the severity of the presenting dysphagia and the need to refer for further instrumental testing if warranted. As a clinical tool, it has known limitations including providing limited information on the pharyngeal stage of the swallow and the inability to detect silent aspiration^[21,22]. However despite this, the CSE remains a principal tool used in the process of assessing and diagnosing dysphagia for many clinicians^[23].

The first published report of conducting a CSE via telerehabilitation documented the outcomes for a single assessment session conducted with a rural patient post stroke^[24]. The case study reported the potential to obtain information on the nature and extent of swallowing dysfunction using a videoconferencing link; however difficulties in obtaining close-up views of the patient were reported, due to the system's cameras which were fixed and of low resolution. The patient's beard also reportedly obstructed the view of larynx and made it difficult to assess laryngeal elevation. While this study demonstrated both the challenges and the potential of using telerehabilitation to assess swallowing function remotely, the lack of validation of the online decisions with FTF assessments limited the extent to which the accuracy of the online clinical decisions could be assured.

Building on from both Lalor *et al*'s^[24] work and the positive results from motor speech research at the time which confirmed that oromotor function could be reliably assessed via telehealth^[25] two studies were subsequently conducted to examine the use of telerehabilitation to conduct assessments of communication and swallowing in laryngectomy patients post discharge^[9,10]. The telerehabilitation system used in the initial study involved a purpose built videoconferencing unit with fixed web cameras^[9]. In the second study additional free standing cameras with light sources and zoom capabilities were added to address technical difficulties experienced with vision^[10]. Both studies used a non-inferiority study design, involving simultaneous assessment by both an online and FTF clinician.

With respect to the swallowing data, the results obtained in both investigations revealed a high degree of agreement between the online and FTF clinicians regarding oromotor functioning and swallowing status^[9,10]. Whilst these studies provided preliminary positive data for assessing dysphagia via telehealth, the clinical population limited the extent to which the findings could be generalized. Although the laryngectomy population does experience swallowing issues^[26], individuals are not at risk of aspiration and are well and cognitively able enough to report any difficulties experienced. As such, whether

or not the system was also capable of providing valid information for patients who were frail, unable to self-feed and facing aspiration risk, required further investigation.

In 2011, a pilot trial of a telerehabilitation system designed to administer a CSE assessment for patients with varying levels of medical complexity and alertness was published^[11]. The telehealth system was a purpose built computer based videoconferencing system loaded onto a laptop to allow mobility and use across a range of clinical environments (bedside, clinic room). It incorporated an additional free-standing web camera to enable multiple angles of viewing as required and a lapel microphone was added at the patients end (in addition to the free field microphone) for enhanced auditory information. Modifications to the assessment procedures were also described including using clear utensils to optimize information regarding timing of bolus delivery and bolus size. Furthermore an additional staff member, an assistant based at the patient end, was included in the sessions. Their role was to help the patient with positioning, orientation and relaying crucial information (e.g. oromotor strength) and performing tasks under direction by the online clinician (e.g. providing feeding assistance). Using simultaneous online and FTF assessments with a trial group of 10 standardized patients (actors portraying dysphagic patients), the study revealed that the proposed system and procedure was feasible for use with a clinical population^[11].

The subsequent clinical validation trial of this system was conducted with 40 patients recruited from the inpatient and outpatient services of a tertiary clinical service^[12]. Across a group of patients presenting with mild to severe dysphagia from varying aetiologies, results revealed high levels of clinical agreement between the online and FTF assessments across all components of the CSE. Most importantly, key clinical decisions regarding safety for oral/non-oral intake and safe food and fluid consistencies were in high agreement. It was concluded that a purpose-built telerehabilitation system, with specific system modifications and an assistant at the patient end, allowed for comparable clinical accuracy as a FTF clinical assessment for dysphagic patients with normal to mild cognitive impairments^[12].

Using the same system, a recent study of 100 patients (25 normal and 25 mild, 25 moderate and 25 severe dysphagics) examined the potential impact of dysphagia severity on assessment outcomes^[13]. Results once again confirmed a high degree of clinical agreement between the online and FTF assessments regardless of patient severity status. Together, this body of work has provided validation of this system and its capabilities. To what extent similar results can be obtained using different technology, however, is yet to be determined.

