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MAIN ARTICLE

Otolaryngologist-performed head and neck ultrasound: outcomes and challenges in learning the technique

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Abstract

Objective: To assess the feasibility and accuracy of otolaryngologist-performed ultrasound in evaluating head and neck pathology.

Method: An ENT trainee, who had undergone basic training in neck ultrasonography, performed this on patients referred with suspected neck pathology. The trainee recorded the presence and nature of any abnormality. Findings were compared with those from a repeated scan performed by an experienced head and neck radiologist.

Results: The study included 250 patients. The absence or presence of lesion as reported by the trainee correlated with the radiologist's findings in 207 cases (83 per cent). There were 144 true positives, 63 true negatives, 32 false negatives and 11 false positives, yielding a sensitivity of 82 per cent, specificity of 85 per cent and accuracy of 83 per cent. Of the 144 true positive lesions, 81 per cent were interpreted concordantly with the radiologist.

Conclusion: Neck ultrasonography performed by an otolaryngologist is less accurate than that performed by an experienced radiologist, but is still a useful adjunct to clinical assessment, facilitating assessment in a 'one-stop' clinical setting.

Key words: Ultrasonography; Neck; Abnormalities; Otolaryngology

Introduction

Ultrasound is a valuable diagnostic tool used in many areas of medicine. It has been described as quick, portable, non-invasive and cost effective, and does not involve ionising radiation.[1–3] In mainland Europe, it is almost the exception for the radiologist rather than the clinician to perform ultrasound in some specialties. However, in the UK, with the exception of obstetric ultrasound, radiologists and radiographically trained sonographers have traditionally provided a service from centralised departments of radiology, where equipment and manpower can be concentrated cost-effectively.

There are increasing demands for other medical specialists to utilise ultrasound as a direct adjunct to clinical examination, and in some specialties it is becoming an integral part of the physician's diagnostic armamentarium and training. This trend is likely to be exacerbated by the increase in referrals and shortage of radiologists.[4] A recent survey distributed by ENT UK discussed the prospects and usefulness of British otolaryngologists learning this skill. Additionally, there is a demand by some European training boards to incorporate ultrasound into clinical training and accreditation. The Royal College of Radiologists recognises that it is appropriate for medical practitioners other than clinical radiologists to develop skills in ultrasound.[5]

The role of head and neck ultrasound performed by the ENT clinician, and the ability of the clinician to carry out the ultrasound and accurately interpret the findings, have not been investigated. This prospective study essentially describes the learning process of an ENT trainee with no previous specialist imaging experience, in acquiring neck ultrasound skills.

Materials and methods

Training

An ENT trainee attended head and neck ultrasound sessions in the radiological ultrasound department of a large teaching hospital for 12 months. A well-established 2-day practical ultrasound course (The Head and Neck Ultrasound Workshop, Morriston Hospital, Swansea) provided a basic introduction. Thereafter, the trainee attended several sessions with one of the course faculty members, observing neck ultrasound examinations. Informal tutorials covered physics and

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instrumentation, and ultrasound anatomy of the neck. Early practical experience was gained by practising on normal volunteer colleagues.

Following this induction, the trainee worked alongside a consultant radiologist with over two decades of experience in head and neck ultrasound (LB). This consultant radiologist works closely with all clinical departments at our centre, including surgery, endocrinology and oncology, helping with the management of patients. Ultrasound sessions included a weekly dedicated 'head and neck lump' clinic. These sessions include patients with no palpable mass, which typically involves a search for an undiagnosed parathyroid lesion in a patient with hypercalcaemia. This arrangement afforded the trainee one-to-one mentorship.

Following the studies of normal volunteers, the second stage of the learning process involved 50 ultrasound examinations of clinical referrals observed by the radiologist. All examinations were repeated by the radiologist who provided immediate feedback to the trainee. These 50 examinations were excluded from the final analysis of the 250 cases that comprise the current study. If any aspect of the trainee's examination was considered technically suboptimal, and where time constraints permitted, the scan was repeated by the ENT trainee following the radiologist's study.

