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Clinical signs, telemedicine and online consultations in head and neck diseases during the SARS CoV-2 pandemic: an Italian experience

Segni clinici, telemedicina e visite online nelle malattie testa e collo durante la pandemia SARS CoV-2: un'esperienza italiana

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SUMMARY

Objective. The aim of this paper is to describe the application of a telemedicine (TM) synchronous model designed to deliver care during the Coronavirus Disease 2019 (COVID-19) pandemic to patients with head and neck disease.

Methods. The first step was to identify the classes of patients eligible for tele-examination. Mild, flu-like symptomatology represents the characteristics of the typical patient who is a candidate for tele-examination. The standard requirements for TM include a computer associated with a digital camera, alternatively a smartphone or tablet. The TM platform is based on the Lifesize™ software, which can be freely downloaded.

Results. The overall number of teleconsultations was 178, of which 163 (91.5%) were managed at home, while 15 (8.5%) were invited for in-presence examination. The number of patients coming from general practitioners was 98 (55.1%), from spoke units 52 (29.2%), patients needing prompt stabilisation and transfer to the hub centre were 20 (11.2%,) while 8 (4.5%) were immediately fast-tracked in the spoke unit after multi-professional tele-consultation.

Conclusions. Telemedicine improves organisational models, and provides a scalable solution to overcome problems of overcrowding, resources and time. Should these developments continue, we could face to a gradual transition to a more digital and efficient healthcare system.

KEY WORDS: head and neck diseases, COVID-19, telemedicine

RIASSUNTO

***Obiettivo**. L'obiettivo di questo articolo è descrivere l'applicazione di un modello sincrono di telemedicina (TM) per fornire assistenza, durante la pandemia di Coronavirus Disease 2019 (COVID-19), ai pazienti con malattie testa e collo.*

***Metodi**. Il primo passo è stato quello di identificare i pazienti eleggibili per un tele-esame. Una sintomatologia lieve rappresenta la caratteristica del tipico paziente candidato per un teleconsulto. I requisiti standard per la TM includono un computer associato a una fotocamera digitale, in alternativa uno smartphone o un tablet. La piattaforma TM si basa sul software Lifesize™, che può essere scaricato liberamente.*

***Risultati**. Il numero di teleconsulti eseguiti è stato di 178: 163 (91,5%) gestiti a domicilio; 15 (8,5%) invitati a una visita in presenza. Il numero di pazienti provenienti da medici generici è stato 98 (55,1%), da unità spoke 52 (29,2%), i pazienti prontamente stabilizzati in unità spoke e ulteriormente trasferiti al centro hub 20 (11,2%), mentre 8 (4,5%) sono stati immediatamente inviati all'unità spoke dopo un teleconsulto multiprofessionale.*

***Conclusioni**. La telemedicina migliora i modelli organizzativi e fornisce una soluzione modulabile per superare i problemi di sovraffollamento, di risorse e tempo. Se questi sviluppi dovessero continuare, potremmo trovarci di fronte a una transizione graduale verso un sistema sanitario più digitale ed efficiente.*

PAROLE CHIAVE: *malattie testa e collo, COVID-19, telemedicina*

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Introduction

Telemedicine (TM) has been described in various forms since the invention of the telegraph and the telephone, and the first time that it was mentioned in scientific publication was in the 1920s [1]. The transmission of radiologic images was feasible since 1950, but only with the diffusion of internet [2] was its application enhanced, initially to improve the provision of care, especially in rural areas, and by facilitating access to specialist advice [3].

Because of the catastrophic impact of Coronavirus Disease 2019 (COVID-19) pandemic, many health services were altered, and thus innovative solutions such as TM have been created resulting in a transformation of health care and in an opportunity to see the role that TM can play in daily clinical management of patients [2].

Initially, in most otolaryngology services, in-hospital visits were suspended, except for urgent cases [4]. As many countries have alternated periods of lockdown, which posed severe restriction in mobility to citizens, the delivery of health care services underwent a complete redesign, privileging solutions based on remote assistance, and focusing on the dimension of the territory. In this scenario, the use of TM was introduced to try to cope with the new difficulties that the pandemic has brought in terms of care [2].

COVID-19 is a highly transmissible respiratory infection and otolaryngologists and all head and neck surgeons (HNS) are the physicians at the highest risk of infection [5] and their offices a place that can foster transmission within the community.

