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Clinical Information Network

CIN INSIGHTS BRIEF 4, FEBRUARY 2025

Assessing quality of care at scale: Research insights from the Clinical Information Network in Kenya

Key points

- Over the past decade, the Clinical Information Network (CIN) has developed a robust platform for collecting routine hospital data, building a dataset from over 650,000 admissions. This has enabled longitudinal, multi-site research, providing a foundation for evidence-based improvements in health care.
- CIN research has offered important insights into disease prevalence, risk factors for poor outcomes, and care practices for key conditions affecting children. Its extensive dataset has also supported the validation of tools for assessing quality of care and predicting mortality, ensuring their relevance and adaptability to low-resource settings.
- The network has also supported several clinical trials, including studies on pneumonia treatment, malaria vaccination, and neonatal medication safety, generating evidence to guide practice and policy.
- During the COVID-19 pandemic, CIN demonstrated its adaptability and value in supporting public health surveillance and delivering rapid, actionable feedback to the government.

ABOUT THIS SERIES

This is **Brief 4** in a series exploring the evolution, implementation, and impact of the Clinical Information Network (CIN) in Kenya. Each brief focuses on a distinct aspect of CIN's work.

Laying the foundations for better care: Developing tools, guidelines, and information architecture to support learning and improvement in Kenya's hospitals

A theory-informed approach: Applying theoretical frameworks to guide the development of CIN and its interventions

Transforming care in Kenyan hospitals: Showcasing CIN's progress in improving care processes and outcomes

Assessing quality of care at scale: Demonstrating research contributions, including validating tools, evaluating guidelines, clinical trials

System influences and interventions: Presenting research on health system barriers and system interventions to improve care

Exploring behavioural and organisational dynamics: Investigating the human and organisational factors shaping care practices

Background

Improving the quality of care in hospital settings presents a substantial challenge in low- and middle-income countries (LMICs), where health care systems often face constraints, including limited resources, institutional weaknesses, and a lack of reliable data to inform decision-making. Much of the evidence for care improvement derives from controlled research environments or high-income settings, limiting its applicability in LMIC contexts.

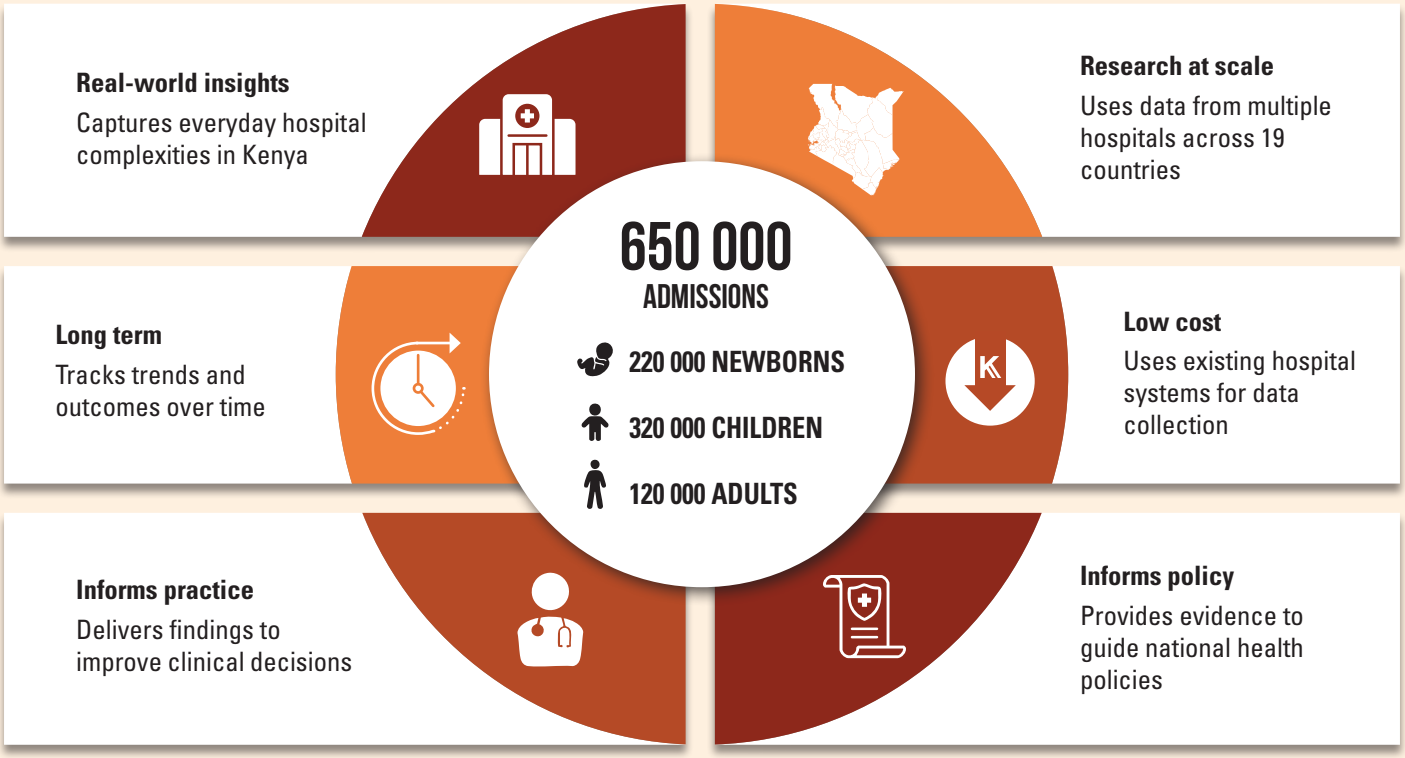
Established in 2013, the CIN is a collaborative platform uniting researchers, government, national organisations and hospitals to support the use of information to improve inpatient care in Kenya. Initially focused on paediatric care, CIN expanded to include CIN-N, a neonatal-focused initiative in 2017, and broadened further during the COVID-19 pandemic to include adult medical admissions.