Learning objectives included the identification of variations in normal neck structures and anatomical relationships, the recognition of any deviation from normal, and correct interpretation of an abnormality. A systematic approach to examination was emphasised. This included comprehensive scanning of neck anatomical triangles, comparing both sides of the neck, and use of Doppler ultrasound where appropriate. Teaching included advanced use of the machine controls, to a much higher level than usually achieved by practitioners other than radiologists or sonographers.

Main study

After the induction and training period described above, the trainee undertook examinations on patients referred to the neck ultrasound clinic. The trainee's study and conclusion was compared with the examination and conclusion of the radiologist. The 'gold standard' was taken to be the radiologist's report rather than eventual surgical or histological diagnosis if biopsy or surgery was undertaken.

Examinations were performed with Toshiba Aplio XG ultrasound apparatus (Toshiba Medical Systems, Crawley, UK) using appropriate high-frequency linear array transducers. All patients referred with palpable neck masses were included. Scans were undertaken with the patient in a semi-recumbent position with neck extension.

Following the scan, the trainee completed a proforma, on which the trainee indicated the presence or absence of a lesion, and commented on its nature and significance. If the lesion was considered indeterminate, the most likely diagnosis was described. Minor findings (e.g. reactive lymph nodes) were considered as lesions and were included in our analysis. The radiologist repeated the study and completed a similar proforma. It was not possible to blind the radiologist to the ultrasound findings described by the trainee because of time constraints and the evaluation process: as part of the evaluation, the radiologist scrutinised, and, if necessary, criticised and corrected the trainee's scanning technique.

TABLE I
OUTCOME CATEGORIES AND DEFINITIONS

Category	Definition
True negative	No lesion is detected by trainee or radiologist; patient is reassured on same visit
True positive	Lesion is detected by both trainee & radiologist; trainee is asked to interpret nature of lesion
False negative	Lesion is not detected (i.e. is missed) by trainee but is detected by radiologist
False positive	Lesion is 'detected' by trainee but not radiologist; typically a normal structure misinterpreted as pathological
Misinterpretation	Lesion is detected by both trainee & radiologist (i.e. true positive), but nature of lesion is misinterpreted by trainee

Anonymised data were entered into a database. Results were placed in one of five categories (Table I): true negative (normal study), true positive (abnormal study), false negative (missed abnormality), false positive (normal study misinterpreted as abnormal), and misinterpretation (abnormality detected, but the nature or significance misinterpreted). There were therefore two aspects to the trainee's assessment. Firstly, identifying whether an abnormality was present, and secondly correctly interpreting any abnormal findings.

Results

A total of 250 consecutive patients with suspected head and neck masses who attended over a 12-month period were included in the study. The median patient age was 50 years, with a male to female ratio of 1:1.7. The range of clinically suspected pathologies at the time of referral is shown in Table II.

Scans performed by the trainee indicated a positive finding in 155 patients. The findings of radiological repeat examinations concurred with the trainee's study in 144 examinations (true positives). Eleven of

TABLE II
SUSPECTED PATHOLOGY

Diagnosis on referral	Patients (*n* (%))
Anterior triangle lump	72 (29)
Posterior triangle lump	26 (10)
Thyroid	60 (24)
Parotid	37 (15)
Submandibular or submental	37 (15)
Parathyroid	18 (7)
Total	250 (100)

TABLE III
TRAINEE FALSE POSITIVE RESULTS*

Pathology	Trainee's misinterpretation	Radiologist's correct impression	Normal structure misinterpreted as pathological
Thyroid	Thyroiditis	Normal	Normal thyroid gland but thickened isthmus
Thyroid	Thyroid nodule	Normal	Normal heterogeneous thyroid gland
Parathyroid	Adenoma	No adenoma	Normal section in lower thyroid lobe
Parathyroid	Adenoma	No adenoma	Normal section in oesophagus
Submandibular†	Stone	Normal	Normal section in hyoid bone
Submandibular	Dilated duct	Normal	Normal section in mylohyoid muscle
Submandibular	Dilated duct	Normal	Normal section in blood vessel
Submandibular	Impinging ranula (mylohyoid defect)	Normal	Normal section in blood vessel passing through mylohyoid
Anterior triangle†	LN	Normal	Normal section in SCM

*11 patients. †$n = 2$. LN = lymph node; SCM = sternocleidomastoid muscle

the trainee's 155 'positive' findings were considered normal by the radiologist and were therefore deemed to be false positives (Table III).

