Introduction

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The sinking of RMS Titanic in 1912 led to the invention of a range of devices as a means of improving the detection of icebergs. During World War I, the technique was further developed into an active sound device using quartz for the detection of submarines. In the following decades and during World War II, the technique was further developed and named sonar (SOund Navigation And Ranging) [1]. The principles and technologies that lead to the development of sonar were also noticed amongst physicians. In 1940, Gohr and Wedekind suggested the use of reflected sound for diagnosing tumours, effusions and abscesses [2]. Dussik was the first to report the clinical use of reflected US as a medical diagnostic tool in his exploration of whether visualisation of intracranial structures and ventricular measurements was possible with US waves [3]. Despite Gohr and Wedekind's initial suggestions and studies published by other authors, the use of TUS as a clinical tool was for many years considered to be limited to the assessment of pleural effusion [2, 4–6]. A description of the use of TUS as a tool for the assessment of horses with respiratory diseases challenged this dogma. Rantanen reported the use of TUS for the assessment and diagnosis of such conditions as lung consolidation, atelectasis, abscesses, pleural effusion, empyema and pneumothorax in horses [7]. Furthermore, Rantanen's paper contains descriptions of vertical and horizontal reverberation artefacts as well as the concept of movement of the "pleural blades" during respiration in normal lungs, and its absence if pneumothorax is present [7]. These signs and artefacts were later to be considered key concepts in TUS [8]. The subsequent studies during the 1990s by researchers such as Targhetta and Lichtenstein lead to the birth of TUS as an essential diagnostic modality in the assessment of patients with known or suspected disease in the chest [9–14].

A milestone was reached when the first international consensus conference producing evidence-based recommendations for point-of-care LUS was published in 2012 [8]. This document achieved the great aknowledgement of becoming the most cited article of the top 50 published in *Intensive Care Medicine*, the journal of the European Society of Intensive Care Medicine; it was even more highly cited than other very

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popular topics in critical care, such as the fluid management of shock and the new definition of acute respiratory distress syndrome [15]. The consensus analysed 320 articles published prior to 2012. The same group of experts is working on the update, analysing around 700 articles on LUS published from 2012 to the present day. This demonstrates the great importance and high impact of TUS in various communities, including, of course, respiratory medicine.

We were thrilled to be asked to be guest editors of this, the very first *ERS Monograph* on TUS. A book solely dedicated to the subject is a clear sign that TUS is now considered to be an essential bedside tool for the modern respiratory physician. Despite this, and the fact that the number of published studies describing the clinical use of TUS is steadily increasing, several aspects are yet to be studied and assessed in robust clinical trials. In comparison with other types of clinical US (*e.g.* abdominal US, echocardiography) the extent of international consensus on several key aspects remains limited. Furthermore, different forms and TUS approaches have been adopted by many different specialities and societies, making a consensus process even more difficult. In the context of this *Monograph*, we chose to use the following definitions:

- TUS: diagnostic ultrasonography of the thorax. The term chest sonography or LUS is often used synonymously in the literature [8, 16].
- Focused TUS: a focused TUS examination.
- Focused ultrasonography: an ultrasonographic examination performed in a focused manner in order to answer specific and clinically relevant yes/no questions. As opposed to diagnostic ultrasonography, focused ultrasonography is believed to require less training and is less time consuming to perform [17]. An example would be FTUS examination used by an emergency physician to assess a patient with respiratory failure in an emergency department.
- Diagnostic ultrasonography: defined as an US examination in which the examiner aims to identify all possible pathologic conditions in an organ or structure, including the ability to declare “normality”. In order to be able to perform diagnostic ultrasonography, dedicated training and more extensive experience are required [18]. Examples are echocardiography performed by a cardiologist or a TUS examination performed by a respiratory physician.

To compensate for the lack of international consensus and different approaches used, we chose to invite a selection of authors for each chapter who were not only recognised experts but also represented different specialities, use TUS in different settings, and work at different institutions in different countries. We are very pleased that we were able to use this approach, and would like to thank all the authors for their positive attitude and collaborative efforts within the group. We hope that the result is that each chapter reflects not only the opinion of experts at a single site in Europe but a multidisciplinary and multicentre view.

In summary, we hope that this *ERS Monograph* will facilitate increased consensus, research, implementation and evidence-based use of TUS to the benefit of the high number of patients being assessed for diseases of the thorax. This technique must surely now be regarded as essential.

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