Collectively, CIN and its extensions now represent one of sub-Saharan Africa's largest and longest-lasting learning health system platforms. They have gathered comprehensive data from over 650,000 hospital admissions including clinical care, treatments, and outcomes. These efforts have facilitated locally-led research at scale, supported pragmatic clinical trials to evaluate interventions, and generated evidence to inform both practice and policy (see figure 1).

This brief summarises CIN's contributions to assessing quality of care at scale through six areas:

1. Understanding severe illness and case management
2. Evaluating the appropriateness of international guidelines in local contexts
3. Validating tools to measure and improve quality of care
4. Uncovering gaps in care and health system challenges
5. Enabling experimental studies and trials to evaluate the effectiveness of interventions
6. Leveraging CIN for public health surveillance.

Figure 1: Benefits of CIN data



1. Understanding severe illness and case management

CIN has used longitudinal data from multiple hospitals to better understand outcomes, risk factors, and the quality of care for conditions including pneumonia, diarrhoea with dehydration (DD), severe acute malnutrition (SAM) and malaria – leading causes of death in children under five in Kenya and sub-Saharan Africa. Similar work through CIN-N has focused on neonatal hypothermia. Table 1 summarises key insights from the research for these conditions.

Table 1 **Research insights for specific illnesses and conditions**

Condition	Scale of problem	Research data	Research insights
Diarrhoea and dehydration[1]	Causes ~0.6 million annual deaths in children under 5 globally, with significant mortality in Africa and Southeast Asia.	Oct 2013 – Dec 2016; 13 hospitals; 8,562 admissions with DD	• 9% in-hospital mortality rate • Associated with severe dehydration and comorbidities like abnormal respiratory and circulatory signs • Correct rehydration therapy associated with 30% lower mortality
Severe Acute Malnutrition (SAM)[2]	Contributes to approximately half of 5.9 million deaths of children aged under 5 years worldwide. In study hospitals, 9.9% of children admitted with medical conditions had SAM.	Dec 2013 - Nov 2016; 13 hospitals; 54,140 admissions	• Case fatality rates varying from 6% to 28.6% across hospitals • Overall mortality among all SAM admissions aged 1±59 months was 15.8% • Associated with insufficient adherence to clinical protocols and quality of care
Malaria[3]	Estimated 247 million malaria cases and 619 000 malaria deaths worldwide in 2021, ~90% of the burden in sub-Saharan Africa. In study hospitals, 67% of children had a diagnosis of malaria.	Mar 2014 - Feb 2016; 5 hospitals (in high-malaria areas); 13,014 admissions with a diagnosis of malaria	• Over 80% of malaria positive cases were prescribed anti-malarials • 46.1% received artesunate (recommended treatment) with ~50% still receiving intravenous quinine. • 69% with a negative result were prescribed antimalarials
Pneumonia[4]	A leading cause of death in children under 5 globally	Mar 2014 – Feb 2016; 14 hospitals; 16,162 admissions with pneumonia	• 5% of admission deaths reported in Kenyan hospitals • Risk factors for death: severe pallor, weight-for-age Z score <–3 SD, and lower chest wall indrawing. • Non-severe pneumonia with these risk factors also increases mortality
Neonatal Hypothermia[5]	In study hospitals, 17.5% of newborns admitted with hypothermia	Jan 2020 - Mar 2023; 21 newborn units; 58,804 admissions	• Low birthweight and very low APGAR scores strongly associated with hypothermia • Increased odds of neonatal death by 35%

