RSNA 2024: Quality Improvement Reports, R5B-QI-8

DIGITALIZATION OF ULTRASOUND QUALITY CONTROL - A STREAMLINED SOLUTION TO COVER HOSPITAL DISTRICT -WIDE OPERATION

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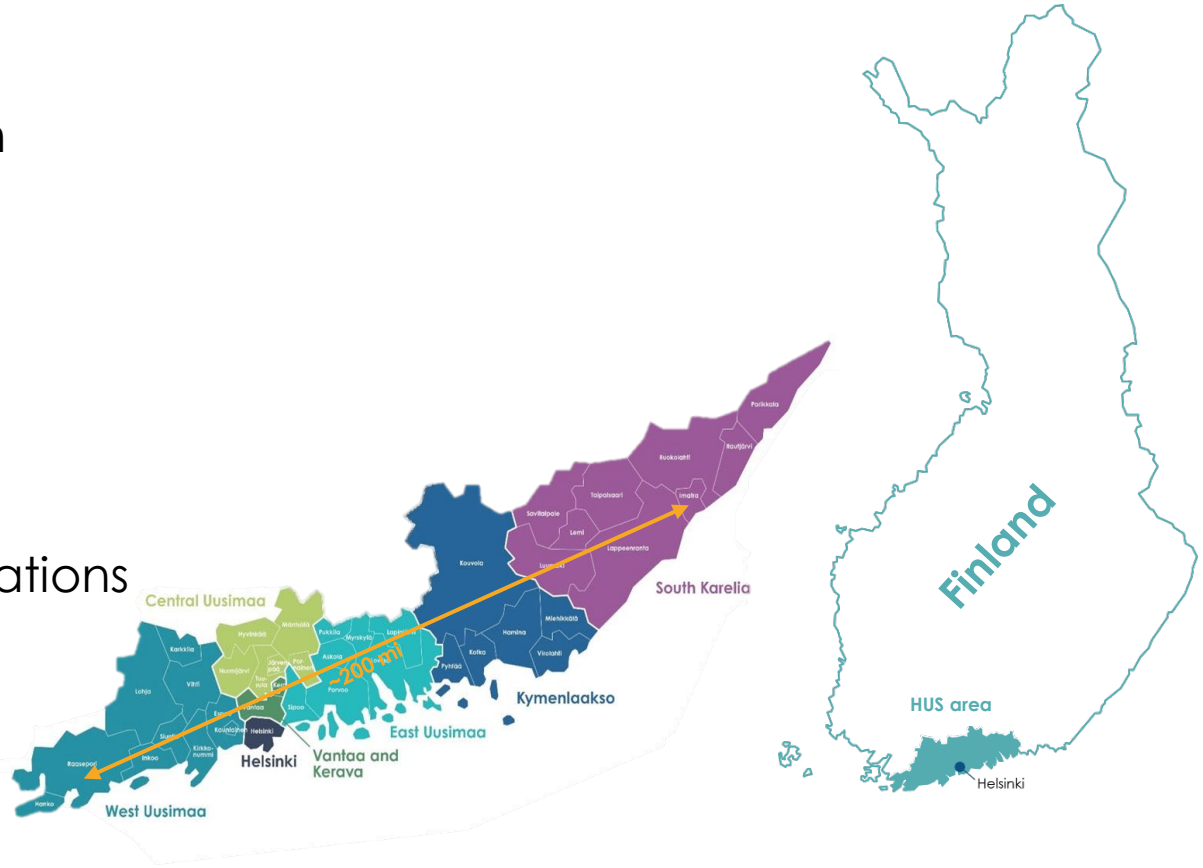
ULTRASOUND AT HUS DIAGNOSTIC CENTER

- Helsinki + 6 wellbeing service counties in Southern Finland
- ~2 million people living in the area
- 24 ultrasound sites (radiology)
  - ~100 ultrasound devices
  - ~ 300 transducers
- Distance between two most distant locations with ultrasound operations ~200 mi



US QC effectiveness

- 90% of transducer defects are seen as signal voids in in-air-reverberation (IAR) images [1,2]
- More careful phantom measurements tie up expert resources but may not reveal anything new
- Faulty transducer can be in use for months without regular QC
- Many transducer defects would have been found with frequent IAR images

