Systematic Review of Telemedicine Services for Patients Affected by Chronic Obstructive Pulmonary Disease (COPD)

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Abstract
The aim of the present study was to conduct a systematic literature review focused on telemedicine services for patients affected by chronic obstructive pulmonary disease (COPD). In particular, it addresses (1) which telemedicine applications and related organizational models have been adopted for patients affected by COPD and (2) the impact of these applications. A computerized literature search was performed utilizing MEDLINE and Cochrane Library databases, selecting articles published between 1996 and 2008 using the following combination of keywords: [COPD] AND [telemedicine OR telehealth OR ehealth OR telecare] and after exclusions, 40 articles were considered. The adoption of telemedicine inevitably resulted in the reconfiguration of the existing practices and sociomaterial relationships. These organizational changes must be understood and addressed.

Key words: business administration/economics, e-health, policy, telehealth, home health monitoring

Introduction
Chronic diseases are the main cause of death in almost every developed country, and deaths from chronic respiratory diseases are second only to those from cardiovascular diseases. Among them, respiratory diseases are second only to the cardiovascular causes. Chronic obstructive pulmonary disease (COPD) is not one single disease but an umbrella term used to describe all chronic lung diseases that cause limitations in lung airflow. According to the latest World Health Organization (WHO) estimates, 210 million people currently have COPD, and 3 million people died of COPD in 2005. WHO has also predicted that COPD will become the third leading cause of death throughout the world by 2030. Between 40% and 50% of patients with COPD discharged from hospitals are readmitted the following year, and 17% of patients treated in emergency departments require hospitalization. COPD creates a serious burden on patients, providers, and healthcare systems. Despite optimal pharmacological therapy, patients with COPD often have severe symptoms that limit normal daily activities and affect quality of life. COPD exacerbations requiring hospital admissions are a major problem because of their negative impact on quality of life, prognosis, and costs. Airflow obstruction also contributes to other serious comorbidities, such as ischemic heart failure, strokes, pneumonia, and lung cancer.

The need to reduce this burden, in the context of a general concern about chronic disease management, has prompted the development of new management strategies for COPD. Home-based programs offering nursing care or pulmonary rehabilitation provide possible alternatives to hospital admission with lower costs for some patients. Hospital-at-home has been shown to be a practical alternative to emergency admission for some selected patients with exacerbations of COPD. Other approaches promote self-management programs that focus in particular on the active role of individuals and avoid the rigidity and fragmentation of traditional healthcare systems. The use of telemedicine has recently been tested in different studies with major endpoints to assess program feasibility. Most existing research and practitioners’ literature on telemedicine, therefore, adopts a clinical, technical, and economic approach. Social and organizational issues, although often mentioned, have instead been scarcely addressed. Therefore, the aim of the present study is to conduct a systematic literature review focused...
on telemedicine services for patients affected by COPD. In particular, it addresses (1) which telemedicine applications and related organizational models have been adopted for patients affected by COPD and (2) the impact of these applications.

**Materials and Methods**

**SYSTEMATIC LITERATURE REVIEW**

An extensive literature review was conducted to identify the relevant telemedicine applications for patients affected by COPD. Firstly, the following systematic search strategy was designed. A computerized literature search was performed utilizing MEDLINE and Cochrane Library databases, selecting articles published between 1996 and 2008 using the following combination of keywords: [COPD] AND [telemedicine OR telehealth OR eHealth OR telecare]. Eighty articles were retrieved. Of these, 31 were determined as being potentially relevant, were written in English, and had no duplicates. All of the studies without abstracts retrieved from the original electronic databases (n = 6) were also excluded. In order to assess whether the remaining studies were relevant, we first browsed the title and abstract of each article. It was then verified whether the study effectively dealt with a telemedicine service, intended as “the provision of medical services and healthcare via telecommunications-based systems” and whether it involved patients affected by COPD. The result was that two articles did not describe telemedicine scenarios, and seven articles did not involve COPD patients. At the end, 30 articles were selected. Finally, two additional articles were included since they were judged relevant for the scope of the analysis. Therefore, a total of 40 articles, retrieved from the literature analysis, were considered, as shown in Figure 1.

![](image)

**Fig. 1.** Systematic literature review methods. COPD, chronic obstructive pulmonary disease.

The articles were subsequently analyzed in order to identify which reported (1) a description of the organizational model of the application and (2) the organizational impact of telemedicine on routine daily work.

