



SYSTEMATIC REVIEW

The neurogenic dysphagia management via telemedicine: a systematic review

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ABSTRACT

INTRODUCTION: Telerehabilitation is the provision of rehabilitation remotely through Information and Communication Technologies (ICT). Recently, there has been an increase of interest in its application thanks to increasing a new technology. The aim of this systematic review was to examine the evidence of the literature regarding the management of neurogenic dysphagia *via* telerehabilitation, compared to face-to-face rehabilitation treatment. The secondary aim was to create recommendations on telerehabilitation sessions for patients diagnosed with neurogenic dysphagia. **EVIDENCE ACQUISITION:** The databases were: Medline, Embase, CINAHL, Scopus. A total of 235 records emerged from bibliographic research, manual search of full text and from gray literature, published until January 2021. Two blinded authors carried out titles and abstract screening and followed by full-text analysis. Sixteen articles were included in the systematic review and assessed through critical appraisal tools. **EVIDENCE SYNTHESIS:** The research shows that the majority of the studies on neurogenic dysphagia involved the Clinical Swallow Examination *via* telerehabilitation, compared with the in-person modality. Significant levels of agreement and high satisfaction from clinicians and patients are reported to support the use of telerehabilitation. Based on the results of this systematic review and qualitative analysis, the authors developed practical recommendations for the management of telerehabilitation sessions for patients with neurogenic dysphagia. **CONCLUSIONS:** Despite the presence of barriers, telerehabilitation allowed healthcare provision and increasing access to care and services with specialized professionals, remote rehabilitation can be a valid resource during the health emergency due to COVID-19.

(Cite this article as: Reverberi C, Gottardo G, Battel I, Castagnetti E. The neurogenic dysphagia management *via* telemedicine: a systematic review. Eur J Phys Rehabil Med 2022;58:179-89. DOI: 10.23736/S1973-9087.21.06921-5)

KEY WORDS: Deglutition disorders; Telemedicine; Rehabilitation.

Introduction

Dysphagia is a frequent swallowing disorder in people affected by neurological disease.^{1,2} In literature, it is well recognized that early intervention can reduce the risk of complications such as malnutrition, dehydration, pneumonia and decrease the risk of morbidity and mortality.^{2,3} Furthermore, swallowing disorders have a negative impact on quality of life and recovery, increasing recovery times and the risk of institutionalization.^{2,4-6}

The barriers to the swallowing managements and treatment are several. Coyle reported the factors which mostly impeded the care and provision of rehabilitation were distance and time to reach health care services and, increased

demand, lack of therapists specialized in dysphagia, difficulties of complexity of the clinical diagnosis usually associated with dysphagia.^{7,8}

Some authors reported the benefits of telehealth delivery in the management of swallowing disorders. Telehealth is the delivery of rehabilitative health care services remotely through information and communication technologies (ICT) for diagnosis, evaluation, treatment, research and continuing education of health professionals.⁹

In particular, telerehabilitation refers to the provision of rehabilitative healthcare services.¹⁰ Telerehabilitation can be a valuable resource to overcome some facilities location issues ensuring access to care for patients in rural and remote areas especially for people with motor disorders.^{11,12} More-

over, it is recognized to optimize time by increasing rehabilitation sessions throughout the day, reduces costs, increase the recovery and promotes personal autonomy of the patient by encouraging the management of their health needs.^{11, 12} The benefits include also the possibility to periodically monitor the patient ensuring long-term continuity of care, especially in the case of neurodegenerative diseases.¹³

The American Speech-Language-Hearing Association (ASHA) considers telerehabilitation an appropriate service delivery model.¹⁴ It adopts the term telepractice to refer to speech therapy and audiology services provided remotely, by linking clinician to patient or clinician to clinician.¹⁴

In recent decades, the growing interest in the provision of social and health care services at a distance and the development in telecommunications have led to a significant increase in the application of telehealth on a global scale. A large number of studies have recently investigated the application of telemedicine reporting evidence of effectiveness,^{15, 16} but studies regarding the management of swallowing disorders remain limited.

Telerehabilitation was valuable resource during the period of health emergency due to the COVID-19.¹⁷⁻¹⁹ In this regard, several publications suggested to postpone the evaluation in presence, or to prefer modalities *via* telerehabilitation.²⁰⁻²⁴ As well as reducing the risk of exposure to the virus, telerehabilitation can reduce post-pandemic waiting lists and limit the movements of the health professionals and patients.^{11, 24} In addition, it allows rehabilitation treatments in a domestic context and guarantees continuity of care, early intervention and follow-up.^{25, 26} The use of telemedicine for interdisciplinary appointments enables to simulate the traditional in-person interdisciplinary model while maintaining social distancing.^{24, 27}

The primary aim of this systematic review is to investigate the evidence in the literature regarding the management of neurogenic dysphagia *via* telerehabilitation, compared to face-to-face rehabilitation treatment.

