Review article

Systematic review on epidemiology, interventions and management of noncommunicable diseases in acute and emergency care settings in Kenya

Christine Ngaruiya [a,*], Annrita Kawira [b], Florence Mali [c], Faith Kambua [d], Beatrice Mwangi [e], Mbatha Wambua [f], Denise Hersey [g], Laventa Obare [h], Rebecca Leff [a,i], Benjamin Wachira [j]

[a] *Department of Emergency Medicine, Yale University, New Haven, CT, USA*
[b] *Department of Surgery, Mwingi Level 4 Hospital, Kitui County, Kenya*
[c] *Department of Medicine, Mwingi Level 4 Hospital, Kitui County, Kenya*
[d] *Department of Pharmacy, Kileleshwa Medical Plaza, Nairobi, Kenya*
[e] *Department of Paediatrics and Child Health, Nanyuki Teaching and Referral Hospital, Nanyuki, Kenya*
[f] *Accident and Emergency Department, Kenyatta National Hospital, Nairobi, Kenya*
[g] *Science Libraries, Princeton University, Princeton, NJ, USA*
[h] *Kakamega County Referral Hospital, Kakamega, Kenya*
[i] *School of Medicine, Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer-Sheva, Israel*
[j] *Accident and Emergency Department, The Aga Khan University, Nairobi, Kenya*

ARTICLE INFO

ABSTRACT

Introduction: Mortality and morbidity from Non-Communicable Diseases (NCDs) in Africa are expected to worsen if the status quo is maintained. Emergency care settings act as a primary point of entry into the health system for a spectrum of NCD-related illnesses, however, there is a dearth of literature on this population. We conducted a systematic review assessing available evidence on epidemiology, interventions and management of NCDs in acute and emergency care settings in Kenya, the largest economy in East Africa and a medical hub for the continent.

Methods: All searches were run on July 15, 2015 and updated on December 11, 2020, capturing concepts of NCDs, and acute and emergency care. The study is registered at PROSPERO (CRD42018088621).

Results: We retrieved a total of 461 references, and an additional 23 articles in grey literature. 391 studies were excluded by title or abstract, and 93 articles read in full. We included 10 articles in final thematic analysis. The majority of studies were conducted in tertiary referral or private/mission hospitals. Cancer, diabetes, cardio-vascular disease and renal disease were addressed. Majority of the studies were retrospective, cross-sectional in design; no interventions or clinical trials were identified. There was a lack of access to basic diagnostic tools, and management of NCDs and their complications was limited.

Conclusion: There is a paucity of literature on NCDs in Kenyan emergency care settings, with particular gaps on interventions and management. Opportunities include nationally representative, longitudinal research such as surveillance and registries, as well as clinical trials and implementation science to advance evidence-based, context-specific care.

African relevance

- Non-Communicable Diseases (NCDs) contribute to the majority of deaths globally, and are expected to surpass deaths due to communicable, maternal and neonatal deaths in Africa by 2030 if the status quo is maintained

- The Emergency Centre (EC) acts as a primary access point for entry into the healthcare system, including in Africa, where primary care infrastructure is often lacking
- It is estimated that 24 million lives and nearly 1 billion DALYs could be averted by advancement of emergency care in LMICs

* Corresponding author.
E-mail address: Christine.ngaruiya@yale.edu (C. Ngaruiya).

- By targeting acute and emergency care settings, we can affect disease in a large proportion of the population that may not otherwise access care
- In order to address NCDs in acute and emergency care settings in Africa where EM is still developing, primary data is crucial, and an understanding of the existing literature can help guide future research and intervention development

Introduction

Non-Communicable Diseases (NCDs) contribute to a global threat accounting for nearly 75% of deaths globally [1]. Furthermore, mortality and morbidity from NCDs in Africa, as measured by Disability Adjusted Life Years (DALYs), has increased by 67% in recent decades and this burden is only expected to increase [2,3]. The leading causes of mortality due to NCDs are: cardiovascular disease, cancer, diabetes, and chronic respiratory disease such as asthma and Chronic Obstructive Pulmonary Disease (COPD) [4]. Addressing the NCD epidemic will require efforts across the healthcare system.

The Emergency Centre (EC) acts as a primary access point for entry into the system [5,6], and as outlined by the Collaborative on Enhancing Emergency Care Research in LMICs (CLEER), plays a key role in "population-level improvements in morbidity and amenable mortality" [7]. Patients present with a variety of NCD-related complaints and are from across the age spectrum [8] making this a high-yield population to target. In addition, the 2013-2020 WHO global action plan for NCDs highlights aims such as: reduction in premature mortality secondary to cardiovascular disease, cancer, diabetes, and chronic respiratory disease; reduction in harmful use of alcohol; reduction in prevalence of tobacco use; reduction in prevalence of raised blood pressure, and increased prevalence of eligible people on appropriate therapy for cardiovascular disease prevention [3]. Interventions in high-income countries (HICs) have demonstrated the effectiveness of the EC in addressing all of these targets, including tobacco cessation, alcohol cessation, and use of navigators to improve compliance among diabetics, among others [9–14]. By addressing these conditions and risk factors in EC populations, we can contribute to reducing the global burden of disease. Specifically, the Disease Control Priorities 3 (DCP3) estimated that 24 million lives and nearly 1 billion DALYs could be averted by advancement of emergency care in LMICs, including those due to NCDs [15]. In sum, the EC is an optimal setting for these and other novel interventions targeting NCDs, however a focus on NCDs in this population continues to lag.

In order to address NCDs in this unique population, acute and emergency care settings in LMICs, primary data is crucial [8,15–18]. Our team conducted a systematic review assessing available evidence on epidemiology, interventions, and management of NCDs in acute and emergency care settings in Kenya to assess existing data and identify potential opportunities for future. Through this study, we aim to inform research priorities, clinical intervention development and local policy implementation. This is the first study of its kind in the region providing a comprehensive assessment on literature addressing NCDs in emergency care populations.

Methods

The literature search was completed by an expert medical librarian (DH) and lead author (CN), with input from senior author (BW) for context-specific terminology and sources. All searches were run on July 15, 2015, and then updated on December 11, 2020. The databases searched were MEDLINE (OvidSP 1946-July Week 1 2015), MEDLINE (PubMed, for in-process and non-indexed citations), Embase (OvidSP 1974-2015 July 14), Scopus (Elsevier, all years), Web of Science Core Collection (Thomson Reuters, 1964-present), Africa-Wide Information (EBSCOhost, all years), and CINAHL (EBSCOhost, all years). In addition, a search of grey literature was performed in both the Intergovernmental Organization and Nongovernmental Organization Google Custom Search Engines and Greylit.org. The formal search strategies used relevant controlled vocabulary terms and synonymous free text words and phrases to capture concepts of Non-Communicable Diseases ("heart attack", "myocardial ischemia", "acute coronary syndrome", "hypertension", "COPD", "diabetes", "asthma"), and Emergency Medicine ("acute care", "emergency services", "emergency department"). For all items identified, the titles and abstracts were independently screened by two reviewers (AK, FM, BM, or FK). For all items deemed potentially eligible, screening of full texts was performed by the same reviewers. Two independent reviewers performed data extraction. Reconciliation of divergent decisions on any articles was resolved via discussion involving both independent authors and the lead author CN. Final synthesis, as described in our study registration [16], was guided by the outcomes: (1) breakdown by study type i.e. epidemiology, intervention, management, (2) outcomes from individual level study on effects of intervention, where applicable, (3) breakdown by disease focus of study (Cardiovascular disease, chronic respiratory disease, diabetes, cancer, and other), and (4) other pertinent emergent themes from individual studies. We included studies that constituted epidemiology, interventions and management that addressed acute or emergency care populations. Given patients from the EC are often triaged to the outpatient clinics, even if they present to the EC, in order to be comprehensive, we have included terms that account for both settings that capture potential acute patient populations. Studies that did not involve a Kenyan population or occur in Kenya, that did not involve an acute or emergency care/emergency centre population, or that did not constitute an epidemiological study, intervention or management pertinent to acute or emergency care populations were excluded. No exclusions or restrictions were applied relative to publication date and language. The protocol of the systematic review is registered under PROSPERO (CRD42018088621) [16].

Results

The final searches retrieved a total of 510 references, which were pooled in Endnote and de-duplicated to 461 total articles (see Fig. 1). 391 studies were excluded by title or abstract and 93 articles were read in full to further screen for inclusion in final thematic analysis. An additional 217 articles were identified in grey literature. Out of all the studies screened, ten were included in the final analysis. Primary reasons for exclusion were that studies were conducted outside of Kenya or did not include Kenyan populations (such as publications conducted in other African populations that were published in Kenyan academic journals). Additionally, several references were policy documents or concept papers with no primary data collection. Systematic reviews and meta-analyses were also excluded from our final analysis. Finally, studies that were basic science in nature, or that lacked clinical relevance in acute or emergency care of patients were excluded (such as use of breast cancer markers for guiding long-term management of treatment from an outpatient cancer clinic sample population). Studies that addressed trauma or traumatic injuries were also excluded given the review scope being specific to chronic NCDs. All ten articles were summarized by key concepts and themes (see Table 1).

Results by study design and disease focus

Among all of the studies included for final review (n=10), majority were quantitative in study design, and only one was qualitative in nature. Burke et al assessed capacity for NCD care in a sample of facilities in the Western region of Kenya [17]. Wachira et al conducted a descriptive analysis on all patients accessing care in a sample of 15 ECs [18]. Two studies assessed cardiovascular disease patient outcomes at a private, tertiary level hospital [19,20]. Otieno et al assessed outcomes of Diabetic Ketoacidosis (DKA) patients admitted at the national public, tertiary referral hospital [21]. Nkumbe et al assessed prevalence of

Table 1

Results of a systematic review on epidemiology, interventions and management of noncommunicable diseases in acute and emergency care settings in Kenya.

