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Diagnostic thoracic ultrasound imaging – An exploration of respiratory physiotherapists' interest and use in clinical practice: A national survey

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Abstract

Introduction: Physiotherapists are learning to perform diagnostic thoracic ultrasound but it is currently unknown how they are learning, how they are using thoracic ultrasound in their practice, or any factors affecting the implementation of thoracic ultrasound into practice. The aim of this survey was to explore the use of thoracic ultrasound by physiotherapists. This information could be used to aid training and implementation strategies to assist physiotherapists to integrate thoracic ultrasound safely into their practice.

Methods: A questionnaire comprising of open/closed questions was distributed to respiratory physiotherapist. Distribution was at three national study days and via a specialist newsletter containing a link to a SurveyMonkey™ questionnaire.

Results: A total of 133 questionnaires were returned with 31 reported that they used thoracic ultrasound imaging and 101 reporting they did not. The most common roles of thoracic ultrasound in practice were to: enhance the ability to differentially diagnose respiratory pathologies, aid respiratory assessment and support clinical reasoning. Of the 133 respondents, 58 reported that they had undertaken training in thoracic ultrasound imaging and 75 had not. The most common factors identified regarding thoracic ultrasound implementation were team support, ultrasound machine availability/cost, time pressures and mentor availability.

Discussion: This survey has provided an understanding of thoracic ultrasound practice amongst respiratory physiotherapists in the UK. The survey results demonstrated the barriers that inhibit current practice and highlighted the importance of mentor support. There was a good understanding by all respondents regarding the clinical application of thoracic ultrasound. These findings are being used to develop professional guidance and ensure safe practice of thoracic ultrasound.

Keywords

Physiotherapy, thoracic ultrasound, survey

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Introduction

Diagnostic thoracic ultrasound (TUS) is an imaging modality used to assess the lung pleura, parenchyma and associated thoracic structures such as the ribs, intercostal muscles and diaphragm. TUS has been shown to be more accurate than chest radiograph (CXR) when diagnosing respiratory symptoms in critically ill patients such as pneumothorax, interstitial syndrome, contusion, consolidation and pleural effusion,

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and has been the subject of a recent systematic review and meta-analysis by Winkler et al.[1] This ability to more accurately assess pulmonary pathologies, guide physiotherapy specific treatment options and monitor the response in respiratory compromised patients would be a useful skill for respiratory physiotherapists to possess.[2]

Respiratory physiotherapists do not routinely learn to perform TUS as part of their practice and have relied on other professionals such as radiographers to provide imaging such as ultrasound scans. However, respiratory physiotherapists are beginning to use TUS to inform their research and clinical practice by performing the TUS scans themselves as autonomous practitioners.[3] It would appear that TUS is currently viewed as an advanced respiratory physiotherapist skill within critical care as shown by two Delphi studies from Skinner et al.,[4] and Twose et al.,[5] performed on Australasian and United Kingdom (UK) physiotherapy experts, respectively, looking at minimum standards of physiotherapy practice on critical care. Both Delphi studies show a high level of agreement (≥92%) with autonomous assessments skills such as observation, palpation and auscultation as a minimum level of skill for physiotherapists within a critical care environment. The ability to autonomously interpret a CXR also has high agreement (≥92%). However, being able to interpret (not perform) a TUS scan was in low agreement at 0% and 1%, respectively. For now, experts believe that the ability to perform TUS should not be included as a minimum standard but rather an advanced skill for those working on critical care.

Diagnostic TUS training opportunities for respiratory physiotherapists within the UK are currently limited. The Intensive Care Society (in the UK) offers the Core Ultrasound Intensive Care (CUSIC) accreditation program[6] that includes a module on lung/TUS as one way for respiratory physiotherapists to gain the necessary skills to perform TUS independently. This accreditation program as an option for respiratory physiotherapists has only been a recent development since December 2017.

It is currently unknown how UK respiratory physiotherapists are using TUS in their practice, how they are learning TUS or any opportunities or barriers they face when trying to implement TUS into their practice.