This systematic review showed a heterogeneity of study. For this reason, the secondary objective is to create recommendations on telerehabilitation sessions for patients diagnosed with neurogenic dysphagia, based on the evidence from the systematic review.

Evidence acquisition

Search strategy

The research question of the review was formulated based on the Patient-Intervention-Comparison-Outcome (PICO),

TABLE I.—PICO analysis.

Population	Patients with neurological disorder in acute or chronic settings
Intervention	Telerehabilitation
Comparison	Standard patient care and management
Outcome	Quality of life, satisfaction with the service provided, reliability of remote evaluation
Type of study	Guidelines, randomized controlled trials, systematic reviews, observational studies, narrative reviews, diagnostic accuracy studies, case reports, pilot studies, expert opinions

TABLE II.—Search string.

Search string	(Telemedicine (MeSH) OR Telerehabilitation (MeSH) OR Telerehabilitation OR Telemedicine OR Telepractice OR Telehealth AND Deglutition Disorders (MeSH) OR Deglutition disorders OR Eating disorders OR Swallowing OR Swallowing disorders OR Dysphagia
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reported in Table I. Databases searched for relevant evidence were: Medline, Embase, Cinahl, Scopus. The research strategy included terms related to dysphagia and telerehabilitation, in particular the search string was created by an Information Specialist and is reported in Table II. The search also involved grey literature, such as Google Scholar and bibliographies of articles, and a manual search of full text provided by experienced clinicians. We used the PRISMA 2009 checklist for the methodology applied in the systematic review.²⁸

Selection criteria

The inclusion criteria applied in the review were the following:

- publications until January 2021;
- papers in English;
- studies concerning swallowing interventions including evaluation, treatment, monitoring, patient education and counseling using telemedicine approach;
- adult patients with neurogenic dysphagia.

We omitted studies involving exclusively patients with swallowing disorder caused by head-neck cancer and studies on instrumental dysphagia evaluation conducted *via* telehealth.

The systematic review included guidelines, randomized controlled trials, systematic reviews, observational studies, narrative reviews, diagnostic accuracy studies, case reports, pilot studies, expert opinions.

The authors decided to include systematic reviews as they could contribute to the aim of the study increasing the

understanding and the creation of summary of effectiveness. The conduction of a meta-analysis was not possible due to the heterogeneity of the included studies.

Study selection

Two blinded authors screened the titles and abstracts of the records produced by the research strategy, applying the inclusion criteria described previously. Afterwards, the same authors analyzed full text of the possible eligible records for final inclusion in the systematic review. In case of disagreement, a discussion was conducted between the two authors involving a third author if consensus was not possible.

Data extraction

The two authors independently extracted the data using tables from the document “Recommendations for clinical practice and research in severe brain injury in intensive rehabilitation: the Italian Consensus Conference” based on the Grading of Recommendations Assessment, Development, Evaluation (GRADE) methodology evidence synthesis models.^{29, 30}

After an initial assessment of the included articles, the authors divided them into three groups according to the type of studies:

- systematic and narrative reviews were analyzed according to year of publication and topic; purpose; number of studies included; outcomes; duration of studies; interventions and controls; AMSTAR score, clinical relevance and transferability;²⁹
- observational studies were examined according to year of publication; clinical severity and setting; population; target condition and reference standards; index and comparator test; follow-up and limits;²⁹
- expert opinions for which the authors created a table including: year of publication and topic; purpose; population; intervention; outcome and results; limits, relevance and transferability.^{31, 32}

Critical appraisal

In order to define the validity of the included studies and assess the risk of bias, two blinded authors evaluated the methodological quality, consulting a third author in case of disagreement. The quantitative assessment was carried out using the checklists contained in the document elaborated in the third Consensus Conference on Severe Acquired Brain Injury based on GRADE methodology evidence synthesis models.^{29, 30}

The methodological quality was assessed using:

- A Measurement Tool to Assess Systematic Reviews (AMSTAR) was used for revisions;^{33, 34}

- Quality Assessment of Diagnostic Accuracy Studies (QUADAS) for the observational studies;
- methodological quality of the pilot study and the case reports was assessed with the checklist Kmet score.³⁵

Each study was judged based on the percentage obtained: a score of >80% was considered good quality; a score between 60% and 79% was considered strong quality; a score between 50% and 59% was considered adequate quality and a score <50% was considered poor quality. The level of evidence of the studies was determined according to the National Health and Medical Research Council of Australia (NHMRC).³⁶

In addition, a summary table was created with the characteristics of the studies included, reported the following items: reference (year of publication, country of origin); study design; study participants; intervention; types of telerehabilitation; conclusions.