**CLASSIFICATION OF THE ORGANIZATIONAL MODELS**

The articles that dealt with specific telemedicine services for patients affected by COPD were catalogued according to:

- some descriptive characteristics of the article, such as the year of publication, the location of the study, and the type of paper, in order to map the state-of-the-art of this topic. The articles were divided into quantitative and qualitative studies. Quantitative studies that included data that made statistical evaluation possible were classified into preliminary result studies, when the application was still in the early stage (few patients enrolled and/or shortness of the period of implementation, feasibility, and pilot studies), and data analysis studies, when the results were supported by extended datasets, and therefore the conclusions may be considered statistically significant. Qualitative studies were instead classified as literature reviews, technology reports, interviews, or focus groups and application descriptions.

- some descriptive characteristics of the application, such as the number of patients involved and the duration of the projects, in order to better comprehend the validity and the representativeness of the results.

- the main characteristics of the organizational model adopted in the service provision. The analysis was mainly focused on telemonitoring projects, which anticipate the transmission of data from the patient’s house to clinicians. In fact, teleconsultation projects for patients affected by COPD, which consist of the provision of a specialist’s medical opinion to primary care physicians, are limited. The applications were therefore classified according to the modality of data transmission (real time or store and forward) and the availability of the telemedicine service (with or without a 24 hour/day emergency support).

**ANALYSIS OF THE IMPACT**

Finally, the number of articles that dealt with the organizational impact of telemedicine services were selected and analyzed in order to appreciate some of the critical aspects of this new way of practicing medicine. Three organizational impacts have been identified as relevant from the analysis of the literature: redistribution of roles and duties, changes in processes and procedures, and variations in productivity and performance (particularly related to nursing resources). Apart from a few studies, notes about the organizational impact of each application were explained briefly.
SYSTEMATIC REVIEW OF COPD TELEMEDICINE SERVICES

Table 1. Classification of the Articles

<table>
<thead>
<tr>
<th>QUANTITATIVE STUDIES</th>
<th>QUALITATIVE STUDIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary results</td>
<td>Literature reviews</td>
</tr>
<tr>
<td>Data analyses</td>
<td>Technology reports</td>
</tr>
<tr>
<td></td>
<td>Interviews/focus groups</td>
</tr>
<tr>
<td></td>
<td>Application descriptions</td>
</tr>
</tbody>
</table>

Results

The review of the literature shows that 85% of the 40 selected articles were published between 2003 and 2008, thus reflecting the very recent debate about this issue. Nineteen of 40 publications are British or American (10 and 9 articles, respectively). A concentration in publications exists since 16 articles have been published in two journals: Telemedicine Journal and E-Health (6 articles) and Journal of Telemedicine and Telecare (10 articles). Most of the studies are qualitative, as shown in Table 1.

ORGANIZATIONAL MODELS

Most of the technological reports and literature reviews do not describe a single application, nor do they provide a description of the organizational model and were therefore excluded from the subsequent sections. Moreover, in some cases more than one article described the same application from different points of view (technology, acceptability) or presented results obtained at different implementation stages. Since this review aimed to analyze and compare telemedicine services for COPD patients and related organizational models, when different articles described the same application they were considered as a single source of data and used together. Therefore, 17 articles were chosen as it was possible to obtain a description of the organizational model of the telemedicine service and its impact. The main characteristics are summarized in Table 2. In particular, three different organizational models adopted in telemedicine applications for patients affected by COPD have been identified. Telemonitoring is the most common service, and it consists of routine data transmission between the patient's home and a nurse located in the hospital; data move rather than people. Home telenursing is a model in which nurses go to the patient's house to monitor the clinical status and to transmit data to a hospital doctor. This model is not widely used, since the need to optimize resources and the increased required competences make it a suboptimal and often inefficient solution. Sometimes, technological devices play the leading role. They store and transmit clinical data and, in the case of irregular values, they alert the clinicians. The technology used in these applications should be very reliable. Automatic data transmission is not particularly applied since the technology is still weak and because of a lack of cultural readiness by patients and clinical staff who do not readily accept the "almost total substitution" of medical care with technological monitoring.