Across conditions, the findings highlight the importance of supporting hospitals to adhere to evidence-based practices. For example, children with DD experienced better outcomes when proper fluid prescription protocols were followed. Research on malaria demonstrates several barriers to effective care, including over-reliance on presumptive treatment, delayed adoption of recommended medicines, and inconsistent use of diagnostic tests.

Neonatal hypothermia emerged as a critical challenge in newborn care. Among newborns admitted, 17.5% presented with hypothermia, and these babies were 35% more likely to die. The findings draw attention to the urgent need for improved temperature regulation during transport and in hospitals, particularly for low-birthweight infants.

2. Evaluating the appropriateness of international guidelines in local contexts

CIN data has been instrumental in assessing the applicability of international (World Health Organization (WHO)) guidelines to health care settings in Kenya, exploring whether some children classified as having "non-severe" pneumonia and recommended for outpatient care under the guidelines might still require hospital admission to reduce the risk of death.[4] By analysing data from 14 hospitals, the research identified risk factors for mortality among children with "non-severe" pneumonia. Severe underweight, defined as a weight-for-age Z-score (WAZ) below -3 standard deviations, and signs of anaemia (pallor) were associated with death rates similar to those of children with severe pneumonia. The findings point to the need for context-specific adaptations of global guidelines and the value of CIN data in generating locally relevant evidence to inform clinical decision making.

3. Validating tools to measure and improve quality of care

CIN research has contributed to the validation of tools to assess the quality of care provided in Kenyan hospitals. The Paediatric Admission Quality of Care (PAQC) score evaluates adherence to clinical guidelines for common illnesses including malaria, pneumonia, and diarrhoea, aligning with the Ministry of Health's Basic Paediatric Protocols. A study across 27 facilities and over 19,000 admissions found the PAQC score to be consistently linked to mortality outcomes, making it an effective benchmark for quality of care.[6] Higher PAQC scores were associated with a 17% reduction in the odds of inpatient death per unit increase in the score, further validating its role as a tool to improve clinical outcomes.

CIN-N has developed tools to predict in-hospital neonatal mortality – the Neonatal Essential Treatment Score (NETS) and the Score for Essential Neonatal Symptoms and Signs (SENSS). Designed for use in low-resource settings, these tools rely on treatment data or clinical signs to predict mortality. Initially tested with data from over 5,000 admissions across 16 hospitals, both tools demonstrated strong predictive performance.[7] This was measured using c-statistics – a standard metric for evaluating prediction models – where values closer to 1 indicate excellent accuracy. The tools achieved scores of 0.92 and 0.91 during initial development and 0.89 during broader testing, reflecting their ability to reliably identify babies at higher risk of death. Subsequent validation studies with data from over 45,000 admissions further refined these models, confirming the reliability of these prognostic scores in high-mortality, low-resource settings.[8]