Evidence synthesis

The literature search identified a total of 222 records (Medline, Embase, CINAHL, Scopus), with 13 additional studies identified from other sources (material provided by experts, analysis of studies identified through bibliographic research, manual full-text transferable research). After the removal of duplicates, the authors independently screened the titles and abstracts of the 86 records retrieved from the search strategy, applying the selection criteria previously described. The remaining records were evaluated full-text for eligibility and five records were deleted for non-transferable content, population and content not relevant to the research objectives or population not sufficiently described (Table III).³⁷⁻⁴¹ Finally, 16 studies were included for qualitative synthesis in the systematic review and 14 of these were subject also to quantitative synthesis. The two articles were excluded from critical appraisal were Ward *et al.* (expert opinion) and Coyle (descriptive study) due to low quality methodology (Kmet score <50%).^{7, 42} The process for

TABLE III.—*Studies excluded during full-text review.*³⁷⁻⁴¹

Study	Reason for exclusion
Gregory <i>et al.</i> , 2011 ³⁷	Non-transferable population
Kim <i>et al.</i> , 2019 ³⁸	Content not relevant to research objectives
Mashima and Brown, 2011 ³⁹	Non-transferable content
Burns <i>et al.</i> , 2019 ⁴⁰	Non-transferable population/population not sufficiently described
Kantarcigil and Malandraki, 2017 ⁴¹	Non-transferable population/population not sufficiently described

the selection of studies was documented in the PRISMA flow chart (Figure 1). The authors carried out the critical appraisal of five observational studies, six reviews (four systematic reviews and two narrative reviews), two case reports and one pilot study. The results of the critical appraisal are reported in a summary table (Table IV).^{8, 12, 13, 15, 43-52} In particular, authors attributed to the four systematic reviews a level of evidence I, the two narrative reviews were not classifiable according to the NHMRC Evidence Hierarchy. One observational study received a level II, another one a level III-2 and the remaining three studies were classified with a level III-1. The other studies (two case reports, one pilot study) were assigned a level IV.

Characteristics of included studies

The main characteristics of the included studies are provided in Table V. Two studies were conducted in the USA,^{43, 44} while the others were conducted in Australia.^{8, 45-49}

Population

An inclusion criterion in this systematic review was the presence of dysphagia due to neurological disorders, but the studies included enrolled participants with different etiologies. Where the diagnosis was not specified, the articles were excluded.^{40, 41}

Ward *et al.* included a total of 40 dysphagic patients, 55% with acquired or progressive neurological conditions

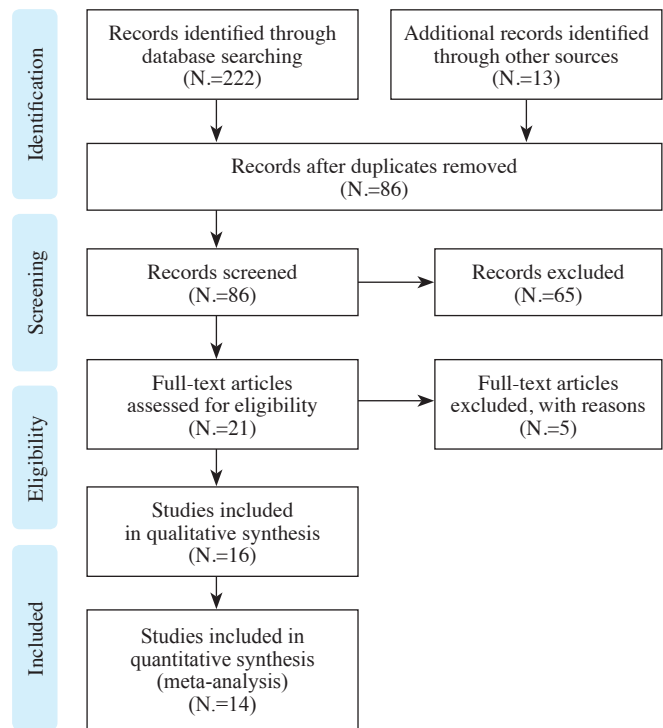


Figure 1.—PRISMA flow diagram.

