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EUROPEAN PAEDIATRIC TRANSLATIONAL RESEARCH INFRASTRUCTURE

# Neotree, optimising newborn clinical care and survival in low-resource settings: real-time data and community voices driving better clinical decisions

**University College London Great Ormond Street**
**Institute of Child Health**

**Accessibility to Digital Technologies 28th March 2025**

Professor Michelle Heys, NIHR and UCL Professor of Global Child Health and Community Paediatrican


NIHR and UCL Professor of Global Child Health and Community Paediatrican (Newham, East London)

**#Global health systems, equity, child health, implementation science, inclusion health**

m.heys@ucl.ac.uk

# Overview

1. Introduction to Neotree
2. Impact and evidence base
3. Patient & community engagement
4. Network approach


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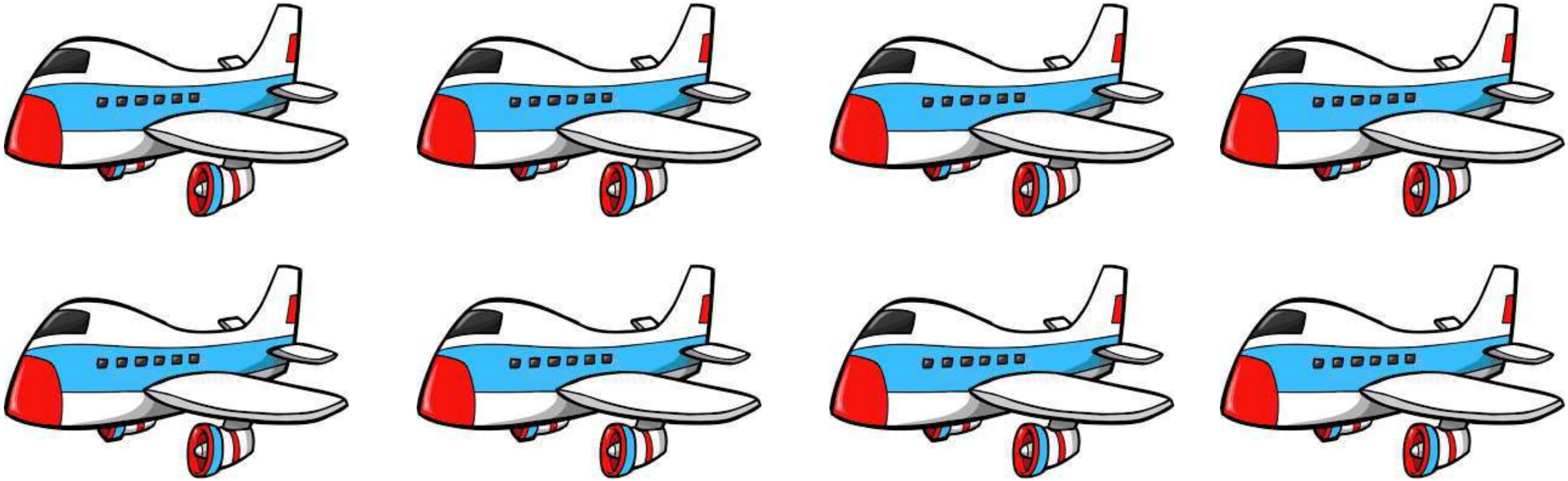
# Section 1:

# Introduction to Neotree

# 8 jumbo jets full of babies dying from clinically preventable causes every day



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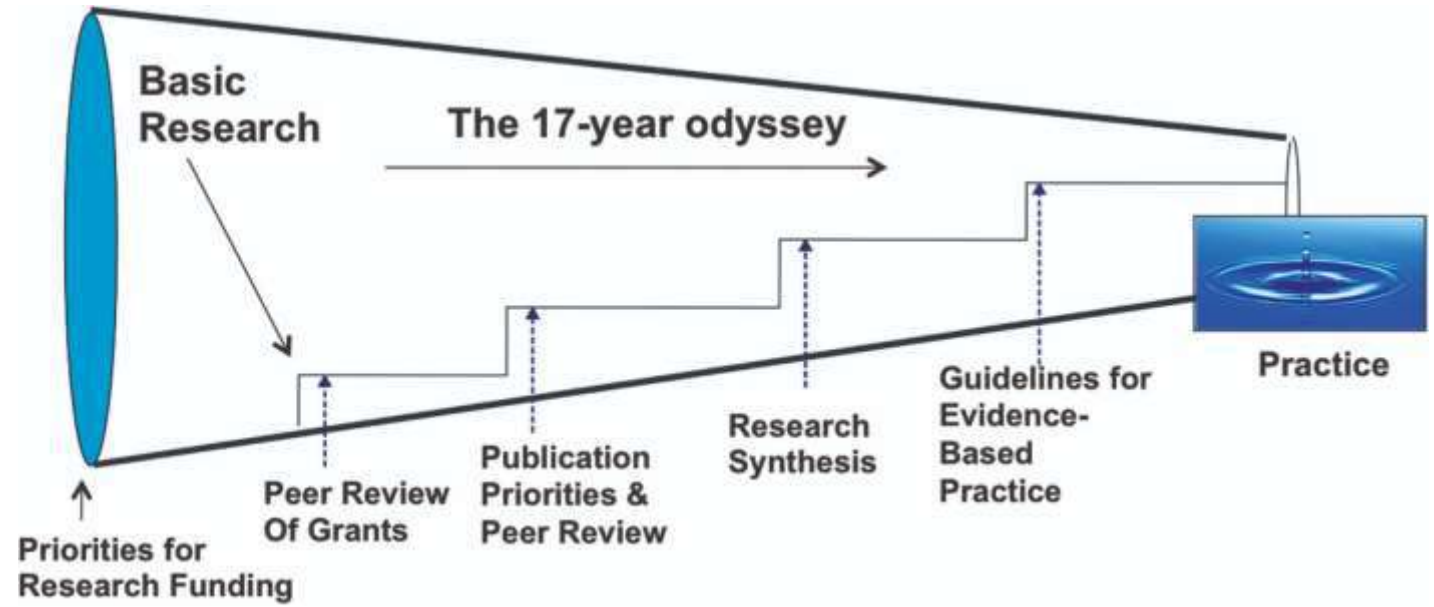
# Implementation gap

Failure of translation of evidence to practice

Strengthening health systems

**Failure to bridge the gap between what we know and what we do**

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# Solution

- Too many babies die of preventable causes **(born in healthcare facilities)**
- **Insufficient data** to drive evidence on how to improve care (**90% from 10%)**
- Many babies and deaths - especially stillbirths are **not counted**


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# Solution

Our tablet-based app guides doctors and nurses at the bedside


The app guides examination, & suggests management according to local & international guidelines