In this setting, the figure of the clinician plays a central role, as they must help patients, examine the severity of symptoms and decide for hospitalisation or home care. Head and neck surgeons (HNS), like otolaryngologists and maxillofacial surgeons, are called upon to address several questions raised by general practitioners, and TM paves the way for interdisciplinary consultations and provides a platform to remotely discuss cases, even in the absence of in-person examination of patients. In this way, patients with COVID-19 could safely be cared for via TM.

Finally, an estimated 41-42% of the population had delayed or avoided seeking care during the pandemic because of concerns about COVID-19.

There are three types of TM:

1. remote monitoring;
2. store and forwards or asynchronous [6];
3. real-time interactive visit or synchronous [4,5].

The first type includes self-testing and self-monitoring, relying upon a range of technologies to monitor patients remotely, and is mainly indicated to manage chronic diseases, such as asthma, diabetes mellitus and other similar diseases.

The second and most common type is the "asynchronous form", in which the information and results of the patient's clinical examination are presented to the physician as a medical record, and therefore there is no direct interview with the patient. This type of consultation is the most widely used among healthcare professionals [7,8].

In the third type, the real-time or "synchronous form", the visit takes place in real time through videoconferencing, and is a live interaction between the health care provider and the patient.

The suitable conditions for asynchronous care are inherently non-emergent. The use of such techniques with the assistance of a licensed health care technician has already been shown to be useful in head and neck oncology consultations, remote otologic and audiologic evaluation, cochlear implantation and hearing aid management, laryngeal ultrasound, nasofibroscopy and tomography review in rhinosinusal diseases [9].

A recent study has reported that 62% of ear nose and throat (ENT) examinations do not require specialist procedures and could possibly be performed with the help of a health technician, who would communicate the data obtained to the physician [5]. Moreover, other publications mention that, in specific situations, the direct consultation of the patient with the physician, with the aid of common technologies, is already available to the general population [5].

In this paper we describe the implementation of a synchronous telemedicine model designed to deliver care during the pandemic, presenting its technical components, settings of application and potentialities, focusing our attention on the possible clinical signs, which can be captured by a remote examinator using available technology. We emphasise the clinical examination of the patient with suspect upper respiratory trait infection using TM, focusing on history assessment, description of symptoms and clinical signs, and present our preliminary results.

Materials and methods

Patient selection and creation of the protocol

During the pandemic, in the Maxillofacial Surgery Department of the University of Udine, Italy, a crucial decision was taken in order to modulate the flow of outpatient clinics, and to decrease the number of patients needing physical consultations in the hospital. The first step was to identify the types of patients eligible for tele-examination: urgent cases were deferred to in-presence evaluation, limiting online examination to non-urgent cases with mild symptoms. A professional, identified within the health care personnel, commonly a nurse performing a telephone triage, to select the appropriate patients, assessed this. Mild, flu-like

symptomatology represents the characteristic of the typical patient who can be the candidate for tele-examination. This organisation offers the possibility to keep potentially infectious patients, both for COVID or non-COVID infection, outside from the hospital, to limit the spread of the virus, especially in the hospital environment where fragile patients are at high risk of complications. Several signs reported during the telephone triage ascertained the need for in-person consultation. These included neck swelling, persistence of sore throat for more than 3 days with fever beyond 38°C and difficulty to swallow or breathe, since these symptoms may be associated with a severe laryngeal disease or local complication like a tonsillar abscess.

Technical components of the telemedicine platform developed at our institution

The standard requirements for telemedicine include a computer associated with a digital camera, alternatively a smartphone or tablet. The latest generation devices are equipped with high-resolution cameras with sensitive light detection and powerful microphones.

Before scheduling the videoconference examination, we asked the patient for his/her availability of technological devices, which type, and, especially for elderly people, the presence of a caregiver or a relative who can provide technological assistance.

Moreover, we also asked the patient to obtain a flashlight or a torch to create the appropriate lighting conditions for complete examination of the oral cavity.

The TM platform is based on the Lifesize™ software [10]. Both the clinician and the patient were required to install a copy of the software, which can be freely downloaded. The software is available for multiple operating systems, including Windows and Mac, as well as for mobile devices (iOS and Android).