and 45% with cancer.⁸ Ward *et al.* in 2013 and 2014 recruited a population composed by 100 patients with different etiologies (51% acute/degenerative disorders; 31%

TABLE IV.—Summary of the quality of studies.^{8, 12, 13, 15, 43-52}

Systematic and narrative reviews			
Reference	AMSTAR (%)	Methodological quality*	NHMRC Level of evidence
Nordio <i>et al.</i> , 2018 ⁵⁰	7/11 (64%)	Strong	I
Weidner and Lowman, 2020 ⁵¹	7/11 (64%)	Strong	I
Regina Molini-Avejonas <i>et al.</i> , 2015 ¹²	5/11 (45%)	Poor	I
Theodoros <i>et al.</i> , 2019 ¹³	8/11 (73%)	Strong	I
Mashima and Doarn, 2008 ¹⁵	2/11 (18%)	Poor	n.c.
Ward and Burns, 2014 ⁵²	1/11 (9%)	Poor	n.c.
Observational studies			
Reference	QUADAS (%)	Methodological quality*	NHMRC Level of evidence
Ward <i>et al.</i> , 2012 ⁸	12/14 (86%)	Good	III-1
Ward <i>et al.</i> , 2013 ⁴⁹	12/14 (86%)	Good	III-1
Ward <i>et al.</i> , 2014 ⁴⁸	13/14 (93%)	Good	III-1
Morrell <i>et al.</i> , 2017 ⁴³	12/14 (86%)	Good	II
Sharma <i>et al.</i> , 2013 ⁴⁷	10/14 (71%)	Strong	III-2
Pilot study and case reports			
Reference	Kmet score (%)	Methodological quality*	NHMRC Level of evidence
Cassel, 2016 ⁴⁴	10/10 (100%)	Good	IV
Sharma <i>et al.</i> , 2011 ⁴⁵	15/20 (75%)	Strong	IV
Sharma <i>et al.</i> , 2012 ⁴⁶	11/12 (92%)	Good	IV

*Methodological quality: good >80%, strong 60-79%, adequate 50-59%, poor <50%.
N.c.: not classifiable.

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TABLE V.—Characteristics of eligible studies included.^{8, 43-49}

Reference	Study design	Study participants	Intervention	Modality	Conclusions
Sharma <i>et al.</i> , 2011 ⁴⁵ Australia	Pilot study	N.=10 simulated patients with different dysphagia severities	Simultaneous swallowing assessment (CSE) telerehabilitation vs. face- to-face mode	Synchronous	High levels of agreement on dietary recommendations
Sharma <i>et al.</i> , 2012 ⁴⁶ Australia	Case report	N.=1 Allied Health Assistant (AHA)	Theoretical-practical training to support swallowing assessments <i>via</i> telerehabilitation	Hybrid	Competences and perceived comfort of the assistant increased with the succession of assessments
Ward <i>et al.</i> , 2012 ⁸ Australia	Observational study	N.=40 dysphagia in head- neck cancer and in degenerative or acquired neurological disorders	Simultaneous swallowing assessment (CSE) telerehabilitation vs. face- to-face mode	Synchronous	High levels of agreement for clinical decisions; severity of dysphagia and recommendations regarding oral or nonoral diet and safe consistencies almost in perfect agreement
Sharma <i>et al.</i> , 2013 ⁴⁷ Australia	Observational study	N.=40 dysphagia in head- neck cancer and neurogenic dysphagia	Pre- and post-assessment questionnaires; CSE conducted <i>via</i> telerehabilitation	Synchronous	Pre-CSE concern of the patients for audio and video quality. Significant increase of satisfaction levels post-CSE. 83% of participants consider the two modalities comparable
Ward <i>et al.</i> , 2013 ⁴⁹ Australia	Observational study	N.=100 dysphagia from different etiologies and with different severities (DOSS)	Simultaneous swallowing assessment (CSE) telerehabilitation vs. face- to-face mode	Synchronous	Significant levels of agreement for clinical decisions and recommendations
Ward <i>et al.</i> , 2014 ⁴⁸ Australia	Observational study	N.=100 dysphagia from different etiologies and with different severities (DOSS)	Simultaneous swallowing assessment (CSE) telerehabilitation vs. face- to-face mode	Synchronous	Acceptable levels of agreement between the two modes of conducting the CSE, not influenced by the severity of dysphagia
Cassel, 2016 ⁴⁴ USA	Case report	N.=3 dysphagia in patients with stroke or traumatic brain injury	Rehabilitation treatment: training in the use of swallowing safety strategies	Hybrid: two in-person sessions and one session in telehealth in a synchronous mode	High levels of adherence to the strategies trained during rehabilitation sessions
Morrell <i>et al.</i> , 2017 ⁴³ USA	Observational study	N.=100 hospitalized patients diagnosed with acute ischemic stroke or intracerebral hemorrhage	Sequential swallowing assessment <i>via</i> telerehabilitation vs. bedside	Synchronous	Excellent levels of agreement for liquid and solid dietary textures. Dietary recommendations were not influenced by the location and severity of the stroke