Author name and year	Population	Study type	Dates	Sample size (n)	Study primary findings
Burke et al (2014)	All 30 primary and secondary hospitals and a stratified random sampling of 30 dispensaries and health centres in western Kenya	Cross-sectional	Nov 2013-Jan 2014	60 (healthcare facilities)	Top ten most common conditions were reported to be communicable diseases, except for trauma (30%-60%, depending on facility). 100% of MI patients were referred in lower-level facilities, 80% in higher-level facilities. 93% felt ill-prepared to manage DKA at lower-level facilities, 67% at higher-level facilities. Among diagnostics: 87% had BP cuffs, 13% had EKG, 30% had XR, 57% had glucometer. Among medications and management supplies: 12% had nitroglycerin, 48% had insulin, 53% had oxygen, 38% had intubation supplies.
Dawsey et al (2010)	Patients with a histologic or endoscopic diagnosis of EC who were <30y	Case series	1996-2009	109 (65 male; 44 female)	Follow-up information obtained on n=60 (55%) of patients. 4 (7%) were candidates for esophagectomy, one of whom survived >5 years. N=45 (79%) had positive family history of CA, n=21 (43%) had family history of esophageal CA. Tobacco smoking present in n=9 (15%), alcohol use in n=9 (15%).
Nkumbe et al (2010)	Diabetes clinic patients, diagnosed with DM in past 12 months	Cross-sectional	2001-2002	71 (30 male; 41 female)	A total of n=65/71 patients were included, with the remainder excluded due to poor quality of images obtained. 42% of subjects were male. The prevalence of diabetic retinopathy in men and women was 33% and 28% respectively (P = 0.15), while the overall prevalence was 30.4%. Diabetic retinopathy was unilateral in three patients (6.5%) and bilateral in 11 (23.9%). Four out of 46 patients (8.7%) had clinically significant macula edema (CSME).
Aduda et al (2014)	Women > 18y who had been tested for Syphilis or undergone cervical cancer screening	Qualitative	2009	64 (females)	On cervical cancer screening, there was understanding of asymptomatic nature of disease in early stages, and on typical signs and symptoms later, but also misconceptions on how it is contracted. Respondents were appreciative of pre-test consent and found it educational, but still found screening fearful with concerns about possible positive screening results. Results were desired as soon as possible, and verbal administration of results was preferred over written given anxiety, impersonality, and illiteracy. A deference to "God's will" was also evident.
Otieno et al (2010)	Emergency Department and hospital patients	Cross-sectional	Dec 2001-Aug 2002	51 (25 male; 22 female)	8% (n=51/648) of diabetic patients admitted during study period had DKA. Mean age 33.4 (95% CI 15.2). 51% were newly diagnosed. Polyuria (85%), polydipsia (83%) and vomiting (43%) were lead presenting symptoms. 36% (n=17) were obtunded with GCS 3-8. 32% (n=15) were severely dehydrated. Mortality was 30% (n=14/47). Abnormal renal function (71%), AMS (100%), new DM diagnosis (64%) and being female (64%) were poor prognosticators.
Wachira et al (2012)	Emergency Department patients presenting alive, on randomly generated set of days during data collection period	Cross-sectional	Oct 2010-Dec 2010	1887 (940 male; 947 female)	27% of patients aged 0-9y; 70% aged >13y. 58% had tests done, malaria blood film most common. Trauma lead diagnoses in adults (24%), malaria in children (24%). Wound care (26%), fluid resuscitation (10%), management of bronchospasm (7%), splinting (4%), and management of hyperglycemia (3%) were top 5 most common treatments. 19% (n=354) were admitted, 7% (n=127) were referred.
Wachira et al (2014)	Adults >21y admitted from the ED with a diagnosis of Acute Coronary Syndrome (ACS)	Retrospective chart review	Jan 2012-Feb 2013	45 (37 male; 8 female)	Compliance rates with: ECG done in 10 min of first medical contact was 89%; door-to-needle (fibrinolysis) goal of 30 min was 43%; door-to-balloon (PCI) goal 90 min was 29%; in-hospital complication rate was 13.3%.
Wachira et al (2015)	Adults aged >18y with In-Hospital Cardiac Arrest (IHCA)	Retrospective chart review	Jan 2013-Dec 2013	108 (63 male; 45 female)	The predominant initial rhythms post cardiac arrest were pulseless electrical activity (41.7%) or asystole (35.2%). Hypertension (43.5%), septicemia (40.7%), renal insufficiency (30.6%), diabetes mellitus (25.9%) and pneumonia (15.7%) were the leading pre-existing conditions in the patients. A Modified Early Warning Score (MEWS) of 5 or more was reached in 56 (67.5%, n = 83) patients before the cardiac arrest. The rate of survival to hospital discharge was 11.1%. All the patients who survived to hospital discharge had a good neurological outcome.
White et al (2002)	All cancers diagnosed during the study period at Tenwek Hospital	Case series	Jan 1989-Dec 1998	1459	Top 5 most commonly diagnosed cancers: esophageal (n=274), stomach (n=137), prostate (n=79), liver (n=71) and colorectal (n=61). Breast cancer among top ten (n=51). Mean age at diagnosis was: 56y for women and 54y for men (14-91y). 11% of esophageal cancer cases were aged <30y.
Wools-Kaloustian et al (2007)	Outpatient HIV clinic patients	Cross-sectional	May 2004-	389 (125 male; 264 female)	For the 373 individuals with complete data, the mean CrCl was 90ml/min (range 30 –200ml/min). CrCl <60ml/min was identified in 43 (11.5%) subjects with 18 (4.8%) having

(continued on next page)

Table 1 (*continued*)

Author name and year	Population	Study type	Dates	Sample size (n)	Study primary findings
			Nov 2005		a CrCl <50ml/min. In the multi-variate analysis, only lower haemoglobin [OR 0.79 (0.69–0.91), p=0.001] and wasting syndrome [OR 4.17 (1.15–15.11), p=0.03] were associated with a CrCl <60ml/min. History of tuberculosis [OR 3.0 (1.02–8.96), p=0.04] was significantly associated with proteinuria.

Abbreviations: ACS-Acute Coronary Syndrome, AMS-Altered Mental Status, BP-Blood Pressure, CA-Cancer, DM-Diabetes Mellitus, EC-Esophageal Cancer, ED-Emergency Department, EKG- Electrocardiogram, DKA-Diabetic Ketoacidosis, GCS-Glasgow Coma Scale, IHCA-In-Hospital Cardiac Arrest, NCD-Non-Communicable Disease, XR- X-ray

diabetic retinopathy at an outpatient ophthalmology clinic [22]. Two case series were conducted at a mission hospital: one included all cancer patients and a second focused solely on esophageal cancer patients [23,24]. Wools-Kaloustian conducted a cross-sectional study at an HIV clinic in Western Kenya to assess prevalence of renal disease in these patients [25].

Finally, a qualitative study was conducted by Aduda et al in an outpatient clinic to assess ethical considerations of screening for cervical cancer among patients [26]. Of the ten studies, those with a specific disease focus were: cardiovascular disease (n=2), cancer (n=3), diabetes (n=2) and renal disease (n=1). An assessment of the risk of bias of the included studies are included (see Table 2).

Results by target population focus and population location

Only five studies addressed EC patients or patients admitted to the hospital from the EC. Three of the ED-specific studies incorporated patient populations in the public health system [17,18,21], where the majority of patients in Kenya receive care. The other two studies on EC populations [19,20] were among patients at a private teaching and referral hospital, Aga Khan University Hospital – Nairobi (AKUHN).

Of the five additional studies that were not conducted on EC patients, two were conducted in the outpatient setting at a well-established mission hospital, Tenwek hospital [23,24]. The final three were conducted at specialty clinics: an outpatient diabetes clinic [22], an outpatient HIV clinic [25] and among cervical cancer patients at an

antenatal clinic [26].

Of note, none of the studies were nationally representative in sampling. Women were equitably represented in the studies or constituted the predominant sample population. Results on children were only present in one of the studies [18]. Finally, half of the studies were conducted at facilities in the urban capital city, Nairobi.

Results by individual study

In the capacity assessment by Burke et al of 60 healthcare facilities in Western Kenya, their capacity to manage NCDs or complications of NCDs (heart attack and diabetic ketoacidosis) was poor [17]. Majority of patients required referral for heart attack, and even at higher acuity level facilities in the sample, only 44% reported stabilizing heart attack patients prior to transfer, such as providing oxygen. In a national sample of 15 public hospitals in Kenya by Wachira et al, they described patient presentations and management [18]. Hypertension (3%) and acute asthma attack (3%) were among the top ten lead diagnoses in adults. Among the top most common treatments were "management of acute bronchospasm" (7%) and "management of hyperglycemia" (3%). Malaria screening was the most common test ordered.

A retrospective chart review was also conducted by Wachira et al among EC patients accessing care at the private hospital AKUHN with the aim of assessing compliance with guidelines for the management of ST-elevation Myocardial Infarction (STEMI) [19]. They found the prevalence of compliance ranged from 29%-89%, with the goal of initial

Table 2
Quality assessment (method: Cochrane collaboration' tool for assessing risk of bias).

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data addressed (attrition bias)	Selective reporting (reporting bias)	Other sources of bias	Total low on risk of bias
Burke et al (2014)	Low risk	Low risk	High risk	High risk	Low risk	Low risk	Low risk	(5/7)
Dawsey et al (2010)	Low risk	Low risk	Low risk	Low risk	High risk	High Risk	Low Risk	(5/7)
Nkumbe et al (2010)	Low risk	Low risk	Low risk	Low risk	High risk	Low risk	Low risk	(6/7)
Aduda et al (2014)	High risk	High risk	High risk	Low risk	High risk	Low risk	Low risk	(3/7)
Otieno et al (2010)	High risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk	(5/7)
Wachira et al (2012)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(7/7)
Wachira et al (2014)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(7/7)
Wachira et al (2015)	Low risk	Low risk	Low risk	Low risk	High risk	Low risk	Low risk	(6/7)
White et al (2002)	Low risk	Low risk	Low risk	Low risk	High risk	Low risk	Low risk	(6/7)
Wools-Kaloustian et al (2007)	High risk	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	(5/7)

From: Higgins JPT, Altman DG, Sterne JAC, eds. Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S, eds. Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011.