ORGANIZATIONAL IMPACT

Three organizational aspects have been identified as relevant from the analysis of the literature. The redistribution of roles implies the creation of a patient-centered network. Telemedicine can represent an opportunity for different parties to renegotiate their respective boundaries and to extend their influence. In particular, a redistribution of roles can be implemented (1) in the relationship between specialists and primary care physicians, (2) within the disease management program between the clinical team and the patient, and (3) within the clinical team between nurses and specialists. First of all, the development of home care services and their integration into hospital or primary care services lead to the development of new organizational models based on services networks. Any tensions between goals in primary and secondary care therefore need to be handled with care and “partners struggle to extract mutual gains from the collaboration.” The patient-centered approach raises at least two major challenges for managers and providers. First, work arrangements traditionally based upon pre-established intervention plans must adapt to respond to patients' ad hoc needs and alerts. Second, constant linkages between traditional and new service delivery models become mandatory. The role of patients also changes: the use of telemedicine has helped nurses to allow older people to gain better access to information and to improve their attitude toward self-monitoring. The most important issues consist, in fact, in establishing a shared vision as an essential tool for effective care management, interagency working, and mainstreaming activities. Telemedicine services, therefore, allow the development of home-based services with the involvement of patients and caregivers as partners in disease management. Better and more trustworthy relationships were also developed between nurses and doctors. The procedures show that nurses were expected to handle most cases autonomously and to refer to doctors only in exceptional cases. We therefore detect a delegation of clinical tasks to nonmedical personnel. This means that a variety of remedial strategies must be out of place to align this new division of labor to the existing legal and organizational framework.
Table 2. Summary of the Articles of the Systematic Literature Review

<table>
<thead>
<tr>
<th>PRINCIPAL AUTHOR</th>
<th>YEAR</th>
<th>LOCATION</th>
<th>TYPE OF STUDY</th>
<th>STUDY DESIGN</th>
<th>PATIENTS</th>
<th>CONTROL GROUP</th>
<th>DURATION (MONTHS)</th>
<th>TRANSMISSION</th>
<th>SERVICE AVAILABILITY</th>
<th>ORGANIZATIONAL MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2008</td>
<td>UK</td>
<td>Qualitative</td>
<td>Interviews/focus group</td>
<td>6 pts with COPD</td>
<td>No</td>
<td>12</td>
<td>Synchr.</td>
<td>Business hours</td>
<td>Telemonitoring</td>
</tr>
<tr>
<td>2</td>
<td>2008</td>
<td>Canada</td>
<td>Qualitative</td>
<td>Interviews/focus group</td>
<td>22 pts with chronic illness</td>
<td>No</td>
<td>17</td>
<td>Asynchr.</td>
<td>Business hours</td>
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</tr>
<tr>
<td>3</td>
<td>2007</td>
<td>USA</td>
<td>Quantitative</td>
<td>Data analysis</td>
<td>161 pts with COPD and Chr</td>
<td>Yes</td>
<td>24</td>
<td>Synchr.</td>
<td>24 h/day</td>
<td>Telemonitoring</td>
</tr>
<tr>
<td>4</td>
<td>2006</td>
<td>Italy</td>
<td>Quantitative</td>
<td>Data analysis</td>
<td>45 pts (17 with COPD)</td>
<td>No</td>
<td>9</td>
<td>Synchr.</td>
<td>24 h/day</td>
<td>Telemonitoring</td>
</tr>
<tr>
<td>5</td>
<td>2009</td>
<td>Italy</td>
<td>Quantitative</td>
<td>Data analysis</td>
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<tr>
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<td>Quantitative</td>
<td>Data analysis</td>
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<td>Business hours</td>
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<tr>
<td>7</td>
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<td>Spain</td>
<td>Quantitative</td>
<td>Data analysis</td>
<td>158 pts with COPD</td>
<td>Yes</td>
<td>24</td>
<td>Asynchr.</td>
<td>Business hours</td>
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<td>8</td>
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<td>Canada</td>
<td>Qualitative</td>
<td>Application description</td>
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<td>–</td>
<td>–</td>
<td>Synchr.</td>
<td>24 h/day</td>
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<tr>
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<td>Data analysis</td>
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<td>USA</td>
<td>Quantitative</td>
<td>Preliminary results</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>11</td>
<td>2003</td>
<td>USA</td>
<td>Quantitative</td>
<td>Preliminary results</td>
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<td>Business hours</td>
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<td>Data analysis</td>
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<td>Synchr.</td>
<td>24 h/day</td>
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<td>13</td>
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<td>USA</td>
<td>Quantitative</td>
<td>Data analysis</td>
<td>59 pts (17 with COPD)</td>
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<td>–</td>
<td>Asynchr.</td>
<td>Business hours</td>
<td>Telemonitoring</td>
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<td>14</td>
<td>2005</td>
<td>Japan</td>
<td>Qualitative</td>
<td>Application description</td>
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<td>No</td>
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<td>Synchr.</td>
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<td>15</td>
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<td>UK</td>
<td>Qualitative</td>
<td>Interviews/focus group</td>
<td>9 pts with COPD and 11 nurses</td>
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<td>–</td>
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<td>–</td>
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<td>16</td>
<td>2004</td>
<td>UK</td>
<td>Quantitative</td>
<td>Application description</td>
<td>Ethnographic study with 12 nurses</td>
<td>–</td>
<td>22</td>
<td>Synchr.</td>
<td>Business hours</td>
<td>Telemonitoring</td>
</tr>
<tr>
<td>17</td>
<td>2005</td>
<td>UK</td>
<td>Quantitative</td>
<td>Application description</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>18</td>
<td>1999</td>
<td>UK</td>
<td>Quantitative</td>
<td>Application description</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
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<tr>
<td>19</td>
<td>2005</td>
<td>Greece</td>
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<td>Preliminary results</td>
<td>18 pts with COPD</td>
<td>No</td>
<td>18</td>
<td>Synchr.</td>
<td>Business hours</td>
<td>Home telemonitoring</td>
</tr>
</tbody>
</table>

