Interventional Pulmonology

Respiration

Respiration 2020;99:171–176
DOI: 10.1159/000504632

Received: June 13, 2019
Accepted after revision: November 5, 2019
Published online: January 10, 2020

Clinical Use and Barriers of Thoracic Ultrasound: A Survey of Italian Pulmonologists

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Keywords
Thoracic ultrasound · Barriers to use · Pulmonologists · Survey · Italy

Abstract
Introduction: Thoracic ultrasound is accurate in the diagnosis of a wide range of respiratory diseases. Yet the extent of its use is unknown. Through a national survey, we aimed to explore the clinical use of thoracic ultrasound and the barriers to the diffusion of the technique in Italy. ***Methods:*** Accademia di Ecografia Toracica (AdET) developed a self-administered survey which was sent by email to Italian pulmonologists via national scientific societies and networks. ***Results:*** Of the 2010 physicians invited, 514 completed the survey (26% response rate). According to 99% of responders, thoracic ultrasound had a relevant clinical role. Seventy-nine percent of the responders used thoracic ultrasound at least once a month. The main settings were: 53% pulmonology ward, 15% outpatient clinic, 15% interventional pulmonology room, 10% internal medicine ward, 4% respiratory intensive care units, and 9% other. Thoracic ultrasound was primarily used: (1) with both diagnostic and interventional aims (72%), (2) as diagnostic imaging (17%), and (3) as guidance

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for interventional procedures (11%). The main clinical applications were: (1) diagnosis and management of pleural effusion, (2) pneumothorax, (3) pneumonia, (4) cardiac failure, and (5) acute dyspnea. Twenty-one percent of the responders do not use thoracic ultrasound. The main reported barriers were: (1) availability of an ultrasound system (52%), (2) lack of protected time and training (22%), and (3) use of the technique by other specialists (15%). ***Conclusion:*** Thoracic ultrasound is widely used by Italian pulmonologists and considered a clinically relevant tool. The availability of dedicated ultrasound systems seems to be a major limit of the use of the technique.

Introduction

In the course of the past 3 decades, it has been shown that several respiratory diseases alter the acoustic properties of the lung, thus making it accessible to sonographic exploration [1–4]. Going beyond its ascertained role in the management of pleural effusion, ultrasound (US) has been applied widely in the approach of respiratory failure as it may detect pneumonias [4–6] and pneumothoraces [7, 8], differentiate acute heart failure and exacerbation of chronic obstructive pulmonary disease [3, 9], assess morphological changes of the lung in acute respiratory distress syndrome [10], or be used to study diaphragmatic function [11, 12]. The strengths of the technique are the lack of radiation, the portability at the bedside, a steep learning curve, and relatively low costs that make this technique of high clinical interest in the evolving field of respiratory medicine [1, 13, 14]. Yet, despite a wide use of the technique in some research centers [15], the current use of lung US in clinical practice remains largely unknown.

Therefore, we sought to investigate whether thoracic US is currently applied in real life. Through a national survey in Italy, we aimed to explore the clinical use of thoracic US and the barriers to the diffusion of the technique amid pulmonologists.

Materials and Methods

We here report a physician self-administered cross-sectional survey conducted in Italy from May to July 2017. The questionnaire (online suppl. appendix; for all online suppl. material, see www.karger.com/doi/10.1159/000504632) comprised 21 questions and was endorsed by the two scientific national respiratory societies Associazione Italiana Pneumologi Ospedalieri (AIPO), Società Italiana di Pneumologia (Italian Respiratory Society, IRS), and Chest Delegation Italy. It was developed through question-item generation/reduction [16, 17] performed to fit the study aims of Accademia di Ecografia Toracica (AdET), an independent panel of experts on thoracic US.

The questionnaire was composed of 4 groups of questions: questions 1–6 aimed to characterize the responders; questions 7–8 defined responders as "US users" or "non-US users" and aimed to assess responders' beliefs on usefulness and practice; questions 9–18 were targeted at US users to assess experience in US, training paths, availability and type of US equipment, aim and frequency of US examinations, and whether a written report of the US was produced; questions 19–22 were targeted at non-US users to assess the main reasons for not performing US and undertaking US training.

The questionnaire was distributed by email over a 3-month period through the databases of Italian pulmonologist societies (AIPO and IRS), Chest Italy, and physician networks (PleuralHub, PneumoLab). Non-respondents were contacted by email with three reminders and were encouraged to participate. Analysis was performed using descriptive statistics (IBM SPSS Statistics for Windows, version 21, IBM Corp., Armonk, NY, USA) and the data are reported as counts and percentages.