EKG being done within 10 min of first medical contact being the most successful intervention (see Table 1). Compliance with guidelines was lower for definitive treatment, with "door-to-needle" (fibrinolysis) goal achieved only 43% of the time, and "door-to-balloon" primary percutaneous coronary intervention (PCI) goal achieved only 29% of the time. There was near universal administration of aspirin (98%) and clopidogrel (91%), though time to administration was not addressed.

The second study on cardiovascular disease was a descriptive analysis of In-Hospital Cardiac Arrest (IHCA) patients, which was also a retrospective chart review conducted at AKUHN [20]. The review included all patients seen in 2013. 108 patients were included in the study. Only 4% of arrests occurred in the EC, and the majority (40%) occurred in the Intensive Care Unit (ICU). In case of an IHCA, an assigned team of EC and ICU nurses and doctors responds. The average team response time was 164 seconds (outside of the EC and ICU). 44% of patients had hypertension, 17% had history of MI, and 7% had other evidence of CVD with stroke or heart failure. A Modified Early Warning Score (MEWS), an indicator for severity of illness, was documented on just 77% of patients but in those documented, 68% had the highest severity MEWS 4 h prior to arrest, indicating a poor prognosis.

Otieno et al demonstrated a mortality rate of 30% (n=14/47) in DKA patients presenting to KNH in a prospective, descriptive analysis conducted between 2001-2002 [21]. Primary determinants of mortality were abnormal renal function which was present in 71% of those that died, altered mental status (100%), a new DM diagnosis (64%) and being female (64%). There was one cross-sectional study on diabetic retinopathy by Nkumbe et al [22] that had 71 subjects, which was conducted in a diabetes clinic in the largest referral hospital in Kenya, Kenyatta National referral hospital. They included all patients accessing care at the diabetes clinic with a recent diagnosis of 1 year or less and used screening with color fundus photographs. 30.4 % of all the participants were found to have diabetic retinopathy while 8.2% had vision threatening retinopathy.

A case series on all cancer patients presenting to Tenwek hospital, a well-established mission hospital located in Western Kenya with a catchment of 400,000 patients, demonstrated esophageal cancer to be the most common cancer diagnosis [24]. In addition, they found a disproportionately high prevalence of the disease in patients aged 30y or younger. A subsequent case series from the same hospital on "young" esophageal cancer patients, defined as 30y or younger, demonstrated that established risk factors for disease such as tobacco and alcohol are unlikely or absent in this population [23]. Among patients diagnosed, no women (n=44) reported tobacco use, and only one reported alcohol use. Family history, on the other hand, was prevalent in 79% (n=45/60) of cases, with 44% reporting a first degree relative, and 28% with multiple relatives affected. The final study addressing cancer was also the only qualitative study included, and the only study that addressed attitudes towards care or care received. The study addressed ethical issues related to compulsory and voluntary screening in outpatient clinics in Kisumu [26]. They found that patients appreciated education associated with pre-testing, desired immediate results rather than waiting, demonstrated anxiety over results and coping with positive screening results, and desired verbal over written results given anxiety associated with the impersonal nature of written results, and illiteracy.

Finally, we identified a sole study on renal disease conducted by Wools-Kaloustian et al [25] which assessed antiretroviral naïve HIV-infected outpatient population in Western Kenya. It was a cross sectional study with 373 participants. Of the 373 participants, 43 (11.5%) were found to have renal insufficiency with a creatinine clearance of <50 [25].

Discussion

In this study, we found a dearth of literature on NCDs in the acute and emergency care setting in Kenya. Of all of the studies, we found that the vast majority used a quantitative study design, and around half conducted retrospective chart reviews as part of their methodology. Of the leading four NCDs [3], chronic respiratory disease was unaddressed. Two studies were helpful in providing initial capacity assessments, though they were limited in their location and scope [17,18]. Another two studies addressed cardiovascular disease morbidity and mortality [19,20], the foremost contributor to the global NCD burden [3], albeit in a tertiary care center that is private and unlikely to be accessed by majority of the population. None of the studies addressed interventions, treatment or implementation science targeting acute or emergency care populations in Kenya. Finally, all of the studies were observational in nature, no clinical trials were found.

Notably, five out of eight of the facility-based studies were conducted on patient populations at Kenyatta National Hospital, and Moi Teaching and referral hospital [19–22,25]. As two of the major referral hospitals in the country, both have access to large patient populations, and academic physicians with the potential resources to facilitate conducting research. Reasons for lack of research from other sites may also be due to publication bias [27]. All the same, the lack of studies from other facility levels, and regions, particularly in rural regions where the majority of care is provided [8] needs to be addressed. In particular, nationally representative studies are needed.

In addition, there is a need for long-term data collection through the use of cohort studies, surveillance and registries [28] to assess epidemiology, mediators of disease, and outcomes of patients to better equip the healthcare system for resource allocation based on trends. This is particularly true for those diseases with a large burden of morbidity [3], such as cardiovascular disease, asthma and chronic kidney disease, and which were underrepresented in our literature review. The Pak-NEDs surveillance study in Pakistan was a key demonstration of the role of surveillance to improve emergency care, with the potential for rich data analysis guiding potential intervention design in this case addressing road traffic injury patients – from pre-hospital care, to patient presentations, and patient outcomes [29–32]. To date, the longest running registry in Africa affecting emergency care populations was the trauma registry led by Kobusingye et al in Uganda that was implemented at the Mulago and Kawolo hospitals, with the former being one of the oldest hospitals in Africa and a leading referral center [33]. In Kenya, the KEMRI-Wellcome Trust population-based registries are some of the oldest on the continent. These latter registries have not only provided routine data for the country as it pertains to malaria, a predominant communicable disease, and subsequently child and maternal health but also provided a framework for research training in the country for decades [34]. In sum, while resource-intensive to establish [28], the role of surveillance and registries in guiding care including for chronic NCDs cannot be overstated, with opportunities including longitudinal follow-up of patient outcomes, cost of care, among other beneficial data.

Majority of the study designs that met our inclusion criteria used quantitative methods, and we found only one qualitative study. Given the predominance of retrospective chart reviews in clinical research originating from LMICs [35] due to a lack of access to data, and other barriers that hinder de novo collection of primary data, this is not surprising. All the same, prioritization should also be given to conducting mixed methods or qualitative studies, which are lacking. The value for qualitative data tends to commonly be overlooked [36,37]. Qualitative studies are needed to better understand the underlying contributors to patient and provider practices pertaining to NCDs in the acute and emergency care setting. Implementation science will also be important in determining approaches to intervention development, piloting and dissemination [38]. Finally, randomized controlled trials assessing effectiveness of clinical therapy, guidelines and other interventions are desperately needed in emergency care populations to guide best-practices unique to this setting [39].

In addition, most of the studies focused on patient clinical outcomes, with only three assessing healthcare system factors, such as resource availability [17,18] and provider compliance [19]. In the study by Wachira et al on STEMI patients at AKUHN [19], they found that

compliance with guidelines in early phases of CVD care, such as obtaining EKGs on patients, was high likely secondary to the recent implementation of guidelines prior to the study [19]. The authors cite the relatively new implementation of PCI at their institution, and difficulty accessing PCI outside of regular business hours, as limitations to compliance with definite therapy (PCI). In the second study by Wachira et al, which assessed IHCA patients [20], they found that a quarter of patients that arrested did not have a MEWS score documented on the chart. They purport that enforcing documentation, and indicators such as the MEWS to help identify high risk patients early on may help mobilize resources earlier for patients that need them and in turn reduce morbidity and mortality from delayed recognition [20]. Implementation of healthcare system interventions has been shown to improve outcomes, such as with pre-hospital guidelines for CVD outcomes [40], early blood pressure control in hemorrhagic strokes [41], specialty training for pediatric airway management [42], and diabetes referral to care guidelines [43] in both Western nations with well-established emergency care, such as the US and Europe, and other African settings. Greater attention is needed addressing healthcare system interventions, clinical policy development, guideline implementation, and assessment of evidence-based, locally-generated quality measures [7,44].

While it is encouraging that studies focused on the leading NCDs [3], CVD, cancer, and diabetes, no studies addressed chronic lung disease. Furthermore, we found only one study on complications of disease, which was assessing diabetic retinopathy [22]. In line with the WHO Global NCD action plan [3], we believe that given the morbidity and mortality of these leading four chronic NCDs, studies should be aligned with these diseases. The research gap on chronic lung conditions has been identified as a key priority area with need for advanced research in Africa, including due to the unique exposure in LMICs associated with biomass fuel [45,46]. Furthermore, asthma in pediatric patients is a significant source of morbidity [47]. More research is also needed on NCD-related complications such as stroke, diabetic retinopathy, kidney failure, and diabetic neuropathy, to further guide resource allocation and interventions targeting these patients when they present to the EC [22,48–50]. Moreover, the studies by Dawsey et al [23] and White et al [24] reinforce the need for primary data in the LMIC setting. As demonstrated, factors such as hot tea and diet have been shown to be leading risk factors associated with esophageal cancer in Kenyan populations, a deviation from more commonly established factors like tobacco and alcohol [3]. In sum, greater understanding of the burden of disease, contributing factors, and complications of disease is desperately needed to help mitigate mortality and morbidity [51,52].

Limitations

Emergency medicine is a fledgling specialty in most parts of the world including Africa [6] where, for example in Kenya, there has only been a single emergency medicine "consultant" ("attending") in practice over the last decade. Lack of awareness on the relevance of emergency care is likely a major contributor to the lack of prioritization and, in turn, dearth of research on this population. In our own findings, the majority of EC-based literature has been spearheaded by the sole emergency medicine "attending" or "consultant" in the country [8,18–20]. This demonstrates that by prioritizing the training of emergency care professionals, we not only improve clinical outcomes for patients in the emergency care setting [6,51], but in turn secondarily contribute to driving research and development of evidence-based guidelines for this population. Given increased visibility on the development of emergency care in recent years, such as via incorporation into the Universal Health Coverage agenda by the WHO [52], and efforts by the African Federation for Emergency Medicine and other such bodies [53], ideally research efforts will only increase in volume and quality.

