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Using lung ultrasound to diagnose pulmonary tuberculosis: evaluating scanning methods and the ultrasound probes for accuracy in Zambia

Submission date
21/11/2024

Recruitment status
Recruiting

Registration date
13/12/2024

Overall study status
Ongoing

Last Edited
07/01/2026

Condition category
Infections and Infestations

[X] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

Plain English summary of protocol

Background and study aims
TB is a major global health problem and the leading cause of death from infectious diseases. It is therefore crucial to quickly and accurately diagnose and treat TB, but current diagnostic tools are expensive and need experts to operate them, making them hard to use in areas with high TB rates.
Lung ultrasound (LUS) could help because it is cheaper, faster, safe, and can be done by nonspecialists. Previous studies have shown that LUS can help diagnose TB in the lungs, but what still remains unknown is the best way to use it or which type of ultrasound probe is best. In places where specialist ultrasound operators are unavailable, a simple LUS method would be very useful. If it meets the World Health Organisation's standards, it could lead to the development of computer programs to help interpret the images remotely.
The aim of this study therefore is to test how accurate lung ultrasound is for diagnosing TB in the lungs using different methods and ultrasound probes. It will further set out to compare these accuracies by HIV status, a history of previous TB or chronic respiratory disease, and also collect LUS images for use in future training of an AI model to automatically read these images for likelihood of TB.

Who can participate?
Adult patients (18 years of age and above) suspected of having TB based on symptoms

What does the study involve?
The study involves enrolling adult patients suspected of having TB based on respiratory symptoms and randomly assigning them to have a lung ultrasound done with one of four combinations of LUS technique (comprehensive or simplified) and type of probe (curvilinear or linear). These four combinations will therefore be comprehensive/curvilinear, comprehensive /linear, simplified/curvilinear and simplified/linear. By comparing these different combinations against the standard test, the study aims to find the best approach for diagnosing TB using LUS.

What are the possible benefits and risks of participating?
The benefits of the study include having certain lung abnormalities detected on LUS that would

have otherwise been missed by the conventional chest x-ray. This would then open the possibility of these abnormalities being treated. LUS is a non-invasive diagnostic tool and thus is pain-free; however, it requires that one takes off their clothing to expose their chest, and a risk of discomfort. However, it will be conducted in a private room.

Where is the study run from?
Kanyama Hospital (Zambia)

When is the study starting and how long is it expected to run for?
January 2023 to March 2027

Who is funding the study?
1. National Institute for Health and Care Research (NIHR) (UK)
2. Wellcome Trust (UK)
3. DELFT Imaging (Netherlands)

Who is the main contact?
Dr John Kondwelani Mateyo, john.mateyo@lshtm.ac.uk

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Study information

Scientific Title
Lung ultrasound in pulmonary tuberculosis: evaluating image acquisition protocol-and-probe accuracy in Zambia

Acronym
LUSPTB

Study objectives
The overall aim of this research is to assess the diagnostic accuracy of lung ultrasound for pulmonary tuberculosis using different image acquisition protocols and probes, compared to a reference standard of Xpert® MTB/RIF Ultra.
While the utility of lung ultrasound for pulmonary tuberculosis has shown promising results in recent studies, the methods used to obtain images (image acquisition) and the type of ultrasound probe used, have not been compared. We therefore wish to compare a simple acquisition protocol that can be taught and applied by a non-specialist healthcare worker to a comprehensive one, for accuracy. Should this be comparable, it would open possibilities for use in settings without specialists and thus further allow the use of computer-aided diagnosis of non-specialist acquired images using this method. Then, the comparison of probes allows us to ascertain which one will be better placed for tuberculosis diagnosis.

The aim is intended to be achieved through a randomised diagnostic accuracy study comparing the accuracy of:
1. A simplified LUS image-acquisition protocol with a comprehensive one, and
2. The curvilinear with the linear ultrasound probe for PTB diagnosis.

