Clinical diagnosis in paediatric patients at urban primary health care facilities in southern Malawi: a longitudinal observational study

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Abstract

Background: Despite health centres being the first point of contact of care, there are challenges faced in providing care to patients at this level. In Malawi, service provision barriers reported at this level included long waiting times, high numbers of patients and erratic consultation systems which lead to mis-diagnosis and delayed referrals. Proper case management at this level of care is critical to prevent severe disease and deaths in children.

Objective: Adopting ETAT to improve ability to identify severe illness in children at primary health centre (PHC) level through comparison with secondary level diagnoses.

Methods: We implemented ETAT mHealth algorithm at eight urban PHCs in Blantyre, Malawi between April 2017 and September 2018. Health workers and support staff were trained in mHealth ETAT. Stabilisation rooms were established and equipped with emergency equipment. All PHCs used an electronic tracking system to triage and track sick children on referral to secondary care, facilitated by a unique barcode. Support staff at PHC triaged sick children using ETAT Emergency (E), Priority (P) and Queue (Q) symptoms and clinician gave clinical diagnosis. The secondary level diagnosis was considered as a gold standard. We used statistical computing software R (v3.5.1) and used exact 95% binomial confidence intervals when estimating diagnosis agreement proportions.

Results: Eight-five percentage of all cases where assigned to E (9.0%) and P (75.5%) groups. Pneumonia was the most common PHC level diagnosis across all three triage groups (E,P,Q). The PHC level diagnosis of trauma was the most commonly confirmed diagnosis at secondary level facility (85.0%) , while a PHC diagnosis of pneumonia was least likely to be confirmed at secondary level (39.56%). The secondary level diagnosis least likely to have been identified at PHC level was bronchiolitis 3 (5.2%). The majority of bronchiolitis cases (n = 50; (86.2%) were classified as pneumonia at the PHC level facility.

Conclusions Implementing a sustainable and consistent ETAT approach with stabilisation and treatment capacity at PHC level reinforce staff capacity to diagnose and has the potential to reduce other health system costs through fewer, timely and appropriate referrals.

Background

Despite progress made in reducing childhood mortality, 1 in 13 children continue to die before their fifth birthday in Sub-Saharan Africa in 2018 [1]. Though effective prevention and treatment interventions are available, complications during birth, pneumonia, diarrhoea, and malaria remain the biggest killers of under-five children in Sub-Saharan Africa [1].

Whilst primary health centres (PHC) are often the first point of contact with the health care system, there are frequent challenges in providing high quality care at this level [2–4]. Proper case management is critical to prevent complications and death. In many low-income countries, less qualified personnel are utilised to provide promotive, preventive and curative services across primary care settings [2, 5, 6]. Malawi suffers an acute shortage of qualified personnel with 1.49 health workers (clinical, nursing and allied staff) per 1,000 population [3], far from the World Health Organisation (WHO) recommended ratio of 4.45 health workers per 1,000 population [4]. This may help to explain why Malawi had one of the highest infant (42 deaths per 1,000 live births) and under-five (63 deaths per 1,000 births) mortality rates in 2015 [7].

Malawi's health care system is organised at three levels, primary, secondary and tertiary [8]. The different levels are linked to each other through an established referral system. Health services are provided through the free public sector alongside private service providers who charge a fee. Promotive, preventive, and curative health services are provided free of charge at PHC level. Secondary level care provides both outpatient and inpatient services and consists of district and mission hospitals receiving patients referred from both PHCs and community hospitals. Tertiary services in Malawi consist of four central hospitals which provide specialised care at regional level, receiving referrals from district hospitals within the region and where necessary wider field.

Health centres are generally managed by medical assistants, clinical technicians and nurses with average training durations of 2–3 years [8]. Studies conducted in similar contexts have identified challenges experienced by staff working in government health centres. These include heavy patient workloads, inadequate supervision and limited clinical case management capacities [2, 3, 9–11]. The PHC level barriers to recognition of severe illness include long waiting times, high numbers of patients and erratic consultation systems which often lead to misdiagnoses and delayed referrals [12].