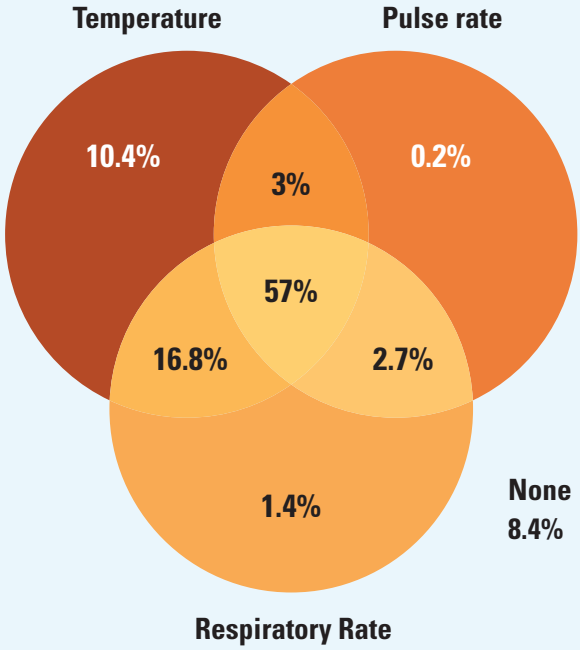
4. Uncovering gaps in care and health system challenges

Several studies have uncovered significant gaps in routine care practices, resource availability and diagnostic processes, highlighting health system barriers to improving hospital care.

Monitoring vital signs

Monitoring vital signs is necessary for effective inpatient care, especially for children with severe illnesses. In low-resource settings like Kenya, limited staffing and infrastructure often hinder this practice. Research across 13 Kenyan hospitals found that a full set of vital signs was recorded for only 57% of children on admission, while 8.4% had no documented vital signs (see figure 2).[9] Partial recordings were common, and blood pressure was rarely measured. Ongoing monitoring also varied widely, with a median of nine observations per child over 48 hours instead of the recommended 18. Staffing shortages, with nurse-to-patient ratios up to 1:41, were a major challenge. Addressing these gaps requires more staff, better training, prioritisation of high-risk patients, and use of technologies to improve the efficiency of monitoring.

Figure 2 **Proportion of children whose vital signs were documented at admission**



