




BMJ Open Characterising Kenyan hospitals' suitability for medical officer internship training: a secondary data analysis of a cross-sectional study

Yingxi Zhao ¹, Boniface Osano,^{2,3} Fred Were,² Helen Kiarie,⁴ Catia Nicodemo ⁵, David Gathara,⁶ Mike English ^{1,7}

To cite: Zhao Y, Osano B, Were F, *et al.* Characterising Kenyan hospitals' suitability for medical officer internship training: a secondary data analysis of a cross-sectional study. *BMJ Open* 2022;**12**:e056426. doi:10.1136/bmjopen-2021-056426

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-056426>).

Received 13 August 2021
Accepted 08 April 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Yingxi Zhao;
yingxi.zhao@ndm.ox.ac.uk

ABSTRACT

Objective To characterise the capacity of Kenya internship hospitals to understand whether they are suitable to provide internship training for medical doctors.

Design A secondary data analysis of a cross-sectional health facility assessment (Kenya Harmonized Health Facility Assessment (KHFA) 2018).

Setting and population We analysed 61 out of all 74 Kenyan hospitals that provide internship training for medical doctors.

Outcome measures Comparing against the minimum requirement outlined in the national guidelines for medical officer interns, we filtered and identified 166 indicators from the KHFA survey questionnaire and grouped them into 12 domains. An overall capacity index was calculated as the mean of 12 domain-specific scores for each facility.

Results The average overall capacity index is 69% (95% CI 66% to 72%) for all internship training centres. Hospitals have moderate capacity (over 60%) for most of the general domains, although there is huge variation between hospitals and only 29 out of 61 hospitals have five or more specialists assigned, employed, seconded or part-time—as required by the national guideline. Quality and safety score was low across all hospitals with an average score of 40%. As for major specialties, all hospitals have good capacity for surgery and obstetrics-gynaecology, while mental health was poorest in comparison. Level 5 and 6 facilities (provincial and national hospitals) have higher capacity scores in all domains when compared with level 4 hospitals (equivalent to district hospitals).

Conclusion Major gaps exist in staffing, equipment and service availability of Kenya internship hospitals. Level 4 hospitals (equivalent to district hospitals) are more likely to have a lower capacity index, leading to low quality of care, and should be reviewed and improved to provide appropriate and well-resourced training for interns and to use appropriate resources to avoid improvising.

BACKGROUND

In Kenya as in many countries, doctors are first trained for 5 or 6 years in medical school (typically 2 or 3 years preclinical, 3 years clinical). This is followed by a mandatory 1 year internship prior to receiving a license to practice from the national regulatory board,

Strengths and limitations of this study

- ⇒ Using data collected from a national health facility assessment, our study is able to characterise the capacity of 61 out of 74 Kenya internship hospitals and contrast findings across levels of hospitals and with the minimum requirements outlined in the national guidelines for medical officer internship training.
- ⇒ Our analyses have clear implications for Kenya policy-makers to improve the conditions of internship hospitals.
- ⇒ More widely, our findings point to the need to carefully consider the potential consequences of rapidly expanding medical training and of appropriate planning and financing for new internship centres, especially in rural areas.
- ⇒ Our analysis was only limited to the 61 internship training hospitals sampled by Kenya Harmonized Health Facility Assessment (KHFA), mostly public hospitals; and KHFA data were collected in 2018 prior to COVID-19 therefore it is possible that the capacity of Kenyan internship training centres has improved since 2018.
- ⇒ To assess the capacity we selected 166 signal indicators from the 3000 questions from KHFA survey, however the indicators selected focused only on the structural and organisational features of internship training hospitals, and the selection process could be somewhat subjective.

that is, the Kenya Medical Practitioners and Dentists Council, overseen by the National Ministry of Health.¹ The Kenyan medical internship included supervised rotation in four major departments (surgery, internal medicine, paediatrics and child health and obstetrics and gynaecology (OBGYN)) in one Internship training centre but since 2020 mental health and community health practice became added requirements. The competencies medical interns are expected to develop, for example, compulsory procedures that should be carried out either independently

or under supervision, are outlined in national guidelines and in greater detail in interns' personal log books.² After successfully completing internship and subsequent licensure, individuals can practice medicine unsupervised as general medical officers in different types of facilities.

Medical internships are undertaken in specific hospitals approved for this purpose after evaluation by the Kenya Medical Practitioners and Dentists Council, and all hospitals should meet and maintain their minimum requirements. These sites are an essential component of the health and education system producing a country's future physicians.³ Ensuring internship training hospitals are well-staffed and equipped is important so that medical graduates can be supervised and supported to consolidate their knowledge and skills, including of common clinical procedures, and become competent medical doctors.⁴ Improving internship training could also improve the quality of care and patient safety as interns are at the frontline of patient management especially in low-income and middle-income countries (LMICs).⁵

As with other African countries, medical schools in Kenya are expanding to meet human resources for health gaps. The number of Kenyan medical schools has increased dramatically from 2 in 2004 to 12 in 2018,⁶ meanwhile the number of medical doctors graduating almost doubled from 287 in 2006 to 573 in 2018.^{7,8} The number of internship training centres recognised by the Ministry of Health and regulators also increased from 6 to 74 over the past 15 years and includes private or mission/fait-based hospitals.^{9,10} Many new training centres that were formerly district hospitals but are now county hospitals in Kenya (at level 4 of its six-level health system, usually primary facilities including district hospitals) became recognised as internship centres alongside more established secondary or tertiary regional and national hospitals (at level 5 and 6, respectively). However, these county hospitals may have shortages of staff, limited diagnostic facilities and frequent stockout of medications and diagnostics reagents. Such lack of organisational structures and resources, that is, inadequate capacity, would mean these facilities are not ready and suitable for providing internship training, for example, a qualitative study in Kenya suggested that these county hospitals are 'not organised for training purposes'.⁹

Previous studies conducted in Kenya between 2012 and 2014 highlighted poor working conditions and experiences for interns at district hospitals, however they were limited in scale (all including <10 hospitals) and did not compare hospitals at different levels and sizes.^{9,11,12} Using data collected from the Kenya Harmonized Health Facility Assessment 2018 (KHFA), we address the question 'what capacity do facilities offering internship training have?' To do this, we characterise the capacity of 61 internship hospitals contrasting findings across levels of hospitals and with the minimum requirements outlined in the national guidelines for medical officer internship training,² with a specific focus on the 'structural' component of the

Donabedian quality of care framework (structure, process and outcome).¹³

METHODS

Data sources

This is a secondary data analysis using data from the 2018 KHFA. Details of the KHFA and its methodology are publicly available.¹⁴ KHFA used the Kenya Health Master Facility List (MFL) as the sampling frame, randomly sampled 2980 out of 10 535 health facilities in Kenya, but purposely included all secondary hospitals, public primary hospitals and maternity and nursing homes. Sixty-one out of 74 internship training centres were sampled in KHFA. The survey included over 3000 questions covering five main modules on resource availability, management and finance, readiness, quality and safety of healthcare and data verification (information systems). Data were collected through facility audit, observation and validation, provider interview and record review. To supplement the KHFA data we extracted, the inpatient bed number in 2020 from the MFL¹⁵; the total delivery count between 2018 and 2020 from the national Kenya Health Information System (previously District Health Information Software-2 (DHIS2)); and verified key human resources for health data for six hospitals with incomplete information through direct contact with hospitals.