Queen Elizabeth Central Hospital (QECH), the largest referral hospital in Malawi, functions as both a secondary level facility for health centres in Blantyre district and as a tertiary hospital for the southern region of Malawi. The speciality offered at QECH include, medical, surgical, paediatric, neonatology, orthopaedic, oncology, ophthalmology, dermatology, Ear, Nose and Throat (ENT). Patients are referred from 29 public primary health centres (PHC) as well as dispensaries managed by the Blantyre District Health Office. Additional services in the district are provided by private hospitals and clinics but the majority of the population of 1,251,484 [13] rely on the government and public services. Over half of the Blantyre district is under 15 years old [14] and a high proportion of presentations at primary level are for paediatric services. Burdens at individual clinics are high with a health facility per population ratio for the city exceeding the recommended urban planning standard of 10,000 persons per facility [4, 14]. In addition, health centres in the district are under-staffed and lack adequate resources, leading to many paediatric deaths occurring within the first 24 hours of admission [15–17]. At PHCs, standard practice has been for adults and children to queue together and to be seen on a 'first come, first served basis'. Triage at PHCs was rare before implementation of ETAT and severe illness in children was often missed, resulting in mortality, disability and complications [12], often increasing burdens on primary facilities. In rural areas, the burden on PHCs is often relieved by a combination of health surveillance assistants (HSA), village clinics and integrated community case management linked to a primary clinic, but this is often less structured in urban catchment areas.

Some of these negative outcomes could be prevented if critically ill children were identified quickly, treated without delay and promptly referred to a secondary level hospital. This led to the development of the WHO Emergency Triage Assessment and Treatment (ETAT) guidelines [18, 19], adopted and implemented at secondary and tertiary level facilities. Following implementation of the ETAT protocol at PHC level in Blantyre district using an mHealth algorithm to improve

consistency in diagnosis this study was designed to expand on primary level intervention with two main aims:1) to improve capacity of PHC level staff to diagnose severity of illness, stabilise patients and make appropriate and timely referral decisions and 2) to establish a surveillance system to track patients and outcomes through the health system. This paper provides a useful contribution to understanding accuracy of severe illness identification and ways of strengthening clinical diagnosis at PHC level facility.

Methods

Study area and study centres

The analysis in this paper focuses on eight urban PHCs in Blantyre district where a full tracking system was operated. The catchment population of the PHCs was 795,384 of which 5%, 17% and 48% were under one, five and 15 years old respectively in 2017 [14]. Paediatric definitions of 0 to 14 were based on those defined at central hospitals. We implemented ETAT-based triage with mobile health (mHealth) technology to prompt healthcare workers and support staff to recognise and prioritise children with serious illness. Through this project the national ETAT training manual was revised to better align with the needs of PHC level staff. Clinicians and nurses were trained in mHealth triage and emergency management for 2.5 days while support staff trained in mHealth triage for 1.5 days. The triage algorithm from the manual was uploaded on the phone. Rooms were established and equipped with emergency drugs and supplies to ensure that patients with emergency signs could be stabilised before referral. All PHCs were supplied with mobile phones which enabled triaging of patients, capturing of patient information and diagnosis at PHC level and secondary level facility. No personal identifiers were collected on the mHealth phones. A unique barcode was stamped into patients' health passports to trace individual experiences through the system and link between different sites within the study. This facilitated data capture across sites. Each barcode was linked to date of birth, age, sex, the PHC level facility and outcome for data analysis. Blantyre district health office provided permission to conduct the surveillance study at these facilities. We worked in collaboration with Ministry of Health and ethical approval was granted by the College of Medicine Research Ethics Committee (protocol number 09/16/2021, as well as the Liverpool School of Tropical Medicine Research Ethics Committee.