cancer care; 18% other not specified).^{48, 49} In Sharma *et al.*, ten patients were simulated by two clinicians with experience managing swallowing disorders acting five different dysphagia severities.⁴⁵ In 2013, Sharma *et al.* included 45% of patients with dysphagia due to head-neck cancer while the remaining 55% presented dysphagia associated with acute and progressive neurological conditions.⁴⁷ Morrell *et al.* enrolled a population of 100 patients, but after the removal of one patient, the study evaluated 99 participants with stroke. Five patients of the population included presented also dementia and 25 aphasia.⁴³ A case report by Cassel concerned the management of three neurological

patients: two patients presented cerebral vascular accident and one patient had a traumatic brain injury.⁴⁴

Assessment

Six out of the 16 studies included (37.5%) in the review concerned the functional assessment of swallowing, conducted *via* telerehabilitation and compared to standard face-to-face mode.

The Clinical Swallow Examination (CSE) was conducted with structured proforma formed by four sections regarding: general orientation and alertness, oromotor and laryngeal function assessment, performance during

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food and fluid trials, clinical decisions and recommendations.^{8, 45, 47-49}

In these studies, CSE was conducted *via* telehealth, the online therapist was supported by an assistant who stand alongside the patient.^{8, 45, 47-49} The patient, the face-to-face therapist and the assistant were located in one room and the online therapist was in another room. The online therapist conducted the swallowing assessment in real-time meanwhile the face-to-face therapist observed the evaluation and simultaneously completed the CSE proforma independent of the other therapist.^{8, 45, 47-49} The simultaneous assessment was preferred in order to not increase the patient's exposure to aspiration. However, this method could introduce bias as the face-to-face therapist had the benefit to observe the interaction between the online therapist and the patient.^{8, 45, 47-49} In order to minimize possible bias, the two therapists were asked to not verbalize any decisions and not communicate with each other. The levels of intra- and inter-operator agreement were assessed through percentage exact agreement (PEA) and percentage clinical agreement (PCA).^{8, 47-49}

Exclusively in the study by Morrel *et al.*, the two assessments were conducted in sequential mode, introducing potential bias due to possible fatigue of the patient and the variability of swallowing skills in post-stroke hospitalization.⁴³ Nevertheless, the period of time between the two assessments seemed to have not influenced the levels of agreement.⁴³

The included studies reported significant levels of agreement between the face-to-face and online assessment. The modality of assessment did not affect the clinical decisions regarding safety of swallowing and intake recommendations. Lower agreement (<0.4 kappa values) levels were found for the following parameters: evaluation of oral hygiene, some items in fluid trials (anterior spillage, oral pharyngeal transit, delay in pharyngeal swallow, laryngeal elevation) and items in food trials (laryngeal elevation, wet voice).⁴⁸ Another parameter that differs between the online and face-to-face assessment was the need of referral to another professional but this was probably due to differences in the clinical practice patterns.⁴⁸

In a 2014 study by Ward *et al.*, patients were stratified according to the Dysphagia Outcome and Severity Scale (DOSS) to study the impact of dysphagia severity on clinical decisions *via* telerehabilitation. The levels of agreement were statistically significant for the evaluated parameters and did not appear to be influenced by the severity of the swallowing disorder (>0.80 kappa values).⁴⁸ A secondary stratification is conducted based on groups

across age, gender, etiology and cognitive status, but these factors were not considered in the data analysis.⁴⁸

The 2017 study by Morrel *et al.* was the first to test the swallowing assessment *via* telerehabilitation in an inpatient stroke setting. The results demonstrated excellent reliability of telerehabilitation with high levels of agreement for dietary recommendations on solids (87% agreement; $k=0.792$; Kendall's $\tau_b=0.844$, $P<0.001$; Wilcoxon signed rank 0.243, $P=0.808$) and liquids (91% agreement; $k=0.808$; Kendall's $\tau_b=0.813$, $P<0.001$; Wilcoxon signed rank -0.818, $P=0.417$).⁴³ The study also investigated the influence of the severity of stroke, evaluated by the National Institute of Health Stroke Score (NIHSS), and its location.⁴³ There was suggestive but inconclusive evidence that NIHSS scores correlate with lower levels of agreement for liquid diet recommendations (OR=0.895 [95% CI: 0.793–1.01]; $P=0.07$); there was no impact of NIHSS score for solid diet recommendations and no impact of stroke location.⁴³