Domains and indicators

We focus on the 'structure' component of the Donabedian quality of care framework to characterise hospitals. Specifically, we explore staffing, equipment and service availability and whether they fulfil the minimum requirement outlined in the Kenyan National Guidelines for Internship Training of Medical and Dental Officer Interns (2019) and the National Guidelines and Log Book for Medical Officer Interns (2019).² For example, the guidelines require that each internship training centre: (i) has a minimum of five medical specialists, covering paediatrics and child health, general surgery, internal medicine, OBGYN and family medicine, (ii) is fully operational on a 24-hour basis including accident and emergency, diagnostic and pharmacy services, (iii) enables interns to observe and/or perform certain procedures to fulfil competency for each specialty. Examples of the latter in surgery include a total of 36 competency procedures such as appendicectomy or repair of inguinal hernias. This requires that these services be provided by internship training centres.²

Two authors (ME, YZ) initially filtered out 277 indicators from the 3000 questions from KHFA to identify those most relevant to the minimum criteria defined by the national internship guidelines. Two authors (BO, FW) who are medical school faculty and who supervise medical officer interns subsequently reviewed these indicators identifying those felt to be most useful to characterising hospitals as contexts for internship training by. A final list of 166 indicators was agreed by all four authors and

Table 1 Domain and indicator summary

Category	Domain	Number of indicators	Example indicators	Indicator and domain conversion
Human resources	(a) Human resource for health	6	Total staff assigned, employed, seconded (including part time)—paediatricians, neonatologists	All the indicators were converted into binary responses with 1 representing ‘available’ and 0 representing ‘unavailable’. For most indicators on availability, we defined available as ‘onsite, observed, non-expired and functional’. For tests that are reported to be available offsite, or tests that are observed but expired, and for equipment reported available but not observed, or not available now, we labelled them as ‘unavailable’. We also considered an indicator to be unavailable if the health facility did not answer this question, usually because its filter questions were answered no.
Diagnostics and supportive care	(b) Laboratory test (including four subdomains, rapid test, basic lab test, infectious diseases test, advanced lab test)	31	TB test availability—Xpert MTB/RIF rapid diagnostic testing for TB	
	(c) Oxygen and respiratory support	10	Please tell me if the pulse oximeter are available anywhere in the outpatient service area and are functional	
	(d) General equipment	8	ECG equipment available and functioning today	
Service continuity and safety	(e) 24/7 availability	8	Is emergency medicine specialist or general medical practitioners always available 24 hours for emergency service, either onsite in emergency unit or not onsite in emergency unit but on-call inside facility?	
	(f) Infectious prevention and control	9	Does this facility have guidelines or protocols for cleaning the facility such as the floors, counters, and beds?	
	(g) Quality and safety	24	How frequently does the quality assurance committee meet?—monthly	
Major specialties	(h) Surgery (including two subdomains, equipment/medicine and service)	20	Functioning of basic surgical equipment—ECG electrodes	
	(i) Internal medicine (including two subdomains, equipment/medicine and service)	12	Do providers in this facility diagnose and/or manage diabetic patients?	
	(j) Obstetrics-gynaecology (including two subdomains, equipment/medicine and service)	11	Parenteral administration of antibiotics (intravenously or intramuscularly) for mothers carried out	
	(k) Paediatrics (including two subdomains, equipment/medicine and service)	20	Is kangaroo mother care for premature/very low birthweight babies used in this facility?	
	(l) Mental health	6	Does this facility offer any services for mental and/or neurological conditions?	
TB, tuberculosis.				

selected for further analysis as 'signal indicators' of the minimum requirements for internship training centres. All the indicators were converted into binary responses with 1 representing 'met/available' and 0 representing 'not met/unavailable'. We grouped indicators into 12 logical domains described in brief in [table 1](#) with further

detail of all indicators available in online supplemental material 1.

Analysis

For each domain, we calculated a score as a percentage based on the number of indicators with a score of 1 (met/available)

divided by the total number of indicators (those met/available+those not met/unavailable). We generated an overall capacity index as the unweighted mean of all 12 domain scores for each facility. We stratified the 61 included internship training centres into three categories based on hospital administrative level and inpatient bed number. Kenya has a six service-level system based on the essential package for health, whereas level 1 refers to community-level, level 2 dispensaries and clinics, level 3 health centres, level 4 primary facilities including district hospitals, level 5 secondary provincial hospitals and level 6 tertiary and national hospitals. We first grouped all internship hospitals that are level 5 and 6 together (bed number 174–1455, $n=15$) as historically they have been better resourced; for the internship hospitals that are level 4, we divided them based on bed number into: level 4 small hospitals (bed number 82–175, $n=23$) and level 4 large hospitals (bed number 176–320, $n=23$). Data analysis was conducted using Stata V.16 (StataCorp, Texas, USA).

Patient and public involvement

Patients and the public were not directly involved in the design, recruitment or conducting of this study.

RESULTS

Sixty-one out of 74 internship training centres are sampled in KHFA and are mostly public hospitals owned by the Ministry of Health ($n=54$). The 13/74 hospitals not sampled are either private hospitals ($n=4$), faith-based or mission hospitals ($n=8$) or a military hospital ($n=1$). Comparing hospital characteristics retrieved from DHIS2 and MFL between the 61 KHFA-sampled hospitals with 12 of the 13 other hospitals (the military hospital did not report to DHIS2 or MFL), the 61 KHFA hospitals are slightly larger in terms of hospital beds (median and IQR 200 (156, 276) vs 180 (106, 221)), and report conducting three times as many deliveries (median annual deliveries 3981 vs 1150) and twice as many caesarean sections (median 987 vs 537 per year). Detailed characteristics comparing the 61 KHFA internship training centres and

these 12 others are presented in online supplemental material 2.

Overall capacity

The distribution of capacity score by domain is presented in figure 1 and table 2. Ideally, an internship centre should score 100% against the (minimum) signal indicators but the overall capacity index is 69% (95% CI 66% to 72%) for all internship training centres, and 63%, 67% and 81% for level 4 small, level 4 large and level 5 and 6 hospitals, respectively. Hospitals have moderate capacity for most of the general domains other than quality and safety. Surgery and OBGYN have higher scores regardless of hospital size, level and location, suggesting that the capacity for these two specialties is better across all facilities. Level 5 and 6 facilities have higher capacity scores in all domains when compared with level 4 hospitals.