Reliable data are captured for use at both hospital and government level

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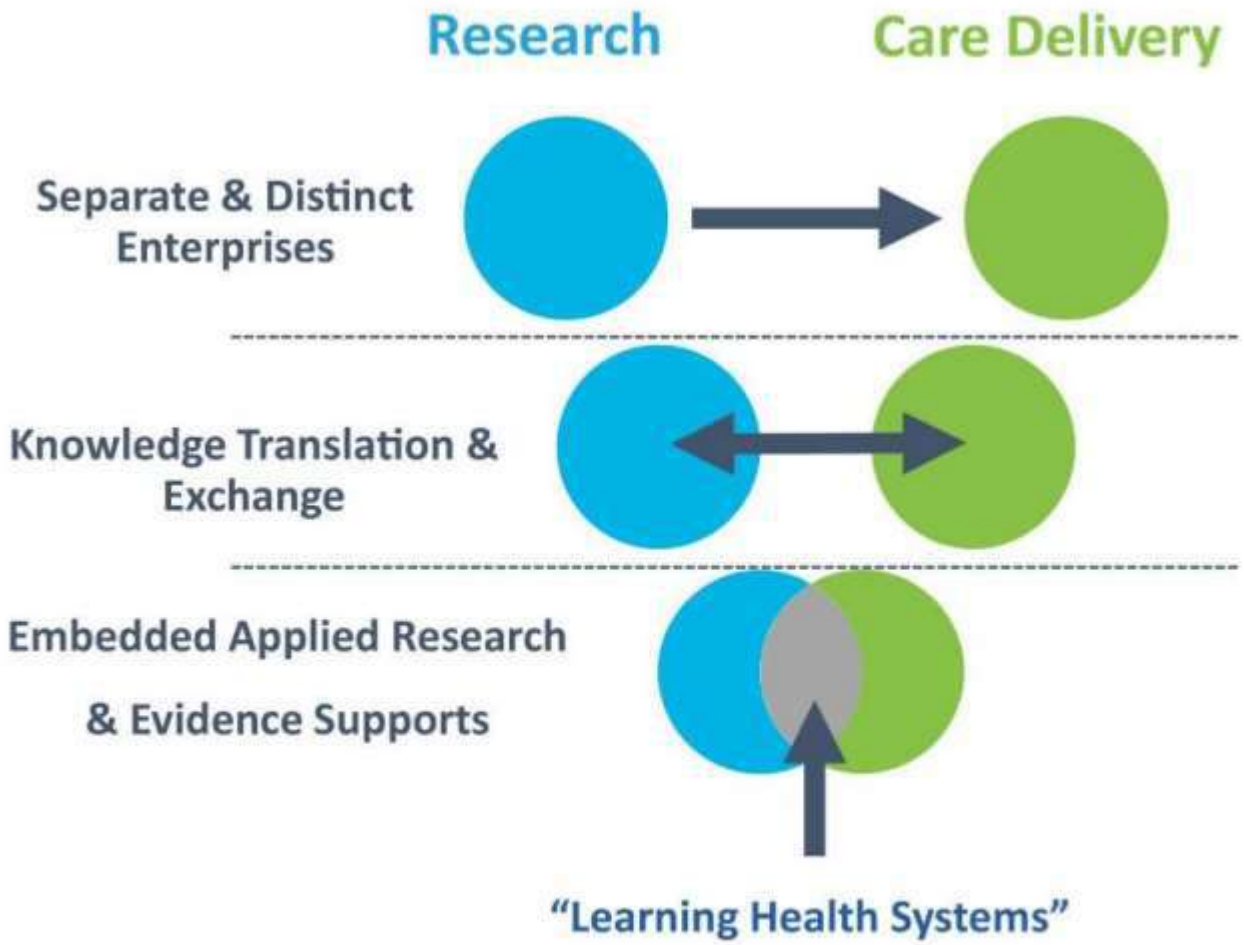
# Learning health system

"science, informatics, incentives, and culture are aligned for continuous improvement and innovation, with **best practices seamlessly embedded in the delivery process and new knowledge captured as an integral by-product** of the delivery experience"

Research **with and within health and community agencies**, as part of their 'usual business'




Reid et al. SSM Health Systems, 2024

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# Location

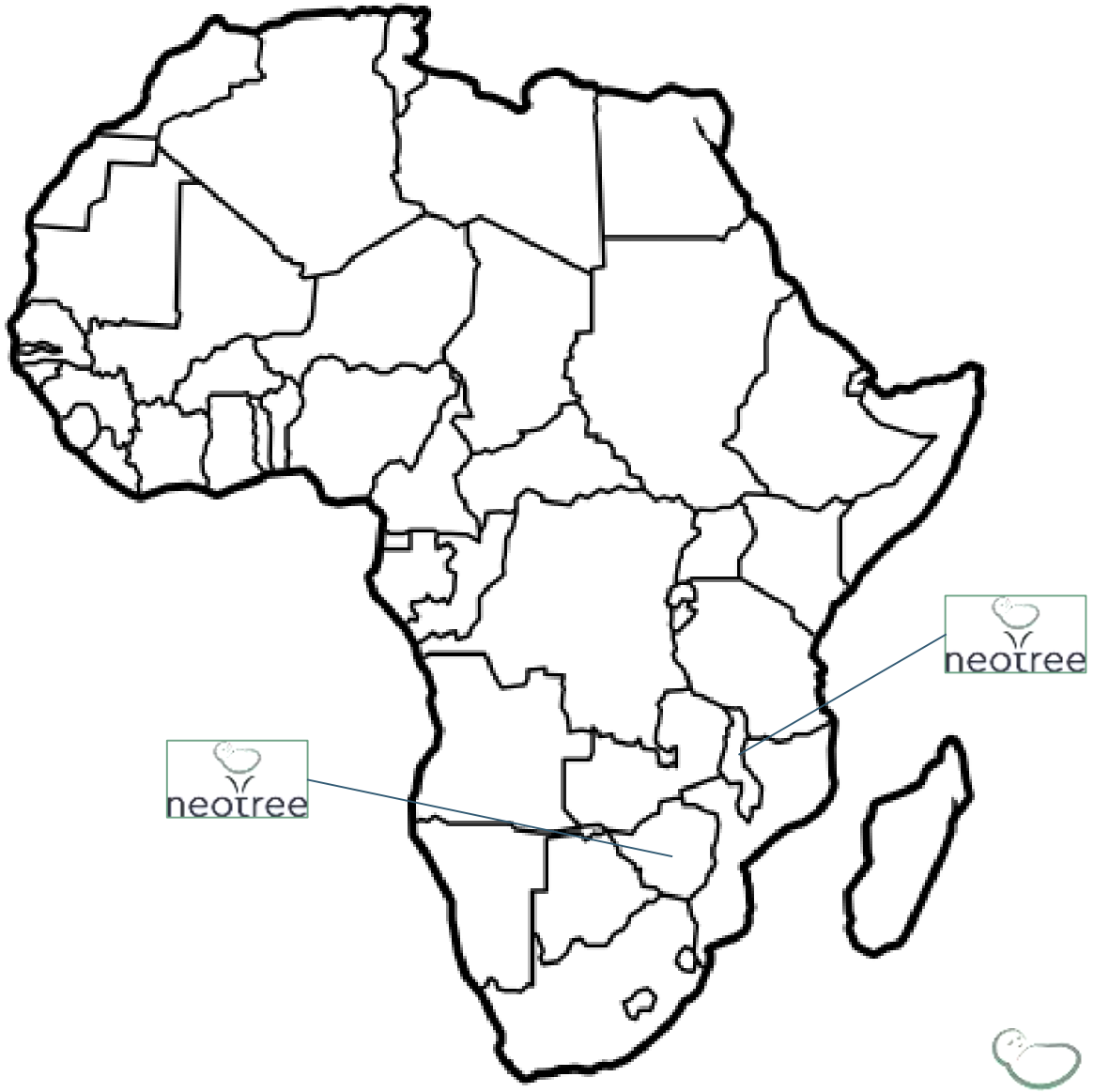
9-> 18 by summer 2026; 26 by summer 2027

**Zimbabwe (4 facilities currently)**

1. **Sally Mugabe Central Hospital**
2. **Chinhoyi Provincial Hospital**
3. **Parirenyatwa Group of hospitals**
4. **Bindura Provincial hospital**

**Malawi (6 facilities currently)**

1. **Kamuzu Central Hospital**
2. **Lumbadzi Primary Health Centre**
3. **Kabudula Community Hospital**
4. **Kasungu District**
    1. **Kasungu district hospital**
    2. **Bua Primary Health Centre**
    3. **9 additional PHC's (over the next year)**

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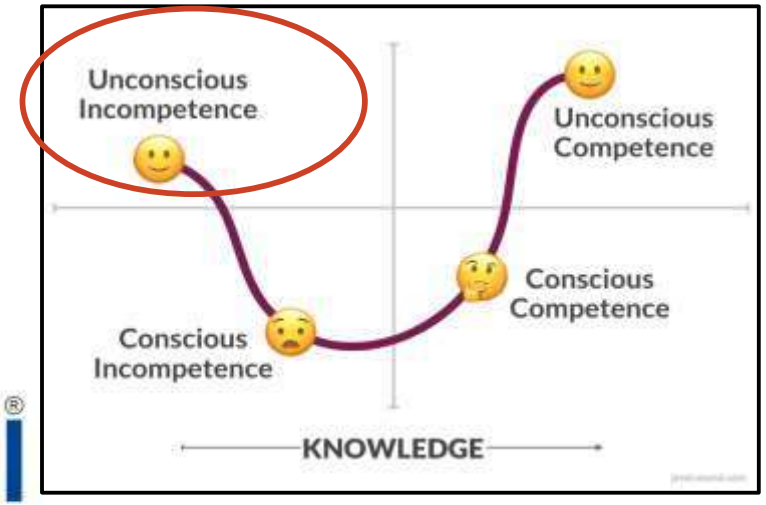
# Clinical Decision Support

How can we predict whether a baby has a given diagnosis on admission, **based on history and clinical examination alone**?