[1] ULTRASOUND QUALITY ASSURANCE, BMUS web-page https://www.bmus.org/education-and-cpd/cpd-resources/top-tips/ultrasound-quality-assurance/
[2] BMUS Equipment QA and fault management https://www.bmus.org/media/resources/files/10.15_PP.pdf

OUR QUALITY CONTROL SCHEDULE

- Commissioning tests (in-air reverberation (IAR), uniformity, contrast, resolution, visualization depth, SNR, screen/monitor QC)*
- Electrical safety testing (during annual maintenance)**
- IAR image (+ visual inspection after 2024)
- Annual tests (IAR, uniformity, screen/monitor QC, visual inspection)*
- Warranty tests (IAR, uniformity, contrast, resolution, visualization depth, SNR, screen/monitor QC)*

*requiring medical physicist (or trained sonographer) and special equipment
**requiring medical technician and special equipment

Before 2024:

After 2024:

Local personnel in the US units given more responsibility for QC!

2024 QC INTERVENTION

Annual phantom tests were omitted

The effectivity of annual phantom tests was poor and tied up expert resources. Most transducer defects were evident in IAR images. **In the new scheme, only commissioning and warranty tests require a medical physicist and phantoms.**

Monthly visual inspection and IAR image acquisition was introduced

It could take multiple months for users to identify transducer defects. More frequent IAR image acquisition accompanied with visual inspection of the machine and transducers facilitates timely intervention. **These tests can be performed by local staff in the ultrasound unit.**

A web-based results browser was developed

The QC results database was arduous to maintain, so we wanted to automatize the process. In addition, **making the database visible to the units allows the local staff to be posted and contact technical personnel if they encounter deviations.**

”SAMPO” – WEB-BASED QC PLATFORM

- Modular QC platform containing modules for US, CT, MRI, planar X-ray imaging, mammography, and diagnostic monitors
- US module containing applications for
  - External inspection of the US machine and transducers
  - IAR image visualization (+ quantitative analysis WIP)
  - Technical QC of the screen (AAPM-18 test image form)
- Based on Django (web UI), PostgreSQL (database), and Orthanc (DICOM server)
- Different modules run as Docker containers

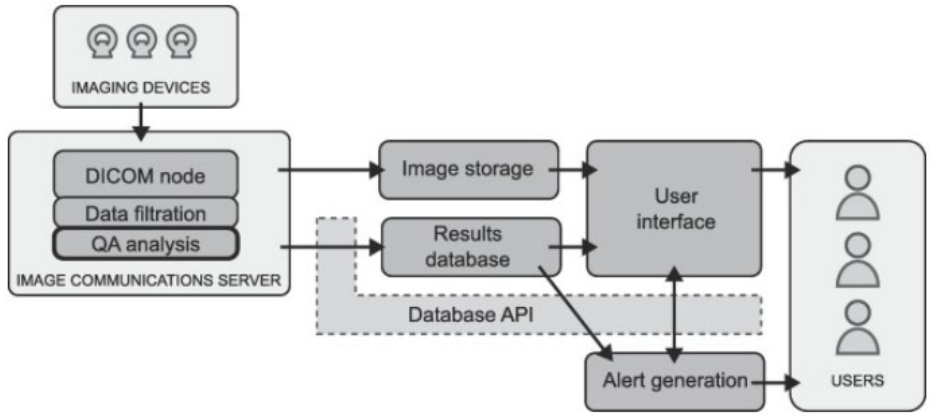


Fig. 1. A simplified schema of the modular design and data flow of the QC system. From *Peltonen, Honkanen, and Kortesniemi (2023)* https://doi.org/10.1016/j.ejmp.2023.103173

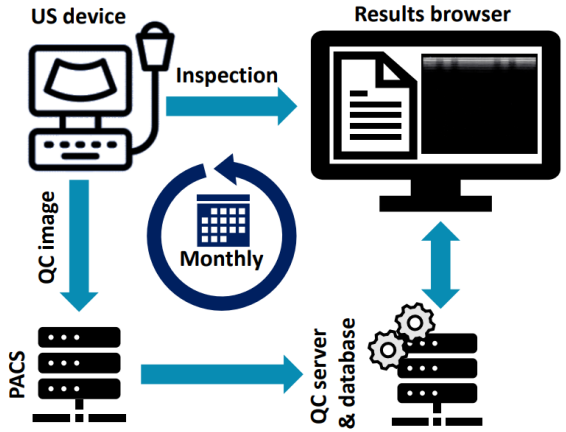


Fig. 2. US data flow in the QC system.

