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Learning cardiac ultrasound: a study comparing extended reality–based training with standard teaching for medical students

Submission date 08/01/2026	**Recruitment status** No longer recruiting	[_] Prospectively registered [_] Protocol
Registration date 08/01/2026	**Overall study status** Completed	[_] Statistical analysis plan [_] Results
Last Edited 08/01/2026	**Condition category** Circulatory System	[_] Individual participant data [X] Record updated in last year

Plain English summary of protocol

Background and study aims
Point-of-care ultrasound (POCUS) is increasingly used, but learning basic cardiac image acquisition and probe orientation is challenging for beginners. Extended reality (XR) can support training by showing a 3D heart model and providing real-time feedback on probe position and the intended view. This study compares XR-supported training using the "Augmedicine: Ultrasound" application with standard instructor-led training, to evaluate whether XR training leads to similar competence in basic cardiac ultrasound measurements.

Who can participate?
Medical students during their internal medicine clerkship at Leiden University Medical Center (LUMC) with little to no prior ultrasound experience. Students are not eligible if they previously participated in an XR ultrasound study or completed substantial extracurricular anatomy training (e.g., dissection courses outside the regular curriculum).

What does the study involve?
Participants complete brief baseline assessments (questionnaire, mental rotation test, and a short anatomy knowledge test). All participants receive the same introductory cardiac ultrasound teaching and supervised practice. They are then randomly allocated to either (1) a fixed period of independent practice with the XR application or (2) a fixed period of one-to-one supervised practice on a volunteer. Afterwards, all participants complete a practical ultrasound test on a volunteer, including two measurements. The examiner is blinded to the training group. XR participants also complete a short questionnaire about any XR-related discomfort.

What are the possible benefits and risks of participating?
Participants may benefit from additional cardiac POCUS practice. The main burden is extra time during a clerkship day. Risks are minimal; XR use may cause temporary symptoms such as dizziness, headache, nausea, or eye strain. Participants can stop at any time.

Where is the study run from?
Leiden University Medical Center (LUMC) (Netherlands)

When is the study starting and how long is it expected to run for?
March 2024 to May 2024

Who is funding the study?
Investigator initiated and funded

Who is the main contact?
Tessa Mulder, t.a.mulder@lumc.nl

Contact information

Type(s)
Public, Scientific, Principal investigator

Contact name
Miss Tessa Mulder

ORCID ID
https://orcid.org/0000-0001-9606-8007

Contact details
Albinusdreef 2
Leiden
Netherlands
2333 AS
+31 (0)715296151
t.a.mulder@lumc.nl

Additional identifiers

Clinical Trials Information System (CTIS)
Nil known

Integrated Research Application System (IRAS)
Nil known

ClinicalTrials.gov (NCT)
Nil known

Protocol serial number
Nil known

Study information

Scientific Title
Augmedicine: Ultrasound. Training in Ultrasound Using XR – a randomized controlled trial

Study objectives

The aim of this study is to assess if training using the XR application is non-inferior compared to standard training to learn POCUS.

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 22/02/2024, Educational Research Review Board of the LUMC (Hippocratespad 21, Leiden, 2333 ZD, Netherlands; +31 (0)71 526 91 11; p.g.m.de_jong@lumc.nl), ref: OEC/ERRB /20240213/1

Study design
Single-centre assessor-blinded parallel-group non-inferiority randomized controlled trial

Primary study design
Interventional

Study type(s)
Efficacy

Health condition(s) or problem(s) studied
Training effectivity of XR application in medical students

Interventions
Novice medical students during their internal medicine clerkship were allocated 1:1 by block randomization (block size 2) to XR-integrated POCUS training (intervention) or standard instructor-guided POCUS training (control), with outcomes assessed immediately after training.

Intervention Type
Behavioural

Primary outcome(s)
1. E-point septal separation (EPSS) measured in millimetres using M-mode echocardiography during a parasternal long-axis view, assessed during a practical ultrasound test immediately after training and compared to expert reference measurements.
2. Tricuspid annular plane systolic excursion (TAPSE) measured in millimetres using M-mode echocardiography during an apical four-chamber view, assessed during the same practical ultrasound test immediately after training and compared to expert reference measurements.

Key secondary outcome(s))
1. Time to complete the ultrasound test, measured in seconds using a stopwatch during the practical test immediately after training.
2. Image quality, assessed by two blinded experts using a validated point-of-care echocardiography image scoring form, based on images obtained during the practical test immediately after training.
3. XR-related discomfort (cybersickness symptoms), assessed using a short self-report questionnaire completed immediately after XR training (XR group only).

Completion date
28/05/2024

Eligibility

Key inclusion criteria
Medical students without previous ultrasound experience

Participant type(s)
Learner/student

Healthy volunteers allowed
No

Age group
Mixed

Lower age limit
18 years

Upper age limit
100 years

Sex
All

Total final enrolment
56

Key exclusion criteria
1. Prior participation in a study with an XR ultrasound application
2. Participated in extracurricular activities related to anatomical education, such as dissection courses

Date of first enrolment
20/03/2024

Date of final enrolment
28/05/2024

Locations

Countries of recruitment
Netherlands

Study participating centre
Leiden University Medical Centre
Albinusdreef 2

Leiden
Netherlands
2333 AS

Sponsor information

Organisation
Leiden University Medical Center

ROR
https://ror.org/05xvt9f17

Funder(s)

Funder type
Not defined

Funder Name
Investigator initiated and funded

Results and Publications

Individual participant data (IPD) sharing plan
Individual participant data (IPD) will be available upon reasonable request from the corresponding author Tessa Mulder (t.a.mulder@lumc.nl)

IPD sharing plan summary
Available on request