Data and study population

The study population comprised all patients (n = 228,094) aged 0–14 years seeking care in any of the eleven PHCs outpatient departments (OPD) between April 2017 to September 2018 (Fig. 1). We excluded records from three rural PHCs in Chikwawa (n = 18,960) as the full tracking system was not implemented in these due to poor network coverage prevented tracking of data. Records without clinician outcome data from the PHCs (n = 43,440) and those not admitted at secondary facility n = 165,351 were removed from the analysis Most of these patients were referred to QECH for specialized clinics such as orthopaedic, ophthalmology and dermatology. A further 110 records were excluded as they had either no PHC or secondary level data, leaving 233 records for the analysis (Fig. 1).

Data collection, diagnosis and stabilisation

Data were collected using mHealth phones at four stages. The first stage was upon arrival at the waiting area in a paediatric outpatient department in PHCs where patients were triaged by support staff who placed a barcode in the health passport and assigned a prioritisation group (Emergency (E), Priority (P) and Queue (Q)). Children assigned to the Emergency group were taken for immediate consultation or to the resuscitation room for emergency treatment, those assigned to the Priority group were moved to the front of the queue and those with a Queue assessment awaited their turn to be seen by the clinician. At the second stage, clinicians verified the triage category. A fieldworker was posted at each PHC to capture clinician triage and consultation outcome and referral information through a second mobile phone. At the third stage, a mobile phone was again used at the outpatient department of the secondary level facility (QECH) if arrival was between 7:30am and 10 pm. All patients (0–14) arriving at QECH had their health passports and referral stamp checked by a fieldworker, who scanned the barcode sticker using the phone to retrieve the patient's details and verify that the patient had arrived at QECH. Finally, at the fourth stage, a research nurse scanned the barcode using a tablet to link the triage category and PHC data to QECH admissions data and to retrospectively collect information on patient diagnosis. The secondary level diagnosis from QECH is considered to be the gold standard diagnosis in this paper.

Statistical analysis

The mHealth data were stored on a central, access-controlled, encrypted database. Statistical analyses were performed using the statistical computing software R (v3.5.1) [20]. We computed descriptive statistics (i.e. frequencies, percentages) and used exact 95% binomial confidence intervals when estimating diagnosis agreement proportions.

Results

Participant Characteristics

Table 1 lists the sex, age and triage distribution of patients captured by the 233 analysed records. The percentages shown in (Table 1) are for the total number of recorded values only. There are more male children than female (58.7%) and most children were under-five (75.4%).

Table 1
Personal characteristics of successful referrals who had both PHC and secondary diagnosis captured(n = 233)

Patient characteristics		n	(%)
Sex	Female	74	(41.3%)
	Male	105	(58.7%)
	Not recorded	54	-
Age	Neonates and infants (< 12 months)	76	(42.4%)
	12–59 months	59	(33.0%)
	5 years and above	44	(24.6%)
	Not recorded	54	-
PHC level triage	Emergency (E)	21	(9.0%)
	Priority (P)	176	(75.5%)
	Queue (Q)	36	(15.5%)

Agreement between PHC and secondary diagnoses

Generally, common childhood illnesses were over diagnosed at PHC level facilities (Table 2). Trauma and malnutrition were the PHC diagnoses with highest confirmation rates (over 80%) at secondary facility (Table 2). Pneumonia cases were commonly over-diagnosed at PHC facilities with only 39.6% of the diagnoses confirmed at QECH. The PHC diagnosis of anaemia, gastroenteritis (GE), bronchiolitis, malaria, sepsis and meningitis had proportions of 79.2%, 75.0%, 75.0%, 65.9%, 58.5% and 44.4% respectively being confirmed at the secondary level facility (Table 2).

Table 2
Agreement between PHC and secondary level facility on common childhood illness diagnosis