The trainee examination indicated a negative finding in 95 patients. The radiologist's repeat examination indicated normal findings in 63 patients (true negatives). Therefore, according to the radiologist gold standard, the trainee missed abnormalities in 32 (34 per cent) of the abnormal scans (false negatives). These abnormalities included palpable and impalpable neck masses (Tables IV and V).

Of the trainee's 144 true positives, the trainee's interpretation of the lesion was concordant with that of the radiologist in 117 (81 per cent) of the abnormal scans. The trainee's interpretation of detected pathology was considered a misinterpretation in 28 cases (19 per cent of all abnormal scans) (Table VI).

Using the radiological opinion as a gold standard, the overall figures for sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the trainee examinations were: 82, 85, 93, 67 and 83 per cent, respectively.

Of all the 250 examinations, we were able to reassure 127 patients by excluding serious pathology (50 patients) or excluding any lesion (77 patients). Only 16 patients required biopsies, of which 10 proved to be malignant. Of the 16 patients that underwent biopsy, the trainee failed to detect 1 malignant lesion (false negative) and misinterpreted 4 malignant lesions as benign (interpretive error).

Although it was not the purpose of this study to evaluate the use of ultrasound in expert hands, with a minimum follow-up period of two years, none of the patients have re-attended with a significant lesion.

Discussion

This is the first study to describe the process of an ENT trainee undertaking structured training in neck ultrasound. Head and neck ultrasound is difficult, and fraught with pitfalls. Nevertheless, the radiologist in this study (LB) has trained numerous radiologists to a level consistent with non-specialist general radiology practice. The experience required to define or interpret some lesions may be measured in years rather than months, and this would apply equally to a radiologist or sonographer learning head and neck ultrasound.

Surgeon-performed neck ultrasound is infrequently discussed in the literature, with most reports describing the value of peri-operative localisation of parathyroid lesions in shortening operation time.[6–8] Other studies focused on the advantage of clinic-based ultrasound in changing decisions about operative management of thyroid disease when compared to scans performed by a conventional ultrasound practitioner before the clinic visit.[9] Spurious lesions are frequent in head and neck ultrasound (Table III), commonly the result

TABLE IV
TRAINEE FALSE NEGATIVES: PALPABLE LUMPS*

Pathology	Lesion missed by trainee	Source of error
Submandibular	Stone	Scanning too quick
Submandibular	Sublingual ranula herniate thought mylohyoid muscle	Trainee considered ranula a normal structure (muscle)
Parotid†	Lipoma	Controls set to a deeper level‡
Parotid	Sebaceous cyst	Controls set to a deeper level‡
Parotid	Duct stricture with sialectasis	No comparison made to contralateral side (wider lumen)
Thyroid	Solid colloid inside large thyroid cyst	Failure to scan entire cyst
Anterior neck	Level III LN	Distraction by incidental adjacent thyroid nodule
Anterior neck	Prominent transverse process of vertebrae	Inadequate knowledge of US features of a bony structure**
Posterior triangle	Thrombosed blood vessel	Doppler scan was not used

*10 patients. †$n = 2$. ‡Lesion was in superficial skin layers. **Appears as white line as it reflects sound. LN = lymph node; US = ultrasound

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TABLE V
TRAINEE FALSE NEGATIVES: IMPALPABLE LUMPS*

Pathology	Lesion missed by trainee	Source of error
Parathyroid†	Parathyroid adenoma	Failure to adjust image to correct depth, or lesion considered a normal structure
Submandibular‡	Ranula	Lesion considered a normal structure (muscle)
Thyroid**	Thyroid nodule	Incomplete scanning
Parotid**	LN	Area scanned too quickly, or some areas missed
Anterior neck‡	LN (1 malignant)	Unaware of need to actively search around IJV (where LNs often exist)
Anterior neck	Thyroglossal cyst	Failure to adjust magnification (so cyst appeared too small)
Anterior neck	Normal thyroid tissue (laryngectomised)	Inadequate knowledge of US features of normal thyroid tissue
Anterior neck‡	Lipoma	Failure to adjust image to correct depth
Anterior neck	Calcified thyroid cartilage	Failure to apply sufficient coupling gel