The aim of this study was to explore the use of TUS by respiratory physiotherapist through a national UK-wide questionnaire. Topics investigated include the perceived role of TUS use, to identify the type and content of current or future training programmes and finally to identify any factors that have influenced the ability of respiratory physiotherapists to use TUS imaging in clinical practice. It is hoped this information will aid the future development of training and implementation strategies to assist respiratory physiotherapists to use TUS in their practice.

Methods

This study involved the distribution of a questionnaire as a survey tool. The questionnaire explored professional attributes of respiratory physiotherapists who reported an interest in TUS and the features that had influenced their interaction with the modality.

The Blackpool Teaching Hospitals NHS Foundation Trust's research and development deemed this survey to be a service evaluation and therefore ethical approval was not required. All questionnaire participants were anonymous, not deemed to be vulnerable, were in the public domain and performed the questionnaire voluntarily. A copy of the questionnaire can be found online in Appendix 1.

The questionnaire used in this study was a modified version of the questionnaire used in the professional doctoral thesis by co-author Innes[7] as no existing questionnaire was directly relevant to the research questions.

Questionnaire distribution

The target population of the questionnaire was made up of physiotherapists in the UK who define themselves as a 'respiratory physiotherapist'; however, exact numbers of respiratory physiotherapists within the UK are currently unknown. As it is impossible to gain access to the entire population, a representative sample was accessed.

Convenience sampling

The questionnaire was distributed by hand at two study days attended by respiratory physiotherapists, from the North West of England, and one critical care study day, held in South Wales, between April and June 2018. Respiratory physiotherapist delegates at all three study days were invited to voluntarily and anonymously complete the questionnaire and their responses were collected by hand.

The second distribution method was via the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) newsletter. The newsletter included a link to a SurveyMonkey™ questionnaire containing the same survey questions (online Appendix 1). The ACPRC is the respiratory physiotherapy special interest group for the Chartered Society of Physiotherapists (CSP) within the UK. Participating respiratory physiotherapists were encouraged to forward the SurveyMonkey™ link to other UK-based colleagues who had an interest in respiratory

physiotherapy as a method of 'snowballing' its distribution (Table 1).

The questionnaire was open on SurveyMonkey™ for a six-week period between July and August 2018. No further responses were possible after this time.

Results

A total of 133 questionnaires were completed and returned. The number of questionnaires returned from each of the two distribution methods has been presented in Table 1.

Question 1: Do you use TUS imaging in clinical practice?

Of the 133 respondents, 31 (23%) reported that they used TUS imaging in clinical practice with 101 (76%) reporting that they did not. One individual left this question blank. Two responders who indicated "yes" to using TUS in their clinical practice explained that a member of the medical team acquires and interprets the scan and they use this information to inform their physiotherapy practice.

Individuals who responded "yes" to using TUS in practice were asked to briefly state the role or roles of the modality in their practice and those who responded "no" were asked to comment on the anticipated or potential role or roles of TUS in their practice (Table 2).

As can be seen in Table 2, the most common roles of TUS in practice were to enhance the ability to differentially diagnose respiratory pathologies, to aid respiratory assessment and to use the information to support clinical reasoning. It would also appear to have a role guiding weaning, diaphragm function assessment and as an outcome measure to monitor pathology or disease changes with this cohort of questionnaire responders.

Table 2 also shows a wider range of responses to the potential uses of TUS with the top six responses

Table 1. Number of questionnaires completed from both distribution methods.

Questionnaire distribution method	Number of questionnaires completed
Combined from the three study days	60
ACPRC newsletter link to SurveyMonkey™	73
Total number completed	133

Table 2. Summary of responses from all participants divided into those who do ($n = 31$) and those that do not ($n = 101$) use thoracic ultrasound when asked to briefly state both the role and potential role of the modality in their future practice (N.B. One individual left this question blank).