So that we can ensure babies get the right evidence-based clinical interventions - to **standardise clinical care.**

Clinical prediction modelling




**Evidence-based algorithms:**

- **Thermoregulation**
- **Convulsions**
- **Low birth weight**
- **Prematurity**
- **Hypoglycaemia**
- **HIV and Syphilis**
- **Respiratory distress**
- **Neonatal encephalopathy**
- **Sepsis**
- **Jaundice**
- **Congenital abnormalities**

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# Clinical Decision Support - WHO SMART guidelines

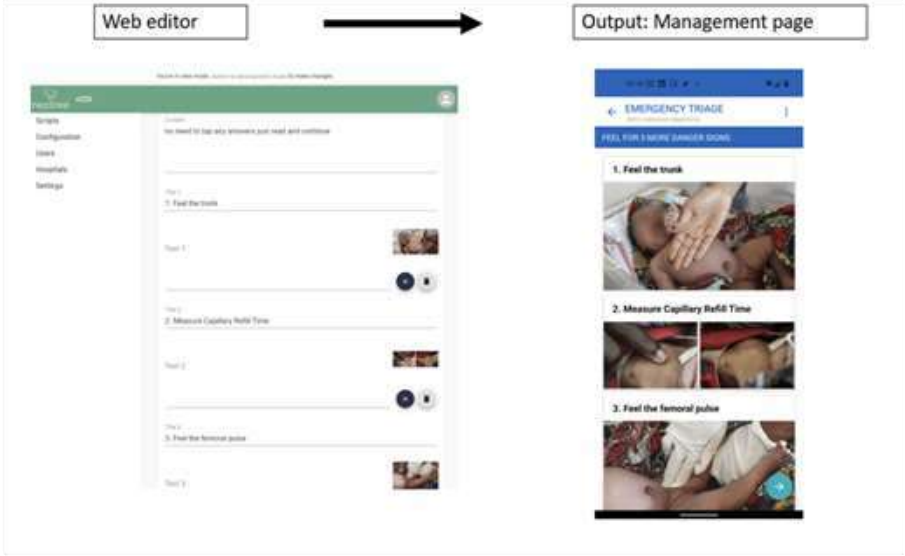
## Visualisation of Neotree CDS aligned with WHO SMART guideline development

**Narrative/paper (level 1)**

**Operational (level 2)**

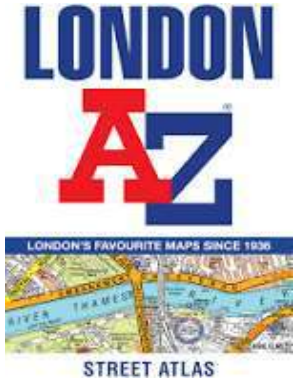
e.g. Pathological jaundice:
($YColour = 'Y' and $Age < 24) or ($YColour = 'Y' and $Gestation =< 35) or ($YColour = 'Y' and ($Jaundice = '5' or $Temperature >= 38 or $BirthWeight < 2500 or $Colour = 'White'))

**Machine readable (level 3)**

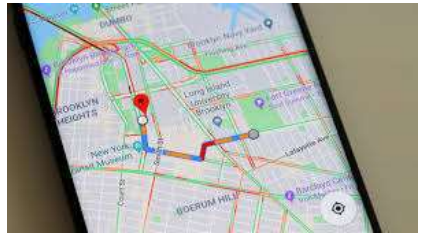



**Executable (level 4)**

**Dynamic, precision health methods (level 5)**

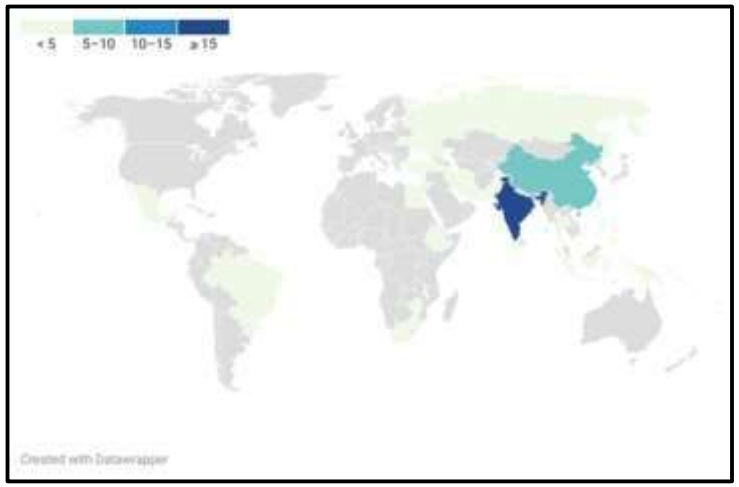

Not easy, guidelines out of date, poor data



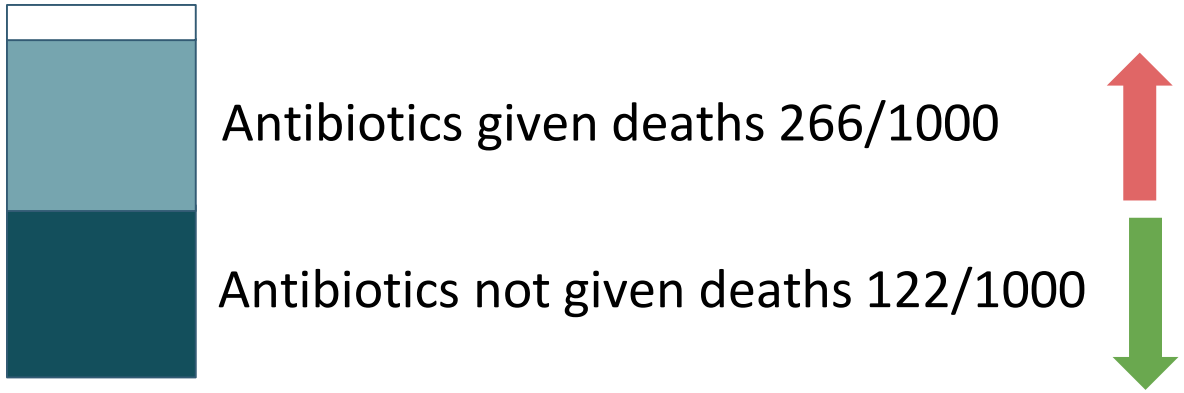
# Clinical Decision Support: Sepsis

## Development of clinical prediction models: sepsis

1. What does the literature say?




2. What do our data say?




91% babies should have been given antibiotics, in fact only 40% got them

Neal, S., Sturrock, S, Musorowegomo D, Gannon, H., Zaman, M., Cortina-Borja, M, Le Doare K, Heys, M., Chimhini, G., Fitzgerald, F. Clinical prediction models to diagnose neonatal sepsis in low-income and middle-income countries: a scoping review. **BMJ GH March 2025** (accepted): Clinical prediction models to diagnose neonatal sepsis in low-income and middle-income countries: a scoping review | medRxiv

Khan N., Shrestha S., Cortina-Borja M., Chimhini G., Zailani G., Gannon H., Mangiza M., Chimhuya S., Fitzgerald F., Heys M., Chiume M. Assessing the use of neonatal sepsis guidelines and antibiotic prescription with large-scale prospective data from Zimbabwe and Malawi. **Journal of the Pediatric Infectious Diseases Society** JPIDS-2024-144.R2 - March 2025 (accepted)