There has also been some examination of patients factors and their potential impact on CSE session outcomes. Ward *et al.*^[27] examined a subgroup of 10 patients who had undergone an online assessment of their swallowing difficulties as part of the larger published cohort study. Although the online assessments of all 10 patients had been successfully completed, certain patient factors complicated the online assessment session. These included the presence of speech and/or voice disorders, hearing impairments and dyskinesia and behavioural and/or emotional issues. The results of this paper highlighted the importance of having an assistant based at the patients end and having telehealth systems with adequate flexibility to be able to adjust and accommodate for patients with varying levels of function and physical and psychological co-morbidities (e.g. changing camera angles, enhancing audio signals).

Whilst the emerging body of evidence is positive, it is important that it be considered preliminary at this stage. The current findings

have been the work of a single research group, and as such, requires further validation by different research teams and using different telehealth systems. Furthermore determining exactly how other systems, with different levels of capability (e.g. basic videoconferencing with no additional webcam or audio support) may work, and their level of clinical accuracy is yet to be determined. This information is needed to help inform clinical services that have access to equipment with different capabilities.

TELEHEALTH AND INSTRUMENTAL SWALLOWING ASSESSMENTS

It is widely accepted that objective evaluation through instrumental assessments such as Fiberoptic Endoscopic Evaluation of Swallowing (FEES) and Modified Barium Swallow (MBS) is critical to accurately diagnose dysphagia, optimize swallow safety and plan rehabilitation^[21,28]. Together, MBS and FEES provide the clinician with the opportunity to identify anatomical and physiological abnormalities that impact on swallowing, visualize the occurrence and cause of aspiration (silent and audible), assess mucosa and pharyngolaryngeal sensation, examine the effects of compensatory strategies, determine optimum swallow safety and efficiency for the patient and plan rehabilitation^[29,30]. These assessments demand specialist staffing and equipment including access to speech pathologists trained in the administration and interpretation of the procedures, essential clinical support (e.g. radiographer, radiologist, ENT specialist) and necessary radiological/ENT equipment. Due to the limited number of skilled clinicians and restriction on resource allocation internationally, not all facilities have capacity to perform these examinations and patients are required to travel to access these essential assessments^[18].

Telerehabilitation has the potential to ease the disparity between access to instrumental swallowing assessments and patient demand, and studies evaluating the use of telehealth in the administration of these assessments are emerging. A technological framework to direct and evaluate MBS assessments remotely via an Internet connection was first documented in 2002^[17]. Known as the Teledynamic Evaluation Software System (TESS), this technological design allowed transmission of fluoroscopic images across two sites. At the hospital site, a PC computer known as the *video-interface computer* was connected to the fluoroscope and supported the transmission of images over the Internet to a second computer in a remote location. The second computer, known as the *control and analysis computer* managed the flow of fluoroscopic images both in real-time, and as stored images at the end of the assessment, and was also capable of analyzing the examination data after transmission was complete. To support the clinical procedure, a web camera was positioned within the fluoroscopy suite to provide views of the patient to the off-site clinician, and a speaker telephone connection allowed information to be transmitted between the two sites. While this study did not incorporate clinical trials, it described the first technological framework for a telefluoroscopic assessment.

In 2011, Malandraki and colleagues^[18] evaluated the TESS system with 32 dysphagic patients. Their study employed a sequential study design, with each patient undergoing two videofluoroscopic assessments (one in FTF format and using the TESS system) no more than 30 minutes apart. Three clinicians were involved in the study. Two clinicians independently directed the studies in the traditional mode, and one clinician directed the studies in the telefluoroscopic mode. Evaluations of the examination recordings were conducted by the assessing clinicians and compared. Results identified good

agreement between the two assessment modalities in subjective severity ratings, ratings of penetration/aspiration, and treatment recommendations. However where larger differences were observed on some patient ratings, factors created by the sequential study design, including analyzing two different assessments and changes in patient state were identified as possible contributing factors. Issues of transmission delays and inconsistent quality of images were also highlighted and authors stressed the importance of ensuring Internet connection speeds were optimized to ensure better quality image transmission in the future.