Table 1. Characteristics of the survey respondents

Responders	514 (100)
Females	206 (40.1)
Fellows	112 (21.8)
Setting	
Community hospital	225 (43.8)
University hospital	210 (40.8)
Outpatient clinic	40 (7.8)
Rehabilitation	20 (3.9)
Other	19 (3.7)
Age	
Under 40 years	262 (51)
41–50 years	107 (20.8)
51–60 years	86 (16.7)
Over 60 years	59 (11.5)
Region	
Northern Italy	331 (64.4)
Central Italy	77 (15.0)
Southern Italy	100 (19.5)
Abroad	6 (1.2)

Data are presented as *n* (%).

Results

Study Responders

Five-hundred and fourteen physicians answered the questionnaire (25.6% response rate). The characteristics of respondents are reported in Table 1. They mostly (84.6%) worked in general or university hospitals. The specific work settings were: in 56.6% a pulmonology ward, in 14.6% an outpatient service, in 10.5% an interventional pulmon-

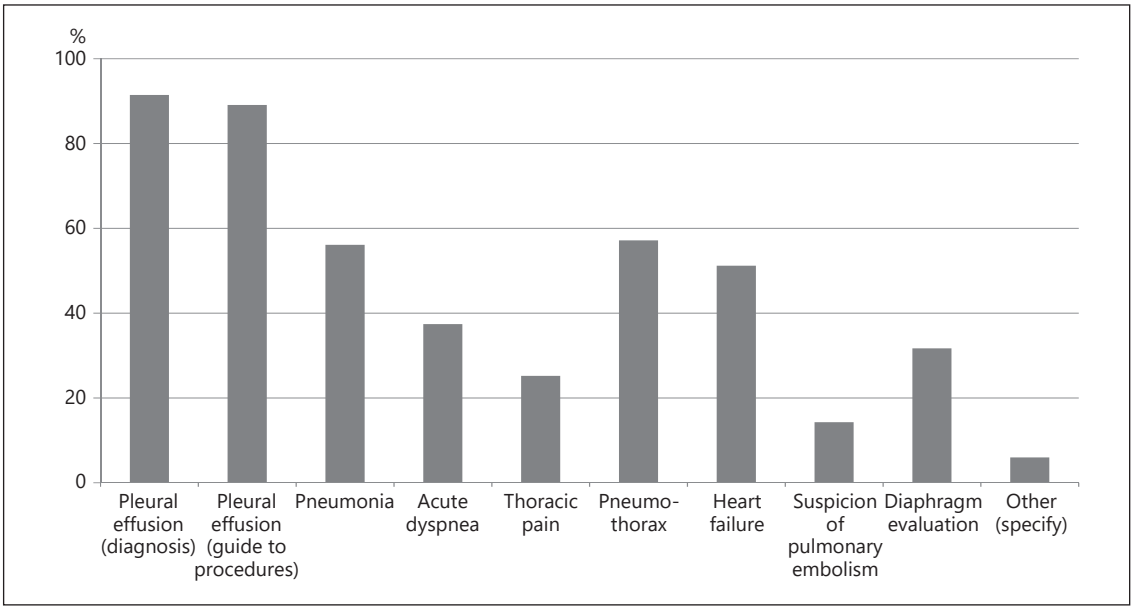

Fig. 1. Clinical applications according to pulmonologists who perform thoracic US (n = 385, 75% of responders).

ology service, in 9.7% an internal medicine ward, 4.7% in the emergency room, and 3.9% in a rehabilitation center. According to 511 (99.4%) physicians, the technique had an impact on their clinical practice. Regional distribution showed a similar pattern of US use in Northern (82.4% of users vs. 17.6% of non-users) and Central Italy (79.0% of users vs. 21.0% of non-users) and a lower use in Southern Italy (71.0% of users vs. 29.0% of non-users).

There was a tendency towards an increased use among young pulmonologists. Amid pulmonologists aged <40 years, 81.5% were US users versus 18.5% who were non-users. In those aged 41–50 years, 80.8% were users versus 19.2% who were non-users. In those aged 51–60 years, 75.1% were users versus 24.9% who were non-users. Finally, among those aged over 61 years, 66.1% were users versus 33.9% who were non-users.