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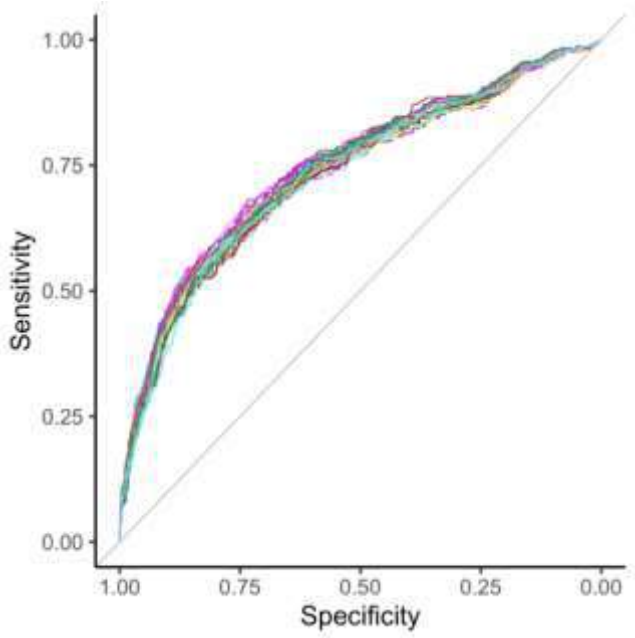
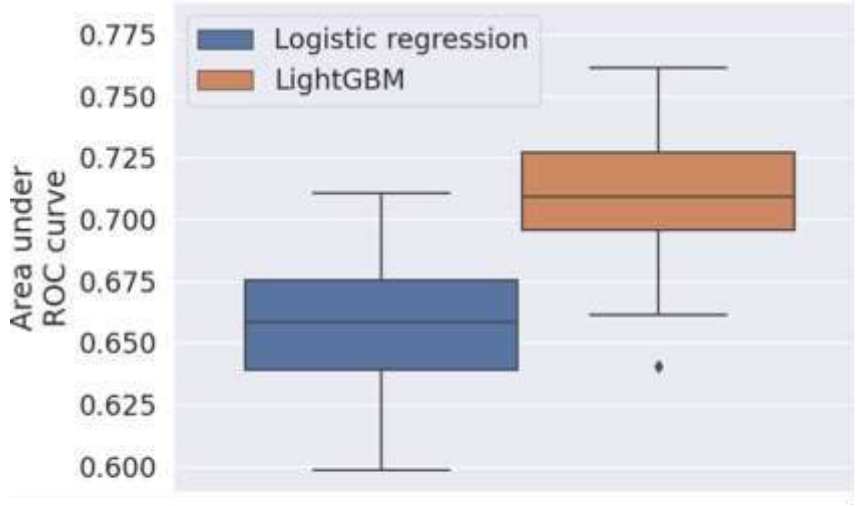
# Clinical Decision Support: Sepsis




sensitivity of 95% (92%–97%), corresponding specificity was 11% (10%–13%)




LightGBM: Machine learning technique
Logistic regression: standard statistical technique
Area under ROC curve: Assessment of predictive performance

High sensitivity - 95%, Low specificity - 30%

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Lowther E, Khan, N, Cortina-Borja, M, Chimhini, G, Neal, S, Mangiza, M, Fitzgerald F, Heys, M, Chimhuya, S. Predicting risk of sepsis in low-resource neonatal units using routine healthcare data: Development and evaluation of multivariate statistical and machine learning models (submitted Feb 2025 Archives of Disease in Childhood)

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# Clinical Decision Support: extension to ML/AI

Wider development and delivery of ML models

- Understanding of behaviour and decision making
- Ongoing work with families and clinicians to explore the feasibility of shared decision-making
- co-create user interface
- Data pipeline
- AI governance
- Linking with other data e.g. weather

Dynamic, precision health methods (level 5)


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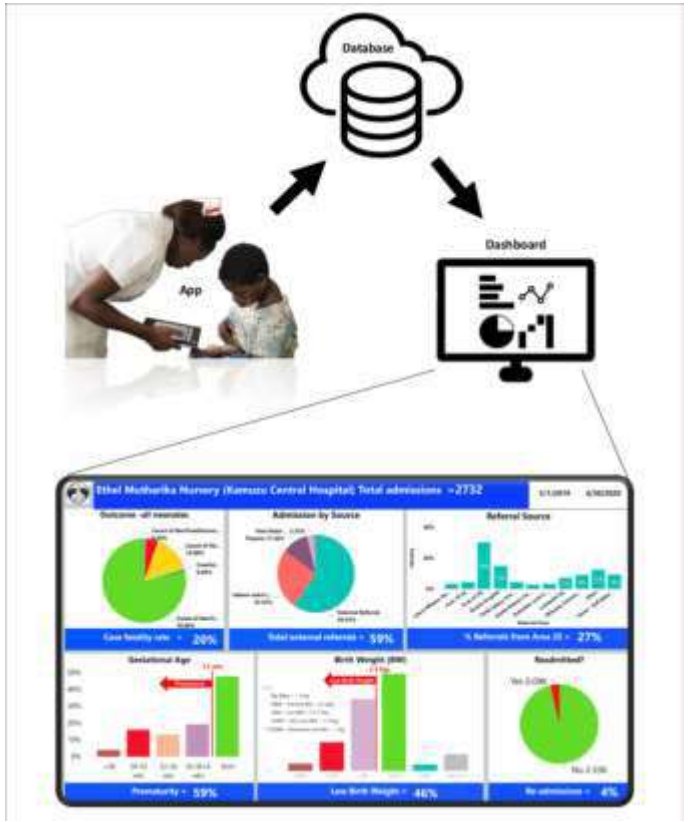
# Data for impact




Data export to
- morbidity mortality slide deck
- QI visualisations
- Health surveillance/trends

Reliable data are captured for use at both hospital and government level

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Image acknowledgement: Crehan, C, Chiume M, Mgusha Y, Dinga P, Hull-Bailey T, Normand C, Sassoon Y, Nkhoma D, Greenwood K, Lorencatto F, Lakhanpaul M, Heys M. Usability-Focused Development and Usage of NeoTree-Beta, an App for Newborn Care in a Low-Resource Neonatal Unit, Malawi. Front Public Health. 2022 Apr 28;10:793314. doi: 10.3389/fpubh.2022.793314.