This software was adopted by our institution, and it allows to create a virtual agenda, wherein management is assigned to the case manager of our clinic. Appointments for examinations were scheduled every 40 minutes, including a 15-minute window allowing both the patient and clinician to correctly configure the platform and devices. In this way, a virtual meeting space is created in which a virtual room environment (VRE) hosts the tele-examination. In our experience, this resulted in the creation of a "Maxillofacial Surgery Clinic Examination Office", which was the modality it appeared on the patient's screen.

After receiving the confirmation of reservation for a tele-examination, we sent to the patient a portable document file (PDF) containing the instructions for the meeting, the consent details for registering and storing images and video frames and the download links for Lifesize as well as the access code. Once the patient entered the given code, they were admitted to the virtual space. Specific frames of the examinations were taken in form of screenshots or short video frames, which were stored for each examination to provide documentation of clinical findings. The clinical database was compiled as if a physical examination was performed, and another appointment date was communicated to the patient if follow-up was needed.

Networks between Hub Unit - Spoke Unit - general practitioners

TM becomes an essential resource and support in order to provide a communication between the main hospital (hub unit) and minor hospitals (Spoke units) (Fig. 1). Territorial healthcare (general practitioners) can fast-track a request for a specialist evaluation from a spoke unit to its hub body and rapidly make a correct diagnosis and a shared decision on where, when and how to treat a patient with upper respiratory tract infections (e.g., transfer the patient for more intensive care, need for laboratory analysis, therapies, or observation). Tele-consultation and tele-examination are the most appropriate TM modalities to enable this process, based on a remote cooperation between the hub specialist, spoke emergency doctors and general practitioners who are offered the opportunity of teleconsulting. The specialist can guide the doctor to perform evaluations through telesemeiology, as defined later in this paper, by using a virtual environment.

Clinical application

Upper airways are examined based on a simple schematisation within three areas, which are affected by infections and offer different possibilities and limitations for remote examination:

- nasal, or superior compartment;
- oral cavity and oropharynx, or middle compartment;
- laryngeal, or inferior compartment.

The nasal compartment can be only externally visualised during tele-examination, thus offering the possibility to assess the presence of secretions. Anamnesis plays a crucial role and allows to investigate the presence of symptoms related to infections, including most commonly secretions, and nasal obstruction. In case of sinusitis, a common finding is cacosmia and the patient often refers the presence of postnasal drip. Most importantly, the clinician should investigate the absence or presence of smell, which is more specific for COVID-19 infections.

The oral cavity is eligible to direct inspection with the aid of a smartphone camera and appropriate lighting, and can be examined up to the palatopharyngeal arch, in the presence of a collaborating patient. The patient is invited to