Role of thoracic ultrasound	No. reporting this role ($n = 31$)	No. reporting this potential role ($n = 101$)
Enhanced differential diagnosis	15	55
Aid respiratory assessment	10	20
Aid clinical reasoning	9	34
Weaning guidance (from mechanical ventilation)	6	7
Diaphragm function	5	13
Monitoring tool/outcome measure	4	25
Lung ultrasound score	1	–
In research	1	4
Imaging obtained faster	1	7
Real-time imaging	1	3
In multi-disciplinary team discussions	1	1
Unsure	–	7
Guiding non-invasive ventilation	–	3
Reduce imaging radiation exposure	–	2
In teaching	–	2
Dysfunctional breathing	–	2
Compensate for physiotherapist hearing loss	–	1
Degree of secretions	–	1

(continued)

Table 2. Continued.

Role of thoracic ultrasound	No. reporting this role ($n=31$)	No. reporting this potential role ($n=101$)
Post-operative pulmonary complications	–	1
Biofeedback	–	1
Image at the bedside	–	1
Serial scanning	–	1

remaining the same as those who use TUS in practice albeit in a slightly different order. All but one of the remaining responses appears to be within the clinical capabilities of TUS. The one response stating that TUS could be used to "identify the degree of secretions" is currently beyond the known clinical ability of TUS.

Question 2: Have you undertaken any training in TUS imaging?

Of the 133 respondents, 58 (44%) reported that they had undertaken training in TUS imaging and 75 (56%) reported that they had not. Four individuals stated they used TUS in practice but also replied they had not had any training. Of the 58 who reported having had training in TUS, 31 reported they do not use it in clinical practice.

The 58 individuals who had reported undertaking training in TUS were asked to briefly state the methods and duration of the training. Fifty-two participants had undertaken a formal introductory TUS course which typically consisted of ultrasound physics, machine setup and practical scanning sessions. Only 10 had progressed from the introductory course and gone on to complete further formal assessment of competency. Typically, this formal assessed education comprises of supervised then independent scanning followed by a viva or triggered assessment to achieve accreditation. Informal clinical observation and attendance at a lecture on TUS were other methods of TUS training reported (Table 3).

The 75 who had not undertaken any TUS training were asked what method and format would they prefer for any future training (Table 4). Almost half reported wanting training that included "hands-on" practice. Attendance at a study day or course was reported as a popular option along with the delivery of face-to-face lectures. Potential TUS trainees also reported the desire to have on-line learning material and access to clinical supervision. Only seven mentioned wanting to complete a formal assessment of competency and three wanting that competency to be assessed over time.

Table 3. Education methods reported by questionnaire participants who answered "yes" to question 2.

Method of thoracic ultrasound training	No. reporting this method
One hour lecture	2
Informal education (Clinical observation)	4
Formal introductory course only (one or two days) (Theory and practical sessions)	42
Formal assessed education (Introductory course, supervision and assessment)	10
Total ($n=58$)	58

Table 4. Preferred education methods reported by questionnaire participants who answered "no" to question 2.

Preferred method of thoracic ultrasound training	No. reporting this method
Practical "hands-on" session	37
Study day/course	28
Lectures	25
E-learning/on-line/distance learning	20
Clinical supervision	20
Formal assessment of competency	7
Case studies	6
CPD/maintenance of competency	3
Blank response	6
Unsure	1

CPD: continuous professional development; E-learning: electronic learning.

Question 3: Have any factors influenced your ability to use TUS imaging in clinical practice?

There were over 200 individual responses from the 133 returned questionnaires. Twenty four (18%) respondents left Question 3 blank with a further four reporting "None," "nil" or "no" to the question. The responses were divided into positive and negative factors. Due to the wording of some responses, it was not possible to interpret whether the response was referring to a positive of negative factor, so these responses were categorised as "unclear."

Table 5 shows the identified factors that have influenced all questionnaire respondents' ability to use TUS. The most common factors identified in order of frequency were "team support," "availability or cost of a machine," "time pressures," "availability of a mentor," "understanding of, or evidence to support its use" and "availability or cost of training." The majority of responses for all factors were predominantly negative with the exception of "team support" which was more evenly balanced. "Time pressure," "availability or cost of training" and "governance" were factors that were reported as almost exclusively negative.