*23 patients. †$n = 8$; ‡$n = 2$; **$n = 3$. LN = lymph node; IJV = internal jugular vein; US = ultrasound

of a misinterpretation of a normal neck structure. This more likely occurs at an early stage, before the trainee becomes familiar with the radiological anatomy of the neck. Bony structures such as the hyoid or prominent transverse processes of vertebrae can simulate macrocalcification in a lesion or a calculus in Wharton's duct. A blood vessel can be confused with a duct, but this distinction can usually be made by skilled Doppler ultrasound technique.

The process of palpation before the scan does not necessarily facilitate the ultrasound study. Table IV comprises 10 cases where the ENT trainee suspected a definite palpable abnormality prior to performing the ultrasound study, yet nevertheless went on to miss the abnormality on the scan. The ultrasound study may need to go beyond confirming the organ of origin of a positive palpation finding. An example of this is the quest for a calculus following the identification of a sialectatic salivary gland or duct. It may be important to further characterise a lesion; for example, defining a solid component that may require a biopsy within an otherwise cystic lesion. Extremely superficial lesions such as lipomas or sebaceous cysts may easily be overlooked if the focus of the ultrasound apparatus is suboptimal or too much pressure is applied to the ultrasound transducer.

It is notable that false negative results and misinterpretations on the part of the trainee were the most frequent types of errors (Tables V and VI). We regard this as a constructive rather than a discouraging learning outcome, as we will continue to develop this skill. It is likely that many of these errors would have been made by radiologically qualified practitioners less experienced than the gold standard radiologist of the current study. We analysed the trend of our false negative results by equally dividing the total number of examinations into five consecutive blocks. Interestingly, most errors occurred at the initial stages; the learning curve showed subsequent improvement (10 of the 32 missed lesions occurred in the first 50 examinations, and this figure was reduced to 8, 6, 6 and 2 in subsequent blocks). Individual readers of this study will decide

TABLE VI
TRAINEE MISINTERPRETATIONS*

Pathology	Trainee's misinterpretation	Radiologist's correct impression	Source of misinterpretation
Thyroid (7)	Malignant nodule (5), benign nodule (2)	Benign nodule (5), malignant nodule (2)	Inadequate knowledge of pathological features of thyroid nodules
Thyroid	Paratracheal LN	Thyroid nodule	Location of lesion close to trachea
Parathyroid	Parathyroid lesion	Paratracheal LN	Location of lesion deep to thyroid gland
Parotid (3)	Pleomorphic (3)	Metastasis (2), Warthin's tumour (1)	Inadequate knowledge of pathological features of parotid lesions
Submandibular (4)	Stone (2), LN (2)	LN (2), stone (2)	Whitish hilum (i.e. hyperechoic) of LN, so confused with stone
Submandibular (2)	Malignant	Sialectasis	Inadequate knowledge of pathological features of submandibular gland
Anterior triangle	Thyroid malignancy	Level IV LN malignancy	Loss of LN structure
Anterior triangle	Thyroglossal cyst	LN	Location of LN near hyoid bone
Anterior triangle (5)	Malignant LN (4), reactive LN (1)	Reactive LN (4), malignant LN (1)	Inadequate knowledge of pathological features of LN
Anterior triangle	LN	CBT	Failure to recognise lesion at bifurcation of carotid (typical of CBT)
Anterior triangle	Branchial cyst	Haematoma	Failure to recognise lesion is solid, not cystic (even when non-vascular)
Posterior triangle	Lipoma	Synovial cyst	Failure to recognise origin of lesion (sternoclavicular joint)

Numbers in parentheses represent number of lesions. *28 patients. LN = lymph node; CBT = carotid body tumour

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whether this is acceptable following a regime of training that is unlikely to be equalled or surpassed in other centres. The subjective impression of the radiologist participating in this study is that the level of the ENT trainee's ability surpasses that of general radiology trainees.