Human resources

The 61 internship training hospitals had a median of 14 postlicensure medical officers, 4 medical specialists, 25 clinical officers, 210 nurses and midwives, 14 medical laboratory technologists, 5 radiographers and 14 allied health professionals. Differences between small and large level 4 hospitals were small for most cadres, whereas level 5 and 6 hospitals have, on average, double the numbers of specialists, nurses and midwives (table 3). The national guideline specifically requires at least five medical specialists to act as the main clinical teachers and supervisors for medical officer interns. However, only 29 out of 61 internship training centres had at least five medical specialists assigned, employed or seconded (including part-time staff). Most hospitals had at least one surgeon ($n=59/61$), paediatrician ($n=52/61$) and an obstetrician-gynaecologist ($n=56/61$), whereas only 35/61 hospitals have at least an internal medicine specialist. Although not a requirement from the regulator, only 30/61 hospitals have a physician anaesthesiologist (figure 2) with anaesthesia mostly provided by clinical officers (51/61 hospitals have at least one anaesthetist clinical

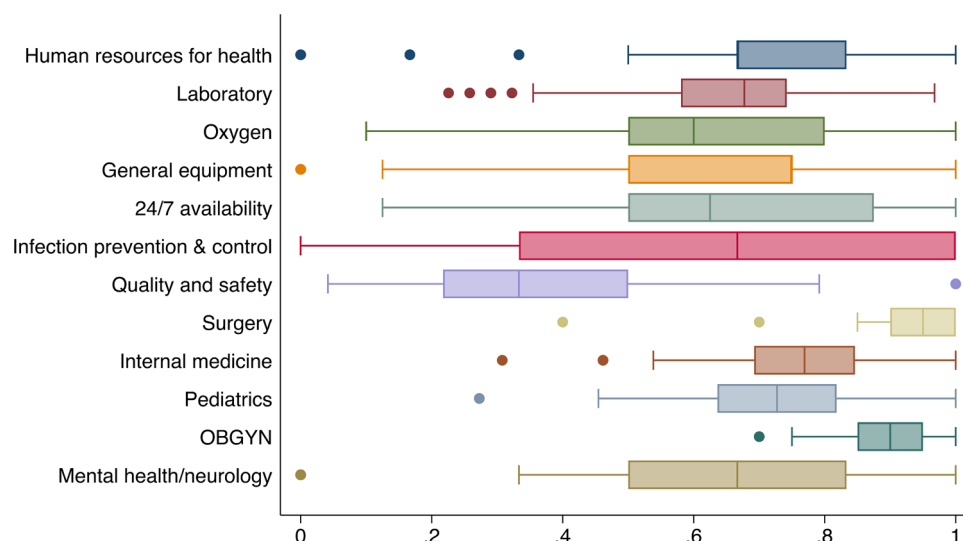


Figure 1 Distribution of capacity score by domain.

Table 2 Capacity scores by hospital characteristics

	Level 4 small hospitals (n=23)	Level 4 large hospitals (n=23)	Level 5 and 6 hospitals (n=15)	Total (n=61)
Total capacity index	63%	67%	81%	69%
Human resources for health	64%	67%	89%	71%
Lab test	60%	63%	77%	65%
Oxygen and respiratory support	64%	57%	77%	64%
General equipment	53%	59%	72%	60%
24/7	58%	65%	68%	63%
Quality and safety	35%	38%	50%	40%
Infection prevention and control	57%	58%	92%	66%
Surgery	94%	89%	97%	93%
Internal medicine	70%	73%	90%	76%
Paediatrics	67%	70%	81%	72%
OBGYN	89%	91%	91%	90%
Mental health/Neurology	44%	73%	83%	64%

The colours in the figure reflect the relative values of capacity scores, the darkest green represents the highest values in the table, while the darkest red represents the lowest values.
OBGYN, obstetrics and gynaecology.

officer). The four well-established university tertiary hospitals have better human resources and all but one fulfilled all the requirements.

Diagnostics and supportive care

As for laboratory tests, internship training centres overall have moderate availability (over 60%) for rapid tests and basic laboratory lab tests (figure 3 and online supplemental file 3), although ability to offer urine dipstick testing was present in fewer than 50% hospitals (n=26/61); 54/61 hospitals have rapid HIV tests, 16 hospitals provided onsite PCR testing for HIV but only 5 had onsite HIV viral load testing. An additional 19 hospitals relied on off-site PCR testing. Availability for advanced lab tests is poor across all hospitals, only 12/61 hospitals can read papanicolaou test results and prepare and examine any tissues or samples for cancer diagnosis onsite. Level 5 and 6 hospitals on average have better availability of

diagnostics than level 4 hospitals, especially for infectious disease and advanced lab tests.

Internship training hospitals vary when assessed for 10 oxygen and respiratory support indicators. While all hospitals were reported to have functional paediatric and neonatal oxygen, only 32 hospitals have ventilators available for adults and 13 hospitals had continuous positive airway pressure (CPAP) available for neonates (at the time of survey in 2018 pre-COVID-19). Lastly for other general equipment, around 55 hospitals reported functioning ultrasound and X-ray services. In comparison, functional ECG (27/61) and CT scan (21/61) availability was poor in most facilities.

Service continuity and safety

The national guideline requires that internship hospitals need to be fully operational on a 24-hour basis including accident and emergency, laboratory diagnostic services and pharmacy

Table 3 Human resources for health cadres by hospital characteristics

	Level 4 small hospitals (n=23)	Level 4 large hospitals (n=23)	Level 5 and 6 hospitals (n=15)	Total (n=61)
Medical officer	12 (6, 18)	14 (10, 20)	29 (21, 58)	14 (10, 26)
Medical specialist	2 (1, 7)	4 (1, 11)	16 (2, 26)	4 (1, 11)
Clinical officer	20 (13, 26)	25 (15, 33)	35 (21, 44)	25 (15, 33)
Nurse and midwife	206 (95, 248)	150 (113, 210)	336 (267, 534)	210 (114, 323)
Medical laboratory technologist	13 (11, 14)	14 (11, 18)	23 (19, 46)	14 (12, 20)
Radiographer	4 (3, 5)	4 (2, 6)	9 (6, 22)	5 (3, 7)
Allied health professional	11 (3, 14)	14 (10, 17)	29 (24, 44)	14 (6, 24)

Data are presented as median (IQR), allied health professional refers to physical therapist, occupational therapist, orthopaedic technician, plaster technician, nutritionists and dietitians.