Furthermore, limitations due to publication bias likely also contributed to the dearth of studies found in our study. Publications not indexed in databases from which we sourced our review may have been excluded. We attempted to mitigate these effects by incorporating grey literature and reviewing Africa-centered databases such as Africa-Wide Information in the protocol. Additionally, we included all articles in the final thesis as long as they met our a priori inclusion criteria, on epidemiology, interventions and management [16].

Finally, data in the studies discussed are not representative of the general Kenyan population. Nearly half incorporate data from private hospitals and one mission hospital (n=4/10), which are not accessed by the majority of Kenyans, or assessed urban populations. The majority of Kenya's population resides in the rural areas. More research needs to be done focusing on emergency care at lower acuity health facilities and in rural areas, as recommendations made based on findings among urban populations cannot necessarily be generalized nationally.

Conclusion

There is limited evidence on epidemiology, interventions and management of NCDs in Kenyan acute and emergency care populations, and there is need for increased research. Opportunities for research include nationally representative epidemiological studies on NCDs, and associated complications, as outlined by the WHO NCD action plan with the consideration for long-term cohort studies, registries and surveillance. Furthermore, studies are needed to address health system factors affecting NCD care in these settings, including through use of implementation science to inform policy, guideline development and dissemination. Finally, randomized, controlled trials to assess current and novel interventions among these populations are needed widely in LMIC emergency care settings, including Kenya.

Update 1/2021

This is an update from our PROSPERO protocol that was published in 2015 [16], in which we have included publications between 2015 and December 2020. As a result of re-running our search strategy, we ended up with 439 de-duplicated records, and 14 additional publications after exclusions were made by title and abstract, and subsequently by full text [54–67] (see Table 3). Review for inclusion of articles was conducted independently by two members of the team, and ratified by a third reviewer, as previously detailed in the methods section of the paper. Primary reasons for exclusion were, similar to our original review, primarily due to articles which: (i) were not focused on NCDs primarily (including focusing on HIV with no NCD outcomes but mentioned in theory such as part of an introduction or discussion), (ii) did not take place in Kenya/address Kenyan populations, (iii) were review articles, systematic reviews themselves, or policy pieces with no primary data, (iv) were conference abstracts, due to limited access to methodologies and outcomes, and (v) did not have clinical relevance to acute or emergency care (such as the use of biomarkers for diagnosis in outpatient oncology clinics). Once again, we did also consider studies that occurred in acute/outpatient clinics for inclusion given the potential clinical relevance for the patient population. Furthermore, there is an overall paucity of data from emergency care units alone, and we sought to present as comprehensive of results as possible that still had relevance to the target population. As such, we also did not exclude case reports in the updated review given findings that may benefit current clinical practice and further incite research. An assessment of the risk of bias of the included studies are included (see Table 4).

A retrospective chart review by Saleeby et al, conducted on patient records at KNH between October 2014 to January 2015 (n=20,359/23,941 available records) demonstrated the increasing burden of NCDs as compared to communicable disease in this setting [54]. ICD-10 diagnoses for triage and admitted patients were predominantly associated with traumatic injury (24% and 34%, respectively), secondarily due to NCDs (17% and 21%, respectively) and lastly due to communicable disease, maternal or neonatal conditions (15% and 8%, respectively).

Table 3

Updated results of a systematic review on epidemiology, interventions and management of noncommunicable diseases in acute and emergency care settings in Kenya (2015-2020).

Author name and year	Population	Study type	Dates	Sample size (n)	Study primary findings
Ali et al (2018)	Oncolology patient presenting to the Department of Medicine, Aga Khan University, Nairobi, Kenya	Case report	–	1	Owing to the lack of other opioids in our country and the increasing amount of morphine being used, rectal suppositories containing 60 mg of lidocaine and 5 mg of hydrocortisone were started. Over the course of 72 h, use of the suppositories greatly improved his pain. His morphine was tapered and finally discontinued before discharge. At a follow-up visit one month later, his pain was well controlled on two suppositories a day and he had commenced working part-time from home. (His current medications included oral morphine 20 mg every 4 h, paracetamol (acetaminophen) 500 mg orally every 6 h, and meloxicam 15 mg orally once a day. He was compliant with his medications but rated his anal pain as 7 out of 10, worse on sitting and lying on his gluteal area.)
Bahiru et al (2018)	Acute coronary syndrome (ACS) cases managed at Kenyatta National Hospital	Retrospective chart review	Nov 2016 - Apr 2017	196 ACS admissions (127 male; 69 female)	The majority (65%) was male, and the median age was 58 years. Most (57%) ACS admissions were for ST-segment-elevation myocardial infarction (STEMI). In-hospital dual antiplatelet (> 85%), beta-blockade (72%) and anticoagulant (72%) therapy was common. A minority (33%) of patients with STEMI was eligible for reperfusion therapy but only 5% received reperfusion. In-hospital mortality rate was 17%, and highest among individuals presenting with STEMI (21%).
Bahiru et al (2018)	Healthcare providers involved in the management of ACS patients at Kenyatta National Hospital in Nairobi, Kenya	Prospective qualitative analysis	Jan 2017- Feb 2017	16 interviews during the study period, including with one cardiologist, two accident and emergency (A&E) attending physicians, two medical officers in the casualty department, three A&E nurses, and eight medical registrars	More than half (56%) of the interviewees were women. Major themes included the need to improve the diagnostic and therapeutic capabilities of the hospital, including increasing the number of ECG machines and access to thrombolytics. Participants highlighted an overall wide availability of other guideline-directed medical therapies, including antiplatelets, beta-blockers, statins, anticoagulants, and ACE inhibitors. All participants also stated the need for and openness to accepting future interventions for improvement of quality of care, including checklists and audits to improve ACS care at Kenyatta National Hospital.
Cranmer at al (2018)	Emergency obstetric readiness standards at 44 Kenyan primary care facilities in Kakamega County	Cross-sectional	Feb 2013- May 2013	44 (primary care facilities)	In hypertensive emergencies, facilities can treat the disorder only when all needed resources to identify and treat the emergency are simultaneously present. Of 44 facilities, 36 had sphygmomanometers and stethoscopes (88.12%). Far fewer also stocked the antihypertensive drug hydralazine that should be simultaneously administered with magnesium sulfate (6.82%) in hypertensive obstetric emergencies.
Edwards et al (2015)	Patients, registered in a Médecins Sans Frontières (MSF) chronic diseases clinic in the informal settlement of Kibera with hypertension and/or diabetes mellitus with or without HIV who were >15 y	Retrospective cohort	Jan 2010 - June 2013	2206 patients	In comparing the proportion of patients by presenting hypertension stage, HIV positive (PLHIV) patients presented more frequently with stage 1 and those without HIV had significantly more cases in stage 3. Of those who were treated for hypertension, there were similarly good improvements in blood pressure, regardless of HIV status (40% achieved target SBP PLHIV; 50.0% HIV-negative patients). The median duration of follow-up was shorter among those who were HIV-negative versus PLHIV, 1 and 1.4 years, respectively. This is felt to be largely

Table 3 (*continued*)

Author name and year	Population	Study type	Dates	Sample size (n)	Study primary findings
					due to the high lost to follow up rate after 6 months, which was 36% in HIV-negative patients versus 22% in PLHIV.
Evans et al (2017)	A mobile ECG recorder screened 50 African adults (66% women; mean age 54.3 ± 20.5 years) attending Kijabe Hospital (Kijabe, Kenya)	Prospective observational study	July 12 – 23, 2016	50 African adults (66% women; mean age 54.3 ± 20.5 years)	ECG tracings of 4 of the 50 patients who completed the study showed AF (8% AF yield), and none had been previously diagnosed with AF. When asked about continuous access to Internet and personal mobile devices, almost all of the health care providers surveyed answered affirmatively.
Juma et al (2019)	HIV-infected adult patients (> 18 years) at Ukwala sub-county hospital	Retrospective chart review	June 2013 - Jan 2015	1502 patients (466 male; 1,036 female)	Cardiovascular screening of people living with HIV revealed a significant prevalence of undiagnosed hypertension (13.3%) and raised total cholesterol levels (14%). There was no association between hypertension and current ART regimen, however raised total cholesterol was more likely in those on TDF [adjusted OR 2.20 (1.28–3.78), p = 0.0042], AZT [adjusted OR 2.50 (1.50–4.18), p = 0.004] and D4T-containing regimens.
Kamau et al (2018)	Patients with established histological diagnosis of Esophageal Cancer (EC) at Kenyatta National Hospital (KNH)	Retrospective cohort study	Sept 2016 - Nov 2016	85 patients	Majority (89.4%) were diagnosed in stage III and IV of the disease. The median time to histological diagnosis of EC was 90 days. The time to first presentation was more than 30 days among 78.8% of subjects. The median time from first consultation to referral to a diagnostic-capable facility was 30 days, with 76.5% of the participants taking more than 30 days to reach KNH. Those who could not afford transport and consultation were more likely to report delay to first presentation (OR 3.6 95% CI 1.2-11.3, p=0.022). Referral delay was associated with residence, with those living in the rural areas less likely to delay (OR 0.2, 95% CI 0.0-0.8, p=0.019).
Kimeu et al (2016)	Patients presenting to Nairobi Hospital with acute myocardial infarction >18y	Retrospective chart review	Jan 2007 - June 2009	64 patients (87.5% were male)	40.6% arrived at the emergency department more than 12 h after the onset of chest pain. In the STEMI arm, 79.5% of patients underwent thrombolysis, 17.9% had rescue percutaneous coronary intervention (PCI) and 2.6% had no reperfusion therapy. Medical management was carried out in 29% of the patients, 19.1% had a coronary artery bypass graft and 40.4% had PCI. The in-hospital mortality rate was 9.4% and mean in-hospital probability of death according to the GRACE risk score was 16.05%. Discharge medication was a β-blocker in 84.5% of patients, an ACE inhibitor or angiotensin receptor blocker in 48.3%, low-dose aspirin in 96.6%, clopidogrel in 96.6% and statins in 93.1%.
Lin et al (2017)	Health care providers working on inpatient wards at Moi Teaching and Referral Hospital (MTRH) -Eldoret, Kenya	Qualitative cross-sectional	–	199 surveyed providers	Most respondents stated that stroke scales should always be used (58.3% of respondents), 3 h was the appropriate time limit for thrombolysis (53.8% of respondents), and CT scan should be always be obtained prior to administration of anticoagulant therapy (61.3% of respondents). Because thrombolytic therapy (tissue plasminogen activator) [t-PA] is not used at MTRH, 40.7% of respondents reported always substituting t-PA with streptokinase or heparin for treatment of acute ischemic stroke. Neither venous thromboembolism prophylaxis nor dysphagia/swallowing screening were considered to be done a majority of time.
Mbui et al (2017)	Hypertensive patients attending a medical out-patient clinic of Ruiru sub-county hospital in Kiambu County, Kenya	Mixed- method retrospective chart review in combination	Jan 2015 - Apr 2015	247 hypertensive patients	ACEIs and thiazide diuretics were the most commonly prescribed drugs, mainly as combination therapy. Treatment typically complied with guidelines, mainly for stage 2