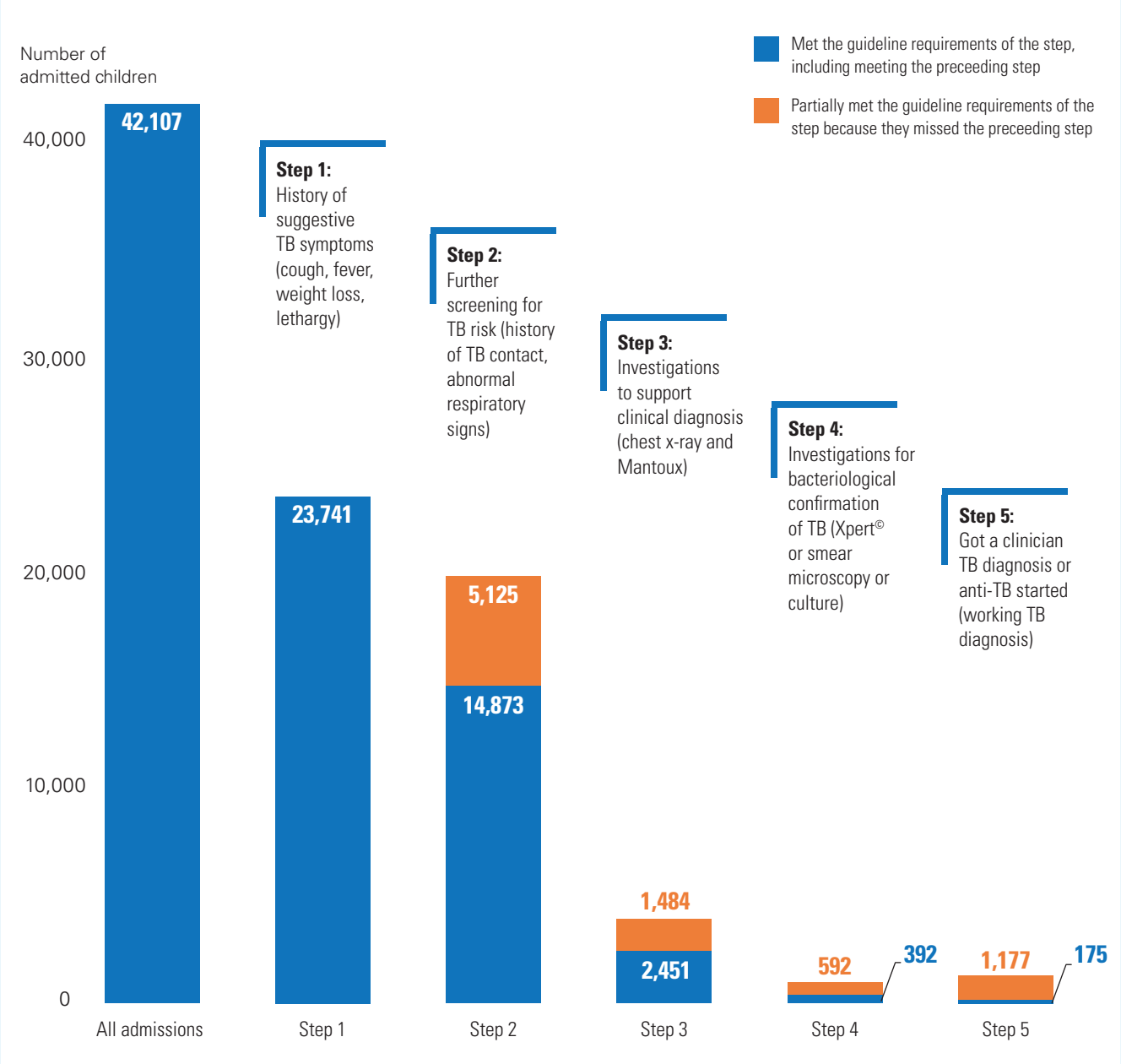
Source: Adapted from Ogero et al, 2018[9]

TB diagnostics

Childhood tuberculosis remains a major public health challenge, with its true burden often underestimated. Hospitalised children offer an important opportunity for case detection. Research utilised data from the CIN to conduct a clinical audit of adherence to Kenya's paediatric TB diagnostic guidelines in 13 county hospitals, exploring how TB is recognised, investigated, and documented in routine care.[10] While over half of more than 42,000 paediatric admissions showed symptoms suggestive of TB, less than 3% were diagnosed with TB, and diagnostic investigations were inconsistently applied (see figure 3). Access to diagnostic tools were available but underutilised.

A complementary qualitative study delved into the perspectives and practices of health workers, revealing key barriers to effective TB diagnosis.[11] These included individual-level challenges, such as limited confidence, experience, and skills in using diagnostic tools, alongside institutional factors like mentorship gaps, inefficient workflows, and prevailing hospital norms that resist the adoption of new technologies.

Figure 3 **Paediatric TB care cascade across 13 CIN hospitals over two calendar years**



Source: Adapted from Oliwa et al, 2019[12]

Pulse oximetry adoption and oxygen use

Pulse oximetry, a key tool for detecting hypoxemia, has been recommended in LMIC for years, yet long-term data on its use in real-world settings has been limited. Over seven years, CIN research tracked the adoption of pulse oximetry in Kenyan hospitals and its impact on oxygen prescription practices.[12] While pulse oximetry adoption rose from 10–20% in 2014 to 50–70% in 2016 across 18 hospitals, variability remained high reflecting hospital-specific factors such as resource availability and capacity. Most oxygen prescriptions were not based on pulse oximetry results, indicating that clinical decisions were often driven by situational factors rather than measured hypoxemia. The findings demonstrate the difficulties of integrating new technologies into clinical practice, even when they are well-established in guidelines.