Pulmonologists Performing Thoracic US

Four-hundred and six responders (79.4%) confirmed that they use thoracic US at least once a month. These were defined as "US users." Of the responders, 37.4, 33.2, 14.6, 11.4, and 3.4% stated that each week they perform 1–2, 3–5, 6–10, 11–30, and more than 30 US exams, respectively. US users had been performing thoracic US for the following periods of time: less than 1 year, 12.2%; 1–3 years, 31.2%; 3–5 years, 29.6%; 5–10 years, 17.9%, more than 10 years, 9.1%. US users learned the technique with the following methods (more than one answer allowed): self-learning (books or online resources), 53.5%; chest US courses, 53.3%; clinical practice with a mentoring tutor, 52.9%; US courses of internal medicine, 19.7%; emergency US courses, 12.2%.

Clinical Application

Pulmonologists used thoracic US primarily: (1) with both diagnostic and interventional aims (72%), (2) as diagnostic imaging (17%), and (3) as guidance for interventional procedures (11%). The thoracic clinical applications are reported in Figure 1. Responders principally used US for pleura and lung assessment (96.4%) and chest wall assessment (50.9%). Diaphragm, heart, and extra-thoracic assessments were performed by less than 30% of the responders. The main settings of application were bedside use in wards (78.4%) and respiratory outpatients (44.9%).

A written report of the US exams was produced by 83.9% of the responders. The remaining 16.1% confirmed that they do not write a report mainly for the following reasons: "not enough skilled," "lack of authorizations," "lack of time."

US Systems

Three-hundred and five physicians (74.9%) responded on the availability of at least one US system. Of these, 325 (84.4%) had an US dedicated to the ward or the service,

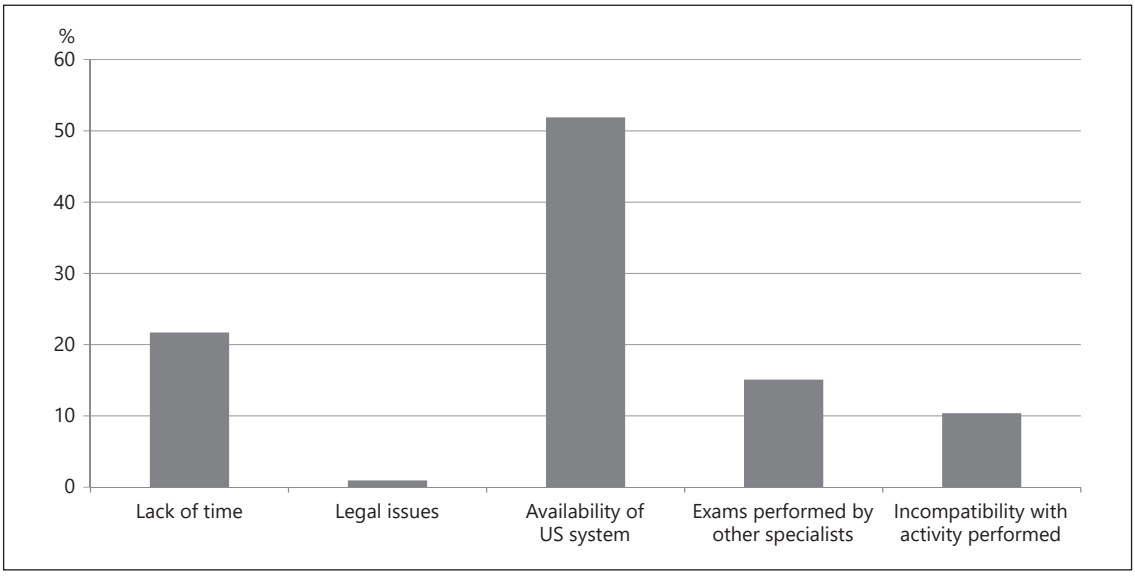

Fig. 2. Barriers to the execution of thoracic US (n = 106, 21% of responders).

33 (8.6%) had an US on demand (e.g., available in another ward), 25 (6.5%) had access to a US system with some difficulties (such as the system being in another ward that is difficult to access or that could be used during limited hours). The US systems used by pulmonologists were: a portable system in 323 cases (83.9%), a chart-based system in 55 cases (14.3%), and an ultra-portable device in 7 cases (1.8%).

Pulmonologists Who Do Not Perform Thoracic US

One-hundred and eight (20.6%) of the responders reported not performing thoracic US. The main reasons were: "no US machine available" (52%), "no time to learn it" (22%), "other colleagues were already performing it" (15%), "no compatibility with their daily activity" (10%), and "fear of legal risks" (1%; Fig. 2).

