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Key points

- The costs of care assistance in chronic disease patients are dramatically increasing.
- Telemedicine may be a very useful application of information and communication technologies in high-quality healthcare services.
- Many remote health monitoring systems are available, ensuring safety, feasibility, effectiveness, sustainability and flexibility to face different patients' needs.
- The legal problems associated with telemedicine are still controversial.
- National and European Union governments should develop guidelines and ethical, legal, regulatory, technical, administrative standards for remote medicine.
- The economic advantages, if any, of this new approach must be compared to a "gold standard" of homecare that is very variable among different European countries and within each European country.
- The efficacy of respiratory disease telemedicine projects is promising (*i.e.* to tailor therapeutic intervention; to avoid useless hospital and emergency department admissions, and reduce general practitioner and specialist visits; and to involve the patients and their families).
- Different programmes based on specific and local situations, and on specific diseases and levels of severity with a high level of flexibility should be utilised.
- A European Respiratory Society Task Force produced a statement on commonly accepted clinical criteria for indications, follow-up, equipment, facilities, legal and economic issues also of telemonitoring of ventilator-dependent chronic obstructive pulmonary disease patients.
- Much more research is needed before considering telemonitoring a real improvement in the management of these patients.

Educational aims

- To clarify definitions of aspects of telemedicine
- To describe different tools of telemedicine
- To provide information on the main clinical results
- To define recommendations and limitations

Nicolino Ambrosino[1], Guido Vagheggini[1], Stefano Mazzoleni[2], Michele Vitacca[3]

[1]Fondazione Volterra Ricerche, Auxilium Vitae, Volterra, Italy.
[2]The Biorobotics Institute, Scuola Superiore Sant'Anna, Pisa, Italy.
[3]Istituti Clinici Scientifici Maugeri IRCCS Lumezzane, Lumezzane, Italy.

nico.ambrosino@gmail.com

Telemedicine in chronic obstructive pulmonary disease

Telemedicine is a medical application of advanced technology to disease management. This modality may provide benefits also to patients with chronic obstructive pulmonary disease (COPD). Different devices and systems are used. The legal problems associated with telemedicine are still controversial. Economic advantages for healthcare systems, though potentially high, are still poorly investigated. A European Respiratory Society Task Force has defined indications, follow-up, equipment, facilities, legal and economic issues of tele-monitoring of COPD patients including those undergoing home mechanical ventilation.

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We need much more evidence before telemedicine can be considered as real progress in the management of COPD patients http://ow.ly/Rko8305tpnJ

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Introduction

Age- and lifestyle-related growing incidence and costs of chronic and noncommunicable diseases, such as cancer, cardiovascular and respiratory diseases, represent an increasingly high burden for healthcare systems. The need to face increasing citizen requests for welfare and, at the same time, to limit healthcare costs has developed telemedicine modalities. Furthermore, recent advances in sensor technology have allowed intermittent measurement processes for continuous monitoring, in the frame of an "intelligent" intervention [1]. Information and communication technologies (ICT) applied to healthcare promise increasing efficiency, improvement of patients' health-related quality of life (HRQL) and contribution to new developments in health markets. Nevertheless, the view of European Union (EU) is that this promise is still unfulfilled [2].

As shown in table 1, telemedicine is the distribution of health services in conditions where distance is a critical factor, by healthcare providers using ICT to exchange at distance information useful for diagnosis (eHealth) [3]. We still need clear definitions of the terms used to describe telemedicine systems. Some commonly accepted definitions are also shown in table 1 [3]. eHealth can be an efficient, cost-effective alternative to traditional healthcare delivery able to improve patients' HRQL and satisfaction [4]. Figure 1 shows an example of eHealth platform. Generally, telehealth interventions [5] include:

- video or telephone links with healthcare professionals in real time or using store-and-forward technologies [6] (figure 2)
- Internet-based telecommunication systems with healthcare professionals [7]
- wired and wireless telemonitoring of physiological parameters such as spirometry, respiratory rate, blood pressure or oxygen saturations processed or authorised by a healthcare professional with feedback to the patient [8] (figure 3)