Table 5 also shows the factors identified, however, the responses have been divided into those who do and do not use TUS in clinical practice. Factors that negatively affect clinicians who report using TUS in practice were "time pressures," "availability of a mentor" and "availability or cost of a machine". Whereas respondents who report not using TUS in clinical practice find the same issues as above with additional negative factors around the "availability or cost of training", a lack of "understanding of, or evidence to support its use" and a lack of "team support."

Discussion

Ultrasound is not commonly used as part of a respiratory physiotherapist's clinical practice, although it is gaining recognition as a potential respiratory assessment and outcome tool within the profession.[3] The accuracy of TUS to differentiate between many common pulmonary pathologies[1] makes it an attractive

Table 5. Factors identified that have influenced all questionnaire respondents' ability to use thoracic ultrasound.

	Report using TUS in clinical practice			Report NOT using TUS in clinical practice			
Factors identified	Positive	Negative	Unclear	Positive	Negative	Unclear	Total
Team support (Management/medical/therapy)	8	6	1	6	13	11	45
Availability or cost of a machine	3	9	1	2	15	7	37
Time pressure	0	13	0	0	19	3	35
Availability of a mentor	2	10	0	1	14	1	28
Understanding of, or evidence to support its use	2	4	0	4	14	2	26
Availability or cost of training	0	2	0	0	17	0	19
Personal attitude i.e. "confidence"	0	1	1	2	5	2	11
Governance	0	2	0	0	3	1	6
"None", "nil" or "no"	–	–	2	–	–	2	4
Total	15	47	5	15	100	29	211
Blank	–	–	–	–	–	–	24

Note: Responses divided into those who do and do not use TUS in clinical practice.
TUS: thoracic ultrasound.

addition to any respiratory physiotherapists skill set but it is currently unclear how this novel modality is being used in practice or how respiratory physiotherapists are learning to perform TUS. To the authors' knowledge, this is the first national questionnaire looking at how respiratory physiotherapists are training and subsequently using TUS and what factors are potentially influencing the implementation of TUS into clinical practice.

Almost a quarter of participants reported they used TUS in their clinical practice which is much higher than the authors expected considering it is a new modality for respiratory physiotherapists. This high response rate could have been influenced by the questionnaire ''snowballing'' sampling method. It remains unclear from the responses whether the ''use'' of TUS in clinical practice includes those at differing stages of their TUS training or that they use TUS in a fully independent capacity. Unless specifically stated, as in the two examples where participants report utilising the results of TUS performed by other professions, this questionnaire cannot separate out clinicians who fully acquire, interpret and integrate TUS into their clinical reasoning from those who utilise just one aspect of the scanning process.

The summary of the role of TUS from participants who use the modality in their clinical practice can be found in Table 2. Out of a total of 11 roles, the 2 highest roles reported where to enhance differential diagnosis and to aid respiratory assessment. These uses are both supported by systematic reviews by Winkler et al.[1] on critical care, Chavaz et al.[8] in pneumonia and Wang et al.[9] in pulmonary oedema. Accurate assessment of respiratory pathologies and the ability to differentially diagnose is paramount when dealing with a dynamic organ such as the lung whose condition, and therefore function, can change minute to minute. This being the case, it is apparent from the responses in Table 2 that there is a need for a greater evidence base and more dissemination of the clinical advantages of TUS.

Through aiding respiratory assessment and enhancing differential diagnosis, TUS can also potentially aid clinical reasoning which is the third role reported by participants. The exact effect of how TUS can impact respiratory physiotherapy clinical reasoning has not been explored yet but the authors are aware of at least two ongoing studies into this area. Weaning (from mechanical ventilation) guidance is reported six times and diaphragm function five times (Table 2). These are currently a popular area of combined research and have been the topic for three recent systematic reviews by Llamas-Álvarez et al.,[10] Zambon et al.[11] and Li et al.[12] It would appear that some measures of diaphragm function such as excursion is not recommended and others such as thickening fraction are only modest predictors of weaning success.

The sixth use of TUS as a method to monitor outcomes or as an outcome measure for respiratory physiotherapists has not been established within the literature to date (Table 2). It does make sense that the enhanced assessment and diagnostic abilities of TUS could also be utilised to reassess after an intervention or treatment and therefore be used as a method to monitor changes in those pathologies or conditions over time. More research into the effectiveness of this use is required.