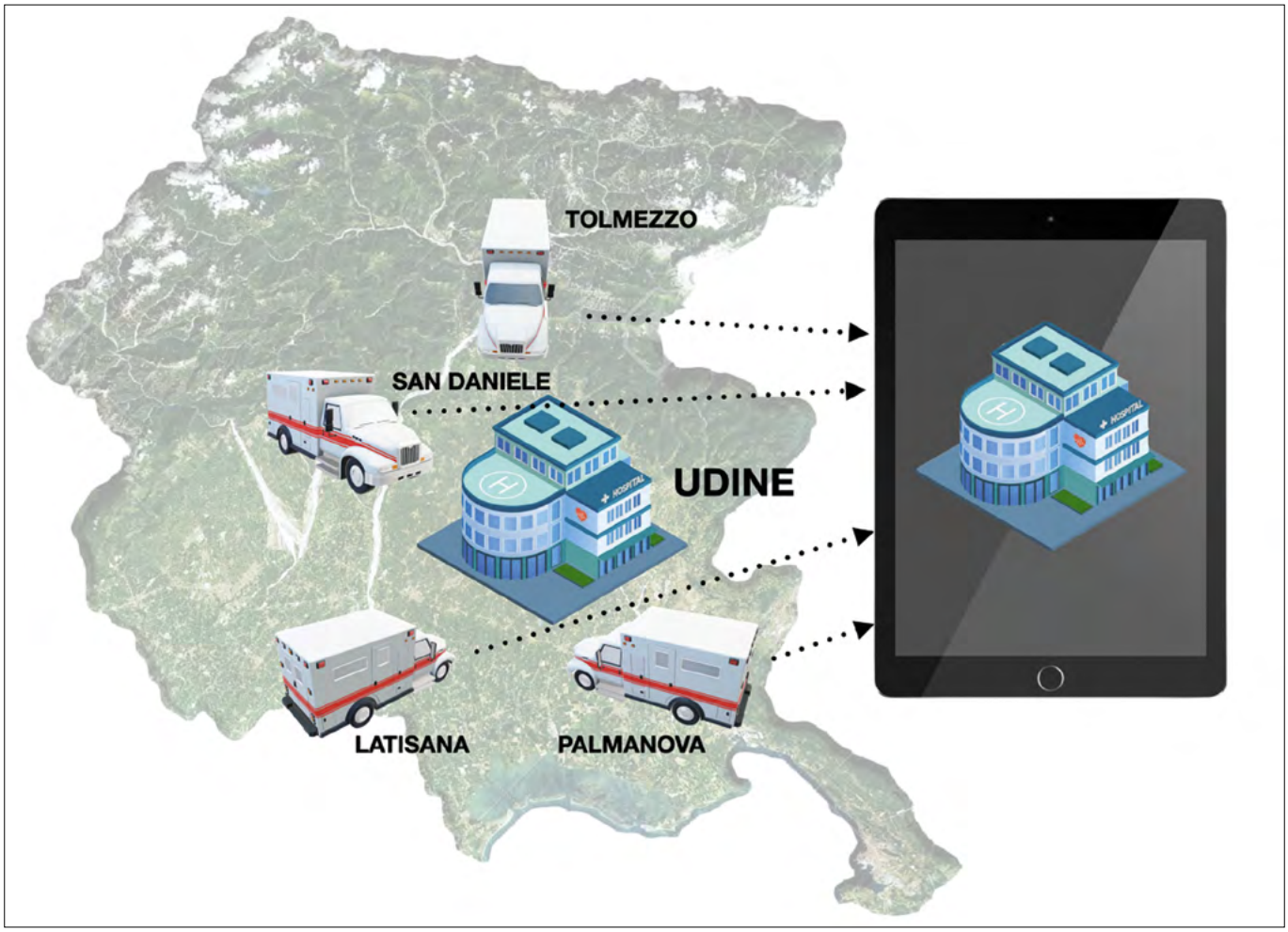

Figure 1. Schematic illustration of the hub – spoke hospital network within the University Hospital of Friuli Centrale. Contacts prior to centralisation of patients are mediated by teleconsultations, which also provide clinicians from spoke units with the possibility to discuss clinical cases and define whether patients should be treated at the spoke unit or centralised to the hub centre (Udine).

open the mouth, lower the tongue and at the same time pronounce the sound "A" exposing the posterior oropharyngeal wall. Findings related to upper airway infection include mucosal hyperemia, tonsil enlargement and the presence of plaques. As seen for the nasal compartment, even for the oral cavity anamnesis plays an important role, since patients usually complain of sore throat, which exacerbates during swallowing. A specific element to investigate to focus attention on a possible COVID-19 infection is the absence of taste, which is often associated with the absence of smell [11].

The laryngeal compartment can be investigated with anamnesis and sound. The most common symptom is cough and a lower, croaking voice, as well as noisy breath, possibly due to vocal fold inflammation but also to early glottic cancer. The laryngeal compartment cannot be examined using a smartphone-based examination, as it would require flexible optics to inspect the laryngeal opening, which are available only in a specialist setting.

At the end of the procedure, records were registered in an electronic archive, and a formal description of the examination was reported. Moreover, at the end of each tele-examination, a questionnaire was filled in by the responsible physician which included six categories of items describing the overall fluidity of the examination, quality of visualization, model of device used, visual signs captured by clinical inspection, referred symptoms and the programme for further care and follow-up. Clinicians from hub, spoke centers and general practitioners reported a considerably high satisfaction score, and deemed tele-examination a useful and rapid ally for both urgent and non-urgent situations.

The rise of "telesemeiology"

As part of their training, all clinicians were instructed to perform a complete on-line anamnesis and to evaluate visual signs associable to upper airway infections. We created the term 'telesemiology' [12], a novel expression coined to define the group of signs and symptoms detectable through remote clinical inspection performed using technological devices. The reliability of such signs is strongly dependent upon patient collaboration, since they are requested to perform specific tasks in front of the camera, with appropriate lighting and following the instructions of the clinician (Fig. 2). When the consultation is performed in presence of a physician such as in case of connection between hub unit, spoke units and general practitioners, the examination is more reliable.