	PRIMARY HEALTH CENTRE				SECONDARY LEVEL FACILITY			
Diagnosis	**Total**	**Confirmed at secondary n (%) [95% CI]**			**Total**	**Identified at primary n (%) [95% CI]**		
Anaemia	24	19	(79.2%)	[57.9%,92.9%]	25	19	(76.0%)	[54.9%,90.6%]
Bronchiolitis	4	3	(75.0%)	[19.4%,99.4%]	58	3	(5.2%)	[1.1%,14.4%]
GE	12	9	(75.0%)	[42.8%,94.5%]	23	9	(39.1%)	[19.7%,61.5%]
Malaria	44	29	(65.9%)	[50.1%,79.5%]	39	29	(74.4%)	[57.9%,87.0%]
Malnutrition	6	5	(83.3%)	[35.9%,99.6%]	18	5	(27.8%)	[9.7%,53.5%]
Meningitis	9	4	(44.4%)	[13.7%,78.8%]	7	4	(57.1%)	[18.4%,90.1%]
Pneumonia	91	36	(39.6%)	[29.5%,50.4%]	44	36	(81.8%)	[67.3%,91.8%]
Sepsis	41	24	(58.5%)	[42.1%,73.7%]	54	24	(44.4%)	[30.9%,58.6%]
Trauma	20	17	(85.0%)	[62.1%,96.8%]	18	17	(94.4%)	[72.7%,99.9%]

Identification of secondary diagnosis at PHC level facility

The likelihood of the secondary level facility diagnosis being correctly identified at PHC level clinics was high for trauma, pneumonia, anaemia and malaria cases with 94.4%, 81.8%, 76.0% and 74.4% respectively (Table 2). The secondary level diagnosis least likely to be identified was bronchiolitis with only 3 (5.2%) correctly identified at PHC.

Triage category distribution according to PHC diagnosis

The highest ETAT triage categorisation was priority (P) across all nine diagnoses analysed at PHCs (Fig. 2) Out of all nine diagnoses analysed, pneumonia was the most common PHC diagnosis in each of the 3 triage groups (E,P,Q). Meningitis, malnutrition, GE and bronchiolitis cases had no emergency (E) categorisation at PHC (Fig. 2).

Co-occurrence of diagnosis at PHC and secondary level facilities

Table 3 lists how many times two given conditions were co-diagnosed at PHC and secondary level facility. The total number of case records exceed 233 in this analysis as patients can be diagnosed with more than one condition at both PHC and secondary level facility. To calculate percentages, we used the number of unique diagnoses at the secondary level. The majority of bronchiolitis cases at secondary level, 50 of 58 (86.2%), were diagnosed as pneumonia at PHC

level while 16 of 25 (64.0%) of anaemia cases at secondary level were classified as malaria at PHC level. Almost all trauma cases 17 of 18 (94.44%) at secondary level were also classified as trauma at PHC level facility.

Table 3
Proportions (number) distribution of secondary level diagnosis against PHC level diagnosis

	Secondary level facility															
		Anaemia		Bronchiolitis		GE		Malaria		Malnutrition		Meningitis		Pneumonia		Sepsis	
PHC level facility	Anaemia	76.00%	19	0.00%	0	4.35%	1	35.90%	14	11.11%	2	0.00%	0	2.27%	1	7.41%	4
	Bronchiolitis	0.00%	0	5.17%	3	4.35%	1	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0
	GE	0.00%	0	0.00%	0	39.13%	9	2.56%	1	5.56%	1	0.00%	0	0.00%	0	12.96%	7
	Malaria	64.00%	16	6.90%	4	30.43%	7	74.36%	29	22.22%	4	14.29%	1	6.82%	3	14.81%	8
	Malnutrition	0.00%	0	0.00%	0	0.00%	0	0.00%	0	27.78%	5	14.29%	1	4.55%	2	5.56%	3
	Meningitis	4.00%	1	0.00%	0	8.70%	2	2.56%	1	0.00%	0	57.14%	4	4.55%	2	11.11%	6
	Pneumonia	4.00%	1	86.21%	50	21.74%	5	7.69%	3	27.78%	5	14.29%	1	81.82%	36	18.52%	10
	Sepsis	12.00%	3	8.62%	5	17.39%	4	15.38%	6	22.22%	4	57.14%	4	11.36%	5	44.44%	24
	Trauma	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	1.85%	1
	Total unique diagnoses at Secondary level		25		58		23		39		18		7		44		54