Participants who do not use TUS in their clinical practice reported a much more diverse range of 21 potential roles of TUS. All roles reported by TUS users except one, the ''lung ultrasound score,'' were also reported by participants that do not use TUS in clinical practice. This seems to imply that despite not using TUS clinically most of the participants in this survey had a clear and accurate understanding of what TUS could offer their practice. All responses in Table 2, besides the seven that responded ''unsure,'' show a realistic and positive expectation of how TUS could be integrated into respiratory physiotherapy practice. The only response that, in the authors opinion, does not appear to be a potential role of TUS is to ''identify the degree of secretions.'' Most of the responses in Table 2 are already known roles of TUS from the medical literature, i.e. ''in teaching,'' ''biofeedback'' and ''serial-scanning'' but others, such as ''guiding Non-Invasive Ventilation,'' ''dysfunctional breathing'' and with ''post-operative pulmonary complications (PPC),'' warrant further investigation to ascertain the effectiveness of TUS in these roles.

Training opportunities in the UK remain limited for those without a General Medical Council (GMC) number such as respiratory physiotherapists but there are opportunities starting to emerge as national programmes continue to develop.[13] The previously mentioned CUSIC programme from the UK has been adapted to allow all allied health professionals, not just respiratory physiotherapists, to access its training in recent years. This could be one factor that has prompted respiratory physiotherapists to become more aware of the role of TUS in the questionnaire responses now that respiratory physiotherapists have a means to access training and a route to achieve TUS accreditation.

The most effective method of training clinicians in TUS is another popular topic within the literature that has been amalgamated in the systematic review by Pietersen et al.[14] It must be noted that when responding to the question regarding their preferred methods of training, participants did not have structured responses

and would not have necessarily been aware of what training methods were available, possible, preferable, required or even evidenced based. Their responses express a preference and should be considered but the structure of future training should also be based on the best available evidence.

The majority of participants who had some form of training in TUS reported attendance on an introductory TUS course (Table 3). A further 10 participants reported progressing onto more formal assessed training. The exact content of these courses was not captured but would be worth investigating in further depth. More detail was given by respondents to the preferred methods of training (Table 4). The preference seems to be reported as a condensed training course (i.e. one to two days) containing both lecture and practical sessions. Popular responses were on-line e-learning material provided prior to the course followed by ongoing clinical supervision from a mentor on return to the clinical setting.

When looking at the methods of TUS training reported and the preferred methods reported by participants compared to the evidence, there are some similarities. Despite Pietersen et al.[14] concluding that there is no compelling body of evidence supporting one method of learning TUS over another in their systematic review, they did find that all training courses in their selected studies showed progress in theoretical and practical skills regardless of the method used. Pietersen et al.[14] went on to highlight a ''three-step mastery-learning approach'' to cover the following:

1. Theoretical knowledge through classroom or web-based education.
2. Focused hands-on sessions on simulators or healthy subjects.
3. Supervised scanning of real patients with feedback from a trained mentor until ready for independent practice.

All but one of the studies included in the Pietersen et al.[14] systematic review were published after the seminal paper by an expert round table on ultrasound in intensive care unit entitled ''International expert statement on training standards for critical care ultrasonography.''[15] The expert statement recommended that theoretical training should be given in both a standard lecture format and internet-based learning, should include hands-on training with normal volunteers and utilise a locally qualified mentor until competency has been acquired. As it transpires the preferences expressed by the participants (Table 5), the recommendations from the Pietersen et al.[14] systematic review and the expert statement[15] all share some common core training themes.

