AI-assisted assessment, triage and management of hearing loss and tinnitus

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The Problem

- **Hearing loss and tinnitus** represent a **major and growing public health challenge** in the UK, affecting 11 million and 7 million people, respectively.[1,2] These conditions significantly impair communication, psychosocial wellbeing, and social participation, and are strongly associated with loneliness, isolation, and poorer mental health outcomes.[3]
- Tinnitus alone accounts for over **one million GP consultations annually**, and patients referred to ear, nose and throat (ENT) services frequently experience **prolonged waiting times, often exceeding one year**, delaying diagnosis and intervention.
- Royal Cornwall Hospitals Trust's (RCHT) **virtual hearing loss and tinnitus clinics** have demonstrated improved efficiency.[4] However, **every case still requires full clinician review,** limiting scalability and efficiency.
- This creates a **pathway bottleneck**, where rising demand and limited resources delay time to treatment for simple cases and reduce specialist focus on complex patients.

Project Aims

- **Systematic Review & Meta-analysis**
  Conduct a formal systematic review of the current evidence on the use of artificial intelligence in the **diagnosis, triage, and management of hearing loss and tinnitus in ENT**, identifying gaps in clinical application and real-world validation.
- **Local diagnostic performance evaluation (Phase 1)**
  Evaluate an **explainable AI clinical decision support system (AI-CDSS)** within the virtual clinic by comparing AI-generated triage and MRI referral recommendations with clinician "gold standard" decisions, assessing accuracy (sensitivity, specificity) and agreement, while maintaining a non-interventional ("shadow") setup.
- **Feasibility, acceptability and implementation (Phase 2)**
  Assess the **feasibility, safety, and usability** of integrating AI into the clinical workflow, alongside evaluation of **patient and clinician experience, acceptability, and trust**, using mixed quantitative and qualitative methods under full clinician oversight.

Methods

Systematic Review & Meta-analysis

A PROSPERO-registered systematic review (CRD420251057007) was conducted in accordance with PRISMA 2020 guidelines. A comprehensive literature search was performed across MEDLINE, EMBASE, CINAHL, and the Cochrane Library without date restrictions, limited to English-language studies. Eligible studies included those evaluating artificial intelligence applications in the triage, diagnosis, or management of hearing loss and/or tinnitus across all healthcare settings. Risk of bias was assessed independently using PROBAST-AI and QUADAS-AI frameworks.

Local diagnostic performance evaluation (Phase 1)

A previously developed and evaluated an explainable AI clinical decision support system was built on a feasibility dataset of 789 patients (Jan 2023–Apr 2024) using Decision Trees (explainability) for predicting triage and MRI recommendation. This model's performance was prohibited by extensive manual effort to extract data. Phase 1 addressed prior data limitations by implementing structured, machine-readable inputs, including:

- Standardised pure tone audiogram data
- Electronic symptom questionnaires (JSON format via Netcall)

This enabled a standardised data pipeline. Successful grant funding application provided a new working contract with Certus Technology to develop a continuous learning system using retrospective and prospective data from August 2025 onwards.

Model development includes:

- **Comparison of multiple algorithms** (Decision Trees, MLP, Random Forest, Support Vector Machine)
- **Performance evaluation using sensitivity, specificity, and AUC**
- **Internal train/test split and 5-fold cross-validation**

Estimated sample size: ~1500 patients/year, with training and validation conducted asynchronously in "shadow mode", ensuring no impact on clinical care.

Feasibility, acceptability and implementation (Phase 2)

Prospective mixed-methods satisfaction/acceptability evaluation of AI integration within a live AI-assisted virtual clinic, by patients and staff. The AI system functions as a decision-support tool under full clinician oversight, with no autonomous decision-making.

Methods include:

- Quantitative assessment: patient/staff satisfaction questionnaires (Likert-scale measures of confidence, acceptability, trust)
- Qualitative evaluation: semi-structured interviews with patients and staff

Directed content analysis guided by the NASSS framework. Assessment of workflow integration, usability, safety, and implementation barriers. This phase evaluates real-world feasibility and user acceptability of the AI-assisted pathway.