In a different type of study, Malandraki and colleagues^[31] reported the use of a teleconsultation model, as opposed to a teleassessment model, to evaluate the videofluoroscopic evaluation and treatment recommendations of a newly dysphagia trained clinician based in Greece and an expert speech pathologist in the United States. For the study, MBS examinations were conducted in the FTF mode at a hospital in Greece, then recorded and stored on a website. These recordings were then accessed and evaluated by both the local and the remotely based speech pathologist in the United States. While the authors reported that there was agreement between the novice and expert rater for most of the diagnostic indicators, overall decisions regarding care were reported to be substandard for more than half the patients when comparing agreement between the novice and expert clinician. This study highlighted the value in using an asynchronous teleconsultation model to assist less experienced clinicians in the interpretation of MBS data and treatment planning for oropharyngeal dysphagia.

To date there are no published studies exploring the application of telehealth in FEES assessment. Otolaryngology clinics however have reported the successful integration of telehealth equipment with nasendoscopy to evaluate ENT disorders. Researchers at The New York Eye and Ear Infirmary evaluated the use of live, real-time transmitted nasendoscopy images for the assessment of patients with and without head and neck pathology^[32]. Using a simultaneous assessment method, the study reported good agreement between the FTF and online raters for both gross and subtle pathology, while gross vocal cord mobility was also assessed with accuracy. Similarly, Dorrian and colleagues^[33] reported the successful use of tele-nasendoscopy to transmit live real-time images between a local doctor's surgery and consultant otolaryngologist for head and neck cancer assessment in Scotland. As such these studies demonstrate the potential to conduct FEES assessments remotely utilizing telehealth.

When exploring the use of telehealth for instrumental swallowing assessments, image quality is an important issue, as this is critical for accurate diagnosis. Previous telefluoroscopic studies have highlighted technological limitations that have prevented achieving live, real-time interpretation^[18]. Though, it is acknowledged that as technology advances, there will be greater capacity to transmit images at high quality and faster speed, supporting capability for live, online interpretation. However, bandwidth and transmission speed are not the only factors influencing image quality. New evidence is emerging on how the speed of *image acquisition* influences diagnosis and treatment recommendations^[34]. This has highlighted the importance of ensuring any instrumental tele-dysphagia equipment and system of image transmission is developed with the capability to transmit and display images of sufficient quality to support accurate clinical diagnostics.

DYSPHAGIA THERAPY

To date the majority of research has been focused on the clinical validity of conducting dysphagia assessments via telehealth. As such,

currently there is minimal data available to support online delivery of therapy. Burns *et al*^[15] reported the use of videoconferencing to support the assessment and rehabilitation of adult dysphagic patients following head and neck cancer treatment. However, as the study was purely a pilot feasibility study, no data on the frequency, type and outcome of swallowing treatment provided to the patients was reported. Furthermore, there was no comparison group who received treatment via traditional modality. Randomised controlled studies, where patients receive either online or FTF management are needed to establish if outcomes of online dysphagia therapy are comparable to traditional rehabilitation.

There are a number of commercial online resources already available which could potentially be used to enhance dysphagia rehabilitation. With the growing popularity of mHealth (the delivery of health services via mobile devices), numerous applications (e.g. iSwallow app) are available to support patient education and monitoring. To date though, there has been no systematic evaluation of these types of programs, their relative efficacy compared to FTF therapy, patient adherence to therapy delivered via online modalities or patient perceptions of them, and this is an area for future research.

CONSUMER PERCEPTIONS

Exploring the perceptions of “consumers” of telehealth services requires systematic investigation of not only the patients accessing the services, but also those of the clinician providing them and the service administrators supporting its use. Whilst early studies speculated that some individuals, in particular the elderly, may not be supportive of, or willing to participate in receiving health care services via telehealth^[35] many studies since have disproved this assumption. Specific to dysphagia assessments, recent data has reported that both clinician and patient satisfaction with dysphagia assessments provided via telerehabilitation is high^[36]. The majority of clinicians felt they developed good rapport, found the system easy to use and were satisfied with the service. Patient perceptions were also positive with nearly all feeling comfortable using telehealth to assess their swallow and most feeling that the telehealth assessment was comparable to a traditional assessment session^[36].