Device visual inspection form:

Add inspection

Fill in observations in the form below

Name

N.N

Check, if OK:

- [ ] Cleanliness of device and transducers
- [ ] Device casing is intact
- [ ] Cables and wiring are undamaged
- [ ] Wheels and wheel locks are working
- [ ] Filters have been cleaned
- [ ] Filters have been vacuumed
- [ ] Knobs, buttons and controls work
- [ ] Screen is clean

Other remarks:

- [ ] Hide device from the list

Lisää mittaus | Sulje

Inspection records log view:

SIDE_ID / DEVICE_ID

Inspection date	31/10/24	30/09/24	30/08/24	30/07/24
Measurer	S. Sonographer	U. Sound	S. Sonographer	U. Sound
Casing	☑	☑	☑	☑
Cleanliness	☑	☑	☑	☑
Cables and wiring	☑	☑	☑	☑
Wheels and wheel locks	☑	☑	☑	☑
Filters cleaned	☑	☑	☑	☑
Filters vacuumed	☑	☐	☑	☑
Controls	☑	☑	☑	☑
Screen cleaned	☐	☐	☐	☐
Remarks	No need to vacuum		No need to vacuum	

Transducer-specific results page:

SITE_ID / DEVICE_ID / PROBE_ID / PROBE NAME

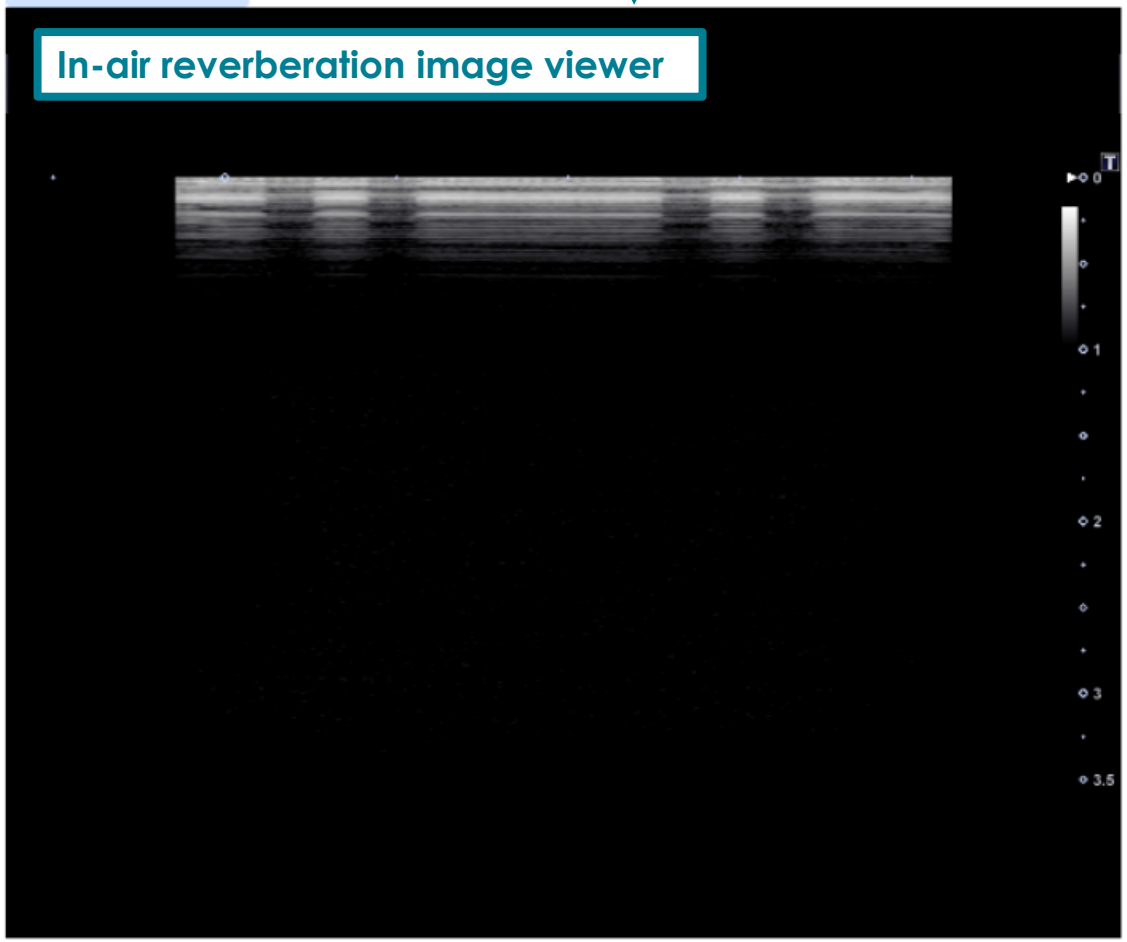
Measurements

previous images selectable for viewing

windowing, zooming and translation functionalities in the viewer

Instructions

In-air reverberation image viewer



Comment log for deviations

Comments on in-air reverberation image and transducer