continued →
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<tr>
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<th>DURATION (MONTHS)</th>
<th>TRANSMISSION</th>
<th>SERVICE AVAILABILITY</th>
<th>ORGANIZATIONAL MODEL</th>
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<tbody>
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<td>Zarabokis et al.</td>
<td>2004</td>
<td>Greece</td>
<td>Qualitative</td>
<td>Application description</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Syncr.</td>
<td>-</td>
<td>Telemonitoring</td>
</tr>
<tr>
<td>Dale et al.</td>
<td>2003</td>
<td>UK</td>
<td>Quantitative</td>
<td>Preliminary results</td>
<td>65 pts</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>Telemonitoring</td>
</tr>
<tr>
<td>Young et al.</td>
<td>2001</td>
<td>USA</td>
<td>Qualitative</td>
<td>Technology report</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Asynchr.</td>
<td>Business hours</td>
<td>Automatic data transmission</td>
</tr>
<tr>
<td>Johnston et al.</td>
<td>2000</td>
<td>USA</td>
<td>Quantitative</td>
<td>Data analysis</td>
<td>212 pts with chronic illness</td>
<td>Yes</td>
<td>18</td>
<td>Syncr.</td>
<td>24 h/day</td>
<td>Telemonitoring</td>
</tr>
</tbody>
</table>

COPD, chronic obstructive pulmonary disease.

The introduction of a new technology stimulates the need for new organizational approaches that are influenced by the creativity of the people involved and a touch of opportunism to take advantage of the resources and competences available. Technology is, by definition, always technology-in-use and should be studied as such. The attitude of the nurse is critical in the modeling of new ways of working. Some nurses were unsure about leaving patients at home "just in case the machine did not work." Sometimes they lacked confidence and knowledge about the equipment. Healthcare professionals reported that a great deal of time was wasted. "I had to come down to the office...access the electronic care plan...we also spent a lot of time sorting out the telephone line." The literature reports several studies that highlighted the difficulties of nurses in handling technologies. Mair et al., for example, report that telecare services did not match the nurses' views of the most appropriate or preferred use of their skills. The telecare service seemed unlikely to become part of routine healthcare delivery because the nursing team was not sure that it was a safe way to provide healthcare and it was not perceived to improve efficiency. Hibbert et al. set up an ethnographic analysis to study the issue. In detail, the work highlighted the complex problems that health professionals encounter when they try to integrate new technologies into routine service delivery. The concerns that arise from the interplay of new technology with existing professional practices and relationships go beyond simple training issues. The technology was sometimes seen to undermine the nurses' professional security and credibility, and there was also some concern about its potential to replace nurses. The issue of the risks to patients was also raised. These aspects are relevant in the analysis of the organizational impact, since an adverse attitude toward technology sometimes led healthcare professionals not to change the way they worked. This was confounded by their perception that "the machine was not reliable" and that sicker patients did not meet the criteria of telecare. Operators also recognized that their lack of confidence in the equipment, and hence their attitude toward telecare, might have influenced the introduction of telecare. This leads them to be "picky" about whom to offer this service. Efforts have to be made to integrate telehomecare activities into other home care services. Despite all this, two alternatives emerged from the literature: the specialized model and the polyanalytic model. The first one resulted in the concentration of activities between nurses with specific competences. This specialized approach allowed services to develop somewhat independently of other home care activities. In the polyanalytic model, instead, a committee was responsible for the development of the clinical guidelines, selection of the patients, and the planning of the human resources.