Results

Teleconsultation for upper respiratory infection started in April 2020, after pressure exerted by the pandemic on the Italian health care system forced the adoption of novel organisational designs. During this period and using the appropriate technological devices and a suitable internet connection, examinations were successfully conducted for all patients. The specialist prepared a synthetic checklist to collect all the necessary information intuitable from the teleexamination. This "telesemeiology checklist" was based on the aforementioned aspects, with particular attention on recent anamnesis reported by the patient and signs visible in an on-line consultation. Many clinical signs were attributable to simple manifestations of infections, including sore throat, rhinorrhoea, cough and mild fever. In COVID-19 patients, a higher frequency of smell and taste reduction was observed, although the same symptoms were also common in patients affected by seasonal flu or cold.

The overall number of teleconsultations performed was 178, of which 163 (91.5%) were managed at home with medical therapy or observation, while 15 (8.5%) were invited to an in-presence examination. In such cases, the clinical signs related with the history of the patient posed the threat of possible worsening of clinical conditions, in fact some patients were hospitalised with the following diagnoses: tonsillar abscess (4 patients), odontogenic abscess (2 patients), acute sinusitis (2 patients) and 3 had neck masses which required further investigation. In particular, one of the patients requiring immediate teleconsultation was referred to our attention by the general practitioner, as he had

Figure 2. An overview of possibilities offered by telesemeiology with remote inspection in patients undergoing oral cancer resection and reconstruction with free flaps. Panel A illustrates complete wound healing after 6 months; panel B shows tongue movement and functional integrity of hypoglossal nerve after neck dissection; panel C shows mouth opening, with a complete restoration of mandible excursion; panel D shows healing of the donor site (radial forearm free flap).

presented with suggestive symptoms of neck abscess, including fever beyond 39°C, respiratory tirage and fatigue, sensation of airway compression and loss of consciousness, and was rapidly admitted to the intensive care unit.
Concerning organisation and networks, the results also include evaluation of the number of patients coming from general practitioners (98-55.1%), from spoke units (52-29.2%), and patients promptly stabilized in spoke units and further transferred to the hub centre (20 patients-11.2%). Eight (4.5%) patients were immediately fast-tracked in the spoke unit after prompt multi-professional tele-consultation between spoke and hub units.

Discussion

Already in the pre-COVID era, the topic of TM was studied mainly to enable care for patients in rural areas of the United States. In fact, McCool & Davies were studying the eligibility of different anatomical sites in 2017 that resulted from 92% in inner ear diseases to 39% in laryngeal disorders. In addition, their data show that otology is particularly well suited for this type of propaedeutic approach. Diagnostic concordance rates ranged from 79 to 85% [13].
Other authors have reported high diagnostic reliability in patients with various ENT conditions, including otologic conditions, rhinosinusitis, peritonsillar abscess, and nasal fracture [14]. The diagnostic accuracy and effectiveness of empiric therapy provided during TM visits are of particular interest in determining the feasibility of its use in the effective management of patients [14]. A limitation to this type of approach is the need for an adequately trained health care technician to perform diagnostic and minor therapeutic procedures [13,15].
During this pandemic, considering the pressure and load on healthcare system, reorganisation and flexibility have played and continue to play a key role across all levels. Similarly, this pandemic offers the opportunity to study and develop innovative solutions to overcome the problem of crowding within closed spaces, and isolation of positive COVID-19 patients, or in those with suspicion of infection. Indeed, in the last two years the number of original and review papers has multiplied, and it is now possible to know the experience of different services worldwide.
Even if the TM is of interest, it also has some limitations: one of the greatest is the unique head and neck anatomy, which requires palpation and specific tools to examine. Moreover, remote lighting of the structures in the ear nose and throat is, at the moment, not an easily and widely available technology, thus limiting the eligibility of a large number of ENT visit that could be performed with TM [2].
Wu et al. found that the use of TM with the help of a health technician, who can perform the clinical examination and transmit the data in real time to the specialist, was used mostly for ear diagnoses (52.6%). The remaining diagnoses included throat problems (14.1%) and nasal disorders (13.3%), earwax plug (9.2%), chronic otitis externa (8.1%) and otitis media (8.1%) [15]. The same authors noted that a specialised procedure was not required to diagnose and treat 51% of cases; therefore, they were considered suitable for TM, but the eligibility varied depending on the anatomic site. In the remaining 49% of cases, specialised procedures were performed in the clinic by a health care technician under the supervision of an otolaryngologist via telemonitor. The most common procedures were cerumen removal and endoscopic examinations of the larynx and nose. Other procedures included removal of foreign bodies, repositioning manoeuvers and topical treatments [15].
In otology, a study with asynchronous video-otoscopy (using an appropriately licensed health care technician) has reported a diagnostic capability equivalent to physician-directed otoscopy [5,9].
The diagnosis of otologic diseases is mostly noninvasive. The initial diagnosis usually involves a detailed history and physical examination by otoscopy. The problem with TM in the field of otology is clinical examination. Conventional otoscopy is not expensive, but raw images cannot be shared online. In recent years, smartphone otoscopy is being developed, which seems to have demonstrated good reliability, and is promising in terms of TM. In addition, these tools are increasingly accessible to the population, thus offering the patient the ability to contact physicians directly for advice [5].
Indeed, in recent work, carried out in a tertiary centre where the spectrum of disease was broad, most middle ear diseases were diagnosed using patient-reported symptomatology and use of smartphone otoendoscopy, with a high degree of accuracy [5].
The limitations observed are mainly due to the resolution or contrast of the images, or to the instrument being too large for narrow ear canals [5,9]. Subtle findings such as a mild retraction pocket, atelectasis, pinhole perforation, or small cholesteatoma may not be evident in low-quality images [9].
Similarly, other authors cite that the effective use of telemedicine in otolaryngology consultations is highly dependent on the ability to transmit clinical images of adequate quality for remote diagnosis [9,16].
In addition, image quality may be affected not only by the technology used, but also by the skill level of the health care technician. Further research is needed to evaluate the distinction between image acquisition by a trained specialist and by a general practitioner or health care technician,