However, although patient perceptions have been reported to be positive, use of a pre and post session methodology revealed that a small proportion of patients had some pre-session reservations, stemming from a lack of awareness/understanding of what a telerehabilitation session to assess dysphagia would be like^[36]. There was also a proportion who indicated they still would prefer to have a traditional assessment session if given the choice. This data highlights the issues of exploring patient concerns about the “unknown” telerehabilitation service, and potential implications of these perceptions on the uptake of services. A recent study^[37] found there were seven predictors which had an important role on older adults' perceptions of home telehealth services, including: perceived usefulness, effort expectancy, social influence, perceived security, computer anxiety, facilitating conditions, and physicians opinion. This information has particular value for developing future systems and for predicting older users' preferences and use of telehealth.

There also remains a degree of mismatch in the perceptions of how clinicians think patients will receive telehealth services and what patients themselves actually think. Dunkley *et al*^[8] highlighted discrepancies between clinician and patient perceptions, where the speech pathologists erroneously believed rural consumers of health services would have poor access to technology and would hold negative attitudes toward telehealth services. In fact, the rural cohort studied had good access to technology and expressed great

willingness to try it. As such, this data highlights the importance of consumer input and evaluation of telehealth services.

HEALTH ECONOMICS

In recent years health service evaluation has become even more prominent with a growing focus on ensuring that implemented health care models are of proven benefit, safe, acceptable and offer value for money^[38]. Considerable resources, both capital and human are required to establish and deliver telehealth services and these costs need to be balanced against the costs incurred by the patient to access the service, associated changes in quality of life, along with the subsequent societal costs and benefits. While there are no published studies comprehensively evaluating the health economics of dysphagia assessment in telehealth, preliminary reports are emerging detailing positive cost benefits. A study by Burns *et al*^[15] reported data from a pilot telehealth clinic designed to support swallowing and communication difficulties of head and neck cancer patients. They identified 80% of telehealth appointments were conducted within the scheduled timeframe, and that all patients avoided travel expenses through receiving specialist management at their local facility. In this area in particular, a significant amount of research is still required. Future studies demand integration of an economic evaluation in order to support the sustainability of services and also establish operational requirements to guide future service planning.

CURRENT PROCEDURAL/POLICY DOCUMENTS

The increasing acceptance of telehealth internationally has seen a growing number of professional practice guidelines and policies being developed to support and guide its development and implementation, such as “A Blueprint for Telerehabilitation Guidelines”^[39] and “Knowledge and Skills Needed by Speech-Language Pathologists Providing Clinical Services via Telepractice”^[40]. Translating services into a new model of practice requires research, planning and extensive consultation. This is particularly relevant in health services where clinical, financial, technological and professional guidelines need to be considered and integrated. An additional layer of complexity also exists if these new services are connected across different health service districts, states or countries where models differ, necessitating negotiation and often compromise on service agreements. As the uptake of telehealth in speech pathology and allied health grows internationally, this field will benefit from more comprehensive, well designed policy documents and professional, discipline specific position statements which will help to ensure a high quality of services and patient care are maintained.

CONCLUSION

Current evidence supports the use of telerehabilitation in the assessment and management of adult dysphagia. Through simple modifications, the CSE can be conducted and evaluated reliably using live, realtime telerehabilitation connections. Its use with instrumental swallowing assessments is also emerging, demonstrating the capability for MBS to be directed remotely and evaluated asynchronously using telerehabilitation. To date, no studies exist on the application of telerehabilitation with FEES and there is currently limited evidence on its use in dysphagia rehabilitation.

With consumers’ and clinicians’ perceptions of this model of care being generally positive, with acknowledgment of the potential service cost-benefits, and in light of the growing access

to inexpensive and mobile technology, dysphagia services via telerehabilitation will become increasingly popular for patients and health services. In an era of rapidly advancing technology it is the challenge of researchers to continue to evaluate the equivalency of dysphagia based telerehabilitation models across this array of new devices and technology platforms. Outcomes from such research will help guide professional and technical standards, direct resource allocation, and enhance the effective delivery of dysphagia services via telerehabilitation.

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CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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