Ethics approval required
Ethics approval required

Ethics approval(s)
1. approved 29/11/2024, University of Zambia Biomedical Research Ethics Board (Ridgeway Campus, Nationalist Road, Lusaka, 10101, Zambia; +260 (211)256067; rhinno.support@ethixpert.org.za), ref: UNZA-5889/2024

2. approved 06/05/2025, LSHTM (Keppel Street, London, WC1E 7HT, United Kingdom; +44 (0)20 7927 2221; ethics@lshtm.ac.uk), ref: 31242 /RR/36756

Study design
Randomized diagnostic accuracy study

Primary study design
Interventional

Study type(s)
Diagnostic, Screening

Health condition(s) or problem(s) studied
Pulmonary tuberculosis

Interventions
This is a randomised diagnostic study. Consenting presumptive tuberculosis patients will be randomised to one of four lung ultrasound image acquisition protocol/probe combinations:
1. Comprehensive protocol/curvilinear probe
2. Comprehensive protocol/linear probe
3. Simplified protocol/curvilinear probe
4. Simplified protocol/linear probe

Randomisation will be sequentially done using the following steps:
1. Stratify Participants: Strata will be created based on relevant baseline characteristics such as age and gender to ensure balanced allocation across groups.
2. Generate Random Sequence: A computer-generated randomisation sequence will be used with random number generators in statistical software.
3. Randomisation Blocks: To maintain equal distribution across groups throughout the study block randomisation will be used. For this study with 2600 participants and 4 groups, a block size of 4 or a multiple of 4 will be used to help prevent imbalances if the study were to stop prematurely.
4. Allocation: Each participant will be assigned to one of the four groups. The randomisation sequence will determine the order in which participants are assigned to these groups.
5. Blinding: Blinding researchers and participants to the allocation will not be done given the apparent differences in the scan techniques and probes
6. Implementation: A secure system with access controls will be used to ensure the allocation sequence is followed strictly and that those enrolling participants cannot predict the next assignment

Intervention Type
Mixed

Primary outcome(s)

The diagnostic accuracy of LUS for PTB relative to Xpert® MTB/RIF Ultra will be measured using sensitivity and specificity for each protocol/probe combination at a single timepoint (baseline). A positive LUS is one that will have the presence of subpleural consolidation or consolidation or pathological B-line
Sensitivity of LUS = true TB positives /true positives + false negatives (relative to GeneXpert)
Specificity of LUS = true TB negatives/true TB negatives+ false TB positives (relative to GeneXpert)

Key secondary outcome(s))
1. Sensitivity of LUS in HIV-positive compared with HIV-negative individuals: Sensitivity will be measured using the proportion of true positive cases correctly identified by lung ultrasound (LUS) in both HIV-positive and HIV-negative individuals. Measurements will be taken at baseline (single timepoint)
2. Specificity of LUS in patients with previous PTB compared with patients without previous PTB: Specificity will be measured using the proportion of true negative cases correctly identified by LUS in patients with and without previous pulmonary tuberculosis (PTB). Measurements will be taken at baseline (single timepoint)
3. LUS features predictive of PTB: Predictive features will be identified through human reader analysis of LUS images (specifically for the presence/absence of subpleural nodules, consolidations, cavities, pleural irregularities, and pathological B-lines). Measurements will be taken at baseline (single timepoint) and the sensitivity and specificity of each of these LUS features measured individually, as in 1 and 2 above.

Completion date
31/03/2027

Eligibility

Key inclusion criteria
1. Age 18 years and older consenting to enrolment
2. Presenting to the outpatient department, TB clinic, or ART clinic with symptoms suggestive of TB (cough>2 weeks plus at least one additional symptom including fever, night sweats, weight loss, or haemoptysis)

Participant type(s)
Patient

Healthy volunteers allowed
No

Age group
Mixed

Lower age limit
18 years

Upper age limit
99 years

Sex
All

Total final enrolment
0

Key exclusion criteria
1. Inability (or refusal) to give written informed consent
2. Current in-patient
3. Too unwell or unwilling to undergo study procedures
4. Known microbiologically confirmed PTB

Date of first enrolment
08/09/2025

Date of final enrolment
31/03/2027

Locations

Countries of recruitment
Zambia

Study participating centre
Kanyama First Level Hospital
Chikulukulia Road
Kanyama
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10101

Sponsor information

Organisation
NIHR Global Health Research Programme

Organisation
Delft Diagnostics

Organisation
Wellcome Trust

ROR
https://ror.org/029chgv08

Funder(s)

Funder type
Government

Funder Name
National Institute for Health and Care Research

Alternative Name(s)
National Institute for Health Research, NIHR Research, NIHRresearch, NIHR - National Institute for Health Research, NIHR (The National Institute for Health and Care Research), NIHR

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location
United Kingdom

Funder Name
Delft Imaging

Funder Name
Wellcome Trust

Alternative Name(s)
Wellcome, WT

Funding Body Type
Private sector organisation

Funding Body Subtype
Trusts, charities, foundations (both public and private)

Location
United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study will be available upon request from the PI John Kondwelani Mateyo (John.mateyo@lshtm.ac.uk)

IPD sharing plan summary
Available on request