Blood culture and sensitivity (BCS) testing

BCS testing is vital for managing infections and monitoring antimicrobial resistance (AMR), but its use in Kenyan hospitals is limited by several factors. Based on interviews with health care workers from eight hospitals, research found that clinicians often rely on empirical diagnosis instead of BCS testing due to long turnaround times, high costs for patients, and mistrust in results.[13] This delays accurate treatment and contributes to the overuse of antibiotics. Frequent stockouts, inefficient procurement, and inadequate staff training further disrupt testing availability. Addressing these challenges requires strengthening supply chains, increasing training opportunities, and strengthening hospital management support to make BCS testing a reliable tool for patient care and AMR surveillance.

The lack of diagnostics in many Kenyan hospitals is closely tied to resource constraints that limit the ability to investigate and treat severe illnesses. Research from the first year of the CIN, involving 13 hospitals and data from 30,042 medical admissions, highlights key causes of these gaps.[14] Important tests, such as haemoglobin measurements for severe anaemia and blood glucose testing for severe illness, were often not conducted even though they could help identify life-threatening conditions. Even when ordered, many tests were not completed, with results frequently missing from laboratory records. These limitations stemmed from lack of availability of essential equipment and reagents alongside significant financial barriers, with families frequently unable to afford the costs of diagnostics.

5. Enabling experimental studies and trials to evaluate the effectiveness of interventions

CIN hospitals have provided platform to enable large-scale trials, including pragmatic randomised trials and multi-country cluster-randomised trials, to evaluate the effectiveness of interventions (see table 2). Unlike explanatory trials, which test interventions in controlled environments, pragmatic trials assess outcomes in routine settings and tackle questions that are important to policy makers, practitioners, and patients. This approach is particularly important for improving facility-based care in LMICs, where health care contexts differ significantly from those in high-income countries (HICs), making it difficult to generalise findings from HIC trials. Pragmatic trials bridge this gap by ensuring that interventions are not only effective and acceptable to those affected by illness but also feasible and affordable to implement in LMIC settings.[15]

6. Leveraging CIN for public health surveillance

During the COVID-19 pandemic, CIN adapted to include the collection of data on adult medical admissions and severe acute respiratory illness (SARI) in 16 public hospitals. Between May 2020 and December 2022, the network facilitated the rapid collection of high-quality data on demographics, co-morbidities, clinical outcomes and vaccination status.

The surveillance data identified several risk factors for SARI mortality, including advanced age, male sex, pre-existing chronic conditions, low oxygen saturation, and anaemia.[16] Additionally, CIN evaluated the effectiveness of COVID-19 vaccines in reducing mortality, reporting a 59% reduction in mortality risk among hospitalised SARI patients. These findings helped to guide Kenya's public health response to COVID-19 and direct resources toward the most vulnerable populations.

Table 2 **Research trials carried out through the CIN platform**

Trial	Participants	Focus	Findings/aims
Enhanced Audit and Feedback Trial[17] (2016)	2,299 admissions; 12 CIN hospitals	**Implementation of new pneumonia guidelines** Tested enhanced feedback methods (frequent updates, goal setting) to improve adoption of oral amoxicillin for indrawing pneumonia.	Findings showed modest improvements in guideline adherence, emphasising the need for sustained interventions for long-term impact.
SEARCH trial[18] (2019-2024)	4,000 admissions; Multiple CIN hospitals	**Alternative antibiotics and feeding strategies for severe pneumonia** Compares the efficacy of intravenous fluids vs. nasogastric feeds in treating severe pneumonia.	Ongoing study; aims to provide evidence to guide treatment protocols and reduce pneumonia-related mortality in children.
SONIA trial[19] (2022-ongoing)	2,180 adults; 14 CIN hospitals	**Low-dose steroid use in pneumonia treatment** Tests whether low-dose steroids can reduce mortality in adults with community-acquired pneumonia in resource-limited settings.	Ongoing study; seeks to determine whether steroids can reduce pneumonia mortality, with a focus on practical application in resource-limited settings.
Malaria vaccine trial[20] (2019-2022)	650,000 children in Ghana, Kenya and Malawi; 6 CIN hospitals	**RTS,S/ASO1E vaccine feasibility and impact** Evaluated the world's first licensed malaria vaccine in Ghana, Kenya, and Malawi, with over 490,000 children completing the three-dose primary series.	Findings demonstrated a 32% reduction in hospital admissions for severe malaria and a 9% decrease in all-cause mortality.
ReGENT trial[21] (2022-2024)	20,000 neonatal admissions; 20 CIN hospitals	**Gentamicin prescribing accuracy** Uses enhanced audit and feedback tools (dashboards, pharmacist integration, infographics) to address gentamicin prescription errors in neonatal care.	Ongoing study; aims to reduce prescription errors and improve medication safety in neonates.