Discussion

Campbell, Duke [21] stated that 10%-20% of sick children presenting at PHC will need to be referred to the next level facility. In this paper, 9% of the emergency conditions were referred to a secondary level facility for advanced care. The relatively low proportion of emergency cases referred may be due to functional ETAT systems at PHCs, which improved stabilisation of children with serious illness that subsequently improved and reversed the need for referral. Furthermore, other emergency (E) cases may have bypassed the triage system as they are taken straight to the stabilisation room at the PHC and this would not necessarily be captured in the system. This study also only captured patients arriving at QECH from 7:30am to 10 pm which results in patients reporting after these hours to be missed, although transport to a hospital after 10 pm is quite difficult

Children in Malawi continue to die from preventable causes such as sepsis, lower respiratory tract infection, GE, meningitis and malaria [22]. In our study, the nine most common disease conditions diagnosed at PHC were pneumonia, malaria, sepsis, anaemia, trauma, GE, meningitis, malnutrition, and bronchiolitis. There was a high proportion (> 75%) of PHC diagnosis of trauma, malnutrition and anaemia confirmed at secondary level. This may be due to the unique clinical presentations of these conditions in comparison to more complex symptom presentation, facilitating early differentiation of cause amongst clinicians at PHC level. For instance, in this study, trauma was correctly classified at PHC level in 94.4% of cases (Table 2). However, clinicians at PHC often face challenges in correctly differentiating malaria, sepsis, meningitis and pneumonia leading to underdiagnosis and misdiagnosis due to similar disease presentations. The similar disease presentation challenges clinicians to correctly diagnose and treat especially if resources are stretched as is often the case at PHC level in low-resource settings [23]. For example, in this study, PHC diagnosis of sepsis, meningitis and pneumonia were correct in only 58.5%,44.4% and 39.6% respectively (Table 2). Furthermore, due to limited resources, clinical technicians and medical assistants are often trained to manage symptoms. Despite case management guidelines and algorithms advocated to improve management, accurate diagnosis of these conditions has proven to be difficult due to their similar presentations [24]. A study in Malawi reports that 95% of children with a clinical case definition for pneumonia also meet the malaria case definition [25].

Over-diagnosis of pneumonia was common in this study; due to misidentification of bronchiolitis as pneumonia at PHCs. This study has also shown that bronchiolitis was the least likely secondary diagnosis identified at PHC level facility (5.2%). In these settings, clinicians diagnosed pneumonia in 86.2% of children who were identified as bronchiolitis cases at secondary level facility (Table 3). These conditions have similar clinical presentation and differentiation has been reported as a challenge for clinicians previously [25, 26]. This may be particularly challenging for clinicians working in PHC as they use case management strategies such as Integrated Management of Childhood Illness (IMCI). A case management approach assumes that the presentation of fever and cough with fast breathing and/or chest indrawing, is most likely due to pneumonia and is to be treated by a course of antibiotics [27]. Due to high numbers of patients and unavailability of stethoscopes, clinicians at PHC are unlikely to undertake comprehensive chest assessments to accurately differentiate bronchiolitis from pneumonia. A study conducted in four hospitals in India found that many children who fulfil WHO's traditional criteria for pneumonia (cough and difficulty breathing with or without chest indrawing) have wheezy viral infections [27]. WHO has recently updated its guidelines for the management of acute respiratory infections (ARIs) in children to include the differential diagnosis of cough and difficulty breathing, and separate guidelines for the management of pneumonia, bronchiolitis and asthma [28]. Failure to follow these guidelines, they warn, will lead to the overuse of antibiotics and under treatment of asthma both of which have significant public health implications in low resource settings such as Malawi [29].

Recognising meningitis at PHC is a challenge [12, 30, 31] since it has overlapping clinical presentations with other febrile illnesses. The PHC staff in Malawi are trained to perform basic laboratory investigations such as rapid diagnostic test for malaria and haemoglobin. However, reagents are often out of stock for these basic investigations[32, 33]. In this study, only 44.4% of suspected meningitis cases at PHC were confirmed at secondary diagnosis, although the numbers are relatively small (Table 2).