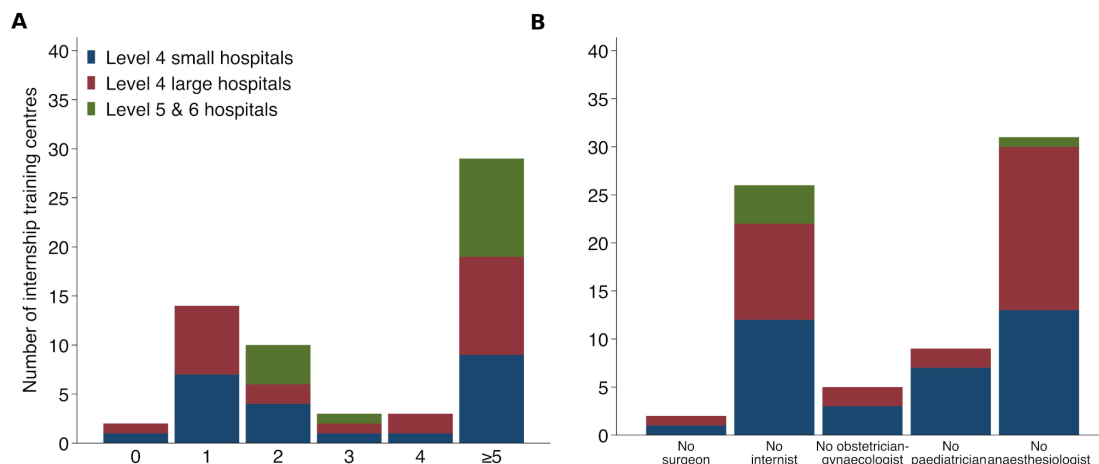


Figure 2 Number of internship training centres with different numbers of specialists (A) and with no surgeon, internists, obstetrician-gynaecologist, paediatrician and anaesthesiologist (B). Note: We have combined different types of surgeons (general surgeons, paediatric surgeons, orthopaedic surgeons, cardiothoracic surgeon, ear, nose and throat surgeons, plastic surgeons, neurosurgeons, urological surgeons) into ‘surgeon’ category. Similarly, specialist physicians (internists), oncologist, neurologist, cardiologist, critical care, gastroenterologist, palliative care specialist, nephrologists, rheumatologist, medical endocrinologist into ‘internist’ category and paediatricians and neonatologists into ‘paediatrician’ category.

which was investigated under ‘24/7 availability’. Forty-eight out of 61 hospitals reported having general medical officers or emergency medicine specialists onsite or on-call within facility. While emergency radiology, laboratory diagnostics (other than rapid test) and pharmacy services are available 24/7 in most facilities, only 13/61 hospitals reported availability of major emergency surgery and anaesthesia 24/7, and only 16 hospitals provide 24-hour emergency services using a structured triage tool such as the WHO integrated triage tool.

The domain average score for infection prevention and control is 66%. Most internship training centres have infection prevention and control (IPC) guidelines and technical IPC committees, however, the actual procedures of cleaning beds, counters/tables, toilets were only done in around half of the hospitals on the day of KHFA survey observation. Twenty-one input/structure indicators on quality and safety are also included in the current analysis. All but one indicator (death review results recorded) performed poorly across all facilities. Most facilities do not have observed guidelines for adverse event reporting, nosocomial infection reporting, surgical adverse event reporting or postoperative infection definitions. Level 5 and 6 hospitals do not necessarily perform better than level 4 hospitals in this domain.

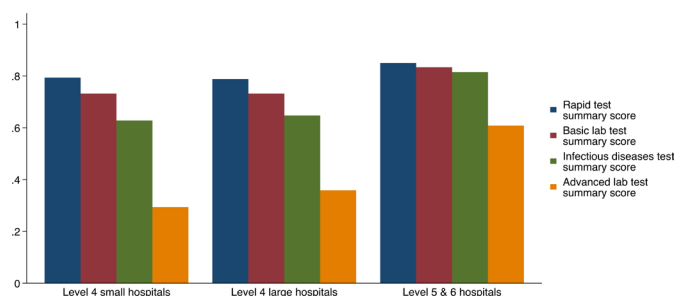


Figure 3 Average lab test score by subdomain and hospital characteristics.

Major specialties

For the four major specialties we used data on both specialty-specific equipment and medicines and specialty service areas (online supplemental material 3). For surgical and OBGYN scores, internship training centres in general have both functional equipment and available medicine (median 100% for surgery, 100% for OBGYN) and also good service availability for procedures relevant to the national guideline and log book (median 100% for surgery, 90% for OBGYN). The only indicator that had a lower score is cricothyroidotomy, where only 43/61 hospitals provide such service; and misoprostol tablet availability, where 44/61 hospitals have this medication available.

For internal medicine, availability of equipment and medicine is low (median 67%) with huge variation across facilities. Thirty-three out of 61 hospitals have a defibrillator, 39/61 have a renal dialysis/haemodialysis machine and 23/61 hospitals have lumbar puncture kits—for the rest of the hospitals they will need to improvise to perform lumbar punctures or cannot provide such a service. Service availability for internal medicine is good on average (median 90%), however availability for more advanced conditions, for example, colorectal cancer screening, diagnosis and/or treatment, and palliative care is limited especially for level 4 small hospitals. Similar with internal medicine, the availability of equipment for paediatrics is lower as compared with other specialties (median 63%). Only 19/61 hospitals had exchange blood transfusion capacity and similarly only 19/61 hospitals had devices for intraosseous (IO) access. The three indicators of paediatric service availability (kangaroo mother care, sepsis, antibiotics regimen and follow-up) had good availability.

Medical officer interns are also required to rotate in mental health for 8 weeks during their 1 year internship

and are required to manage acute mental health emergencies and common mental health conditions. While 52/61 hospitals offer mental health and/or neurological services, only 17 hospitals have a physician psychiatrist. Sixteen hospitals have mental health inpatient wards, other hospitals either only provide outpatient services or lack these services. Only half of level 4 small hospitals offer depression, psychosis and epilepsy diagnosis and follow-up services.

DISCUSSION

Our analysis on the capacity of Kenya internship training hospitals suggested that in 2018 the overall staffing, equipment and service availability was inadequate when compared with the regulator's requirements. Level 4/district, smaller hospitals (23 of the 61 assessed) were more likely to have fewer human resources, equipment and specialty services, and less likely to meet quality and safety indicators. The implication is that hospitals with lower capacity may either have to improvise to offer core services or refer patients to other facilities. This could significantly influence the quality of training as interns might not be able to fully consolidate their knowledge and skills.