Productivity and performance (particularly related to nursing resources) represented another topic apparent in the review. This issue is controversial since it depends on the baseline: a nursing home care service usually already existed, and nurses have the duty to visit the patients' houses regularly to take care of them. In these cases, the results of the cost-minimization analysis made by Paré clearly demonstrate that there were fewer home visits by nurses for the telemedicine group. The telehomecare program cost $6,750 less than the traditional home care program, representing a saving of $355 per patient. This amounts to a net gain of 15% over traditional patient monitoring, a program that cost $46,054. As De Toledo states, the number of patients that can be provided with a closer follow-up is higher, without increasing the workload of the professionals (specialists and case managers). In some other cases, instead, home care services are not provided regularly by nurses. The principal source of savings is therefore represented by the lower hospitalization costs. Young et al. add that computerized, telephone-linked communication systems offer an inexpensive, widely available alternative that can
maintain contact with patients and providers. Such systems could be particularly useful to provide ongoing monitoring and education for patients with chronic illnesses such as COPD. Other studies have shown there was no statistical difference in the length of telemedicine (22 ± 12 minutes) and in-person (22 ± 7 minutes) consultations. Introduction of telehealth services may overburden already stretched resources and be a barrier to implementation of those services.

**Discussion**

This systematic literature review supports the idea that telemedicine assumes and entails some significant changes in work processes. The adoption of telemedicine inevitably resulted in the reconfiguration of the existing practices and sociomaterial relationships. To this extent, a recent European communication states that one of the main characteristics of telemonitoring consists in the contribution to reorganization and redeployment of healthcare resources. This new way of working, in fact, triggers a variety of shifts in coordination mechanisms, work processes, and power relationships in the healthcare sector. Although Lamothe et al. discuss the site-specific features of the telehomecare model, this study testifies that some recurrent characteristics may be highlighted in telemedicine services for patients affected by COPD.

First, doctors have the possibility to delegate part of their own responsibilities and duties to nurses, to primary care physicians, and sometimes even to patients, intervening anyway in case of unforeseen occurrence.

Second, the redistribution of tasks and responsibilities has to be accompanied with a cultural change: nurses (and primary care physicians) need to become aware of the important benefits that technologies may introduce in terms of quality of care, cost-effectiveness, and productivity. When individual and organizational objectives are aligned, an organization increases its chances of success. This scenario may be reached not only through economic incentives, but even with cultural interventions, such as course of training and initiative of networking with nurses who have already conducted a successful telemedicine experimentation.

Third, it is necessary to strengthen collaboration within clinical teams. The organizational studies listed a series of coordination mechanisms. The most famous ones are the mutual adaptation, the direct supervision, and the standardization of processes, results, or competences. It is not possible to decide the most appropriate one, and a contingent evaluation is needed. Notwithstanding, it is relevant to know that this kind of effort has to be faced in order to identify the most appropriate solution. Finally, the patient-centered approach led to promoting a self-management policy. Currently, in fact, patients with chronic conditions are able to take care of themselves in a more aware manner through the adoption of telemedicine services.

To conclude, technology may be seen as an opportunity of change, and at the same time it represents its driver. A rethinking of the organization structure is therefore mandatory in order to maximize technological benefits, in terms of productivity, cost-effectiveness of healthcare, and quality of care. It remains to be demonstrated whether the organizational impacts identified in telemedicine services for patients affected by COPD can be generalized. To this extent, Lehoux et al. state that the potential integration of teleconsultation into practices varies over specialities, as a function of the type of information and the particular routines involved. Thus, additional studies are needed to investigate with more depth issues related to the redistribution of roles, the change of processes, and the staff productivity and performance introduced by different telemedicine services.

**Disclosure Statement**

No competing financial interests exist.

**REFERENCES**


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