Regarding the duration of the session, the online assessment lasted slightly longer than face-to-face conduction. This time difference could be attributed to the preparation of the technological equipment, as well as the orientation of the patient during the CSE and the interaction between the online clinician and the assistant.⁴⁹ In 2014, Ward *et al.* reported an average duration of 45 minutes for the online assessment.⁴⁸

Perception and satisfaction

Four out of six studies concerning the clinical swallowing evaluation investigated the satisfaction and perception of clinicians and patients with regard to telerehabilitation and report data supporting its use. According to Ward *et al.*, telerehabilitation was considered as a valid substitute for the traditional mode, as a facilitator of access to healthcare and a potential benefit for all patients.⁴⁹ In addition, 80% of patients reported no difficulty in seeing the therapist online.⁴⁹ Although 99% of patients felt comfortable during the telehealth evaluation, 37% of participants continued to prefer a traditional approach despite the possible benefits.⁴⁹ The significant changes between the pre- and post-CSE questionnaire revealed the existence of some patient negative positions and barriers to telerehabilitation.⁴⁹ Clinicians' satisfaction was high despite some difficulties due to complex clinical conditions of the patient and technical problems.⁴⁹

In 2013, Sharma *et al.* investigated the factors which could influence the comfort with the use of telerehabilitation approach such as audio and video quality and gen-

eral considerations. High levels of patients' satisfaction emerged from this study, with an increase of compliance following the evaluation *via* telehealth.⁴⁷ The main pre-assessment concerns were related to audio and video quality factors, but they diminished in the post-CSE questionnaire.⁴⁷ Although 83% of the participants considered the telehealth mode comparable to the traditional approach, 45% of the participants preferred the traditional management.⁴⁷

In 2014, Ward *et al.* found that, according to clinicians' opinion and perception, a more complex clinical condition and comorbidity with other disorders (movement disorders, behavioral and emotional disorders, cognitive and linguistic-communicative difficulties, hearing impairment, voice and speech disorders) could complicate swallowing assessment.⁴⁸

Treatment

Only one study (a case report) focused on dysphagia rehabilitation.⁴⁴ Cassel described clinical cases of three patients with dysphagia following stroke and traumatic brain injury. The rehabilitative intervention consisted in providing swallowing safety strategies through in-presence training. Subsequently, the use and accuracy of the strategies were evaluated *via* telerehabilitation at mealtime (hybrid mode).⁴⁴ The study provided preliminary data on dysphagia treatment and follow-up at a distance of the neurological patient, but the methodological quality was limited and not generalizable as it was a case report.

Strategies and technologies

The results showed that the mode of telerehabilitation most commonly used is synchronous (six studies applied a synchronous mode, two studies a hybrid mode). The patient and the speech therapist interacted in real time using commercial free videoconferencing platforms⁴⁴ or software specifically created for research purposes.^{8, 43, 45, 48, 49} Ward *et al.* used a videoconferencing software specially created to conduct the CSE *via* telerehabilitation. The telerehabilitation system was formed by two notebook computers with a videoconferencing software with high audio and video quality and the possibility to record the session.

Lower audio and video quality complicated the evaluation of parameters such as laryngeal movements and post-deglutition voice quality. To address these limitations, Ward *et al.* identified some strategies such as a white surgical tape positioned over the patient's thyroid notch to enhance visualization of laryngeal movement during the swallow, clear utensils and boluses with colored food dye

to facilitate the vision of the dimensions of the bolus and oral preparation times.^{8, 45, 48}

Ward *et al.* and Sharma *et al.* employed peripheral devices in addition to the technological instrumentation in use:

- a lapel microphone clipped to the patient's shirt or collar for a more accurate evaluation of voice quality;^{8, 45, 48, 49}
- additional fixed and free-standing camera, with zoom capability remotely controlled by the therapist to extend the field of vision;^{8, 45, 48, 49}
- pulse oximeter to monitor the saturation levels and cease the assessment in case of any decline;^{8, 45, 48}
- additional light source (*e.g.* torch) for viewing the oral cavity.⁸