This study has some limitations. The mHealth tracking system operated during weekdays from 7:30am to 4:30 pm at PHCs and 7:30am to 10 pm at secondary outpatient departments. The system did not capture patient visits outside these hours. The analysis did not include all patients who were referred and received a PHC diagnosis, as some did not arrive at the secondary facility while others arrived but were not admitted to the ward as the system did not capture the data. The analysis only included 8 urban PHCs from a pool of district hospitals and both urban and rural primary clinics that refer directly to QECH within the Southern region of Malawi. As such, the numbers included are unlikely to be a true reflection of total patients admitted to QECH. The study, however, provides a useful contribution to understanding accuracy of severe illness identification at primary level.

Conclusions

This study found that PHC level staff were able to identify sick children who required advanced care at secondary facility in patients who passed through the ETAT mhealth tracking system. Pneumonia is over-diagnosed at PHC level, largely due to misdiagnosis of bronchiolitis or other Lower Respiratory Tract Infection (LRTI) with similar symptoms. While a tendency to over rather than under-diagnosis is preferable since this ensures patients with Upper Respiratory Tract Infection (URTI) are less likely to be missed, it places additional strains on both human and material resources within the health system. Having functional formal triage of sick children at PHCs using established ETAT guidelines is essential to isolate very sick children presenting with emergency signs in order to prompt appropriate referral and treatment at secondary level. In addition, having functional stabilisation rooms and increased capacity to treat sick children at PHC level is beneficial: as it reduces the referral burden and ensures high rates of successful referral.

However, to optimise benefits from introduction of ETAT at PHC level it is important that it is well integrated with the Integrated Management of Childhood Illness (IMCI) initiative so as to improve overall patient management and outcomes. For health care workers at PHC to provide optimal care ETAT implementation should be integrated with regular training, case management guidelines, emergency supplies, equipment and drugs. Feedback from referral facilities to PHC staff on diagnosis, care provided to patients and outcomes may also benefit more accurate diagnosis in these settings. Further studies are required to assess how such feedback can be captured and communicated efficiently and effectively.

Abbreviations

ASPIRE: Achieving Sustainable Primary Improvement and Engagement in Health, CI: 95% confidence interval, E: Emergency, ETAT: Emergency Triage Assessment and Treatment, GE: Gastroenteritis, mHealth: Mobile Health, MLW: Malawi - Liverpool - Wellcome Trust Clinical Research Programme, MRF: Meningitis Research Foundation, ODK: Open Data Kit, OPD: Out-Patient Department, P: Priority, PEAG: Primary ETAT Advisory Group, PHC: Primary Health Centre, QECH: Queen Elizabeth Central Hospital and WHO: World Health Organization

Declarations

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Authors contributions

ND, DL contributed to the conceptualization of the research project. ND, MG, TO, QD, NL, DL contributed to the study design and methodology. ND generated resources and supervised project activities and MG and TO administrated the project. ND, MG, MH, CM,NL,QD contributed to the investigation, data curation, software, analysis, validation, and interpretation. MG and MH wrote the initial draft. MM, MDM, ND, DL, gave advice on the structure of the paper and critically reviewed all versions. All authors have read and approved the manuscript.

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Approval was obtained from the research ethics boards of the Malawi College of Medicine (P.09/16/2021) and Liverpool School of Tropical Medicine.

Consent for publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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Figures

