The accuracy of sonographers carrying out upper abdominal ultrasound examinations

With the ever-increasing time and cost constraints in modern healthcare, questions have been raised as to whether part of the heavy work load of radiologists could be relieved by sonographers carrying out some examinations. This article summarizes the results of a Norwegian study of the accuracy of newly trained sonographers in carrying out upper abdominal ultrasound exams, compared to radiologists. It was found that the sonographers had accuracy levels similar to those of the radiologists.

Norway educated their first sonographers at the University College in Gjøvik in 2008. Eight students were trained to be able to differentiate negative and positive findings in the diagnostic ultrasound of the upper abdomen. The objective of this initiative was to relieve the radiologists of their large workflow, and free them up to focus on advanced diagnostics.

The educational programme was controversial and gave rise to a lively debate among radiologists. The Norwegian Society of Radiology appointed a committee to study whether it would be acceptable for sonographers to carry out diagnostic ultrasound examinations in Norwegian radiology departments. The Society summarized their report in a public statement strongly discouraging radiology departments in Norwegian hospitals from employing sonographers.

Today, only relatively few sonographers actually practice in Norway. However, significant international developments in advanced radiographic practice suggest that there will be a serious lack of specialists in Norway by the year 2030 [1].

To investigate whether the radiologists’ scepticism was warranted or whether sonographers could adequately address present and future needs, we wanted to analyse the accuracy of Norwegian-educated sonographers and to assess the quality of their work. In particular we wanted to know whether there was agreement between the findings of the sonographers and those of the radiologists and whether in general the sonographers were able to carry out examinations to the satisfaction of the radiologists.

DESIGN OF THE STUDY

To assess the accuracy of the sonographers in Norway we included 244 patients in a prospective controlled study involving five advanced radiographers (sonographers) and four experienced radiologists working in three departments in hospitals belonging to the same hospital cluster in Norway [2].

The radiologists had 20 to 26 years of experience of ultrasound examinations and the sonographers had 6 months of experience (and 7 to 17 years of experience as radiographers).

The examinations in the study were limited to the upper abdomen.

To avoid any possibility of bias due to preconceptions, only polyclinic patients who were presenting for the first time were included in the study.

Each patient underwent two similar ultrasound examinations — one by the sonographer and one by the radiologist. There was no communication between the sonographer and the radiologist before, during or after the examination.

Individuals in both groups separately recorded the time, the number of images taken, the number of images saved, incomplete examinations and their confidence in their diagnostic findings and conclusions.

The examinations carried out by the sonographers were subsequently evaluated by the radiologists who rated the technical image quality, the ability to make their own diagnostic report, the causes of any incomplete examinations as well as the principal and additional findings, and finally an overall evaluation of their examination.

The radiologists made appropriate additions to the
sonographers’ report if they found something that the sonographer had overlooked.

ASSESSMENT

Three forms were developed for and used in the assessment. One form was for the sonographers who recorded their activity; one form was for the radiologists and the third was where the radiologists evaluated the examination of the sonographer. The information recorded on the forms was as described above.

A positive finding was defined as pathology and normal variations and had to be mentioned in the report, to make sure that the sonographers were capable of knowing the difference between pathology and normal variations.

THE RESULTS OF THE INVESTIGATION

Out of 246 patients invited to participate, 244 consented and were included in the study. All five sonographers continued to see patients until they had received 30 positive examinations [Table 1].

There was an agreement in findings between sonographers’ and radiologists in 95.5% of the examinations, which gave a consistency of 0.903 Cohen’s kappa. A cross reference table of the results in absolute numbers is shown in Table 2.

These gives a sensitivity of 9.97 and a specificity of 0.93, LR+ of 13.8 and LR- of 0.03 when using radiologists as a reference.

RADIOLOGISTS’ REPORTS

Although this study was not designed to investigate whether radiologists were mistaken, the radiologists reported to have been mistaken in eight (3.3%) cases when they considered the sonographers’ results to be correct. In six of these specific cases the radiologist had reported negative results and the sonographer had reported a positive result and in two of these cases the radiologists had overlooked additional findings.

WHICH FINDINGS ARE LIKELY NOT TO BE FOUND BY THE SONOGRAphERS’?

The crucial question is whether any patient with a pathology might be overlooked (i.e. false negative). This would support the argument for not using sonographers in Norwegian diagnostic ultrasound procedures.

We found four cases (1.64%) in which the sonographers recorded negative results but in which the radiologist recorded a positive result.

TIME AND NUMBER OF PICTURES

There was a significant difference between the sonographers and the radiologists in the number of images taken (p=0.002, paired T-test) and the number of images saved. There was also a difference in the time taken to carry out the examinations.

On average the sonographers took 17.6 pictures while the radiologists took 16.8 pictures and there was a difference in the numbers of images saved by radiographers and radiologists.

**FIGURE 1.** Experience, hospital, and number of examinations for the five sonographers when they made 30 examinations with positive findings. (2).