The use of ultrasound is expanding rapidly in the emergency room, surgical ward and critical care unit, and more recently in office practice.[6,10–15] The impetus driving this trend may sometimes be suspect, and will vary between differing medical cultures such as private fee-for-item practice as opposed to a British model of salaried public health provision. A catalogue of objections to clinician-based ultrasound frequently raised by radiologists has included: access to an ultrasound machine, medicolegal liability, lack of specific training and fear of lost revenue.[11,16,17] The policy adopted by the Royal College of Radiologists is that it is appropriate for practitioners other than clinical radiologists to seek to develop skills in the performance of ultrasound.[5,18]

There is growing literature to suggest that clinicians with limited experience in radiology can perform niche ultrasound examinations at a level comparable to radiologists. Specific studies have included the gall bladder,[19] breast,[13] parathyroid gland,[6] joints,[10] emergency hepatobiliary pathology,[14] general trauma,[15] and chest in both critical care and trauma settings.[12,20] Similarly, radiographers performed well when they were adequately trained.[21] Ultrasound has been shown to be a more sensitive technique than clinical evaluation in certain conditions and has been recommended as an extension to physical examination.[9,12,22] A further advantage of office-based ultrasound is that it allows clinical and imaging assessment at a single visit.[23]

Ultrasound teaching programmes for surgeons have been established for decades in mainland Europe, as pioneered at the University of Göttingen in 1982. Subsequently, the German Association of Surgery began requiring experience and competence in ultrasound for certification in general surgery, orthopaedics and urology.[11] In 1996, the American College of Surgeons launched an educational programme to train surgeons on the use of this technology, supported by interested surgical societies and professional bodies.[17,24–26] The American Board of Surgery advocates that surgeons 'have the opportunity to gain a working knowledge of ultrasonography of the head and neck, breast, abdomen, and endorectal ultrasound'.[27] Residents in the US are expected to complete a basic ultrasound course.[2,15,28]

There are many specialties (obstetrics and gynaecology, cardiology, emergency medicine, urology, and family practice) where ultrasound skills are included in the training, and model curricula have been developed.[29] Similarly, a robust training model exists for radiographically qualified ultrasonographers, which is delivered in a relatively short timescale.[4] The Royal College of Radiologists stated that radiologists have the background to provide guidelines for the training of medical non-radiologists, which should be to the same standard as those for radiologists, albeit restricted to the relevant area of their clinical expertise.[5] They proposed three levels of minimum training requirement, ranging from the ability to recognise normal anatomy, to performing specialised examinations and interventions. This is consistent with the minimum requirements of the European Federation of Societies for Ultrasound in Medicine and Biology.[5]

Many criteria would need to be met before the experience of the current authors could be extrapolated. Ultrasound training requires a motivated ENT trainee, and a dedicated head and neck radiologist with relevant ultrasound expertise. Short courses are adequate as an introduction, but adequate one-to-one training more than doubles the time taken for each patient ultrasound study. Additionally, there may be competing radiology trainees in a teaching radiology department, and it would be impractical to train more than one person on each patient.

- **Ultrasound is a valuable diagnostic tool used in many areas of medicine including ENT**
- **Provision of ultrasound service by clinicians other than radiologists has gained wide acceptance in USA and Europe, but less in UK**
- **A recent survey published by ENT UK discussed the prospects of otolaryngologist-performed neck ultrasound as a diagnostic tool**
- **This study reports the unique experience, outcomes and lessons of an ENT trainee learning this technique**
- **Although trainee results were less favourable compared with an experienced head and neck radiologist, improvements were steady**
- **We regard this as a constructive learning outcome and will continue to develop this skill**

Specific training and a range of supervised examinations have been suggested before a non-radiologist can be considered competent and credentialled to perform ultrasound. The number of necessary examinations before applying for certification can be between 50 and 400. This wide range probably reflects the individual variation in aptitude and the varying complexity of different organ systems.[5,24,29–31] Some studies have been hyperbolically optimistic about the length of training. In a study evaluating surgeon-performed ultrasound in trauma patients, it was demonstrated that with only 8 hours of didactic and hands-on training, surgeons could acquire the necessary skills to obtain and interpret ultrasound images to accurately detect haemoperitoneum.[17] The radiologist author of the current study (LB) is sceptical about much of this literature and would disregard studies where there has not been participation of a skilled radiologist.