Conclusion

CIN has established one of sub-Saharan Africa's largest hospital-based research platforms, enabling high-quality, large-scale studies across multiple facilities. By leveraging routine hospital data, CIN has facilitated the validation of quality assessment tools, pragmatic clinical trials, and longitudinal analyses of disease patterns and outcomes. This research at scale has generated locally relevant evidence, shaping both clinical guidelines and national health policies while demonstrating the value of learning health systems in low-resource settings.

CIN research has identified significant challenges in health care delivery, including inadequate monitoring of vital signs, underutilisation of diagnostics, and inconsistent adherence to clinical guidelines. These findings highlight areas for system-wide improvements.

Beyond its research contributions, CIN has significantly advanced Kenya's health research infrastructure, fostering expertise in health services research and implementation science. Its ability to generate timely, high-quality evidence underscores the critical role of data-driven approaches in strengthening health care systems.

References

1 Akech S, Ayieko P, Gathara D, et al. Risk factors for mortality and effect of correct fluid prescription in children with diarrhoea and dehydration without severe acute malnutrition admitted to Kenyan hospitals: an observational, association study. The Lancet Child & Adolescent Health, 2018.Volume 2, Issue 7, 516 - 524

2 Gachau S, Irimu G, Ayieko P, et al. Prevalence, outcome and quality of care among children hospitalized with severe acute malnutrition in Kenyan hospitals: A multi-site observational study. PLoS ONE, 2018 13(5): e0197607. https://doi.org/10.1371/journal.pone.0197607

3 Amboko BI, Ayieko P, Ogero M, et al. Malaria investigation and treatment of children admitted to county hospitals in western Kenya. Malar J. 2016 Oct 18;15(1):506. doi: 10.1186/s12936-016-1553-6. PMID: 27756388; PMCID: PMC5069818.

4 Agweyu A, Lilford R, English M, et al. Appropriateness of clinical severity classification of new WHO childhood pneumonia guidance: a multi-hospital, retrospective, cohort study. The Lancet Global Health, 2018 Volume 6, Issue 1, e74 - e83

5 Wainaina J, Ogero M, Mumelo L, et al. Hypothermia amongst neonatal admissions in Kenya: a retrospective cohort study assessing prevalence, trends, associated factors, and its relationship with all-cause neonatal mortality. Front Pediatr. 2024;12. doi:10.3389/fped.2024.1272104. Available from: https://www.frontiersin.org/journals/paediatrics/articles/10.3389/fped.2024.1272104.

6 Opondo C, Allen L, Todd J, et al. Association of the Paediatric Admission Quality of Care score with mortality in Kenyan hospitals: a validation study. The Lancet Global Health, 2018, Volume 6, Issue 2, e203 - e210

7 Aluvaala J, Collins G, Maina B, et al. Prediction modelling of inpatient neonatal mortality in high-mortality settings. Archives of Disease in Childhood. 2021;106:449-454.

8 Tuti T, Collins G, English M, et al. External validation of inpatient neonatal mortality prediction models in high-mortality settings. BMC Med. 2022, 20, 236 https://doi.org/10.1186/s12916-022-02439-5

9 Ogero M, Ayieko P, Makone B, et al. An observational study of monitoring of vital signs in children admitted to Kenyan hospitals: an insight into the quality of nursing care? J Glob Health. 2018 Jun;8(1):010409. doi: 10.7189/jogh.08.010409. PMID: 29497504; PMCID: PMC5826085.