# Data for impact: surveillance

**Impact of COVID-19 Pandemic on Neonatal case fatality rate within two central hospitals**

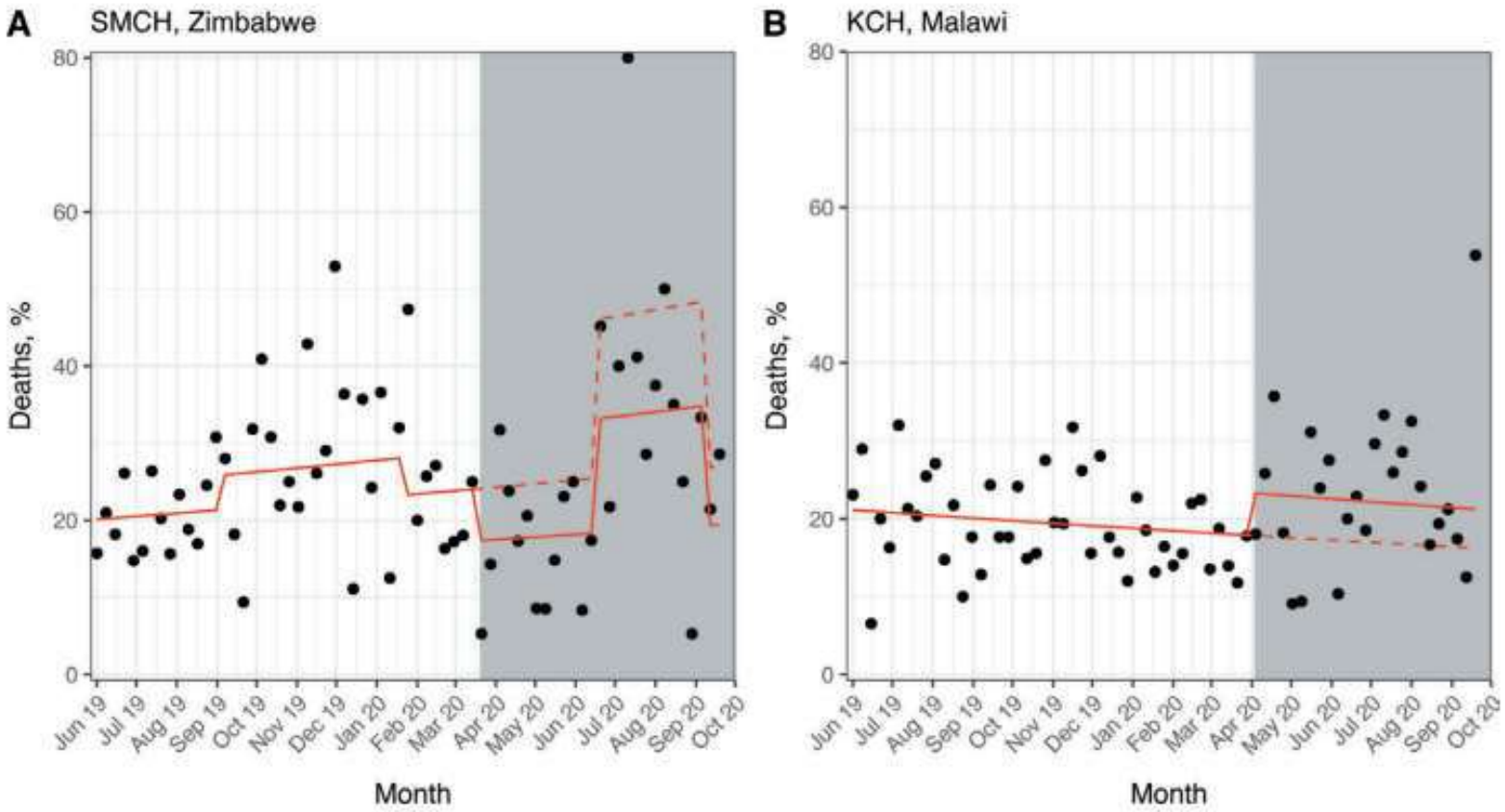


**Figure 4** Interrupted time series for overall mortality. White background: pre-COVID-19 period; grey background: post-COVID-19 period. Solid line: predicted trend from negative binomial regression model (SMCH, A) or Poisson regression model (KCH, B); dashed line: counterfactual scenario. SMCH model (A) adjusted for doctors' and nurses' strike periods; KCH model (B) unadjusted. Data from matched admission and outcome forms only. KCH, Kamuzu Central Hospital; SMCH, Sally Mugabe Central Hospital.

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Chimhuya S, Neal SR, Chimhini G, Gannon H, Cortina Borja M, Crehan C, Nkhoma D, Chiyaka T, Wilson E, Hull-Bailey T, Fitzgerald F, Chiume M, Heys M. Indirect impacts of the COVID-19 pandemic at two tertiary neonatal units in Zimbabwe and Malawi: an interrupted time series analysis. BMJ Open. 2022 Jun 21;12(6):e048955.

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# Data integration: sustainability

| | |
|---|---|
| Electronic Health Records | Develop neonatal module for Zimbabwean **Electronic Health Records** system and rollout to ~1,800 healthcare facilities & **Malawi DHD** around linkage with evolving MaHIS (EMR) |
| DHISv2 | Integration with DHIS2-aggregate in Malawi |
| Vermont Oxford Network | Integrate with VON/Oxford database in collaboration with ANA |






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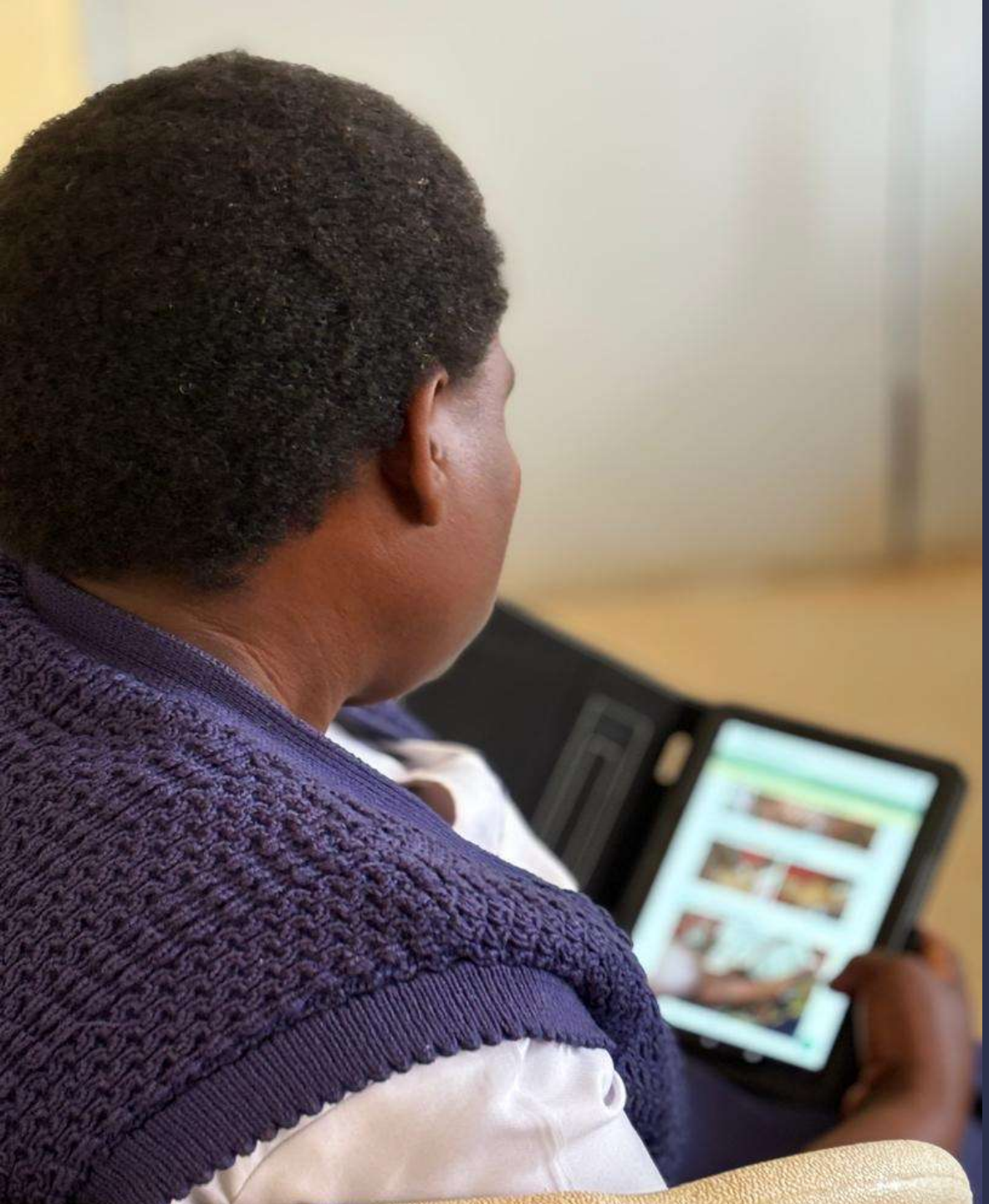

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# Section 2:

# Impact and evidence base

# Evidence of impact

We are committed to generating a robust scientific evidence base for everything we do:

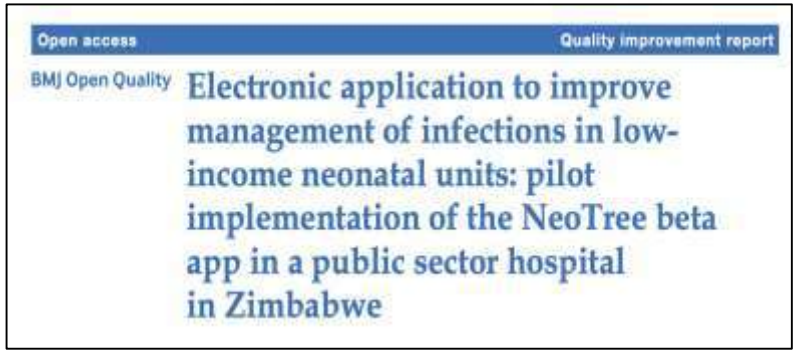
40,000+ babies better cared for

1,400+ trained clinicians

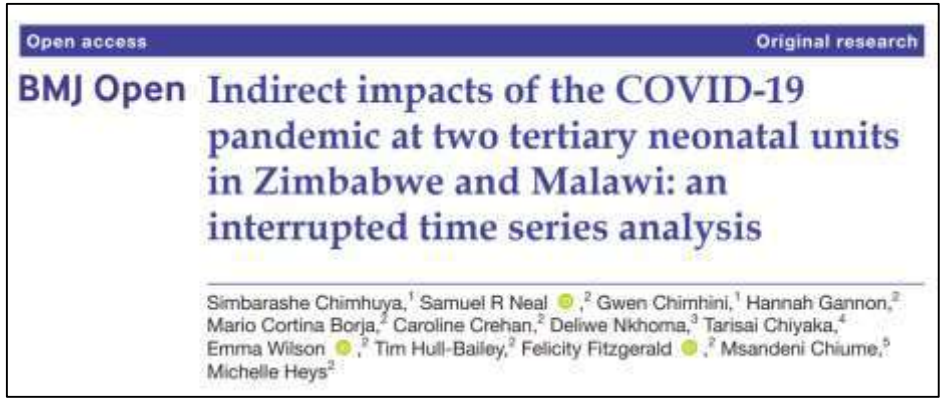
9 sites, 2 countries
(3 central, 2 district, 1 provincial & 1 community hospital & 2 PHC)

>30 academic outputs (>14 in progress)


Learning Health Systems
Open Access
EXPERIENCE REPORT Open Access
Development and implementation experience of a learning healthcare system for facility based newborn care in low resource settings: The Neotree


Open access Quality improvement report
BMJ Open Quality
Electronic application to improve management of infections in low-income neonatal units: pilot implementation of the NeoTree beta app in a public sector hospital in Zimbabwe


Practice
BMJ Global Health
The NeoTree application: developing an integrated mHealth solution to improve quality of newborn care and survival in a district hospital in Malawi


Open access Original research
BMJ Open
Indirect impacts of the COVID-19 pandemic at two tertiary neonatal units in Zimbabwe and Malawi: an interrupted time series analysis
Simbarashe Chimhuya, Samuel R Neal, Gwen Chimhini, Hannah Gannon, Mario Cortina Borja, Caroline Crehan, Deliwe Nkhoma, Tarisai Chiyaka, Emma Wilson, Tim Hull-Bailey, Felicity Fitzgerald, Msandeni Chiume, Michelle Heys


JMIR Publications
JMIR Preprints
Estimating the costs of developing and implementing a digital quality improvement tool designed to improve newborn care and survival in Malawi and Zimbabwe: Neotree
Hassan Haghparast-Bidgoli, Tim Hull-Bailey, Deliwe Nkhoma, Tarisai Chiyaka, Emma Wilson, Felicity Fitzgerald, Gwendoline Chimhini, Nushrat Khan, Hannah Gannon, Rekha Batura, Mario Cortina-Borja, Leyla Larsson, Msandeni Esther Chiume, Yali Sassoon, Simbarashe Chimhuya, Michelle Heys

# Evidence of impact

**Highly usable, acceptable, feasible tool** that has resulted in both perceived, and observed, improvements in newborn care:

- Acceptable to mothers/carers of sick neonates.
- Reduced rates of hypothermia (80% -> 50%)
- Optimised prescription of antibiotics at discharge (97% -> 3%)
- Reduced turnaround time for blood culture results from 5 days to <48 hours

Neotree automatically recorded 99.7% of admissions, >100% discharges, >96% deaths (in comparison to HMIS)

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# Evidence of impact

✓ Cost per admitted baby as low as $5

✓ Time to admit a baby is the same as current handwritten paper methods - but Neotree's digital platform offers better care and better data

✓ Data used for perinatal mortality audits

✓ Neotree App also used for clinical induction of new and junior staff

*"Neotree is like switching on a light"*
Dr. Simbarashe Chimhuya, Neotree PI, Zimbabwe

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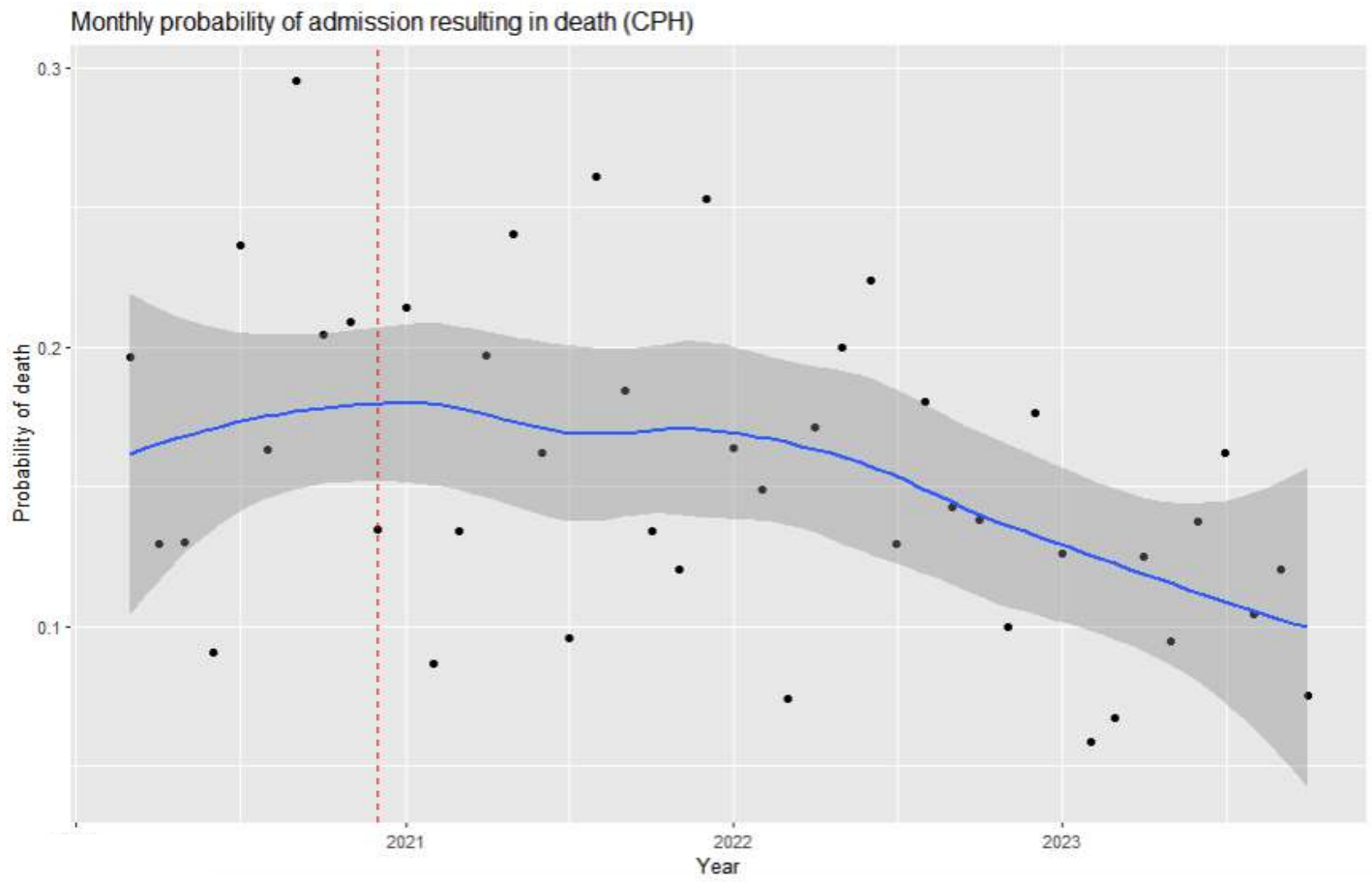
# Evidence of impact