Sixty-five percent of physicians who did not perform US had an education of a different sort on the subject. Specifically, 58% had read a book on US, 43% had attended a chest US course, 25% had completed a general US course, 14% had undertaken a practical US course, and 5% had done an emergency US course.

In the institutions of physicians who do not perform thoracic US, the technique was performed by someone from another department/services in 40% of the cases or by someone of their team in 24% of the cases. Thirty-six percent of the physicians who did not perform US stated that nobody performed the technique in their institutions.

Discussion

We herein report the first comprehensive cross-sectional survey on the use of thoracic US amongst Italian pulmonologists. The study reveals a strong interest and widespread use of thoracic US among pulmonologists. Thoracic US is currently used mainly in the hospital, primarily at the patient's bedside in the pulmonary ward, but also in interventional rooms or outpatient clinics. It is noteworthy that pulmonologists reported a strong clinical impact of the technique that requires further dedicated studies.

Analyzing the results, we can affirm that chest US has largely spread in hospitals, in particular in pulmonology wards, with prompt availability in most cases. Nevertheless, the use of US for respiratory outpatients has also increased, but a dedicated thoracic-US outpatient service has not yet largely diffused. Seventy-three percent of US users have experience of ≤5 years, indicating a quite recent diffusion of chest US, also thanks to the planning of many theoretical-practical courses.

Despite the large diffusion of chest US, the average number of US exams performed weekly is relatively low: more than 60% of all US users perform less than 6 exams per week. This percentage is only partially influenced by years of experience: 76% of responders with <5 years of experience and 56% of responders with >5 years of experience perform less than 6 exams weekly. Thoracic US is

used either for diagnostic imaging and as a guide to pleural procedures, and the most common indications are pleural effusion, pneumonia, pneumothorax, and heart failure. The use of US among pulmonologists is mostly limited to the chest; extra thoracic applications, in particular abdomen US, are poorly used. These data can be explained by the low number of responders that had attended a general US course (20%). In most cases training is focused only on US of the lungs and pleura. Reporting the findings of a chest US exam is common among responders, but some refer to limitations due to their insufficient training or to a difficult organization in their department.

The principal barrier to US use is the unavailability of machines and lack of time to learn the technique. The lack of available machines could explain the lower use in Southern Italy, while the novelty of the technique may explain its increased use among young pulmonologists. Regardless, 65% of physicians not performing the thoracic US had attended a US course or studied a specific book. So, despite the issue of instrument availability, there is interest in this technique. Thoracic US is not performed by anyone in the non-US users' institutions in only in 35% of cases.

Study Limitations

Being a survey, there are important limitations concerning data interpretation. First, respondents familiar with the use of thoracic US may have been more prone to answer the survey. To overcome this limitation, we distributed the survey through national respiratory societies and not through US societies. Second, although many respondents took part in the study, the overall response rate was relatively low, thus limiting the generalizability of the results. However, the potential for a low response rate among physicians is known [18] and the percentage of responders to this study was higher than that of similar studies [17]. Third, despite the survey being anonymous, respondents may have tended to respond in accordance with the literature rather than describing their real practice [17]. A recent prospective audit of pulmonologists' practice on thoracic US seems to confirm our study results [15]. Finally, other physicians, such as intensivists, emergency physicians, thoracic surgeons, and, more recently, pediatricians, also perform thoracic US. Further studies may explore the current practice among these physicians.

In conclusion, our national survey revealed widespread interest and use of thoracic US among Italian pulmonologists. This study provides a rationale to further explore the potential of US in respiratory medicine and offers insights to the removal of barriers, such as increasing investment in US equipment.

Appendix

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Acknowledgements

The authors gratefully acknowledge the technical support by AIPO, IRS (SIP), PleuralHub, and Chest Italy in the diffusion of the survey. We also thank Giampietro Bandelli, Pasquale Berardinelli, Marco Biolo, Elisa Bonatti, Alberto Bordo, Sara Colella, Vittoria Comellini, Giuseppe Failla, Vito Antonio Falcone, Valeria Frassani, Elisabeth Gapp, Kim Lokar Oliani, Vittorio Pietrangeli, Carlo Rattu, Franco Ravenna, and Simone Scarlata.

Statement of Ethics

There were no ethical considerations relevant to this work.

Disclosure Statement

All authors declare no conflicts of interest in writing this paper.
This work was not supported by any funding.

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