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Editorial

The Future of Telemedicine in the Management of Sleep-Related Respiratory Disorders

Telemedicina y enfermedades respiratorias durante el sueño: perspectivas de futuro

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In recent decades, advances in medicine in general and more specifically in the diagnosis and treatment of disease as well as the consequent improvements in the health and increased longevity of the population have been furthered by the incorporation into medical practice of technological innovations in areas such as cell biology, biochemistry, pharmacology, immunology, genetics, biophysics, and bioengineering. One of the few exceptions to this pattern of rapid incorporation of technological advances into medical practice is the field of information and communications technology (ICT). Indeed, the penetration of these technologies has been less significant in the clinical practice of medicine than in other scientific and professional fields and less, even, than in our daily lives. To remedy this situation, public initiatives have been launched in both Europe[1] and the United States of America[2] in the form of programs aimed at facilitating communication between medical professionals and between doctors and their patients, and improving the delivery of health care to patients.

Specifically, the use of ICT in routine practice is particularly limited in the field of respiratory medicine. Some researchers have focused on teleconsultation between professionals working at different levels of the health system.[3-6] Other studies in respiratory telemedicine have dealt with the telecare and telemonitoring of lung transplant recipients and patients with chronic obstructive pulmonary disease, asthma, or cystic fibrosis.[7-12] With the exception of spirometry self-testing in the context of home telemonitoring,[13] ICT initiatives relating to the monitoring of physiological respiratory signs have been limited to a few preliminary studies on the use of these technologies in home mechanical ventilation.[14,15] These were all pilot studies, and as none of them reliably demonstrated the cost-effectiveness of the applications under study, these applications have not been incorporated into routine practice.

The management of sleep-related respiratory disorders is an area of great potential for telemedicine because of the high prevalence and chronic nature of these disorders. Possible applications for telemedicine in this domain include both the sleep-related respiratory disorders in the strict sense of the term (obstructive sleep apnea-hypopnea syndrome and Cheyne-Stokes respiration) and also the diseases which, without being specific to sleep, are nonetheless associated with nocturnal respiratory abnormalities or give rise to the need for ventilatory support during sleep (chronic respiratory insufficiency due to neuromuscular dysfunction or thoracic cage abnormalities, chronic obstructive pulmonary disease, and obesity hypoventilation syndrome). To date, studies have been carried out on the telemetric transmission of physiological parameters while the patient is sleeping[16-18] and on home mechanical ventilation.[14,15] Other uses for telemedicine that have been proposed are the monitoring of treatment with continuous positive airway pressure (CPAP) with a view to improving effectiveness and patient compliance[19,20] and the real-time titration of domiciliary CPAP.[21] Like the other telemedicine applications in the field of respiratory medicine, the studies performed have been exploratory and the findings have not yet been confirmed.

Possibly the chief problem currently limiting the more widespread application of ICT to the delivery of health care is the model of information technology architecture that has generally been used in telemedicine studies. The model most often used for the organization and management of data is based on a network managed by a centralized server operating through a call center.[22,23] One requirement of this model is a series of complicated and costly financial and legal contracts between the hospitals, the companies providing the telemedicine platforms, and the companies providing the telecommunication lines. Moreover, many of the telemedicine models that have been piloted to date have required the patient's home to be equipped with a computer and an Internet connection, often of high specifications and bandwidth. These requirements have been an obstacle to the use of telemedicine among elderly patients and patients with a low socioeconomic level. A centralized ICT model may perhaps be appropriate for the operation of an established medical application, but the use of a centralized model in applications that are still under development, as is the case of telemedicine in the management of nocturnal respiratory diseases, often leads to failure. It is, in fact, almost impossible to study the cost-effectiveness of telemedicine because the technology cannot be

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applied without a complex and expensive ICT platform. On the other hand, the ICT companies and hospitals do not develop these platforms because of the lack of studies supporting their cost-effectiveness. As a result of this vicious circle, respiratory telemedicine is a much less developed and established application than might be expected in view of the advanced technological solutions now available.[24]

With this in mind, an interesting new direction is indicated by the development and commercial availability of telecommunications technology that makes it possible to decentralize the communications architecture used for telemedicine, particularly in the domain of sleep disorders. Using the low-cost miniature integrated circuits now available on the market, devices can be created that are able to do all of the following tasks: *a)* capture the digital signals produced by any conventional device (such as a CPAP device, a home ventilator, or a pulse oximeter); *b)* send control signals to any device (for example a control signal that modifies the parameters of a ventilator); and *c)* function as an Internet server by way of a conventional mobile telephony SIM card with its own web address and password. The last of these 3 characteristics represents the most significant change in the model. Immediate and inexpensive 2-way communication can be established by connecting such a device to the CPAP device or ventilator, thereby enabling continuous monitoring of the patient and control of the ventilation parameters from any location with Internet access.[25] Moreover, this point-to-point connection between the patient and the medical professional monitoring the home treatment does not require a complex platform specifically designed to facilitate telemedicine, and the patient's home does not have to be equipped with any telecommunications infrastructure (computer or Internet connection). It is reasonable to expect that the implementation of recent and future advances in the development and commercialization of telecommunication technologies will facilitate the more widespread application of telemedicine, both in terms of studies undertaken to evaluate the cost-effectiveness of telemedicine applications and the eventual incorporation of these technologies into routine practice.

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