Table 1 *Definitions and applications*

Telemedicine	Distribution of health services in conditions where distance is a critical factor, by healthcare providers that use ICT to exchange information useful for diagnosis at distance
Telecommunications	Use of cable connections, radio, optical means or other electromagnetic channels to transmit or receive signals, such as voice, data or video communications
Telematics	Use of telecommunications to permit computers to transfer programs and data
Teleconsultation	Second opinion on demand between patient/family and staff or among health operators; opinions, advice provided at distance between two or more parties separated geographically
Telemonitoring	Digital/broadband/satellite/wireless or Bluetooth transmission of physiological and other noninvasive data (*i.e.* biological storage data transfer)
Decision support systems	According to a sentinel value, an alert starts for health personnel, who call patient
Remote diagnosis	Identifying a disease by the assessment of the data transmitted to the receiving party through instrumentation monitoring a patient away from the clinic
Tele-evaluation	On-demand data transfer to use as biological outcome measures
Telecare	Network of health and social services in a specific area; in case of emergency, patient calls medical personnel, emergency call service or members of family
Telerehabilitation	Allows reception of homecare and guidance on the process of rehabilitation through connections for point-to-point video conferencing between a central control unit and a patient at home
Telecoaching	Direct reinforcement or recorded messages/communications to improve adherence
Teleconference, audio	Electronic two-way voice communication between two or more people located in different places

Reproduced from [3].

- pulmonary rehabilitation programmes with home-based, video conferencing-supervised exercise and counselling (telerehabilitation) [9]
- telemonitoring of patients on home mechanical ventilation (HMV) [3]

eHealth has been used in several diseases, such as chronic heart failure (CHF), diabetes and chronic obstructive pulmonary disease (COPD), aiming at reducing hospitalisations, improving self-care and enhancing HRQL. A recent survey in the USA [10] reported that 63% of healthcare providers use telehealth. Among these, 72% were in hospitals and health systems, 52% were in physician groups and clinics, and 36% were in other provider organisations, such as ambulatory centres and nursing homes. Telehealth is most commonly used in conditions such as stroke, behavioural health, staff education and training, and primary care. Other practice areas, such as neurology, paediatrics and cardiology, are reported to use telehealth in <20% of cases [10].

In CHF, a systematic review of randomised controlled trials (RCT) of structured telephone support or noninvasive home telemonitoring compared with standard practice concluded that these modalities reduced the risk of all-cause mortality and CHF-related hospitalisations, while improving HRQL, disease knowledge and self-care [11]. Nevertheless, although remote patient monitoring is associated with a significantly lower

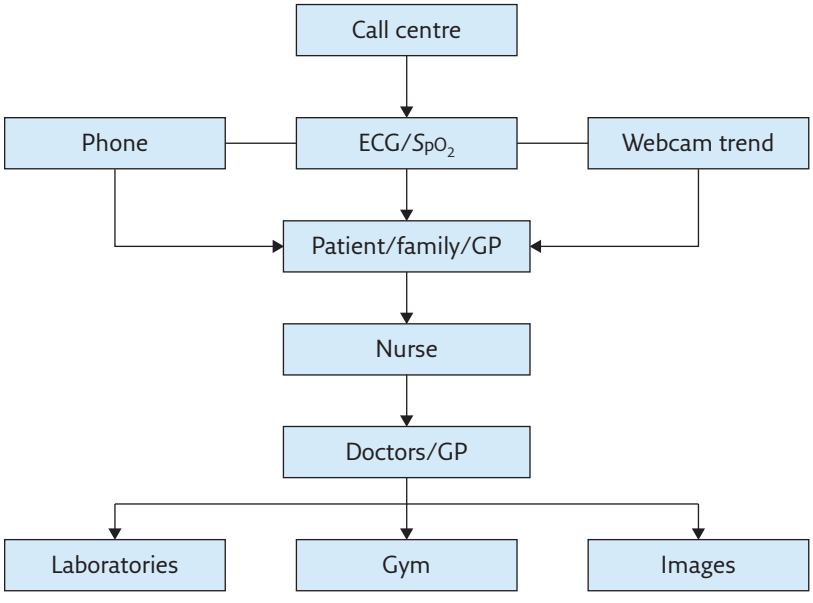

Figure 1 *An example of eHealth platform. S_{pO_2}: oxygen saturation measured by pulse oximetry; GP: general practitioner.*

Figure 2 *A nurse case manager during a video conference with a COPD patient.*

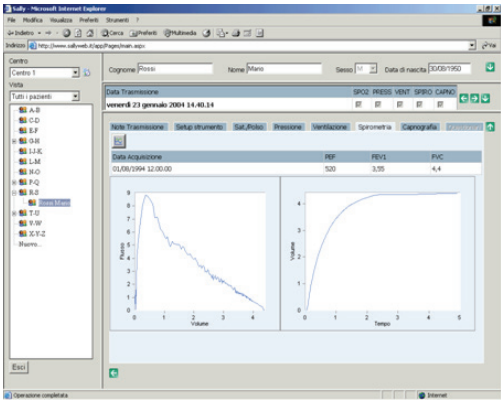

Figure 3 *An example of flow/volume curve during a telespirometry.*

risk of adverse outcomes in patients undergoing initial implantation of cardioverter–defibrillators [12], this technology is used in less than half of those eligible patients [13]. Another large RCT showed no advantage from adding teleassistance to usual care on mortality and all-cause admissions [14].