Over half of the internship training hospitals did not have five or more specialists as required by the regulator, the medical council, which suggests inadequate training and supervision of medical officer interns. Internal medicine specialists and anaesthesiologists were most often lacking suggesting that in many centres non-specialist but licensed general medical or specialist clinical officers fill these roles. Even in these larger Kenyan hospitals such personnel will also likely therefore be leading provision of care for severe COVID-19. Where medical officers are themselves also scarce, medical officer interns may become the only 'in-house' doctor on call and be forced to take on full responsibility for patient care potentially threatening patient safety if interns are forced to care for serious, acute medical and surgical conditions without appropriate supervision.^{9 16 17} The likely challenges to provision of high quality safe care are further suggested by poor scores of all but tertiary hospitals against organisational indicators of quality and safety practice. In fact guidelines or instruction for quality and safety were rarely present and there seemed very limited evidence that quality and safety indicators are monitored, reviewed, reported and acted on. These findings are consistent with reports highlighting challenges with patient safety in LMIC hospitals.¹⁸

Internship hospitals appear most able to provide appropriate essential resources and capacities in the major disciplines of surgery and OBGYN. Challenges were especially noted in the disciplines of internal medicine and paediatrics and neonatology. Many facilities lack ECG machines, CT scans, defibrillators, equipment used for peritoneal or haemodialysis, and lumbar puncture kits. More specific to neonatal and child health were lack of capacity in

ability to provide exchange transfusion, neonatal CPAP and IO access. Capacity to offer mental health and neurological care was especially low most particularly in level 4 small hospitals, likely due to these only being listed as internship requirements in 2020, and that Kenya has a severe shortage of psychiatrists and neurologists as well as psychiatric nurses.¹⁹ For facilities without capacity in the major disciplines now including mental health and neurology services, it is likely that hospitals are forced to refer patients elsewhere or improvise approaches to care in order to serve patients. Interns' training experience is therefore likely to be very varied and more attention may therefore need to be paid to planning how interns can be provided with adequate training in all specialties if this is a key long-term aim.

Kenya has dramatically increased its medical training volume hoping to produce 9000 new graduate medical physicians by 2030 to narrow its staffing gap.⁶ More hospitals especially at county-level (district hospitals) are accredited as internship training centres. These hospitals are usually smaller in size and more likely to be distant from the well-established university tertiary hospitals in major cities that scored much higher across domains in our analysis. Rural rotations and residencies have been recommended by WHO to increase health worker retention.²⁰ Students or interns in these settings may also be more likely to learn hands-on clinical procedures and be actively engaged in patient care²¹ as opposed to tertiary hospitals where the presence of more specialists and general medical officers may result in interns undertaking more administrative work. However, the prerequisite of good internship training is that the hospitals are adequately staffed and equipped and ready to deliver teaching and training. Our data suggested that this is not always the case and are consistent with previous qualitative research suggesting that district hospitals provided limited learning opportunities and supervision with limited suitability as internship sites.⁹

The potential consequences of poor training and supervision during internship are therefore worth consideration. As well as failing to consolidate knowledge and skills in major specialties interns may also develop burnout and stress-related psychological problems more rapidly.⁹ These stresses and being forced to take significant clinical responsibility in poorly resourced hospitals may push medical officer interns to leave the profession or the public sector which is often most resource constrained as soon as they are licensed/registered.²² This will likely worsen the internal and external brain drain undermining universal health coverage and equity and limiting any benefits from public investment in medical education.²² Inadequate support and supervision also threatens patient safety by creating the conditions for significant medical errors to occur. Even in settings without a 'blame culture' such errors can have profound effects on the health workers as well as the patients further exacerbating workers' psychological distress.^{23 24} We must also remember that today's medical officer interns will become tomorrow's general

medical officers who are often then responsible for the training of the next cohorts of interns and other health worker cadres.²⁵ Therefore, poor internship training for medical officers continuously compromises the quality of training and skills that are passed on and this may be a particular challenge to patient safety and healthcare quality that rely so heavily on effectively functioning teams.²⁶

Our analyses have policy implications for Kenya policy-makers. The regulator requires internship hospitals to maintain the minimum requirement of staff and be able to offer a core set of quality services with self-report against such requirements at least once a quarter. Our data would suggest many internship hospitals in Kenya might not continuously achieve these minimum requirements. Should this prevent interns from being licensed or should interns be reallocated to centres meeting regulatory requirements? While more stringent and regular audit and re-accreditation of internship training centres might be conducted by the regulatory council to ensure that only the hospitals that meet the minimum requirements are allowed to receive and train interns, adequate mitigation measures need to be in place so that interns themselves are not disadvantaged further. For example, by rotating interns between different level hospitals with different level of resource availability. More widely, our findings point to the need to carefully consider the potential consequences of rapidly expanding medical training and of appropriate planning and financing for new internship centres, especially in rural areas.

Several limitations should be noted for the current analysis. To start with, our analysis was only limited to the 61 internship training hospitals sampled by KHFA, mostly public hospitals. A total of 13 hospitals were not sampled in KHFA and are either private hospitals or mission hospitals, therefore comparison by hospital ownership was not feasible. Second, aside from the KHFA's own limitation on data missing, we noted data inaccuracy and inconsistency in KHFA data we retrieved. We made efforts to clean these data especially on human resources through correspondence input, although we were unable to validate all the number from the KHFA survey. Third, to assess the capacity of internship training hospitals we selected 166 signal indicators from the 3000 questions from KHFA survey. Our criteria were to ensure that the indicators selected are the minimum requirement and should be achievable (ie, should be '1' for all indicators). Our selection was guided by the national guidelines and agreed by four authors, three of whom have experience supervising interns. However, we acknowledge that this process is somewhat subjective. Fourth, we only focused on the structural and organisational features of internship training hospitals. We did not include indicators on process or outcome indicators, for example, training or patient outcomes due to limited data availability. Ideally, these should be considered while evaluating internship training hospitals. Last, the KHFA data were collected in a snapshot in 2018 prior to COVID-19. The appointment

and posting of specialists may fluctuate from time to time but COVID-19 specifically could have led to the government investing in hospital infrastructure, equipment and emergency hiring to improve their response capacity to COVID-19. Therefore, it is possible that the capacity of Kenyan internship training centres has improved since 2018.²⁷ Despite these limitations, our data do suggest important shortcomings in internship training centres in Kenya. We suggest other LMICs that are rapidly expanding their medical training should also evaluate their internship training sites to explore the generalisability of our findings.

CONCLUSION

We assessed the capacity of 61 Kenyan internship training hospitals using data from KHFA 2018. Our results highlighted major gaps in staffing, equipment and service availability. More specifically, there are weaknesses in areas regarding organisational arrangements that support quality and safety. Smaller hospitals are more likely to have a lower capacity index, and should be re-accredited more stringently and regularly and also be provided with adequate mitigation measures so they can provide appropriate and well-resourced training for medical interns allowing them to become fully competent medical doctors.