**Sustained non-statistically significant reduction in overall mortality (small sample size, 3000)**

**level (RR: 0.877, 95% CI: 0.541-1.423, p=0.596)**

**slope (RR: 0.997, 95% CI: 0.977-1.018, p=0.781)**

Palmer, Chimhuya, Khan, Cortina Borja, Wilson, Hull-Bailey, Gannon, Chiyaka, Rao, Fitzgerald, Madziva, Goodman, Sassoon, Haghparast-Bidgoli#, Michelle Heys #Modelling impact and cost-effectiveness of Neotree, a digital data capture and decision support tool designed to improve neonatal survival in Zimbabwe (submitted BMJ GH)

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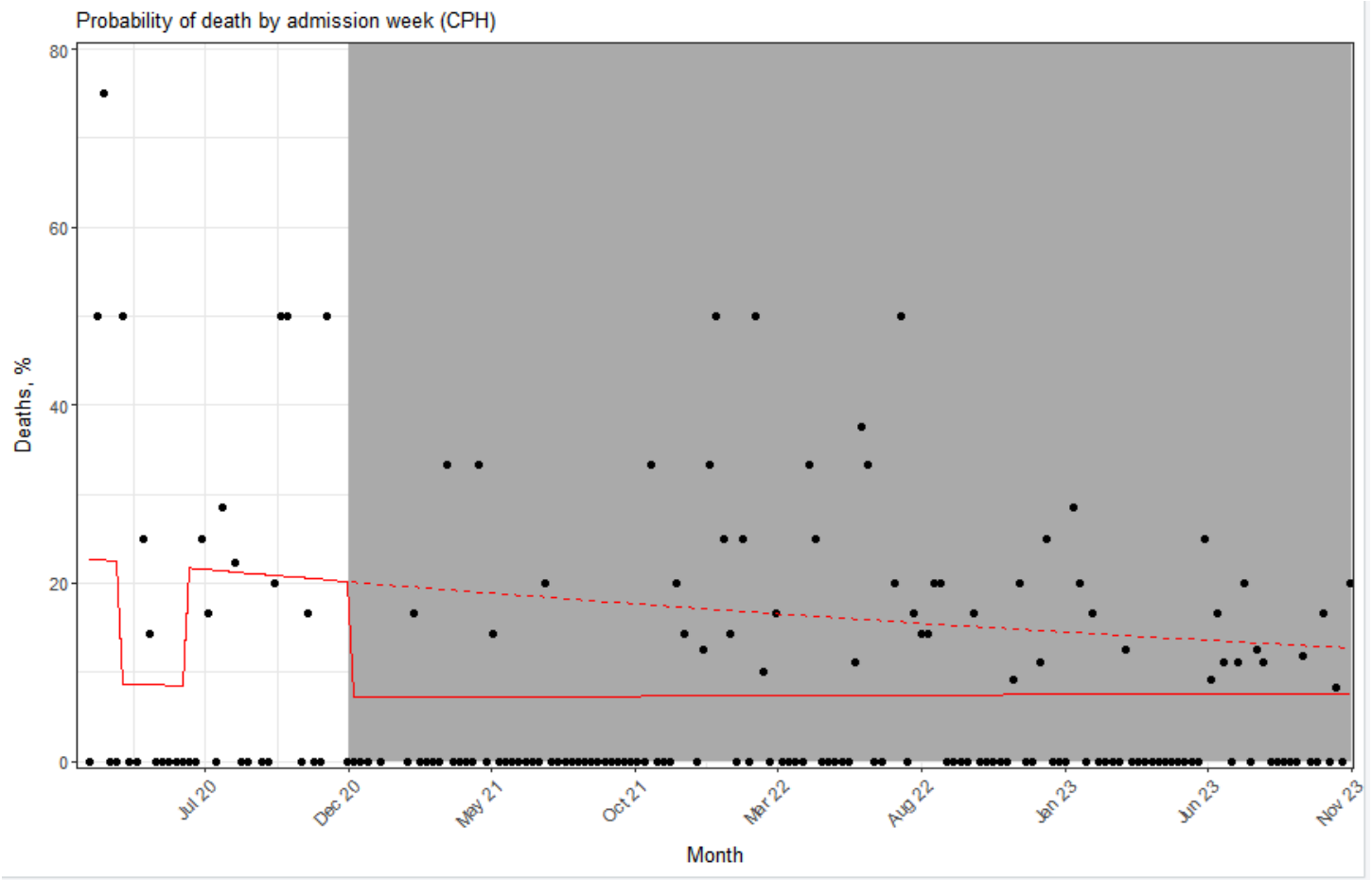
# Evidence of impact




## Even greater impact on mortality for babies born 1.5-2.5kg

Coefficient on level (RR: 0.356, 95% CI: 0.127-1.002, p=0.051) but not the slope (RR: 1.004, 95% CI: 0.965-1.046, p=0.833) of mortality

Palmer, Chimhuya, Khan, Cortina Borja, Wilson, Hull-Bailey, Gannon, Chiyaka, Rao, Fitzgerald, Madziva, Goodman, Sassoon, Haghparast-Bidgoli#, Michelle Heys #Modelling impact and cost-effectiveness of Neotree, a digital data capture and decision support tool designed to improve neonatal survival in Zimbabwe (submitted BMJ GH)

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# Evidence of impact

Using conservative assumptions

Incremental cost-effectiveness ratio $6.35 (£5) per Healthy life year saved if intervention scaled up nationally

Cost effectiveness threshold for LIC $74 -278 per QALY

Needs testing to see if replicated at scale

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# Further development - perinatal and labour ward care

SOLUTIONS

1. create a perinatal module to integrate with postnatal support in Neotree: Mummytree (Dr Simba Chimhuya, UCL PhD)
2. Strengthen labour ward care “Golden hour interventions” (Marcia Mangiza, FCDO Zim funded work)


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# Section 3: Patient and Community Engagement

# Parent and community voice

## Qualitative research and hands-on experience revealed uncomfortable hierarchies and limited patient agency

*“At times you don’t understand and you will feel scared to ask what they are doing. I have heard you will not get good treatment from nurses if you ask them”*

## Implications for patient-centred care and acceptability of Neotree

*"I didn’t understand what was happening. I was asking myself why she was asking me all that. (…) Because maybe the responses I gave them was just to finish it up (…) So if someone comes with a tablet then should explain”*