Chronic obstructive pulmonary disease

The effects of telemedicine in COPD patients are still discussed. A study showed clinical benefits in Global Initiative for Chronic Obstructive Lung Disease group D COPD patients on multiple comorbidities [15]. Reduction in out-patient visits, early detection and proactive intervention in the patient's home before an acute exacerbation were obtained with the coordination of primary care, pneumologists and nursing staff. Another RCT [16] in patients with chronic respiratory failure due to different diseases on long-term oxygen therapy (LTOT) and/or HMV showed that telemedicine was associated with reduction in hospitalisations or general practioner calls, and in healthcare costs. This effect was more relevant in COPD patients. Positive results have also been reported in systematic reviews and meta-analyses [17, 18]. A recent retrospective study in chronically hypercapnic COPD patients on LTOT showed that teleassistance alone, and with greater efficacy when combined with noninvasive ventilation, reduced the frequency of exacerbations [19].

Despite these and other studies showing an advantage in applying telehealth, recent research casts some doubts that these systems are more effective and less expensive than usual care [20–22]. In a 6-month crossover RCT, telemonitoring added to usual care did not improve the time to the next acute hospitalisation, increased hospital admissions and home visits overall, and did not improve HRQL in patients with chronic respiratory diseases [23]. A recent systematic review reports that out of the 18 studies fulfilling the criteria for inclusion, only three studies found statistically significant improvements in HRQL in patients undergoing telemedicine [24].

Despite that it is being suggested that telemedicine could encourage patients' self-management, this has not been clearly demonstrated for COPD [25]. A recent study suggested that aspects of eHealth and its implementation should be tailored to the patient. Patients' expected benefits of using eHealth to support self-management and their disease control seem to play an important role in patients' willingness to use eHealth for self-management purposes [26].

A European Respiratory Society Task Force has defined indications, follow-up, equipment, facilities, legal and economic issues of telemonitoring of COPD patients, including those undergoing HMV [3].

Telerehabilitation

Telerehabilitation can be defined as the provision of services to improve functional status using technologies allowing care and rehabilitation through connections between a central control unit and a patient at home according to four models of service delivery [3, 27]:

- "face-to-face" interactive video conferencing (figure 4)
- telehomecare with a nurse coordinating a service (telesupport)
- telemonitoring with possible interactive tele-evaluation
- telecare where the patient "plays" or performs exercises under home telemonitoring and a therapist may change settings at distance

Telerehabilitation has been promoted as follows.

- Tools: phone calls and messages, e-mail, video phones, websites or mobile phones, and video conferencing; biological electronic sensors able to send data; medical devices able to be programmed at distance; dedicated Internet

Figure 4 *A physiotherapist case manager during a video training session with a COPD patient.*

software and video conferencing. These technologies can improve the care of patients with difficult access to services (particularly those in rural/remote areas) [28].
- Timing of application: after a hospital discharge or to maintain benefits such as functional independence, education, participation, physical change, early detection of relapses, adherence, airway clearance and exercise training.

Although telerehabilitation is promising in patients with cardiopulmonary diseases, clear evidence is still limited. It has been shown that supervised training and counselling patients at home may be associated with safety, feasibility and benefits for severe COPD patients [29]. Nevertheless, compared with usual pulmonary rehabilitation, no significant improvement was seen in COPD patients equipped with a tablet after 7–10 weeks of rehabilitation [30].

Legal issues

The legal problems associated with telemedicine are yet to reach internationally common solutions. Any application of telemedicine is considered a medical act; therefore, despite that many procedures of teleconsultation are peculiar, the legal principles of traditional doctor–patient relationships are also valid in telemedicine. Three figures can be involved in legal problems to delivering performance [3].

- The person transmitting data: the relationship between the patient and other stakeholders must be governed by "informed consent", which includes the patient's awareness of the technicalities, the potential risks, the required precautions and, at the same time, ensures the confidentiality of the information.
- The person receiving data: the medical or nursing user of the service.
- The service provider(s): must ensure the quality and confidentiality of the data.

The use of telemedicine is associated with several risks, as shown in table 2 [3, 31]; therefore, eHealth users must use precautions [32].