- 20/03/2024: four signal defects, physicist informed

Add comment

Quantitative results (work in progress)

Date of analysis: March 20, 2024, 1:30 p.m.

#	Parameter:	Result:
1	Signal depth	0.025 cm
2	Covariance of uniformity	3.079 cm^2
3	Skewness of uniformity	1.352

Uniformity by segments				
10 %	20 %	40 %	20 %	10 %
5.76 %	2.16 %	3.6 %	1.44 %	12.95 %

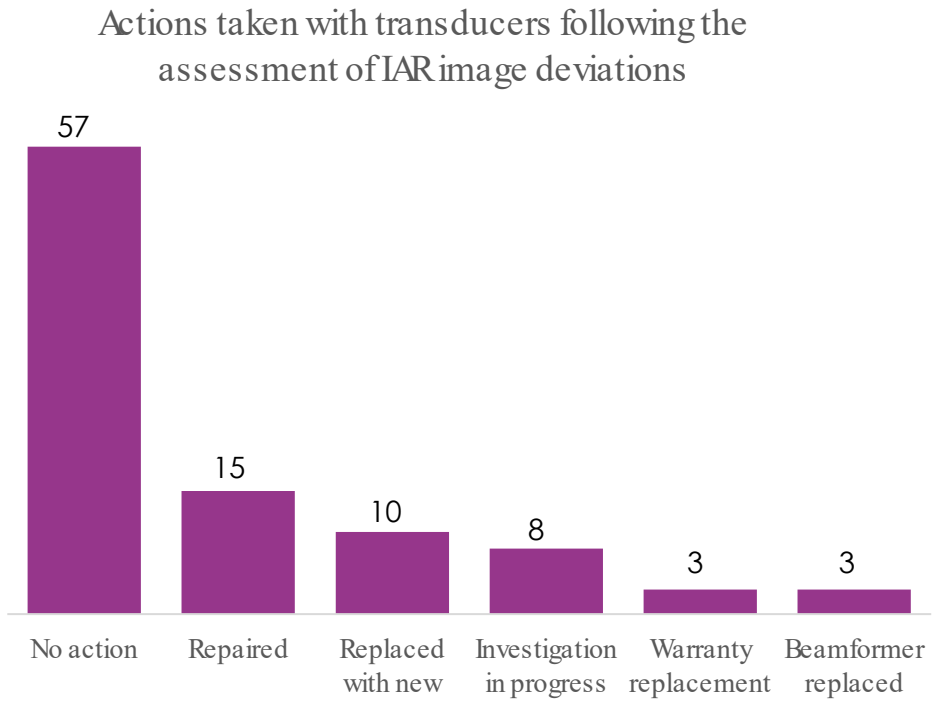
☐ In-air image inspected?

Check: inspected

Verification that this image has been inspected

RESULTS & CONCLUSION

- Since January 1 2024, at least 96 transducers were reported with deviation in IAR image quality
  - Most of these transducers were found to be normal after additional measurements
  - A total of 28 transducers were either repaired or replaced with a new transducer
    - To highlight, three transducers were replaced free of charge due to warranty
- Electrical safety was compromised in at least 4 transducers
  - 3 damaged lenses with excessive leakage current
  - 1 transducer short circuit



By adopting the new QC program our department has been able to receive QC reports more frequently, enabling prompt reaction to transducer defects.

THANK YOU!

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