as the purpose of TM is to provide specialised services when an ENT specialist is not physically present [16].
Nevertheless, other authors note that the quality of videootoscopy recordings was acceptable or better in 87% of cases [9]. Facial palsies and tumors of the outer ear have obvious symptoms and signs, which can be diagnosed on photographs with almost 100% accuracy [5]. The diagnostic accuracy of vertigo, when not using a health care technician, appears to be relatively low, given the inability to perform additional physical examinations and the fact that eye cameras are not currently accessible to most patients. Certainly, when an eye-tracking camera or device will become widely available, the feasibility of diagnosing vertigo of peripheral origin can be reassessed and the overall accuracy of asynchronous TM will likely improve [5].
TM has also been applied to tinnitus rehabilitation and cochlear implant candidacy, fitting, programming and maintenance, as well as hearing aid evaluation and programming. It appears that cochlear implant threshold, comfort and impedance levels are easily obtained via TM and are not significantly different to those achieved by in-person sessions [9].
Although some works have evaluated the use of TM in sinus nasal and laryngology pathologies, it seems that, in those districts, the diagnostic concordance is lower than the results found for otological pathologies. Indeed, Kwok et al. confirm these data. Direct examination of the nasal cavity and larynx requires specialised skills and equipment; these have been particularly challenging during the COVID-19 pandemic because of the potential production of aerosols (which promote contamination) in examinations such as nasoendoscopy [17].
Nevertheless, in sinus nasal pathologies telephone consultation presents a good diagnostic concordance with the diagnosis of the referring physician, thus allowing an appropriate triage of physical appointments and adequate initiation of medical treatment [17].
In cases of nosebleeds, telemedicine can help identify triggers, risk factors and can help manage mild bleeding. Of course, failure to control bleeding with conservative measures should prompt an in-person evaluation [9].
Alternatives within TM include increased use of radiological investigations for sinus disease and laryngeal pathology, with limitations for small mucosal lesions. Other alternatives described are voice recordings and speech analysis systems for speech pathology, although access to these investigations is still limited [9,18]. However, some authors have pointed out that the exclusive use of radiologic investigations for diagnosis is a deviation from the standard of care and may have medicolegal implications [14]. Kwok et al. showed that in resource-limited settings and particularly in crisis situations such as the COVID-19 pandemic, simple initial telephone consultation has high concordance with the final treatment plan despite some limitations in diagnostic concordance due to the inability to perform physical examination [17].
Similarly, Choi et al. examined the concordance in diagnosis and management between the initial TM visit and subsequent laryngoscopic examination in an outpatient tertiary care centre; the overall concordance rates were high: 86.0 and 93.6% for diagnosis and management, respectively. They emphasised that although TM should not replace in-person physical examination and laryngoscopy for laryngology-related disorders, it can be effectively used to provide a preliminary diagnosis, appropriate management plan and triage during the current pandemic [14].
It has been proposed that, in institutions with multiple otolaryngology team members able to perform laryngoscopy examination, a single examiner can capture the image while the others could review the information remotely. This would limit the number of personnel undergoing a procedure that generates aerosol [18]. Some authors strongly recommend the application of TM to voice therapy, as it meets standards of care with increased physician and patient satisfaction [9,19].
Concerning management concordance rates for complaints related to swallowing and general throat complaints (i.e., pharyngodynia, discomfort, or throat knot feeling), TM with video can provide useful preliminary information such as overall swallowing function and change in voice quality/aspiration symptoms after swallowing [14].
According to the work of Choi et al., the diagnostic and management concordance rate for airway complaints was 95%. Detailed history collection, including previous history of trauma, intubation, tracheostomy and major surgery, can guide clinicians towards accurate diagnosis before laryngoscopy. In these cases, TM can be used for appropriate triage during the pandemic, recognising urgent issues that need rapid follow-up (i.e., symptomatic airway obstruction, aspiration, severe dysphagia, suspicion of malignancy, etc.). Of course, it is important to note that the small percentage of cases with misdiagnosis or mismanagement may result in critical morbidity in these patients [14].
TM seems to be easily applicable to facial reconstructive surgery given that the assessment of facial soft tissue relationships and defects is already heavily based on digital photographic documentation and analysis [9,18]. Facial trauma may also be particularly amenable to remote assessment. In fact, high concordance has been reported between evaluation of patients with facial trauma during a traditional visit and evaluation performed via videoconferencing with review of radiologic images. Again, a remote approach can