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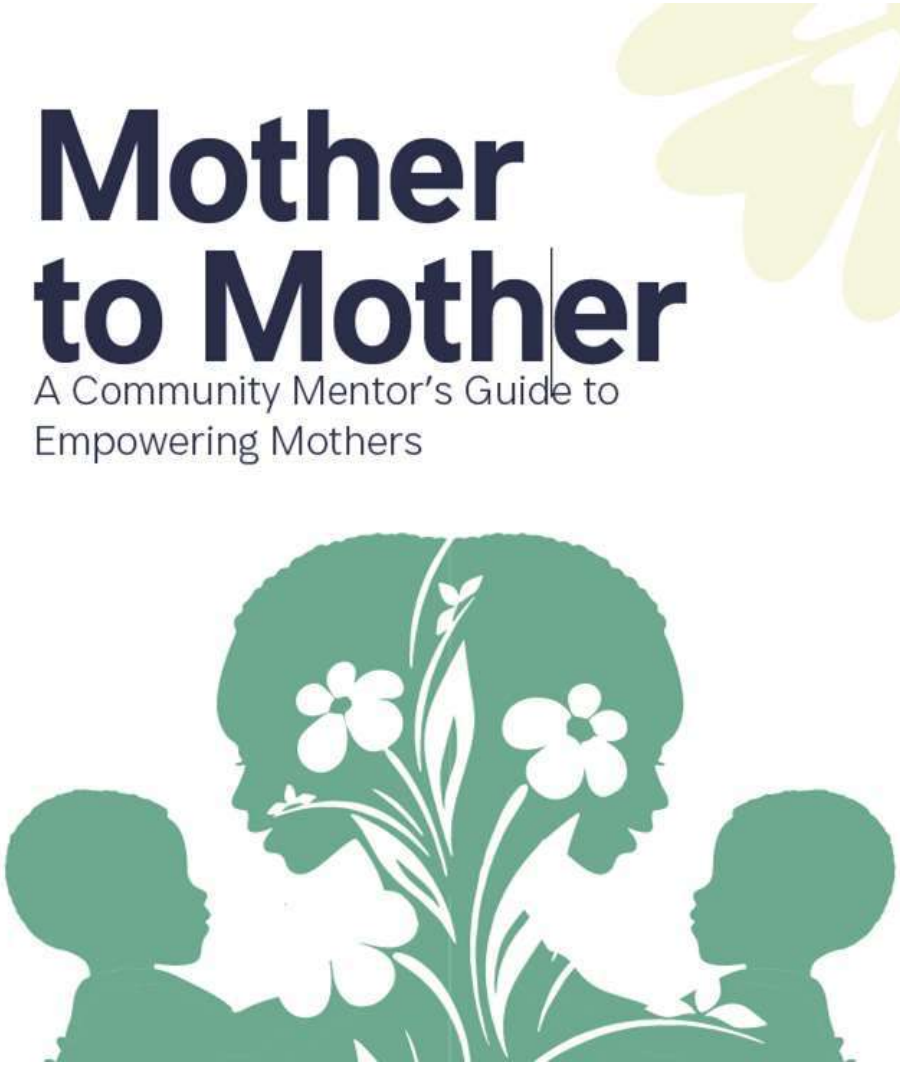
Slide acknowledgement: Dr Emma Wilson

# Parent and community engagement and involvement

- Training in arts-based approaches to surface experiences of health seeking in formal facilities
- **Building relationships** between clinical teams and mothers/ caregivers
- Working with mothers, families and nurses on joint quality improvement plans

# Evidence of impact




- Establishment of dedicated community groups at Neotree sites (n=5)
- Space for mutual support and joint QoC initiatives with clinical staff
- Peer support sessions (mother-to-mother) in postnatal wards and NICU (being co-developed and piloted at SMCH)



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Slide acknowledgement: Dr Emma Wilson

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# Section 4:
# Network approach
# & extension to primary care

# Adaptation and extension to Primary Care


- 40% women deliver in primary care facilities
- Lower quality of care and worse outcomes
- Education in newborn care in primary health clinics
- National and global priority

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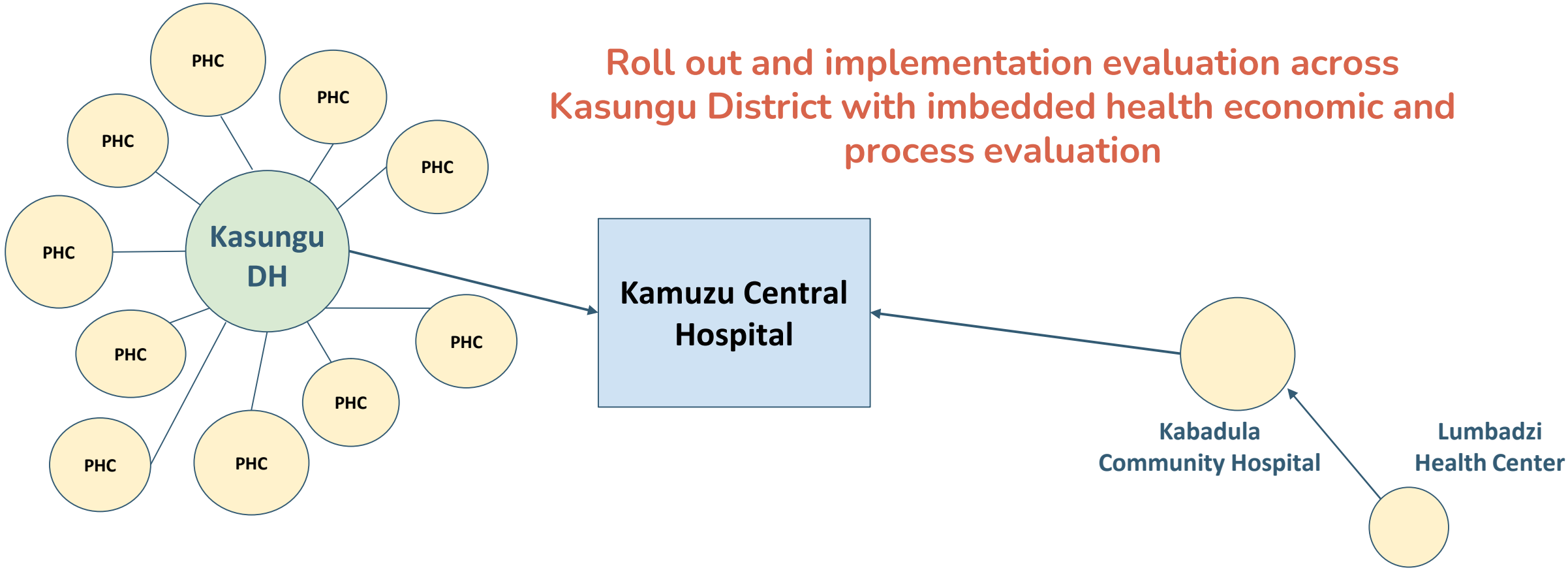
# Network implementation evaluation




Roll out and implementation evaluation across Kasungu District with imbedded health economic and process evaluation

Benefits - improved measures of care, timely transfer, provision of high quality complete data.

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# Acknowledgements

# Neotree co-PIs

**Dr Msandeni Chiume-Kayuni**
Chief Paediatrician on the Ministry of Health (Malawi),
Head of Paediatrics and Child Health department at Kamuzu Central Hospital (KCH)
Co-PI and site leader of the New Born Essential Solutions and Technologies (NEST 360) program
UCL PhD (FCDO-Malawi/ BMGF)

**Dr Simbarashe Chimhuya**
Paediatrician and an academic at the University of Zimbabwe (Faculty of Medicine and Health Sciences). I am head of a 100-bed teaching neonatal unit at Sally Mugabe Central Hospital (Harare)
UCL PhD (NIHR GHRP)

**NIHR UCL Prof Michelle Heys**
Paediatrician, East London NHS Foundation Trust, London
NIHR UCL Professor of Global Child Health, UCL Great Ormond Street Institute of Child Health

# Neotree team



Malawi Government
Ministry of Health

GOVERNMENT OF ZIMBABWE
Ministry of Health & Child Care

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ABOUT RESEARCH TECHNOLOGY SAFEGUARDING OPPORTUNITIES GET INVOLVED

# Counting and caring for every newborn

The Neotree system is a low cost, acceptable, feasible and highly usable tool. It empowers healthcare professionals, in low resource settings, to count and care for every newborn.

WATCH A VIDEO ABOUT NEOTREE ›

# Funders and Prizes


#madeatUCL one of top 5 innovations across UCL


FUNDED BY NIHR National Institute for Health and Care Research

wellcome

UKaid from the British people

Foreign, Commonwealth & Development Office

Healthcare Infection Society

UCL GREAT ORMOND STREET INSTITUTE OF CHILD HEALTH

RCPCH Royal College of Paediatrics and Child Health

BILL & MELINDA GATES foundation

Laerdal Foundation

UCL Grand Challenges

ART & GLOBAL HEALTH CENTER AFRICA

UCL Centre for Behaviour Change

ViiV Healthcare

UKRI Medical Research Council

GHII

NHS East London NHS Foundation Trust

Imperial College London

unicef for every child

BRTI Biomedical Research and Training Institute

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Pierre Fabre

Private donors and foundations, runners, climbers

*“Neotree is like having a digital version of the late Dr. Kazembe in your pocket”*

Dr. Msandeni Chiume
Neotree PI, Malawi

Regarded as the “grandfather of paediatrics” in Malawi and Neotree’s first clinical lead for its clinical decision support testing

Thank you on behalf of the Neotree team
Neotree.org
Twitter: TheNeotree