Table 2 *Legal risks of telemedicine [3]*

Teleconsultation may fail to reach standard of care
Equipment or system may fail
Electronic data can be manipulated
Electronic record may be subject to abuse
The network may suffer from poor data protection (poor confidentiality, authenticity, data report, procedure certification, security and privacy)
The network may show difficulty to ascertain responsibilities and potential obligations of health professionals

- Data security and confidentiality: suppliers and users must ensure data protection, confidentiality and authenticity; the digitally signed and authorised certification of procedures; the security and privacy of the assisted persons; the protection from manipulation of storage and transfer of sensitive data in real time between units.
- Health professionals responsibilities and potential obligations: the relationships between the physician (teleconsultant) and the patient at distance (teleconsulted); the relationship between and coresponsibilities of the specialist consultant and the requesting physician; the applicant, consultant and service supplier.
- Interoperability: mutual exchange of ICT-supported solutions and of data may improve coordination and integration across the entire chain of healthcare delivery to allow personalised management.

With the dissemination of this technology, legal cases will increase; as a consequence, legislation should be updated to resolve many issues. National and EU governments should promote common ethical, legal, regulatory, technical and administrative standards [33].

Economic considerations

By 2060, the European population aged >65 years and those aged ⩾80 years will rise to 30.0% and to 12.1% of the total population, respectively. Accordingly, projections show that the EU average health expenditure may grow to up to 8.5% of gross domestic product due to, besides age, other socioeconomic and cultural factors. These changes have already had an impact on present public perceptions. Furthermore, increasing reductions in public budgets for welfare clash with growing citizen expectations for higher quality services and social care [2, 3, 34].

The health economics impact of the use of telehealth has been evaluated in a meta-analysis [35], indicating a €1060 average decrease of hospitalisation costs and additional €898 savings per patient. A systematic review assessed the economic value of synchronous or real-time video communication, and concluded that these tools were cost-effective for local delivery of services between hospitals and primary care [36].

However, telemedicine may represent an opportunity for health services. Despite the present economic crisis, the potential eHealth market is strong. The global telemedicine market has grown to $11.6 billion in 2011, and is expected to continue to grow to $27.3 billion in 2016 [35]. The health market enabled by digital technologies is rapidly growing, and the cooperation between wireless communication technologies and healthcare devices, and between health and social care is creating new businesses [33].

However, to evaluate the real cost/effectiveness of new methods of care such as telemedicine, it is important to define "standard therapy" and "usual therapy". The superiority (if any) of this new method of care must be compared to the different homecare organisations of the different European countries [33].

Problems and future directions

Variable models of telemedicine exist for COPD patients. Despite the hope of telemedicine as a means of COPD patient care, we need much more evidence before this modality can be considered as real progress in the management of these patients. Telemedicine must be evaluated in the context of other services (homecare, access to hospital and social care), including it in a "care package".

Age, education, experience in technological devices, home environment, cognitive, motor and visual abilities or deficits, phonation, and speech play an important role in the patient's ability to use technology in telemedicine programmes [37]. The training to the use of technology and the structure of the programme should be directed to caregivers in order to make them able to act in accordance with predefined protocols [38]. Major barriers hamper the wider diffusion of telemedicine, as shown in table 3. Solutions of these barriers are areas to be solved for the future.

Areas of future research may be effects of telemedicine on:

- clinical outcomes (survival, HRQL, daily living activities, social interaction, autonomy, self-management and caregiver burden)
- health services (phone calls and technical home visits)
- health resources use (emergency visits, hospital admissions and outpatient visits)

Table 3 *Barriers to tele-monitoring [3]*

Lack of knowledge of eHealth among patients, citizens and healthcare professionals
Lack of interoperability among different solutions
Limited evidence of cost/effectiveness
Legal problems and fears Lack of transparency on data utilisation
Insufficient reimbursement schemes
High start-up costs

Educational questions

1) The expected results from telemedicine in COPD are:
   a. Reduction in hospital stay
   b. Reduction in hospitalisations
   c. Improvement in quality of life
   d. All of the above
   e. None of the above
2) Telecare, telemonitoring and telemedicine programmes will change:
   a. Hospital admission
   b. Relationships among healthcare teams
   c. Drug prescription
   d. All of the above
   e. None of the above
3) The superiority of telemedicine *versus* standard follow-up models on costs has been clearly demonstrated.
   a. True
   b. False
4) Telemedicine is considered as:
   a. A new mandatory alternative to hospital admission
   b. A new supplement care instrument to use alongside conventional systems

Conflict of interest

None declared.

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Suggested answers

1) d.
2) d.
3) b.
4) b.

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