Table 3 (*continued*)

Author name and year	Population	Study type	Dates	Sample size (n)	Study primary findings
		with qualitative interviews			hypertension (75%). BP control was observed in 46% of patients, with a significant reduction in mean systolic (155 to 144 mmHg) and diastolic (91 to 83 mmHg) BP (P < 0.001). Patients on ≥2 antihypertensive drugs were more likely to have uncontrolled BP (OR:1.9, p = 0.021). Patients 65 years and older (n=778) were most commonly admitted due to non-communicable illnesses: cerebrovascular disease (12%), heart disease (11%), hypertensive disease (7%), renal failure (7%), and endocrine disorders (6%).
Saleeby et al (2019)	Accident and Emergency (A&E) department patients presenting to Kenyatta National Hospital	Retrospective chart review	Oct 2014 – Jan 2015	20,359 patients (10,075 male; 9,567 female)	
Simba et al (2018)	Caretakers of asthmatic children aged 6–11 years at Moi Teaching and Referral Hospital.	Cross-sectional	Aug 2016 – Dec 2016	116 caretakers	Most of the caretakers preferred syrups for inhalers in the management of asthma. Specifically 72(62.1%) felt bronchodilatation is best achieved by syrups while only 34(29.3%) would prefer inhalers on their child given choice. Whilst self-reported asthma knowledge was high, with less than one-fifth of caregivers rating themselves as 'not knowledgeable' (n=23, 19.8%) just less than one third of respondents accepted that their child had asthma (n=38, 32.8%).
Varwani et al (2019)	Acute coronary syndrome admissions to the Aga Khan University Hospital, Nairobi (AKUHN)	Retrospective chart review	Jan 2012 - Dec 2013	230 patients (81.2% of STEMI patients; 82.2% NSTE-ACS were male gender)	Delayed presentation (more than 6 h after symptom onset) was common, accounting for 66.1% of patients. Coronary angiography was performed in 85.2% of the patients. In-hospital mortality rate was 7.8% [14.9% for STEMI and 2.3% for non-ST-segment ACS (NSTE-ACS, consisting of NSTEMI and UA)], and the mortality rates at 30 days and one year were 7.8 and 13.9%, respectively. Heart failure occurred in 40.4% of STEMI and 16.3% of NSTE-ACS patients.

Furthermore, among patients 65 years and older, the most common admission diagnosis was due to an NCD, and specifically: cerebrovascular disease (12%), heart disease (11%), hypertensive disease (7%), renal failure (7%), and endocrine disorders (6%), respectively. Overall, head injury was the most common diagnosis associated with death (19%), except among those 65 years or older where NCDs constituted the majority.

We found one study that looked at concomitant NCD and communicable disease [61] in a population of patients seeking care at an HIV clinic in Ukwala sub-county hospital. In this study, Juma et al, conducted a retrospective chart review on all patients seeking HIV care at the clinic between June 2013 and January 2015. They assessed the prevalence of hypertension, high cholesterol, and raised blood glucose levels. 69% (1,036) of respondents were women. The median age in the study was 30 (IQR 31–48) years and median CD4 count was 430 (IQR 308–574) cells/mm3, with 79% of subjects on antiretroviral therapy (ART). Of the 1,502 individuals screened, 40.4% (609/1502) had pre-hypertension, 10.4% (157/1502) had stage 1 hypertension, and 2.9% (43/1502) had stage 2 hypertension. 207 (14%) patients had an elevated non-fasting total cholesterol level (>5.2 mmol/l), and 31 (2.1%) patients had a raised blood glucose level > 7.8 mmol/l. There was increased likelihood of having cardiovascular risk factors among men on ART and among those older than 40 years. ART use also increased likelihood of having elevated cholesterol (p=0.0001, OR 2.53, 95% CI 1.55-4.13) and having stage 2 hypertension (p=0.029, OR 3.48, 95% CI 1.06-11.42).

Bahiru et al, assessed presentation, management and outcomes of acute coronary syndrome patients (ACS) in a registry at the Kenyatta National Hospital (KNH) [56], which is the largest tertiary referral hospital in Kenya and East Africa. As discussed previously, this is a public hospital. They assessed all ACS admissions between November 2016 to April 2017 (n=196) and found that the majority (65%) of cases were male with a median age of 58 years. Administration of in-hospital dual antiplatelet (>85%), beta-blockade (72%) and anticoagulant (72%) therapy was high. However, the definitive treatment of reperfusion therapy for STEMI cases, was only conducted in 33% of those that were eligible. Bahiru et al also conducted a qualitative study to understand facilitators and barriers to ACS care at KNH assessing healthcare providers and healthcare leaders involved in their management [57]. They found themes on: delays in presentation (attributed to lack of patient understanding of ACS symptoms) and delays in inter-hospital transfers. They also found that management and treatment capacity is limited due to lack of access to diagnostics and medications, as well as lack of training of staff. They further described patients' inability to afford the medications rather than actual availability of medications as the barrier to treatment. Finally, they cited lack of awareness, implementation and enforcement of protocols on ACS management as problems. They recommended quality improvement measures such as audits and feedback reports, as well as increased provider training.

In a retrospective study of patients at one of the largest private hospitals in Kenya, Nairobi Hospital, Kimeu et al assessed clinical characteristics, management and outcomes of patients diagnosed with acute myocardial infarction in the Intensive Care Unit (ICU) and high-dependence unit (HDU) between January 2007 to June 2009 [63]. In this study, 64 patients were included, 87.5% of which were male. The sample population had an average age of 56.7 years. The majority (40.6%) arrived at the emergency centre more than 12 h after the onset of chest pain. There was 71.9% prevalence of hypertension, 35.9%

Table 4

Updated quality assessment (method: Cochrane collaboration' tool for assessing risk of bias) (2015-2020).

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data addressed (attrition bias)	Selective reporting (reporting bias)	Other sources of bias	Total low on risk of bias
Ali et al (2018)	High risk	High risk	High risk	High risk	Low risk	High risk	Low risk	(2/7)
Bahiru et al (2018)	Low risk	Low risk	Low risk	Low risk	High risk	Low risk	High risk	(5/7)
Bahiru et al (2018)	High risk	High risk	High risk	Low risk	Low risk	Low risk	Low risk	(4/7)
Cranmer at al (2018)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(7/7)
Edwards et al (2015)	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(6/7)
Evans et al (2017)	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(6/7)
Juma et al (2019)	High risk	Low risk	Low risk	Low risk	High risk	Low risk	Low risk	(5/7)
Kamau et al (2018)	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(6/7)
Kimeu et al (2016)	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(6/7)
Lin et al (2017)	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(6/7)
Mbui et al (2017)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(7/7)
Saleeby et al (2019)	Low risk	Low risk	Low risk	Low risk	High risk	Low risk	Low risk	(6/7)
Simba et al (2018)	High risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(6/7)
Varwani et al (2019)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	(7/7)

From: Higgins JPT, Altman DG, Sterne JAC, eds. Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S, eds. Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011.

prevalence of cigarette smoking, and 25% prevalence of diabetes, 18.8% had a history of ACS and 9.4% had a history of chronic kidney disease. The door-to-ECG time was <10 min in 10.9% of patients. Both aspirin and clopidogrel were received by 96.9% of patients in the emergency centre. As far as management, of those with an NSTEMI, 44% received IIb/IIIa inhibitors, and 68% had a coronary angiogram. Among those with a STEMI, 79.5% received thrombolysis and 17.9% underwent rescue percutaneous intervention (PCI). The door-to-needle time was less than 120 min in 45.2% of the thrombolysis patients. None of the patients underwent primary Percutaneous Intervention (PCI).

In another retrospective review of another large private hospital, Aga Khan University Hospital-Nairobi (AKUHN), Varwani et al assessed outcomes on ACS patients admitted between January 2012 and December 2013 [67]. They had a total of 230 patients in their study, which included 101 with a STEMI, 93 with NSTEMI and 36 with unstable angina (UA). The mean age was 60.5 years, and 81.7% of respondents were male. Majority of patients (66.1%) had a delayed presentation for care, indicated as more than 6 h after symptom onset, and 35% of patients presented after 24 h or more. Coronary angiography was performed in 85.2% of the patients. The average door-to-needle and door-to-balloon times were 49 ($\pm$42) and 137 ($\pm$63) minutes, respectively. The door-to-needle time (DTN) of 30 min was met in 53.1% of patients, and door-to-balloon (DTB) time of 90 min occurred in 26.3% of patients. In-hospital mortality rate was 7.8%, with a 14.9% mortality rate for STEMI and 2.3% for other ACS patients. Additionally, mortality rates at 30 days and one year were 7.8 and 13.9%, respectively. As compared to the earlier study by Wachira et al that took place in 2014 [12], there was an improvement in goals for DTN and DTB which were then at 12% and 5%, respectively.