The National Ultrasound Steering Group (a subgroup of the National Imaging Board in the UK) recommends the establishment of a Clinical Governance Board for all providers of ultrasound imaging services that includes a clinical lead for each department using ultrasound.[3] Quality assurance is emphasised with regard to maintaining professional standards equivalent to those issued by the General Medical Council, the latter of which recommends that doctors recognise and work within the limits of their competence. The Royal College of Radiologists states that National Health Service trusts in the UK are unlikely to be able to mount any defence to an action brought against an untrained practitioner.[5]

In this series, we describe a unique one-to-one training process in neck ultrasound. We consider this model the gold standard for any ENT trainee attempting to learn this technique, as it allows close supervision and input by the radiologist. Although it might look labour intensive to some readers, the process becomes less demanding as skills are learned. Following our study period, the department acquired an ultrasound machine and the radiologist joined our one-stop neck lump clinic, which improved our partnership and made the training more streamlined.

Conclusion

This study evaluated a one-to-one training model of neck ultrasound for an ENT trainee. We identified important learning outcomes and explored potential errors during the initial stages of training that we significantly improved. Neck ultrasound performed by an otolaryngologist, while less accurate than an experienced radiologist, is a useful adjunct to clinical assessment, and can facilitate assessment in a one-stop clinical setting. A close collaboration with the radiology department is a key element in learning this technique. This study can become a platform for the incorporation of ultrasound training in future ENT curricula. The authors consider that the overriding consideration for extending head and neck ultrasound skills beyond the radiology department should be the welfare and management of the patient, rather than the academic or financial competing interests of other professional groups.