Many studies highlighted the importance of the presence of a trained caregiver during the rehabilitation session.^{8, 43, 45-49} The caregiver was responsible for the following tasks: positioning and preparing the patient, monitoring the saturation, managing the technology in use and any peripheral devices, assisting with physical task (*e.g.* feeding the patient during the food and fluid trials), providing emotional and psychological support, minimizing distractions, repeating instructions and providing clarifications under the direction of the therapist.^{8, 43, 45-49}

The 2012 study by Sharma *et al.* explored the effect of a specific training on the knowledge and skills of an Allied Health Assistant (AHA) in supporting the conduction of the CSE and the perceived comfort during telerehabilitation sessions.⁴⁶ It emphasized an implementation in skills and comfort as experience in the field of dysphagia assessment increases.⁴⁶

In 2012, Ward *et al.* provided strategies to cope with patient factors that may influence the telerehabilitation session, such as speech and voice disorders, hearing impairment, movement disorders and behavioral and emotional issues.⁴²

Setting

In the studies included in the systematic review, services *via* telerehabilitation are provided in outpatient or inpatient settings. The study by Morrel *et al.* was the only one in which CSE was addressed to hospitalized post-stroke patients.⁴³

Ward *et al.* and Sharma *et al.* used a research setting consisting of two separate outpatient clinics, within the same hospital.^{8, 45, 48, 49} In the patient's room, the computer was placed on a mobile support so that it could be easily adjusted and viewed from several angles. The environment should be well-lit and silent without distracting stimuli.⁸

Benefits and barriers

The results indicated that telerehabilitation presented some barriers:

- technological limitations due to audio and video quality and disconnections, partially minimized by the possibility of video recording the session;^{8, 12, 45, 49}
- difficulty in positioning the patient, which could make the therapist's vision non-optimal (especially in patients with movement disorders);⁴⁸
- comorbidity with other disorders that could complicate the session of telerehabilitation;^{42, 48, 49, 52}
- use of software that guarantees the security of sensitive data and their adequate management;¹²
- acceptance of a new proposal for healthcare by therapists, patients and caregivers;¹²
- absence of physical contact and tactile feedback.⁵²

According to Morrel *et al.*, some of the barriers associated with telerehabilitation could be overcome through clinicians' experience of the use of technology and patient management, making clinical-patient interaction more natural and easier over time.⁴³

Despite these limitations, numerous advantages were identified including:

- increased access to services that manage swallowing disorders and taking care by professionals specialized in dysphagia;^{7, 12, 15}
- cost savings;^{7, 12, 15, 40, 52}
- high levels of satisfaction of clinicians and patients;^{12, 13, 41, 52}
- promotion of a patient-centred care, encouraging the compliance of patients and caregivers and the acquisition of a new awareness about them to one's own disorder;^{12, 15}
- reduction of patient fatigue, travel time and expenses;¹⁵
- possibility of follow-up and post-discharge monitoring.¹⁵

Recommendations

Due to the lack of specific guidelines in literature, the authors developed practical recommendations for the conduct of telerehabilitation sessions for patients with neurogenic dysphagia. They are based on the results of this systematic review and qualitative analysis, previously described, that the authors summarize in a practical brochure. In order to clarify some information we have attached explanatory photos involving a simulated patient. With the purpose of describing the best patient position during the session, we created a summary table that match the different camera angles and the specific tasks.

The recommendations provide information on the following topics:

- patient eligibility criteria for conducting telehealth sessions;
- preparation of the session;
- setting;
- clinical swallowing assessment;
- observation at mealtime;
- strategies;
- assistance;
- technology;
- end of the session;
- patient positioning.

The recommendations are available in Supplementary Digital Material 1 (Supplementary Text File 1).

These recommendations aim to help health professionals who work with people with swallowing disorders caused by a neurological disease. These suggestions could structure and enhance the dysphagia telepractice sessions, giving a work framework. In the future, the exchange of experience between therapists on telerehabilitation and the technological advances may lead to standardized guidelines and protocols.

Discussion

This systematic review showed that there is an extensive literature on the application of telerehabilitation but limited in the field of neurogenic dysphagia. This could be due to the complexity of neurological clinical diagnosis (such as cognitive and behavioral impairments) which impede the application of telerehabilitation. The majority of studies included people with dysphagia secondary to ischemic stroke or degenerative disorders.