Lin et al assessed provider knowledge on stroke management at Moi Teaching and Referral Hospital (MTRH) [64]. 300 surveys were distributed on the wards, and 199 surveys were returned back. The majority of respondents were medical students (61.8%), but there was

fairly even distribution among the remaining practitioners and included clinical officers, medical officers, registrars, medical students, nursing staff, physical therapists, respiratory therapists and psychologists. Of the medical providers, six identified as being associated with emergency triage, 43 with internal medicine, and two with surgery. Around half of respondents stated that stroke scales should always be used (58.3% of respondents), 53.8% reported that 3 h was the appropriate time period for alteplase (t-PA), and 61.3% reported that CT scan should always be obtained prior to administration of anticoagulant therapy. The respondent's level of clinical experience was identified as a determinant of correctly answering questions, to assess knowledge of appropriate IV fluid use in stroke patients (adjusted p = 0.003) and the ideal initiation time for antithrombotic therapy (adjusted p = 0.0017). Beyond this, healthcare providers demonstrated a wide variability in their responses. The authors proposed increased education and process improvement initiatives to focus on more specific management of strokes. They also suggest improvement in preventative efforts among all providers, such as addressing smoking cessation, initiating stroke education, and diabetes teaching.

Another study assessed the management of hypertension patients at an outpatient clinic of peri-urban Ruiru sub-county hospital, which provides care to approximately 800 patients with hypertension from urban and rural areas [65]. The providers at the hospital consist of consultants, medical officers, and clinical officers. This cross-sectional study was conducted between January and April 2015. They assessed data on the current use of antihypertensive medicine and provider rationale for prescription practices. A mixed-method approach was used to collect data, including semi-structured interviews with providers (five prescribing providers at the time of the study) and a retrospective chart review on prescription patterns during the four-month study period. The majority of patients were female (n=216, 87%), and the mean age was 56 $\pm$ 12.5 years. 178 (72%) had been on antihypertensive therapy for between one and five years, and the most common morbidity was

diabetes with a prevalence of 37%. The majority of prescribers used appropriate dosing (96.4%), and had appropriately prescribed second or third-class medications (95.4%), as outlined by the JNC 8 guidelines. However, compliance with treatment was only 45.1% for stage 1 and 75.2% for stage 2 hypertension. Furthermore, only 46% of hypertensive patients had blood pressure control (defined as BP <140/90 mmHg) at the last recorded clinic visit. Females and patients on $\geq$ two antihypertensive drugs were more likely to have uncontrolled BP (OR: 2.3, 95%CI: 1.03, 5.1, p=0.043) and (OR:1.9, 95%CI: 1.1, 3.3, p=0.021), respectively. Qualitative interviews indicated the need for increased provider training on guidelines. They also cited challenges with management due to lack of patient adherence, inadequate patient counselling, cost of medications, medication stock-outs, and lack of diagnostic testing capacity (such as blood pressure cuffs).

In a cross-sectional analysis of 44 primary care facilities in rural Kakamega County, Cranmer et al assessed readiness for 5 different maternal health emergencies using the WHO-Service Readiness Index (SRI) tool that provides estimates of readiness based on signal functions for each of the emergencies [58]. For hypertensive emergencies, they found that while most facilities (88.1%) had diagnostic equipment such as sphygmomanometers and stethoscopes, far fewer had therapeutics available (such as magnesium sulfate and hydralazine). As such, based on signal functions, for hypertensive emergencies, while the mean readiness for identification was 61.4%, ability to treat was 31.8%, and ability to monitor/modify was only 6.8%.

There was one study on cancer, which assessed delays in esophageal cancer diagnosis by Kamau et al [62]. This was a retrospective cohort study in patients with an established histological diagnosis of esophageal cancer that was conducted between September and November 2016, assessing patients older than 13 years presenting to the endoscopy unit, radiotherapy clinic, and cardiothoracic clinic of KNH. The mean age at diagnosis was 58.7 years, and the majority had stage III (41.2%) or stage IV (48.2%) cancer at the time of diagnosis. Nearly four in five (78.8%) of patients took more than 30 days to present after initial symptoms, and 76.5% took more than 30 days to obtain a referral to a diagnostic facility. Once the referral was made, it only took a median of 7 days for endoscopy to be completed, and an additional median of 7 days for histologic diagnosis to be made. While the capacity to make the diagnosis once referral occurs is fairly expedient, significant delays occur in time to initial patient presentation and referral for care.

We found one study on chronic respiratory disease, focusing on pediatric asthma patients receiving care at an MTRH outpatient specialized clinic. This clinic provides care for around 100 children per month. This was a cross-sectional study conducted between August 2016 and December 2016 assessing patient caregiver knowledge and perceptions on asthma. The age range for study recruitment was 6–11 years old, and respondents had to meet criteria for a diagnosis of asthma based on the International Study of Asthma and Allergies in Childhood (ISAAC) screening questionnaire. 116 families were included in the study, with a median age of 8.3 years for child participants. The majority of respondents were from an urban setting (n=85, 73.3%), and the majority of parent respondents had attained at least secondary school education (n=109, 94%). While the majority of the children's caretakers had favorable scores, with 84 (72.4%) answering at least half of the questions pertaining to asthma knowledge correctly, only 50.9% perceived their child's disease as well controlled and only 66 (56.9%) reported having drugs at home to control symptoms. Additionally, only 32.8% demonstrated acceptance of the diagnosis of asthma in their child and 25.9% stated a healthcare provider discussed an asthma action plan with them.

We identified only one study assessing clinical management of patients, which was a case report. In the case report by Ali et al [55], the authors summarized an alternative approach for chronic pain management in an anal cancer patient who was seen at an outpatient oncology clinic. Clinicians prescribed rectal suppositories containing lidocaine (60mg) and hydrocortisone (5mg) as opposed to conventional regimens including NSAIDs and opioids. These alternatives were chosen given lack of access to opioids in the country.

We also found only one study that assessed an intervention. This was conducted by Evans et al and was a prospective observational study aiming to examine the feasibility of using mobile electrocardiogram (ECG) recording technology to detect atrial fibrillation (AF) [60]. In this study, they recruited patients from several health care clinics and emergency centres affiliated with the Kijabe Hospital, a Christian mission hospital. They used a device called "AliveCor Kardia Mobile ECG", which is a "heart-rhythm monitor that works with the Kardia mobile application for iOS and Android smartphones and tablets". The device functions by recording readings when patients hold it in their hands for 30 seconds. They found that among 51 patients (recruited between July 12 to 23, 2016), 50 (98%) were willing to participate and sign a consent form. Out of the 50 patients, 42 (84%) of the ECGs were "normal", four (8%) were "unclassifiable", and four (8%) had "possible atrial fibrillation." The four ECGs with possible AF were confirmed as AF by a cardiologist, and the "unclassifiable" ECGs were confirmed to be normal. Of note, all of the 4 AF cases were previously undiagnosed. 4/5 (80%) of healthcare providers felt AF was common in the hospital, but only reported a 5.4 (+/-3.1)/10 rating on their knowledge of ECG reading.

Summary

The number of studies focusing on acute and emergency populations has increased as represented by 461 total articles found preceding 2015 compared with 439 in the updated search spanning 5 years (2015-2020) using the same search terms and databases. Similarly, we had a total of 10 final articles in the original search and 14 in the updated 5-year search, respectively, which demonstrates an increase in the number of studies being conducted over time.

Several studies showed the eminent burden of NCDs overall, including the study by Juma et al that demonstrated a high prevalence of concomitant affliction in a HIV clinic. Cardiovascular disease continues to be the primary focus in studies to date, with seven studies in the updated review alone, which also includes a second study conducted on ACS in AKUHN patients. As compared to the study by Wachira et al in 2014 [12], the delay in presentation of symptoms was worse in this second study. Potential reasons for these delays in presentation could include increased prevalence of disease with a concomitant lag in patient education on symptom recognition and appropriate care-seeking behavior; it could also be secondary to improved clinical diagnosis among providers in more subtle presentations that were previously missed. Based on the current results, the primary driver is unclear, but the trend is concerning. While both studies represent fairly small sample sizes, they both included a universal sample of patients: all patients admitted with ACS in the study time period.

Among the studies, we also found that there is a lack of access to medications in rural settings and facilities that are not referral centers like KNH and MTRH, or private hospitals like Nairobi hospital. However, the disparities in care are still worse at the public referral hospital when compared to those that are private. For example, when compared to the KNH study by Bahiru et al, administration of antiplatelet therapy was significantly higher in the study that took place at Nairobi hospital, which is a private hospital. The proportion of patients receiving definitive therapy through thrombolysis or catheterization was also much higher in the private hospital setting (Nairobi hospital). This is concerning as the majority of patients in Kenya receive care in public hospitals, and most of these are not referral hospitals. To that end, affordability of medications for patients which was raised in the single qualitative study in our results, is an issue that warrants both hospital administrators and policy-maker attention alike. Studies assessing healthcare system gaps in linking patients to medications may also provide further solutions.