Author affiliations

¹Oxford Centre for Global Health Research, Nuffield Department of Medicine, University of Oxford, Oxford, UK

²Department of Paediatrics and Child Health, University of Nairobi, Nairobi, Kenya

³Kenya Paediatric Research Consortium (KEPRECON), Nairobi, Kenya

⁴Division of Monitoring & Evaluation, Ministry of Health, Nairobi, Kenya

⁵Nuffield Department of Primary Care Health Sciences, University of Oxford, Oxford, UK

⁶Wellcome Trust Research Program, Kenya Medical Research Institute, Nairobi, Kenya

⁷KEMRI-Wellcome Trust Research Programme Nairobi, Nairobi, Kenya

Twitter Mike English @ProfMikeEnglish

Contributors YZ and ME conceived of the analysis. YZ, BO, FW and ME contributed to data analysis. YZ wrote the first draft of the manuscript. BO, FW, HK, DG, CN and ME provided critical feedback on the first draft of the manuscript. All authors read and approved the final manuscript. YZ is the guarantor and accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

Funding YZ is supported by the University of Oxford Clarendon Fund Scholarship. ME is supported by a Wellcome Trust Senior Research Fellowship (#207522). HK is employed by the Kenya Ministry of Health.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The Kenya Ministry of Health, Division of Monitoring and Evaluation, sought approval for, planned and executed the 2018 Kenya Harmonized Health Facility Assessment. Written informed consent was sought by in-charge or acting in-charge of all the facilities surveyed. Permission was then granted to use these data for the secondary analysis reported here with the purpose of improving quality of health service provision in Kenya.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. The data that support the findings of this study are available from Kenya Ministry of Health but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. All requests for further use of these data can be made through and with the permission of the Kenya Ministry of Health.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution 4.0 Unported (CC BY 4.0) license, which permits others to copy, redistribute, remix, transform and build upon this work for any purpose, provided the original work is properly cited, a link to the licence is given, and indication of whether changes were made. See: <https://creativecommons.org/licenses/by/4.0/>.

ORCID iDs

Yingxi Zhao <http://orcid.org/0000-0002-4937-4703>
Catia Nicodemo <http://orcid.org/0000-0001-5490-9576>
Mike English <http://orcid.org/0000-0002-7427-0826>

REFERENCES

- Ndeti DM, Mathai M, Khasakhala LI, *et al.* University medical education in Kenya: the challenges. *Med Teach* 2010;32:812–5.
- Kenya Medical Practitioners and Dentists Council. National guidelines and log book for medical officer interns. Available: <http://medicalboard.co.ke/resources/NATIONAL%20GUIDELINES%20AND%20LOG%20BOOK%20FOR%20MEDICAL%20OFFICER%20INTERNS.pdf> [Accessed 05 Aug 2020].
- Kupersmith J. Quality of care in teaching hospitals: a literature review. *Acad Med* 2005;80:458–66.
- Colwell NP. The requirement of an intern Hospital. *J Am Med Assoc* 1929;92:1031–3.
- Ogero M, Akech S, Malla L, *et al.* Examining which clinicians provide admission hospital care in a high mortality setting and their adherence to guidelines: an observational study in 13 hospitals. *Arch Dis Child* 2020;105:648–54.
- English M, Strachan B, Esamai F, *et al.* The paediatrician workforce and its role in addressing neonatal, child and adolescent healthcare in Kenya. *Arch Dis Child* 2020;105:927–31.
- Kenya Ministry of Health. Kenya health workforce report: the status of healthcare professionals in Kenya, 2015; 2017. https://taskforce.org/wp-content/uploads/2019/09/KHWF_2017Report_Fullreport_042317-MR-comments.pdf [Accessed 23 Jan 2020].
- Kenya Ministry of Health. Kenya human resource for health strategic plan 2019–2023 (final draft); 2019.
- Muthaura PN, Khamis T, Ahmed M, *et al.* Perceptions of the preparedness of medical graduates for internship responsibilities in district hospitals in Kenya: a qualitative study. *BMC Med Educ* 2015;15:178.
- Kenya Medical Practitioners and Dentists Council. Approved internship Centres- Kenya medical practitioners and dentists Council. Available: <https://medicalboard.co.ke/functions/approved-internship-centres/> [Accessed 12 Feb 2020].
- Njiri F. *Strengths and challenges of decentralized health facilities as medical training and research sites*. Kenya, 2013. <http://erepository.uonbi.ac.ke/handle/11295/61812>
- Muasya MK, Dienya TM, Wagaiyu EG. Capacity of non-tertiary Kenyan health facilities selected for decentralised dental training. *East African Medical Journal* 2016;93:55–9.
- Donabedian A. The quality of care. How can it be assessed? *JAMA* 1988;260:1743–8.
- Kenya Ministry of Health. Kenya health facility assessment (KHFA) 2018/19 reports; 2020. <https://www.health.go.ke/resources/downloads/> [Accessed 09 Mar 2021].
- Kenya Ministry of Health. Kenya master health facility list: find all the health facilities in Kenya. Available: <http://kmhfl.health.go.ke/#/home> [Accessed 09 Mar 2021].
- Capinpuyan ALC, Miguel RTD. Ethical challenges in medical community internships. *Health Hum Rights* 2019;21:141–7.
- Bola S, Trollip E, Parkinson F. The state of South African internships: a national survey against HPCSA guidelines. *S Afr Med J* 2015;105:535.
- Wilson RM, Michel P, Olsen S, *et al.* Patient safety in developing countries: retrospective estimation of scale and nature of harm to patients in hospital. *BMJ* 2012;344:e832.
- Meyer A-C, Ndeti D. *Providing sustainable mental health care in Kenya: a demonstration project*. National Academies Press (US), 2016. <https://www.ncbi.nlm.nih.gov/books/NBK350312/>
- World Health Organization. *Increasing access to health workers in remote and rural areas through improved retention: global policy recommendations*. Geneva, 2010. <http://www.ncbi.nlm.nih.gov/books/NBK138618/>
- Kibore MW, Daniels JA, Child MJ, *et al.* Kenyan medical student and consultant experiences in a pilot decentralized training program at the University of Nairobi. *Educ Health* 2014;27:170–6.
- Essa ZI. Post-medical interns' reflections on medical internships in South African state training hospitals, 2011. Available: <http://wiredspace.wits.ac.za/handle/10539/9209> [Accessed 11 May 2021].
- Goddard AF, Patel M. The changing face of medical professionalism and the impact of COVID-19. *Lancet* 2021;397:950–2.
- Wu AW, Steckelberg RC. Medical error, incident investigation and the second victim: doing better but feeling worse? *BMJ Qual Saf* 2012;21:267–70.
- Kenya Scheme of service for medical officers' dental officers and pharmacists, 2017. Available: <https://www.cog.go.ke/media-multimedia/reportss/category/101-schemes-of-service?download=260:scheme-of-service-for-medical-officers-dental-officers-and-pharmacists>
- STAT. Doctors may learn bad habits at teaching hospitals with safety violations, 2018. Available: <https://www.statnews.com/2018/04/20/doctors-learn-bad-habits-teaching-hospitals/> [Accessed 03 Apr 2021].
- Barasa EW, Ouma PO, Okiro EA. Assessing the hospital surge capacity of the Kenyan health system in the face of the COVID-19 pandemic. *PLoS One* 2020;15:e0236308.