The factors identified that have influenced all questionnaire respondents' ability to use TUS (Table 5) lean heavily towards the negative by almost a ratio of 5 to 1. Time pressures and the availability of both machines and mentors are listed as significant barriers to TUS use. These significant factors could be considered the ''Big 3 barriers'' to TUS use as they account for over half of the reported negative factors. These barriers are common amongst other professional groups when learning to perform ultrasound. Similar barriers are found in other disciplines of physiotherapy, podiatry and medicine not only in the UK but across Europe and globally. Siddle et al.[16] report a lack of mentors for podiatrists when learning ultrasound which is echoed by not only Innes[7] and Potter et al.[17] within the musculoskeletal physiotherapy profession but also Galarza et al.[18] within intensive care medicine across Europe and Peh et al.[19] within internal medicine in Singapore. Ellis et al.[20] surveyed 433 physiotherapists in New Zealand with respondents highlighting that a lack of training opportunities, machines and time as being particular barriers to delivering high quality ultrasound. Again, this was found by Innes[7] within UK physiotherapists and Peh et al.[19] in internal medicine in Singapore. Having insufficient time to train in TUS remains a vague term and further in-depth exploration of this may reveal further specific strategies to overcome this barrier. The lack of availability of a mentor for respiratory physiotherapists to support them through their training will remain a challenge until the number of mentors within the UK increases further. Indications are that this is beginning to occur according to the CUSIC mentor database.[21] Much like the lack of access to mentors, the barrier ''availability or cost of a machine'' will remain a challenge until investment in and access to ultrasound hardware is commonplace.

Despite 58 participants reporting having had training in TUS, 31 (53%) of them report they do not use the modality in clinical practice. Some of these responses could be due to the participants having started TUS training but not yet achieved accreditation but others may have encountered factors that have inhibited their progression toward accreditation. Other barriers to consider are ''governance,'' ''evidence to support its (TUS) use'' and the ''availability of a machine.'' The barrier around ''evidence to support its use'' is an indication that research individuals and research funders should consider exploring the effect respiratory physiotherapists trained in TUS could have on patient outcome efficacy and societal efficacy.[22] This evidence could guide the amount or degree of investment in respiratory physiotherapists training in TUS.

Governance as a barrier to TUS use constitutes a very broad range of topics. In the authors' experience, concerns raised by therapy managers, clinical managers and individual clinicians typically revolve around scope of practice, regulation and education. Two of the authors (SH and MS) have recently published a framework covering these issues for respiratory physiotherapists within the UK as a reference document.[23] There still may be other governance issues not addressed by this framework, so more in-depth exploration of this area should be considered.

Factors identified that have influenced all questionnaire respondents' ability to use TUS once divided into those who do and do not use TUS in clinical practice seem to have the common "Big 3 barriers" of "time pressures," "availability of a mentor" and "availability or cost of a machine" but also additional factors such as "availability or cost of training," a lack of "understanding of, or evidence to support its use" and a lack of "team support" (Table 5). These latter three barriers are factors that with further planning and investment could more easily be overcome. Training opportunities, as mentioned previously, are beginning to develop within the UK. As for a lack of "understanding of, or evidence to support its use" and a lack of "team support," this appears to be an issue around educating senior managers and clinicians around the benefits of respiratory physiotherapy initiated TUS. Governance frameworks and professional society statements could also help clinicians to overcome these barriers.

Limitations and strengths

Limitations of this study are a relatively low number of responses and that it was difficult to categorise, into either a positive or negative factor, the free text responses to question 3. Future studies could look at the setting and clinical roles of future respondents to ascertain how the adoption of TUS is developing across the healthcare sector.

The questionnaire had the strength of brevity by only having three questions with two of these including close questions. This structure facilitated the ease of use and therefore increased the response rate (online Appendix 1).

Conclusions

This nationwide survey has, for the first time, provided an understanding of the scope of TUS practice amongst respiratory physiotherapists in the UK. The survey results demonstrated the limited training that underpins current practice and highlighted the requirements for mentorship to support professional progression. These findings will continue to underpin the development of competencies and recommendations defined by the Chartered Society of Physiotherapists, to support professional development and ensure safe practice of TUS in the UK.

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Ethics Approval

Blackpool Teaching Hospital NHS Foundation Trusts Research and Development department confirmed that National Research Ethical approval was not required on 11 June 2018. A letter stating this has been included in this submission.

Guarantor

Simon Hayward.

Contributors

Mike Smith and Sue Innes both contributed to the development of the project and were significantly involved in the drafting of the article and revising it. Both have given final approval of the version to be published.

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