**FIGURE 2.** Cross-reference table showing the positive and negative findings for sonographers and radiologists.

The time taken to carry out the examinations refers to the real time the operator is actually sitting at the patient’s bedside and carrying out the scan. This was on average 12.43 minutes for a sonographer and 8.19 minutes for a radiologist.

If the sonographer was uncertain of the findings, an average of 13.10 minutes was spent, whereas the radiologist took on average 8.87 minutes.

CONFIDENCE IN OWN FINDINGS

The experienced radiologists were more confident than the newly trained sonographers: sonographers were confident of their findings in 70.9% of cases whereas the radiologists were confident in 90.6% of cases. (p<0.1001).

Out of all the 244 examinations the sonographers were uncertain of their own findings in 29 cases and felt in need of further consultation and considered their own examination as incomplete. There was accordance with the radiologists in 27 of these 29 examinations.

OVERALL PERFORMANCE

99.2% of the sonographers’ examinations had technical image qualities that were better or equal to those of the radiologists. In 99.2% of the sonographers’ examinations the overall performance was evaluated to be “best” and “good” by the radiologists. Overall performance was assessed on the basis of the technical quality of the images, the ability to arrive at findings, and the ability to draw up a diagnostic report.

DISCUSSION

We found that sonographers had positive findings in 63.1% of the cases while the radiologists had positive findings in 62.7% of the cases. Radiologists agreed with 153 of the sonographers’ 154 positive findings. The agreement between the examinations carried out by sonographers and radiologists was 0.903 Cohen’s Kappa, which is in accordance with other studies [3-6].

The sonographers were less educated in drawing up medical reports, but nevertheless 94.7% of the reports were found to be good and the overall evaluation showed that 242 of 243 examinations were assessed by the radiologists to be of “best” or “medium” quality.

In general the radiologists needed less time, took fewer images, and were more confident in their own findings How-
ever they still occasionally failed when the sonographers were right (3.3%), findings which are in agreement with other studies [3]. Since the radiologists had on average 24 more years experience than the sonographers it was therefore understandable that they used less time for examinations.

Another reason may be that they received fewer question from the patients since the sonographers had mostly already addressed them. Sonographers also learn and are used to communicate with the patients while scanning.

A more plausible reason may be that the sonographers were indecisive interpreting pictures or spend extra time going after the “ideal” picture, knowing that a radiologist would be scrutinizing them later.

The accuracy of the examinations of the upper abdomen carried out in this study of Norwegian sonographers in close collaboration with radiologists appears to be good and to be at the same level as found in other European countries [4]. The positive principal findings were correct in 95.1% of the examinations, which satisfies the criteria for reporting radiographers and sonographers.

It may seem unfair to compare sonographers with six months experience with physicians who had similar experience. However this study was deliberately designed to use experienced radiologists as a reference because of the outspoken scepticism of the possibility of using sonographers in Norway at that time.

We found four cases (1.64%) where the sonographer reported negative results and the radiologist reported a positive result. There were six cases (2.45%) where radiologists reported negative results and the sonographer reported a positive result. In all these four of these were discovered. In the day-to-day routine work-load there is a system for double scrutiny only for the sonographers. Not for the radiologists.

The sonographers and the radiologists in this study knew each other in advance. This may have introduced a bias, as their competence profiles and capacities may have been mutually influenced, thus increasing the agreement between sonographers and radiologists.

This could have been avoided by using different, unknown radiologists but they were not available.

It will be interesting to follow the sonographers and carry out another similar study after some years when they have gained more experience. A cost/benefit analysis was conducted last year [7]

SUMMARY
The examinations carried out by the Norwegian sonographers in this study obtained high accuracy and in agreement with the findings of experienced radiologists. Almost all of the sonographers’ examinations (99.2%) were found to be of “best” or “medium” quality in the overall evaluation done by the radiologists. The sonographers missed 1.64% of positive findings.

The Norwegian sonographers appear to be able to differentiate negative from positive findings in the upper abdomen. In addition, they demonstrate accuracies similar to those of experienced radiologists.

REFERENCES
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| Book review |

**Practical Manual of Echocardiography in the Urgent Setting**

*Edited by Vladimir Fridman & Mario Garcia*  
*Pub by Wiley-Blackwell, 2013, 278pp, €56*

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Designed and written by frontline clinicians with extensive experience treating patients, Practical Manual of Echocardiography in the Urgent Setting is the perfect pocket-sized guide for residents in cardiology, emergency medicine, and hospital medicine; trainees in echocardiography; medical students on cardiology or emergency medicine rotations; technicians, nurses, attending physicians -- anyone who practices in the urgent setting and who needs reliable guidance on echocardiographic views, data and normal/abnormal ranges to aid rapid diagnosis and decision-making at the point of care.

The book covers the essentials of echocardiography in the acute setting, from ultrasound basics to descriptions of all pertinent echocardiographic views to clear stepwise advice on basic calculations and normal/abnormal ranges.