Most of the studies on neurogenic dysphagia concerned the clinical swallowing assessment *via* telerehabilitation. This systematic review highlighted high levels of agreement between the face-to-face evaluation and the swallowing assessment *via* telerehabilitation, which seems to be not influenced by the severity of dysphagia, the location of stroke and severity of the disease. Moreover, the analysis of perception and satisfaction of telerehabilitation approach revealed a good acceptance of this modality by both clinicians and patients. The concerns reported by therapists and patients mainly regarded technological aspects of audio and video quality, although the feedback after telerehabilitation swallowing assessments were positive. Clinicians reported greater difficulties in evaluating patients with physical and psychological comorbidities than traditional assessment. In order to minimize these

barriers, the authors elaborated recommendations from the results of the systematic review, including specific strategies for voice and speech disorders, hearing impairments, movement disorders, cognitive and behavioral problems.

This review confirmed that patient's eligibility for the telerehabilitation session must be analyzed on the basis of the patient's characteristics and the presence of associated disorders (physical, sensory, cognitive, behavioral and motivational factors, communication skills and availability of caregivers).

The identification of specific protocols of telerehabilitation and the presence of an assistant are factors that contribute positively to the success of the session. In all studies involving clinical swallow assessment there was an assistant represented by a health professional, but this role could be also attributed to a previously trained caregiver. Before providing a telerehabilitation service, the therapist should investigate any concerns of the patient and the caregiver with regard to this type of service. At the end of the session, the therapist could investigate the level of satisfaction through questionnaires or a semi-structured interview in order to personalize the intervention.

Furthermore, the results of this systematic review showed that the modality of telerehabilitation most commonly used is synchronous with therapists and patients interacting in real-time, but several studies recorded the rehabilitative session. Videotaping allowed to review the session later in case of doubts or ask for a consultation with another professional (teleconsultation). In addition, it allowed to partially compensate for limitations due to technological aspects, such as internet disconnections and reduced audio and video quality.

The included studies were based in the United States or Australia, where telerehabilitation has been widely applied in healthcare to address the lack of services in rural and remote areas and the lack of specialists in dysphagia.

Some limitations of this systematic review were due to the limited methodological quality of the included studies, the small sample size, the heterogeneity of the clinical diagnosis and population that was not sufficiently described in some cases, the lack of controlled for confounding.

With regard to future direction, studies should be conducted on patient populations stratified by severity of dysphagia, etiopathogenesis and by severity of global clinical diagnosis in order to study the effect of these factors on the effectiveness and safety of telerehabilitation sessions. Given the complexity of neurogenic patients which increase the difficulties of treatment *via* telerehabilitation,

the authors extracted some benefits and advantages of this approach and they elaborated recommendations. These recommendations aim to help clinicians to implement telerehabilitation treatment in people with neurogenic dysphagia in different settings. For example, telerehabilitation could be used to conduct anamnestic interview with the patient through videoconferencing platforms. It could also allow a direct communication with the caregiver, which sometimes may be more difficult in outpatient settings. Telerehabilitation can also permit the observation of the mealtime in a home-setting and it can make the application of outcome scales more accessible. The possibility of follow-up is a great resource for neurodegenerative pathologies, in case of difficulties in moving patients in advanced stages of the disease.

In addition, the provision of rehabilitation services *via* telehealth can intensify the therapeutic programme within the domestic context and promote generalization. Therapeutic education sessions can be carried out in synchronous mode on meal management, dietary adaptations and compensatory maneuvers. If necessary, the asynchronous mode can be used to provide explanatory materials. Telerehabilitation offers the possibility of teleconsultation between different health professionals. It can therefore be a great opportunity for training, collaboration and sharing both within the same professional category and between different professionals.

In this context, taking into account the pandemic situation, an integrated approach by an interprofessional team is essential in order to ensure the best possible rehabilitation service.

Conclusions

The studies included in the systematic review provide preliminary data to support dysphagia management *via* telerehabilitation. The results suggest that telerehabilitation is beneficial in people with swallowing problems caused by a neurologic disease. In particular, there is evidence that clinical swallowing assessment using telerehabilitation approach is reliable and effective, compared to the standard modality.

Nevertheless, further studies should be rigorously designed with a higher methodological quality in order to generalize the results.

Finally, the review has led to the development of recommendations evidence-based that is a future opportunity to promote telerehabilitation in the management of the patient with neurogenic dysphagia.

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.—Cristina Reverberi made a substantial contribution to the concept and design of the article as well as interpretation of data. Giorgia Gottardo and Elena Castagnetti made a substantial contribution to acquisition, analysis and for the article. Irene Battel drafted the article and revised it critically giving suggestion for data's interpretation. All authors read and approved the final version of the manuscript.

History.—Article first published online: October 4, 2021. - Manuscript accepted: September 24, 2021. - Manuscript revised: September 17, 2021. - Manuscript received: March 5, 2021.

Supplementary data.—For supplementary materials, please see the HTML version of this article at www.minervamedica.it