10 Oliwa JN, Gathara D, Ogero M, et al. Diagnostic practices and estimated burden of tuberculosis among children admitted to 13 government hospitals in Kenya: An analysis of two years' routine clinical data. PLoS ONE. 2019 14(9): e0221145. https://doi.org/10.1371/journal.pone.0221145

11 Oliwa JN, Odero SA, Nzinga J, et al. Perspectives and practices of health workers around diagnosis of paediatric tuberculosis in hospitals in a resource-poor setting – modern diagnostics meet age-old challenges. BMC Health Serv Res. 2020, 20, 708. https://doi.org/10.1186/s12913-020-05588-6

12 Tuti T, Aluvaala J, Akech S, et al. Pulse oximetry adoption and oxygen orders at paediatric admission over 7 years in Kenya: a multihospital retrospective cohort study BMJ Open 2021;11:e050995. doi: 10.1136/bmjopen-2021-050995

13 Bahati F, Mutua E, Akech S, et al. Effects of health system limitations on the use of blood culture and sensitivity testing in Kenyan county hospitals: an interview-based qualitative study using causal loop diagrams, The Lancet Microbe, 2025, Volume 6, Issue 1, 100945, ISSN 2666-5247, https://doi.org/10.1016/j.lanmic.2024.07.008.

14 Ayieko P, Ogero M, Makone B, et al. Characteristics of admissions and variations in the use of basic investigations, treatments and outcomes in Kenyan hospitals within a new Clinical Information Network. Arch Dis Child. 2016 Mar;101(3):223-9. doi: 10.1136/archdischild-2015-309269. Epub 2015 Dec 10. PMID: 26662925; PMCID: PMC4789757.

15 English M, Karumbi J, Maina M, et al. The need for pragmatic clinical trials in low and middle income settings – taking essential neonatal interventions delivered as part of inpatient care as an illustrative example. BMC Med. 2016 14, 5. https://doi.org/10.1186/s12916-016-0556-z

16 Lucinde R, Gathuri H, Isaaka L, et al. Prospective clinical surveillance for severe acute respiratory illness and COVID-19 vaccine effectiveness in Kenyan hospitals during the COVID-19 pandemic. BMC Infect Dis 24. 2024, 1246. https://doi.org/10.1186/s12879-024-10140-6

17 Ayieko P, Irimu G, Ogero M, et al. Effect of enhancing audit and feedback on uptake of childhood pneumonia treatment policy in hospitals that are part of a clinical network: a cluster randomized trial. Implementation Sci. 2019, 14, 20. https://doi.org/10.1186/s13012-019-0868-4

18 https://cin.kemri-wellcome.org/studies/search/ [accessed February 4, 2025]

19 Lucinde R, Abdi A, Orindi B, et al. A pragmatic randomized controlled trial of standard care versus steroids plus standard care for treatment of pneumonia in adults admitted to Kenyan hospitals (SONIA) [version 1; peer review: 1 approved, 1 approved with reservations]. Wellcome Open Res 2022, 7:269 (https://doi.org/10.12688/wellcomeopenres.18401.1)

20 Asante KP, Mathanga DP, Milligan P, et al. Feasibility, safety, and impact of the RTS,S/AS01E malaria vaccine when implemented through national immunisation programmes: evaluation of cluster-randomised introduction of the vaccine in Ghana, Kenya, and Malawi. The Lancet. 2024, Volume 403, Issue 10437, 1660 - 1670

21 Tuti T, Aluvaala J, Malla L, et al. Evaluation of an audit and feedback intervention to reduce gentamicin prescription errors in newborn treatment (ReGENT) in neonatal inpatient care in Kenya: a controlled interrupted time series study protocol. Implement Sci. 2022 May 16;17(1):32. doi: 10.1186/s13012-022-01203-w. PMID: 35578243; PMCID: PMC9109356.

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