be used for triage, avoiding unnecessary transfers for patients who do not require intervention [9,19].

The limitation in the full adoption of TM for facial trauma assessment is image quality. Low-quality images do not allow for assessment of clinical evidence of septal hematoma, intraoral malocclusion and facial contour asymmetries. In addition, because one cannot palpate the face, one cannot assess the mobility and stability of the facial fracture, differentiate between oedema and haematoma, and assess the degree of sensitivity. With the inability to smell during physical examination, one cannot identify odours that would indicate an infection [19].

Regarding the indication for tonsillectomy with or without adenoidectomy, it appears that telephone consultations were concordant with the results of physical examination (90.4% diagnostic concordance with the referring general practitioner and 99.1% concordance of the diagnosis and treatment plan with the physical appointment). This observation seems to be true especially for paediatric patients [17].

TM can also be successfully used in clinical care of patients with cleft lip and palate. However, patients undergoing cleft lip and palate repair usually require comprehensive, multidisciplinary care over an extended period of time [18].

In the management of the head and neck cancer patient, should any change in symptoms occur, TM can facilitate contact between the patient and their physician, without the need for high-risk face-to-face contact. The MD Anderson Head and Neck Surgery Consortium has created guidelines for management of head and neck cancer by subsite, and TM is incorporated as an essential tool that should be used judiciously whenever possible [18].

The ability to contact the physician may represent a reduction in emotional burden for the patient, improve their quality of life and reduce the discomfort of symptoms that patients face. Indeed, it would appear that patients with head and neck cancer who were monitored through TM intervention reported significantly better quality of life and lower symptom burden after treatment than patients who received routine cancer care [18].

Encouraged by the success obtained by several authors, and especially in the current difficult situation, we organised a TM service in our region. Our region is organised according to a hub and spoke model within a circumscribed healthcare environment, the University Hospital of Friuli Centrale (UHFC) composed of one hub (University Hospital of Udine) and 4 spoke units (Hospital of Latisana, Hospital of Palmanova; Hospital of San Daniele and Hospital of Tolmezzo). Considering the pre-existing organisational health care design and a relatively small region, which also includes mountain territory, which is notably remote to access, we planned a TM network according to these features.

Especially in such difficult times, the challenge for a modern health care institution is to maintain a high quality of care, at the same time safeguarding both patients and clinicians by reducing the number of physical consultations. Because of the rapid spread of SARS-CoV-2 infection, and especially more contagious variants, including the omicron strain, we have seen an increasing flow of patients saturating hospital departments.