Results

Systematic review and metanalysis

4225 articles reviewed. Across **42 included** studies, **AI use in hearing loss and tinnitus were mainly focused on diagnosis and prognostic predictions**, with limited evidence for triage or management support. Most studies were retrospective, internally validated, single centre model-development studies with the majority judged as high risk of bias. Although reported performance was often promising, limited external validation and inconsistent reporting means that current AI tools require further prospective, external validation before clinical implementation at scale.

Figure 1: Data pipeline and model framework

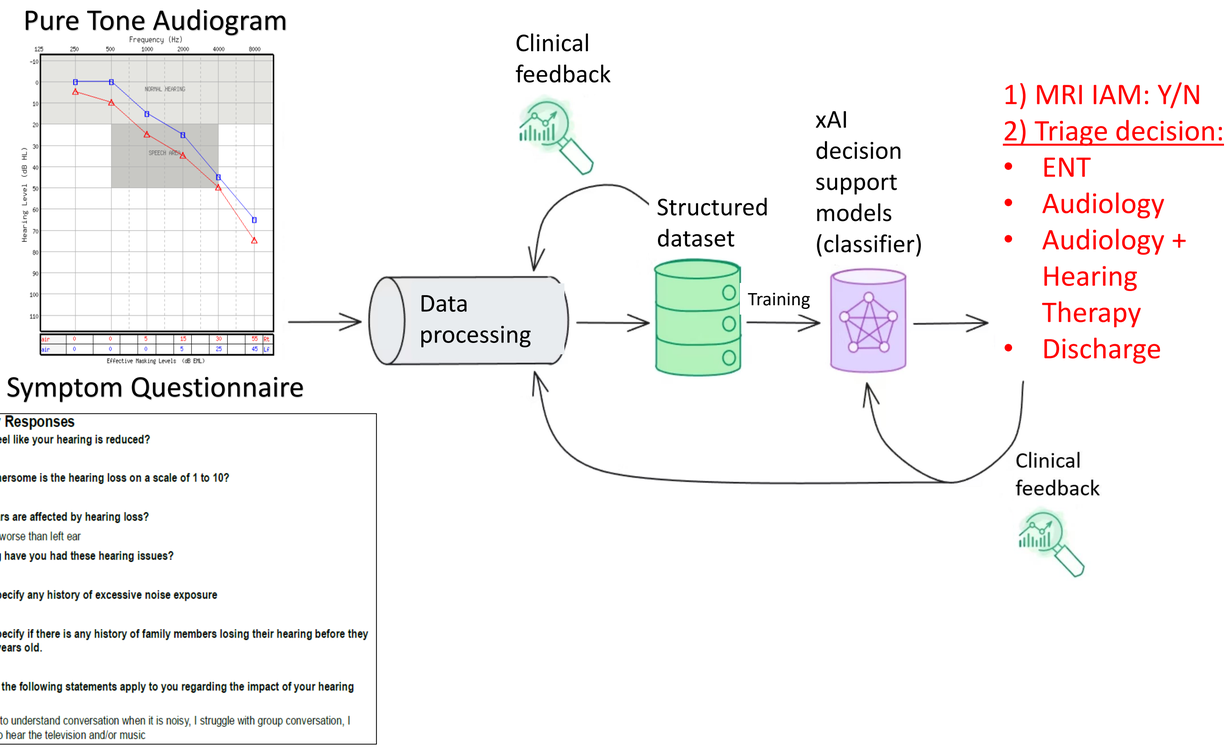
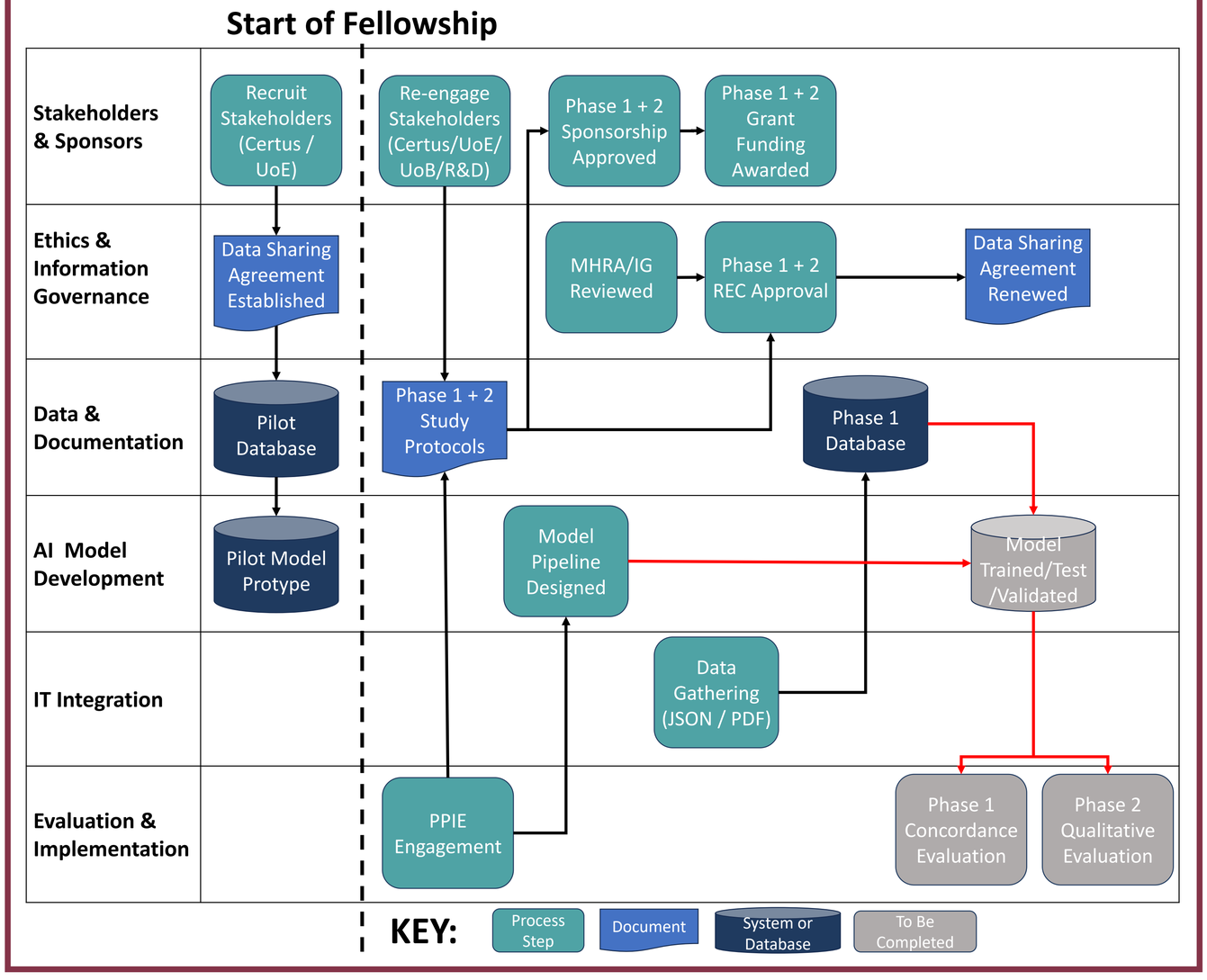


Figure 2: Project Pathway



Future Directions

Complete Phase 1 / Phase 2

C Grimes has secured an NIHR funded Research Associate post to facilitate completion of Phase 1/Phase 2. Additional recruitment from the Cohort 5 Fellowship in Clinical AI to complete Phase 1/2 and set up Phase 3.

Phase 3 (Future multi-site evaluation)

Findings from Phases 1 and 2 will inform the design of a **multi-centre trial** assessing **scalability, generalisability, and system-wide implementation** across NHS settings. This may be designed as a hospital or primary care-facing AI technology.

Phases 1+2 will generate feasibility and performance data, advancing the technology to TRL 4–5, supporting future **NIHR i4i funding applications** and large-scale deployment, with improved integration into existing IT systems and establishing formal MHRA/UKCA approval.

References

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