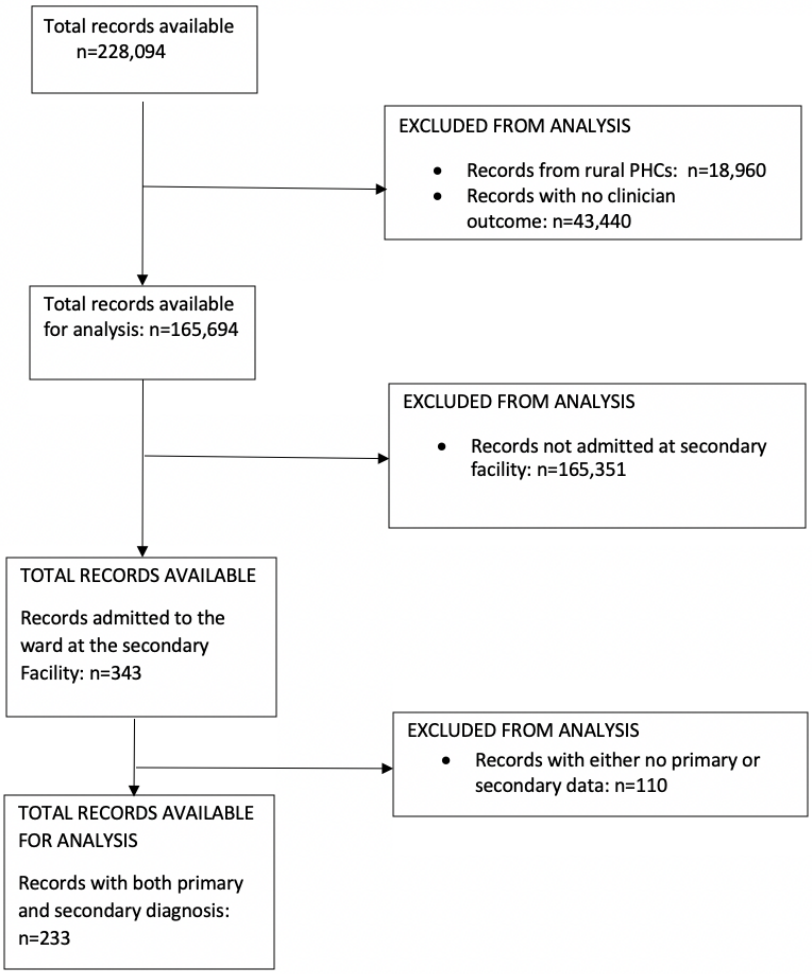

Figure 1

Study Population

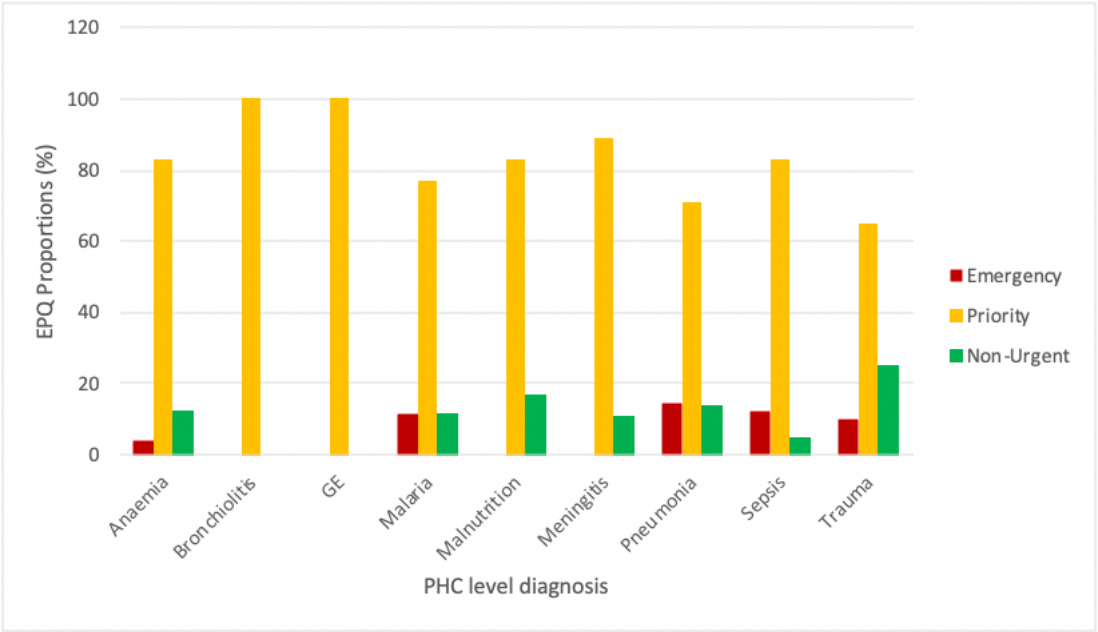

Figure 2