References

1 Rozycki GS, Ochsner MG, Jaffin JH, Champion HR. Prospective evaluation of surgeons' use of ultrasound in the evaluation of trauma patients. *J Trauma* 1993;**34**:516–26
2 Rozycki GS, Feliciano DV, Schmidt JA, Cushman JG, Sisley AC, Ingram W *et al*. The role of surgeon-performed ultrasound in patients with possible cardiac wounds. *Ann Surg* 1996;**223**: 737–46
3 Ultrasound clinical governance (National Ultrasound Steering Group, 2008). In: http://www.bmus.org/policies-guides/ClinicalGovernanceInUltrasound-061108.pdf [22 March 2014]
4 Developing and Growing the Sonographer Workforce: Education and Training Needs (The Society and College of Radiographers, 2009). In: http://www.sor.org/learning/document-library/developing-and-growing-sonographer-workforce-education-and-training-needs [22 March 2014]
5 Ultrasound Training Recommendations for Medical and Surgical Specialties, 2nd edn (The Royal College of Radiologists, 2005). In: http://www.rcr.ac.uk/docs/radiology/pdf/BFCR(12)17_ultrasound_training.pdf [22 March 2014]
6 Jabiev AA, Lew JI, Solorzano CC. Surgeon-performed ultrasound: a single institution experience in parathyroid localization. *Surgery* 2009;**146**:569–75
7 Van Ginhoven TM, Morks AN, Schepers T, de Graaf PW, Smit PC. Surgeon-performed ultrasound as preoperative localization study in patients with primary hyperparathyroidism. *Eur Surg Res* 2011;**47**:70–4
8 Solorzano CC, Carneiro-Pla DM, Irvin GL. Surgeon-performed ultrasonography as the initial and only localizing study in sporadic primary hyperparathyroidism. *J Am Coll Surg* 2006;**202**: 18–24
9 Mazzaglia PJ. Surgeon-performed ultrasound in patients referred for thyroid disease improves patient care by minimizing performance of unnecessary procedures and optimizing surgical treatment. *World J Surg* 2010;**34**:1164–70
10 Iannotti JP, Ciccone J, Buss DD, Visotsky JL, Mascha E, Cotman K *et al*. Accuracy of office-based ultrasonography of the shoulder for the diagnosis of rotator cuff tears. *J Bone Joint Surg Am* 2005;**87**:1305–11
11 Yiengpruksawan A, Ganepola GP, Freeman HP. Extended applications of ultrasonography by the surgeon. A preliminary report. *Am J Surg* 1987;**153**:221–5
12 Rozycki GS, Pennington SD, Feliciano DV. Surgeon-performed ultrasound in the critical care setting: its use as an extension of the physical examination to detect pleural effusion. *J Trauma* 2001;**50**:636–42
13 Whitehouse PA, Baber Y, Brown G, Moskovic E, King DM, Gui GP. The use of ultrasound by breast surgeons in outpatients: an accurate extension of clinical diagnosis. *Eur J Surg Oncol* 2001;**27**:611–16
14 Kell MR, Aherne NJ, Coffey C, Power CP, Kirwan WO, Redmond HP. Emergency surgeon-performed hepatobiliary ultrasonography. *Br J Surg* 2002;**89**:1402–4
15 Buzzas GR, Kern SJ, Smith RS, Harrison PB, Helmer SD, Reed JA. A comparison of sonographic examinations for trauma performed by surgeons and radiologists. *J Trauma* 1998;**44**: 604–8
16 Filly RA. Ultrasound: the stethoscope of the future, alas. *Radiology* 1998;**167**:400
17 Staren ED, Knudson MM, Rozycki GS, Harness JK, Wherry DC, Shackford SR. An evaluation of the American College of Surgeons' ultrasound education program. *Am J Surg* 2006; **191**:489–96
18 Ultrasound training by radiology departments for other medical specialties: resource implications and requirements (The Royal College of Radiologists, 2007). In: http://www.rcr.ac.uk/docs/radiology/pdf/ultrasoundtraining.pdf [22 March 2014]
19 Fang R, Pilcher JA, Putnam AT, Smith T, Smith DL. Accuracy of surgeon-performed gallbladder ultrasound. *Am J Surg* 1999; **178**:475–9
20 Knudtson JL, Dort JM, Helmer SD, Smith RS. Surgeon-performed ultrasound for pneumothorax in the trauma suite. *J Trauma* 2004;**56**:527–30
21 Leslie A, Lockyer H, Virjee JP. Who should be performing routine abdominal ultrasound? A prospective double-blind study comparing the accuracy of radiologist and radiographer. *Clin Radiol* 2000;**55**:606–9
22 Chen SC, Lin FY, Hsieh YS, Chen WJ. Accuracy of ultrasonography in the diagnosis of peritonitis compared with the clinical impression of the surgeon. *Arch Surg* 2000;**135**:170–4
23 Rahman RL, Crawford S, Hall T, Bavosiet D, Quinlan R. Surgical-office-based versus radiology-referral-based breast ultrasonography: a comparison of efficiency, cost, and patient satisfaction. *J Am Coll Surg* 2008;**207**:763–6
24 American Society of Breast Surgeons. Breast Ultrasound Certification. In: https://www.breastsurgeons.org/new_layout/programs/certification/breast_ultrasound_certification.php [22 March 2014]
25 Rozychi GS, Strauch GO. Ultrasound for the general surgeon: an ACS initiative. *Bull Am Coll Surg* 1998;**83**:37–9

https://doi.org/10.1017/S0022215114000760 Published online by Cambridge University Press

26 Society of American Gastrointestinal and Endoscopic Surgeons. Guidelines for granting of ultrasonography privileges for surgeons. In: http://www.sages.org/publications/guidelines/guidelines-for-granting-of-ultrasonography-privileges-for-surgeons/ [22 March 2014]
27 Grosfield JL. American Board of Surgery. *Bull Am Coll Surg* 1996;**81**:57–60
28 Rozychi GS. Surgeon-performed ultrasound: its use in clinical practice. *Ann Surg* 1998;**228**:16–28
29 Mateer J, Plummer D, Heller M. Model curriculum for physician training in emergency ultrasound. *Ann Emerg Med* 1994;**23**:95–102
30 Shackford SR, Rogers FB, Osler TM, Trabulsy ME, Clauss DW, Vane DW. Focused abdominal sonogram for trauma: the learning curve of nonradiologist clinicians in detecting hemoperitoneum. *J Trauma* 1999;**46**:553–64
31 American Institute of Ultrasound in Medicine. Ultrasound practice accreditation. In: http://www.aium.org/accreditation/accreditation.aspx [22 March 2014]

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