Additional file 1. 166 Indicators included for each general domain and speciality domain

Domain	Indicator	1 – considered available	0 – considered unavailable
Human resources for health (6)	At least five medical specialists	- 5 or more specialists	- Less than 5 specialists
	At least one surgeon	- 1 or more	- Less than 1
	At least one internist	- 1 or more	- Less than 1
	At least one paediatrician	- 1 or more	- Less than 1
	At least one obstetrician-gynaecologist	- 1 or more	- Less than 1
	At least one anaesthesiologist	- 1 or more	- Less than 1
Lab test (31)	HIV rapid test	- Observed, at least one not expired	- Not observed, reported available but not seen - Not observed, never available
	Syphilis rapid test	- Observed, at least one not expired	- Not observed, reported available but not seen - Not observed, never available
	Urine rapid test for pregnancy	- Observed, at least one not expired	- Not observed, reported available but not seen - Not observed, never available
	Urine dipstick 3	- Observed, at least one not expired	- Not observed, reported available but not seen - Not observed, never available
	Haemoglobin A1c rapid test	- Observed, at least one not expired	- Not observed, reported available but not seen - Not observed, never available
	Colorimeter or haemoglobinometer	- Observed, functional/valid	- Reported (not seen), functional/valid - Not available today
	Glucometer	- Observed, functional/valid	- Reported (not seen), functional/valid - Not available today
	Glucometer test strips/discs	- Observed, functional/valid	- Reported (not seen), functional/valid - Not available today
	Any blood chemistry test	- Yes, onsite	- No, never available
	Renal function test	- Yes, observed, functional/valid	- No, not available today
	Other tests for bilirubin	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	ABO blood grouping testing	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Rhesus blood grouping testing	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Cross-match testing	- Yes, onsite	- Yes, offsite (specimen sent) - No, not available today
	Onsite PCR for HIV viral load or HIV early-infant diagnosis	- Yes, onsite	- Yes, offsite (specimen sent) - Yes, not functional/not valid - No, not available today
	Xpert MTB/RIF rapid diagnostic testing for TB	- Yes, onsite	- Yes, offsite (specimen sent) - No, not available today
	Urine microscopy	- Yes, observed, functional/valid	- No, not available today
	Malaria smears	- Yes, observed, functional/valid	- No, not available today
	Microscopy test CSF body fluid counts	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Cryptococcal antigen testing	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Gram stain testing	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Culture and sensitivity test	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Blood cultures test	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	Fine needle aspiration cytology	- Perform in facility	- Refer for test - Not used
	Core needle biopsy of lump specimen	- Perform in facility	- Refer for test - Not used
	Prostate Specific Antigen (PSA) Testing	- Perform in facility	- Refer for test - Not used
	Blood gas measurement	- Yes, onsite	- Yes, offsite (specimen sent)

			- No, never available
	Cardiac marker (CK, Troponin) test	- Yes, onsite	- Yes, offsite (specimen sent) - No, never available
	PAP smear read in facility	- Yes, read in facility	- Yes, read outside facility - No - 0 PAP smears were conducted with results recorded during the past 12 completed months
	VIA/VILLI read in facility	- Yes, read in facility	- Yes, read outside facility - No - 0 VIA/VILLI were conducted with results recorded during the past 12 completed months
	Prepare and examine tissues or samples for cancer	- Yes	- No
Oxygen and respiratory support (10)	Surgery oxygen equipment functioning - Oxygen tank/cylinder with attached pressure gauge, pressure regulator	- Yes	- No - Don't know
	Maternity paediatric-sized oxygen delivery apparatus functioning	- Yes	- No
	Outpatient pulse oximeter functioning	- Yes	- No
	Maternity pulse oximeter functioning	- Yes	- No
	Paediatrics/neonatal oxygen functioning	- Yes	- No
	Emergency pulse oximeter functioning	- Yes	- No
	Ventilator available	- Yes, available now	- No
	Chest tubes available	- Observed, at least one not expired	- Not observed, not available today - Not observed, never available
	Adult CPAP equipment available	- Observed, at least one not expired	- Observed, available but expired - Not observed, reported available but not seen - Not observed, not available today - Not observed, never available
	Emergency paediatrics and neonatal CPAP available	- Observed	- Reported, not seen - Not available
General equipment (8)	ECG offered	- Yes	- No
	ECG equipment functioning	- Yes equipment available and functioning	- No equipment not available or not functioning
	Ultrasound offered	- Yes	- No
	Ultrasound equipment functioning	- Yes equipment available and functioning	- No equipment not available or not functioning
	X-ray offered	- Yes	- No
	X-ray equipment functioning	- Yes equipment available and functioning	- No equipment not available or not functioning
	CT scan offered	- Yes	- No
24 7 (8)	CT scan equipment functioning	- Yes equipment available and functioning	- No equipment not available or not functioning
	Emergency service with structured triage tool 24/7	- 24-hour emergency service	- 10 hours - No structured triage tool
	Medical officer onsite or oncall in facility 24/7	- MO or Emergency practitioner always available, onsite - MO or Emergency practitioner always available, not onsite but oncall in facility	- MO or Emergency practitioner always available, not in facility - Staff not available 24 hours
	Formal triage tool used 24/7	- Yes	- No
	Emergency surgery and anaesthesia 24/7	- 24-hour emergency service	- 0, 2 or 8 hours
	Emergency radiology 24/7	- 24-hour emergency service	- 0, 5, 9, 10, 12 hours
	Emergency diagnostics 24/7	- 24-hour emergency service	- 0, 7, 10, 12 hours
	Emergency pharmacy 24/7	- 24-hour emergency service	- 8, 9, 10, 12, 15 hours - No dedicated pharmacy in facility
	Blood transfusion	- Yes available now	- No
IPC (9)	Facility has IPC guideline	- Yes, observed	- Reported not seen - No
	Technical IPC committee	- Yes	- No
	Dedicated (full-time) IPC staff	- Yes	- No