It is worth mentioning that the role of TM was also to prevent overcrowding of hospitals, and especially emergency departments for respiratory infections, which become frequent during winter and are self-resolving in many cases. TM is particularly useful for such cases, which would easily saturate general practitioners' offices or hospitals, but which can also be managed by home care using medical therapies and observation. In contrast, tele-examinations allow to ascertain the potential severity of cases which need hospitalisation, filtering and limiting hospital accesses to conditions that strictly require more intensive management. Especially for head and neck specialists, exposure to potential infectious contacts is not negligible; therefore, TM is a valuable strategy to decrease unessential contacts with patients, together with the aim of maintaining clinicians safe. This is particularly helpful in a time in which depletion of personnel both for overworking and for infections between health workers has put the system into an unprecedented crisis.

Telesemeiology is defined as the evaluation of the complex and composite signs of patients' face or other body parts using a detector technology from remote, via a telecommunications infrastructure and performed through cooperation between clinicians. As mentioned, a variety of head and neck regions can be examined through telesemeiology to ascertain several conditions, such as inspecting the oral cavity and visualising tonsils and the posterior oropharynx. Telesemeiology continues to provide a valuable informational library of recorded data on signs and symptoms of disease, contributing to implement a rapidly growing archive of medical information that is being translated into big data and artificial intelligence technology. Therefore, telesemeiology data will be collected and analysed to continuously improve clinical practice in emergency situations and provide solid data.

Moreover, improving knowledge in the novel field of telesemeiology further corroborates the relationship between hub specialists and spoke clinicians during the pandemic, contributing to the diffusion of new clinical and scientific knowledge, and increasing overall experience in the field.

On the other hand, a clinician should be always aware that tele-examination is mediated by technological devices and provides an incomplete assessment of the patient compared

with in-presence evaluation. Only inspection is possible, and is further limited by factors including inadequate compliance, low resolution cameras and unstable internet connection. Oral cavity visualisation might be biased by inappropriate compliance of patients, in particular the depth of the mouth is not easily visible without appropriate lighting. Moreover, many spaces are not visible without appropriate technological instrumentation, such as nasal cavities, deep throat and larynx. In the future, novel devices might be developed to improve visualisation of such spaces, for instance portable endoscopes and optical cameras which would allow to explore such regions when a spoke unit physician wants to share results of clinical examination with the hub centre referent. However, such devices would not be usable directly by patients, thus maintaining this limitation.

Some authors, in a prospective work, verified that patients' overall satisfaction with TM consultation was excellent, with 87% satisfied or very satisfied. Factors that were unpleasant to patients were the absence of physical examination and poor audio and video quality [3,17,20]. Morisada et al. [21] studied the satisfaction of patients with TM performed synchronously in rhinologic examinations and found no significant difference between TM and undergoing traditional consultations, despite the inability to perform clinical examination and rigid rhinoscopy.

In addition, the ability for frequent video- or image-based communication between patient and physician may improve patient satisfaction by facilitating closer postoperative follow-up and wound care. For evaluation of nonemergent conditions such as skin injuries and wound care, 83% of patients reported that they would prefer TM to traditional evaluation for similar future visits [9].

We foresee that telesemiology, which arose during the COVID-19 pandemic, will profoundly influence the future of clinical examinations together with the education of young physicians. In particular, for university institutions TM can provide valuable resources allowing the possibility to transmit live clinical examinations on streaming platforms, while students observe and learn.

Conclusions

The pandemic allowed to design and implement, in the form of scientific small-scale pilot projects, innovative possibilities to evaluate patients with upper respiratory trait infections, through fluid cooperation among hub and spoke units, general practitioners and head and neck surgeons.

We foresee that TM will improve organisational models, providing a scalable solution to overcome problems of overcrowding, depletion of resources and time. Our hope and belief is that such developments will continue, accelerating the transition to a more digital and efficient healthcare system.

Conflict of interest statement

The authors declare no conflict of interest.

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Authors' contributions

SS, AT, EO and MR: conceptualization; MR and CM: supervision and coordination; SS, AT, JKA and MG: writing; AT: images; CM: management.

Ethical consideration

This study reports results of a novel organizational design. No experimental treatment was applied on patients, therefore ethical commitee was not required.

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