Additionally, provider education and enforcement of clinical

protocols represented recurrent themes to alleviate gaps in care related to timely and appropriate management. Moreover, the effectiveness of current patient education strategies was challenged, by the study on caregivers for asthmatic children, with findings highlighting a lack of adequate communication on asthma and asthma care among acute/outpatient clinic patients. All in all, additional studies are needed to determine how to best bridge the gap between disease identification and appropriate patient management in acute and emergency care populations. Implementation science constitutes an ideal approach for such investigations. Implementation science can aid with design and implementation of culturally-appropriate health education interventions on chronic disease for acute patients, that can then be tested in controlled trials. Interestingly, appropriate clinician prescribing patterns were nearly universal in the hypertension clinic, which demonstrates that this quality of care is attainable. Regarding cancer diagnosis, delays in diagnosis are alarming and there is also a role for increased education and efficient referral by acute and emergency care clinicians. Finally, greater knowledge on interventions addressing the double burden of disease (communicable and non-communicable) is needed as the association is well-established.

As in the original review, studies continued to cluster around the same centers, while rural settings and hospitals with lower acuity levels continue to be under-represented. We also found there was a persistent lack of randomized controlled trials, which are needed to help advance the quality and sustainability of care for these populations in Kenya, and Africa at large.

As outlined in our original study conclusions, which highlighted gaps to be addressed, we found that the 2015-2020 search included more studies on epidemiology and management, results from a registry, and one study that included an assessment of a novel intervention. We also found one study on asthma from a pediatric outpatient clinic, whereas no studies on chronic respiratory disease were identified in the original search. These are all encouraging trajectories for growing evidence in this population despite other gaps that persist. However, studies continue to lack nationally representative populations, and additional longitudinal data would be beneficial. Studies addressing the healthcare system are also needed to assess determinants affecting care outside of the clinical or hospital setting. Implementation science and randomized, controlled trials are additional study approaches that could help to identify context-specific strategies, and the important testing of their efficacy or effectiveness. Finally, additional research is needed on the spectrum of NCDs, as scant studies exist on three of the leading conditions (chronic respiratory disease, cancer, and diabetes), as well as on other NCDs.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.afjem.2021.02.005.

Dissemination of results

The results from this systematic review have been presented at local, regional and international conferences with target audience including healthcare providers that work clinically in acute and emergency care settings in Kenya, and the surrounding region.

CRediT authorship contribution statement

Authors contributed as follow to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: CN contributed 40%; AK, FM, FK and BM 10% each; and MW, DH, LO, RL and BW 4% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of competing interest

The authors declare no conflict of interest.

References

[1] Naghavi M, Abajobir A, Cristiana A, et al. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017;390:1151–210. https://doi.org/10.1016/S0140-6736(17)32152-9.

[2] Gouda Hebe N, Charlson F, Sorsdahl K, et al. Burden of non-communicable diseases in sub-Saharan Africa, 1990–2017: results from the Global Burden of Disease Study 2017. Lancet Glob Health 2019;7:e1375–87. https://doi.org/10.1016/S2214-109X(19)30374-2.

[3] World Health Organization. Global action plan: for the prevention and control of noncommunicable diseases 2013-2020. http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng.pdf. accessed April 2015.

[4] GBD 2015 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016;388:1659–724. https://doi.org/10.1016/S0140-6736(16)31679-8.

[5] Bisanzo M. The frontline of emergency cardiac care in Africa. Afr J of Emerg Med 2014;4:102–3. https://doi.org/10.1016/j.afjem.2014.07.001.

[6] Razzak JA, Kellermann AL. Emergency medical care in developing countries: is it worthwhile? Bull World Health Organ 2002;80:900–5.

[7] Moresky RT, Razzak J, Reynolds T, Wallis LA, Wachira BW, Nyirenda M, Carlo WA, Lin J, Patel S, Bhoi S, Risko N, Wendle LA, Calvello Hynes EJ. National Institute of Health Fogarty International Center convened the Collaborative on Enhancing Emergency Care Research in LMICs (CLEER). Advancing research on emergency care systems in low-income and middle-income countries: ensuring high-quality care delivery systems. BMJ Glob. Health 2019;4:e001265. https://doi.org/10.1136/bmjgh-2018-001265.

[8] Wachira B, Martin IBK. The state of emergency care in the Republic of Kenya. Afr J Emerg Med 2011;1:160–5. https://doi.org/10.1016/j.afjem.2011.10.008.

[9] Boyd M, Lasserson TJ, McKean MC, Gibson PG, Ducharme FM, Haby M. Interventions for educating children who are at risk of asthma-related emergency department attendance. Cochrane Database Syst Rev 2009;2009:CD001290. https://doi.org/10.1002/14651858.CD001290.pub2.

[10] D'Onofrio G, Degutis LC. Preventive care in the emergency department: screening and brief intervention for alcohol problems in the emergency department: a systematic review. Acad Emerg Med 2002;9:627–38. https://doi.org/10.1111/j.1553-2712.2002.tb02304.x.

[11] Lemhoefer C, Rabe GL, Wellmann J, Bernstein SL, Cheung KW, McCarthy WJ, Lauridsen SV, Spies C, Neuner B. Emergency department-initiated tobacco control: update of a systematic review and meta-analysis of randomized controlled trials. Prev Chronic Dis 2017;14:E89. doi:10.5888/pcd14.160434.

[12] Palermo NE, Modzelewski KL, Farwell AP, Fosbroke J, Shankar KN, Alexanian SM, et al. Open access to diabetes center from the emergency department reduces hospitalizations in the subsequent year. Endocr Pract 2016;22:1161–9. https://doi.org/10.4158/E161254.OR.

[13] Williams KW, Word C, Streck MR, Titus MO. Parental education on asthma severity in the emergency department and primary care follow-up rates. Clin Pediatr (Phila) 2013;52:612–9. https://doi.org/10.1177/0009922813479163.

[14] Effects of treatment on morbidity in hypertension. Results in patients with diastolic blood pressures averaging 115 through 129 mm Hg. JAMA 1967;202:1028–34. https://doi.org/10.1001/jama.1967.03130240070013.

[15] Thind A, Hsia R, Mabweijano J, et al. Prehospital and emergency care. In: Debas HT, Donkor P, Gawande A, et al., editors. Disease control priorities. 3rd ed. vol. 1. Essential Surgery, Washington (DC): World Bank; 2015.

[16] Ngaruiya C, Hersey D, Chumo F, et al. Systematic review on epidemiology, interventions and management of noncommunicable diseases in acute and emergency care settings in Kenya. PROSPERO 2018. CRD42018088621 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42018088621.

[17] Burke TF, Hines R, Ahn R, Walters M, Young D, Anderson RE, et al. Emergency and urgent care capacity in a resource-limited setting: an assessment of health facilities in western Kenya. BMJ Open 2014;4. https://doi.org/10.1136/bmjopen-2014-006132.

[18] Wachira BW, Wallis LA, Geduld H. An analysis of the clinical practice of emergency medicine in public emergency departments in Kenya. Emerg Med J 2012;29:473–6. https://doi.org/10.1136/emj.2011.113753.

[19] Wachira BW, Owuor AO, Otieno HA. Acute management of ST-elevation myocardial infarction in a tertiary hospital in Kenya: Are we complying with practice guidelines? Afr J Emerg Med 2014;4:104–8. https://doi.org/10.1016/j.afjem.2013.12.003.

[20] Wachira BW, Tyler MD. Characterization of in-hospital cardiac arrest in adult patients at a tertiary hospital in Kenya. Afr J Emerg Med 2015;5:70–4. https://doi.org/10.1016/j.afjem.2014.10.006.

[21] Otieno CF, Kayima JK, Mbugua PK, Amayo AA, Mcligeyo SO. Prognostic factors in patients hospitalised with diabetic ketoacidosis at Kenyatta National Hospital, Nairobi. East Afr Med J 2010;87:66–73. https://doi.org/10.4314/eamj.v87i2.60600.

[22] Nkumbe HE, Kollmann KHM, Gaeckle HC. Assessment of diabetic retinopathy in newly diagnosed black Kenyan type 2 diabetics. East Afr Med J 2010;87:109–14. https://doi.org/10.4314/eamj.v87i3.62196.

[23] Dawsey SP, Tonui S, Parker RK, et al. Esophageal cancer in young people: a case series of 109 cases and review of the literature. PloS one 2010;5. https://doi.org/10.1371/journal.pone.0014080.

[24] White RE, Abnet CC, Mungatana CK, et al. Oesophageal cancer: a common malignancy in young people of Bomet District, Kenya. Lancet 2002;360:462–3. https://doi.org/10.1016/S0140-6736(02)09639-3.

[25] Wools-Kaloustian K, Gupta SK, Muloma E, Owino-Ong'or W, Sidle J, Aubrey RW, et al. Renal disease in an antiretroviral-naïve HIV-infected outpatient population in Western Kenya. Nephrol Dial Transplant 2007;22:2208–12. https://doi.org/10.1093/ndt/gfm223.

[26] Omondi Aduda DS, Mkhize N. Ethical issues evolving from patients' perspectives on compulsory screening for syphilis and voluntary screening for cervical cancer in Kenya. BMC Med Ethics 2014;15:27. https://doi.org/10.1186/1472-6939-15-27.

[27] Lown B, Banerjee A. The developing world in The New England Journal of Medicine. Global Health 2006;2:3. https://doi.org/10.1186/1744-8603-2-3.

[28] Mowafi H, Ngaruiya C, O'Reilly G, Kobusingye O, Kapil V, Rubiano A, et al. Emergency care surveillance and emergency care registries in low-income and middle-income countries: conceptual challenges and future directions for research. BMJ Global Health 2019;4:e001442. https://doi.org/10.1136/bmjgh-2019-001442.

[29] Atiq H, Siddiqui E, Bano S, Feroze A, Kazi G, Fayyaz J, et al. The pediatric disease spectrum in emergency departments across Pakistan: data from a pilot surveillance system. BMC Emerg Med 2015;15(Suppl. 2):S11. https://doi.org/10.1186/1471-227X-15-S2-S11.

[30] Zia N, Shahzad H, Baqir S, Shaukat S, Ahmad H, Robinson C, et al. Ambulance use in Pakistan: an analysis of surveillance data from emergency departments in Pakistan. BMC Emerg Med 2015;15(Suppl. 2):S9. https://doi.org/10.1186/1471-227X-15-S2-S9 (Suppl 2).

