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volume. However, this recommendation varies across screening programmes from about 500 in the USA to 5,000 in Norway and several other European countries; a variation that is at least partly attributable to a lack of evidence-based knowledge.

Existing studies exploring the relationship between reader

volume and performance are mostly from American or Canadian programmes with single reading of mammograms and are therefore not suitable to act as evidence-based guidelines for European screening programmes that use independent double reading with consensus. Furthermore, most studies are based on screen-film mammograms or a

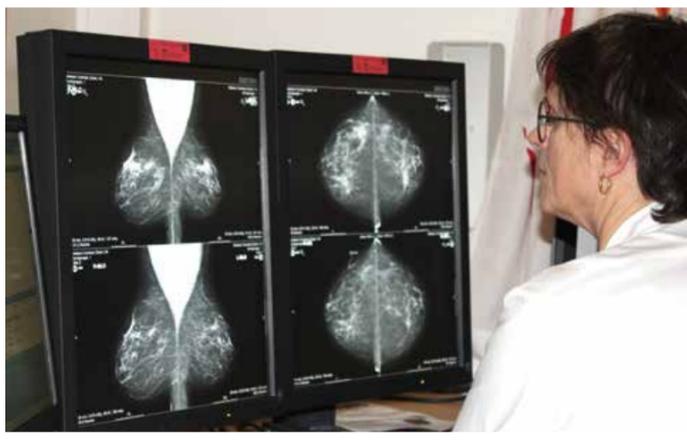
mixture of screen-film and digital mammograms, whereas digital mammograms are the standard in most screening programmes in the western world today. We therefore sought to close an existing gap in knowledge by exploring the influence of annual reader volume on radiologists' performance in a programme that uses independent double reading with consensus of digital mammograms.

We collected retrospective data from more than two million digital screening examinations read by 121 radiologists in BreastScreen Norway from 2006–2016. In the volume range from 100 to 10,000 annual reads we found little effect of volume on sensitivity and screening/cancer detection rate. We did, however, find a decline in the false positive rate with increasing annual volume, most markedly up to 4,000 annual reads. Because of this, the accuracy (sensitivity/FPR) increased by 50% from 100 to 4,000 annual reads and by 15% from 4,000 to 10,000 annual reads. For annual reader volumes in the range from 10,000 to 18,000 we found a paradoxical decline in

both sensitivity and screening/cancer detection rate. According to our results, it thus seems that increasing annual reader volumes, up to a certain level, increases the radiologist's ability to recognise a mammogram as normal, but has little effect on his or her ability to detect cancers. It also seems that extremely high annual volumes might have a negative effect on performance, a finding that could possibly be related to reader's fatigue. Based on our findings, we would suggest that 4,000 to 10,000 reads are an optimal

annual volume range for high radiologist performance in interpreting screening mammograms.

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A radiologist interpreting screening mammograms.

BY KATHARINA MIEDZINSKA

Ultrasound training and education: Quo vadis?

The digital processing revolution is having an impact on many areas of life, including medicine and education. When it comes to the latter, one particular area where such technology is making a difference is the use of simulators.



Two young trainees practising abdominal ultrasound on virtual reality simulators, assisted by a supervisor (provided by Prof. Lars Konge, Copyright: Copenhagen Academy for Medical Education and Simulation (CAMES), Rigshospitalet, Copenhagen).

Simulation has gained much popularity in healthcare education over the past decade, largely due to technological developments that have led to dramatic improvements in the realism and sophistication of simulators.

As it enables trainees to acquire essential skills within a 'safe' environment that closely represents reality, simulation is gaining increasing momentum at different levels of healthcare education. The use of simulators allows trainees to develop skills while applying theoretical knowledge in a controlled setting and thus prepares them for real situations. The training agenda can be determined by the needs of the trainee, and whole procedures or specific components can be simu-

lated. Against this background, medical simulation has been proposed repeatedly as a technique that can counteract disconnects between the classroom and the clinical environment and bridge various educational gaps.

Patient simulation appears to be particularly well suited to ultrasound training. Ultrasound simulators have evolved constantly over recent years, to a point where they now provide an opportunity for realistic hands-on training for a broad spectrum of ultrasound examinations and interventions, with structured step-by-step procedural guidance alongside virtual cases.

However, despite the benefits of clinical simulation methods, their place within the training curriculum

is far from clearly determined. There are still some obstacles to overcome regarding the establishment and integration of ultrasound and other forms of simulation into medical training curricula. According to Prof. Lars Konge, from Copenhagen Academy for Medical Education and Simulation at the University of Copenhagen, Denmark, significant organisational and financial investments are necessary to make simulator training and certification a mandatory part of the education of future ultrasound operators and other radiologists.

In his presentation, Konge will focus on gamification and virtual reality with respect to possible ways to implement these modalities in ultrasound. "There is a huge implementation gap regarding simulation in medical education. Despite solid evidence, simulation is still severely under-utilised as a teaching modality and initial training on patients is still very common," said Konge. "The old 'see-one, do-one, teach-one' approach to medical education is totally outdated. Simulation-based training provides evidence for better efficacy, less stress, better patient outcomes, and improved return-on-investment. The question is no longer *if* we should use simulators to train our future doctors, but *how*."

According to Konge, a part of the answer lies in gamification. "Gamification allows new trainees to measure their own progress and compete against peers, which is highly motivating and could be a driver for implementation. In the future, medical societies could help to implement virtual reality simulation-based training and certification by creating

the necessary training programmes in collaboration with expert radiologists and experts in medical education," he concluded.

Also in this session, Ms. Leizl Nayahangan, from the Copenhagen Academy for Medical Education and Simulation, will speak about the needs assessment of simulations-based training in radiology. Specifically, attendees will learn how to perform a needs assessment using the Delphi method, how a needs assessment can identify technical procedures needed to be implemented in a simulation-based curriculum, and how the list of procedures may be used as a 'guide' for the development of new training programmes.

Konge and Nayahangan will be joined by Prof. Michael Bachmann Nielsen, from the department of radiology at the Rigshospitalet in Copenhagen, who will provide an

overview of the ultrasound simulators market, highlighting which types of simulators are suitable for beginners, advanced levels, and training in interventional ultrasound.

The joint ESR Ultrasound Subcommittee/EFSUMB (European Federation of Societies for Ultrasound in Medicine and Biology) course, entitled 'Ultrasound simulation models in training and education: where are we going?', will be chaired by Prof. Dirk André Clevert, from the institute of clinical radiology at the Ludwig-Maximilians-Universität, Munich, Germany, and Prof. Paul S. Sidhu, of the department of radiology, King's College Hospital, London. The session will close with a panel discussion addressing the question of whether there is an option to include ultrasound simulation models in daily work processes and how to improve the outcome.

Joint Session: ESR Ultrasound Subcommittee with EFSUMB (European Federation of Societies for Ultrasound in Medicine and Biology)

Wednesday, February 27, 08:30–10:00, Room Y
Ultrasound simulation models in training and education: where are we going?

- » Chairpersons' introduction
D.A. Clevert; Munich/DE
P.S. Sidhu; London/UK
- » Needs assessment of simulations-based training in radiology
L. Nayahangan; Copenhagen/DK
- » Review of the available market of ultrasound simulators
M. Bachmann Nielsen; Copenhagen/DK
- » Gamification and virtual reality in medical simulation
L. Konge; Copenhagen/DK
- » Panel discussion: Will there be an option to include these technics in our daily work and how could we improve the outcome?