[31] Khursheed M, Bhatti J, Parukh F, Feroze A, Naeem S, Khawaja H, Razzak J. Dead on arrival in a low-income country: results from a multicenter study in Pakistan. BMC Emerg Med 2015;15 Suppl 2(Suppl 2):S8. doi:10.1186/1471-227X-15-S2-S8.

[32] Bhatti JA, Waseem H, Razzak JA, Shiekh NU, Khoso AK, Salmi LR. Availability and quality of prehospital care on pakistani interurban roads. Ann Adv Automot Med 2013;57:257–64.

[33] Kobusingye OC, Lett RR. Hospital-based trauma registries in Uganda. J Trauma 2000;48:498–502. https://doi.org/10.1097/00005373-200003000-00022.

[34] McCall B. Profile: KEMRI-Wellcome Trust Programme celebrates 25 years. Lancet 2014;383:1796. https://doi.org/10.1016/s0140-6736(14)60868-0.

[35] Ng-Kamstra JS, Arya S, Greenberg SLM, et al. Perioperative mortality rates in low-income and middle-income countries: a systematic review and meta-analysis. BMJ Glob Health 2018;3:e000810. https://doi.org/10.1136/bmjgh-2018-000810.

[36] Sandelowski M. Using qualitative methods in intervention studies. Res Nurs Health 1996;19:359–64. https://doi.org/10.1002/(SICI)1098-240X(199608)19:4<359::AID-NUR9>3.0.CO;2-H.

[37] Lewin S, Glenton C, Oxman AD. Use of qualitative methods alongside randomised controlled trials of complex healthcare interventions: methodological study. Br Med J 2009;339:b3496. https://doi.org/10.1136/bmj.b3496.

[38] Hsia RY, Thind A, Zakariah A, Hicks ER, Mock C. Prehospital and emergency care: updates from the disease control priorities, version 3. World J Surg 2015;39:2161–7. https://doi.org/10.1007/s00268-015-2997-5.

[39] Kobusingye OC, Hyder AA, Bishai D, et al. Emergency medical systems in low- and middle-income countries: recommendations for action. Bull World Health Organ 2005;83:626–31.

[40] Terkelsen CJ, Sørensen JT, Maeng M, et al. System delay and mortality among patients with STEMI treated with primary percutaneous coronary intervention. JAMA 2010;304:763–71. https://doi.org/10.1001/jama.2010.1139.

[41] Anderson CS, Heeley E, Huang Y, et al. 2013. Rapid blood-pressure lowering in patients with acute intracerebral hemorrhage. N Engl J Med 2013;368:2355–65. https://doi.org/10.1056/NEJMoa1214609.

[42] Wright SW, Steenhoff AP, Elci O, Wolfe HA, Ralston M, Kgosiesele T, et al. Impact of contextualized pediatric resuscitation training on pediatric healthcare providers in Botswana. Resuscitation 2015;88:57–62. https://doi.org/10.1016/j.resuscitation.2014.12.007.

[43] Palermo NE, Modzelewski KL, Farwell AP, et al. Open access to diabetes center from the emergency department reduces hospitalizations in the suequent year. Endocr Pract 2016;22:1161–9. https://doi.org/10.4158/E161254.OR.

[44] Razzak J, Beecroft B, Brown J, et al. Emergency care research as a global health priority: key scientific opportunities and challenges. BMJ Global Health 2019;4:e001486. https://doi.org/10.1136/bmjgh-2019-001486.

[45] Salvi S. The silent epidemic of COPD in Africa. Lancet 2015;3:E6–7. https://doi.org/10.1016/S2214-109X(14)70359-6.

[46] van Gemert F, Kirenga B, Chavannes N, et al. Prevalence of chronic obstructive pulmonary disease and associated risk factors in Uganda (FRESH AIR Uganda): a prospective cross-sectional observational study. Lancet Global Health 2015;3:e44–51. https://doi.org/10.1016/S2214-109X(14)70337-7.

[47] Myers JG, Hunold KM, Ekernas K, et al. Patient characteristics of the Accident and Emergency Department of Kenyatta National Hospital, Nairobi, Kenya: a cross-sectional, prospective analysis. BMJ Open 2017;7. https://doi.org/10.1136/bmjopen-2016-014974.

[48] Kalk WJ, Joannou J, Ntsepo S, et al. Ethnic differences in the clinical and laboratory associations with retinopathy in adult onset diabetes: studies in patients of African, European and Indian origins. J. Intern. Med 1997;241:31–7. https://doi.org/10.1046/j.1365-2796.1997.70892000.x.

[49] Balde NM, Kaba ML, Balde MD, et al. Frequency of diabetic microangiopathy in newly diagnosed diabetes mellitus in Conakry: late diagnosis and lack of screening. Dakar Med 2007;52:165–70.

[50] Githeko AK, Kollmann KHM, Adala HS, et al. Prevalence, pattern and risk factors of diabetic retinopathy among diabetic patients attending rural health institutions in central Kenya. East Afr. J Ophthalm 2007;13:2.

[51] Reynolds T, Sawe H, Rubiano A, et. al. Strengthening health systems to provide emergency care. In: Jamison DT, Gelband H, Horton S, et al, eds. Disease control priorities. 3rd ed.. vol. 9, Disease control priorities, Washington, DC: World Bank.

[52] Resolution 72.16. Emergency care systems for universal health coverage: ensuring timely care for the acutely ill and injured. World Health Assembly; 2019.

[53] Bae C, Geduld H, Wallis LA, et al. Professional needs of young emergency medicine specialists in Africa: results of a South Africa, Ethiopia, Tanzania, and Ghana survey. Afr J Emerg Med 2016;6:94–9. https://doi.org/10.1016/j.afjem.2016.02.005.

[54] Saleeby J, Myers JG, Ekernas K, Hunold K, Wangara A, Maingi A, et al. Retrospective review of the patient cases at a major trauma center in Nairobi, Kenya and implications for emergency care development. Afr J Emerg Med 2019;9:127–33. https://doi.org/10.1016/j.afjem.2019.05.002.

[55] Ali SK, Abdulkarim S. Treatment of Anal Cancer Pain-A Case Report. J Pain Symptom Manage 2018;56:e1–2. https://doi.org/10.1016/j.jpainsymman.2018.03.021.

[56] Bahiru E, Temu T, Gitura B, Farquhar C, Huffman MD, Bukachi F. Presentation, management and outcomes of acute coronary syndrome: a registry study from Kenyatta National Hospital in Nairobi, Kenya. Cardiovasc J Afr 2018;29:225–30. https://doi.org/10.5830/CVJA-2018-017.

[57] Bahiru E, Temu T, Mwanga J, Ndede K, Vusha S, Gitura B, et al. Facilitators, context of and barriers to acute coronary syndrome care at Kenyatta National Hospital, Nairobi, Kenya: a qualitative analysis. Cardiovasc J Afr 2018;29:177–82. https://doi.org/10.5830/CVJA-2018-013.

[58] Cranmer JN, Dettinger J, Calkins K, Kibore M, Gachuno O, Walker D. Beyond signal functions in global obstetric care: using a clinical cascade to measure emergency obstetric readiness. PLoS One 2018;13:e0184252. https://doi.org/10.1371/journal.pone.0184252.

[59] Edwards JK, Bygrave H, Van den Bergh R, Kizito W, Cheti E, Kosgei RJ, et al. HIV with non-communicable diseases in primary care in Kibera, Nairobi, Kenya: characteristics and outcomes 2010-2013. Trans R Soc Trop Med Hyg 2015;109:440–6. https://doi.org/10.1093/trstmh/trv038.

[60] Evans GF, Shirk A, Muturi P, Soliman EZ. Feasibility of using mobile ECG recording technology to detect atrial fibrillation in low-resource settings. Glob Heart 2017;12:285–9. https://doi.org/10.1016/j.gheart.2016.12.003.

[61] Juma K, Nyabera R, Mbugua S, Odinya G, Jowi J, Ngunga M, et al. Cardiovascular risk factors among people living with HIV in rural Kenya: a clinic-based study. Cardiovasc J Afr 2019;30:52–6. https://doi.org/10.5830/CVJA-2018-064.

[62] Kamau E, Marial C, Joshi M, Sheikh A. Time to presentation and diagnosis of esophageal cancer in patients seen at the Kenyatta National Hospital. East Afr Med J 2018:95.

[63] Kimeu R, Kariuki C. Assessment of the management of acute myocardial infarction patients and their outcomes at the Nairobi Hospital from January 2007 to June 2009. Cardiovasc J Afr 2016;27:218–21. https://doi.org/10.5830/CVJA-2015-091.

[64] Lin C, Vakani R, Kussin P, Guhwe M, Farjat AE, Choudhury K, Renner D, Oduor C, Graffagnino C; Neuroscience Knowledge Base Investigator Group. Assessment of healthcare personnel knowledge of stroke care at a large referral hospital in sub-Saharan Africa - a survey based approach. J Clin Neurosci 2017;42:71-74. doi:10.1016/j.jocn.2017.04.013.

[65] Mbui JM, Oluka MN, Guantai EM, Sinei KA, Achieng L, Baker A, et al. Prescription patterns and adequacy of blood pressure control among adult hypertensive patients in Kenya; findings and implications. Expert Rev Clin Pharmacol 2017;10:1263–71. https://doi.org/10.1080/17512433.2017.1371590.

[66] Simba J, Marete I, Waihenya R, Kombe Y, Mwangi A, Mburugu P, et al. Knowledge and perceptions on childhood asthma among care-takers of children with asthma at a National Referral Hospital in Western Kenya: a descriptive study. Afr Health Sci 2018;18:965–71. https://doi.org/10.4314/ahs.v18i4.16.

[67] Varwani MH, Jeilan M, Ngunga M, Barasa A. Outcomes in patients with acute coronary syndrome in a referral hospital in sub-Saharan Africa. Cardiovasc J Afr 2019;30:29–33. https://doi.org/10.5830/CVJA-2018-066.