	Guidelines for cleaning	- Yes, observed	- Reported not seen - No
	Step-by-step techniques for specific tasks	- Yes	- No
	Cleaning roster or schedule specifying responsibility	- Yes	- No
	Cleaning beds observed	- Yes	- No
	Cleaning counters/tables observed	- Yes	- No
	Cleaning toilets observed	- Yes	- No
Quality and safety (24)	Monthly quality assurance committee meeting	- Monthly	- Quarterly - Biannually
	Documentation of quality assurance information reviewed	- Yes, documentation observed	- Yes, documentation reported not seen
	Ongoing quality improvement using Plan-Do-Check-Study-Act approach	- Yes, service-specific - Yes, across facility	- No
	Multi-disciplinary quality improvement team	- Yes	- No
	Departmental specific work improvement teams	- Yes	- No
	Documentation of improvement achieved as a result of quality improvement process	- Yes, documentation observed	- Yes, documentation reported not seen - No
	Kenya Quality Model for Health completed in 2017 or 2018	- 2017 - 2018	- 2014 - 2016 - Don't know
	Formal case reviews carried out at least monthly	- At least weekly - At least monthly	- At least quarterly - No specific timing
	Death reviews results recorded	- Yes	- No
	Guidelines of events that are considered adverse and required to be reported	- Yes, documentation observed	- Yes, documentation reported not seen - No
	Notes or reports that show evidence of review and plan of action for the reports about adverse events	- Yes, documentation observed	- Yes, documentation reported not seen - No
	Written guidelines that define nosocomial infections and the process for reporting	- Yes, observed	- Reported not seen - No
	Report or record shows nosocomial infections reported over the past 6 months	- Yes, observed	- Reported not seen - No
	Written policies and procedures for identifying and managing drug-use problems	- Yes, observed	- Reported not seen - No
	Surgery related mortality and morbidity review meetings at least monthly	- At least weekly - At least monthly	- At least quarterly - No specific timing - None conducted
	Surgery related mortality and morbidity review meeting results recorded	- Yes, observed	- Reported not seen - No
	Written guidelines or instructions for reporting on adverse events related to surgery	- Yes, observed	- Reported not seen - No - Don't know
	Notes or reports that show evidence of review and plan of action for the surgery reports	- Yes, documentation observed	- Yes, documentation reported not seen - No
	Guidelines of postoperative infection definition	- Yes, documentation observed	- Yes, documentation reported not seen - No
	Notes or reports that show evidence of review and plan of action for the reports about postoperative infection	- Yes, documentation observed	- Yes, documentation reported not seen - No
	Indicator on deaths prior to discharge among patients who had a procedure in a surgical theater monitored	- Yes	- No
	Indicator on deaths prior to discharge among < 15 year old patients who had a procedure in a surgical theater monitored	- Yes	- No
	Indicator on post-operative surgical wound infection numbers monitored	- Yes	- No
	Facility monitor unplanned and unexpected hospital readmissions for any conditions	- Yes	- No
Surgery equipment and medication (8)	Basic operating table functioning	- Yes	- No
	Overhead operating light functioning	- Yes	- No
	Cardiac monitor functioning	- Yes	- No

			- Don't know
	EKG electrodes functioning	- Yes	- No - Don't know
	Thermometer functioning	- Yes	- No - Don't know
	Blood pressure apparatus functioning	- Yes	- No
	Suction apparatus functioning	- Yes	- No
	Anaesthesia machine available	- Yes available now	- No
Surgery service (12)	Wound debridement service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Acute burn management service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Closed repair of fracture service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Closed reduction of dislocated joint service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Cricothyroidotomy service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Male circumcision service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Hydrocele reduction service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Biopsy of lymph node or mass service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Appendectomy service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Hernia repair service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Open reduction and fixation service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
	Any procedures using laparotomy service available	- Yes, outpatient - Yes, inpatient - Yes both out and inpatient	- No
Internal medicine equipment and medication (3)	Defibrillator available	- Yes, available now	- No
	Renal dialysis/haemodialysis machine available	- Yes, available now	- Yes, not available now - No
	Lumbar puncture kit available	- Observed, at least one not expired	- Observed, available but expired - Not observed, reported available but not seen - Not observed, not available today - Not observed, never available
Internal medicine service (10)	ART prescription and follow-up for U5 children service available	- Yes, ART prescription and clinical follow-up	- Yes, ART prescription, no clinical follow-up - Yes, clinical follow-up, no ART prescription
	HIV/AIDS care and support service available	- Yes	- No
	Diagnose and/or manage diabetes available	- Yes	- No
	Diagnose and/or manage acute myocardial infarction available	- Diagnose, treat and patient follow-up	- Patient follow-up only - No service/refer suspect case
	Diagnose and/or manage chronic respiratory disease available	- Yes	- No
	Diagnose and/or manage chronic kidney disease available	- Yes	- No
	Screening, diagnosis and/or treatment services for breast cancer available	- Yes	- No

	Screening, diagnosis and/or treatment services for colorectal cancer available	- Yes	- No
	Screening, diagnosis and/or treatment services for prostate cancer available	- Yes	- No
	Palliative care service available	- Yes	- No
Paediatrics equipment and medication (8)	Phototherapy machine available	- Yes, available now	- No
	Infant incubator available at outpatient	- Yes, available now	- Yes, not available now - No
	Bed or location for KMC caregiver overnight	- Yes, observed	- Reported, not seen - No
	Exchange transfusion blood available today	- Yes	- No
	Incubator available today	- Yes	- No
	Radiant warmer available today	- Yes	- No
	Artificial ventilation available today	- Yes	- No
	Device for intraosseous access available	- Observed, at least one not expired	- Observed, available but expired - Not observed, reported available but not seen - Not observed, not available today - Not observed, never available
Paediatrics service (3)	KMC for premature or LBW used	- Yes	- No
	Newborn sepsis service available	- Yes	- No
	Newborn sepsis full antibiotics regimen and follow-up always available	- Yes always	- Yes sometimes - Never
OBGYN equipment and medication (10)	Blood pressure apparatus functioning	- Yes	- No
	Infant scale (with 100 gram gradation) functioning	- Yes	- Don't know
	Resuscitation table (with heat source) functioning	- Yes	- No
	Self-inflating bag and mask for resuscitation functioning	- Yes	- No
	Newborn bag and mask size 0 for resuscitation of pre-term babies functioning	- Yes	- No
	Newborn bag and mask size 1 for resuscitation of term babies functioning	- Yes	- No
	Magnesium sulphate injection available	- Observed, at least one not expired	- Not observed, not available today
	Dexamethasone injection available	- Observed, at least one not expired	- Not observed, not available today - Not observed, never available
	Misoprostol tablet 200 mcg available	- Observed, at least one not expired	- Not observed, not available today - Not observed, never available
	Oxytocin injection available	- Observed, at least one not expired	- Not observed, not available today - Not observed, never available
OBGYN service (10)	Active management of third stage labour (AMTSL) service available	- Yes	- No
	Monitoring and management of labor using a partograph service available	- Yes	- No
	Hygienic cord care service available	- Yes	- No
	Parenteral administration of antibiotics carried out	- Yes	- No
	Parenteral administration of oxytocin for treatment of postpartum haemorrhage carried out	- Yes	- No
	Assisted vaginal delivery using manual vacuum extraction (MVE) or forceps carried out	- Yes	- No, service not offered - No, trained staff but no cases
	Manual removal of placenta carried out	- Yes	- No
	Removal of retained products of conception using D&C or manual vacuum aspiration carried out	- Yes	- No, service not offered
	PMTCT available	- Yes	- No
	Treatment of pre-invasive cervical cancer available	- Yes	- No
Mental health / neurology (6)	Any mental/neurological services offered	- Yes, inpatient only	- Not offered
	Mental health inpatient ward available	- Yes, inpatient only	- Not offered

	Neurological health inpatient ward available	- Yes, inpatient only	- Not offered
	Depression diagnosis and follow-up available	- Diagnoses and provides patient follow-up	- Diagnoses only - Provides patient follow-up only - No
	Psychosis diagnosis and follow-up available	- Diagnoses and provides patient follow-up	- Diagnoses only - Provides patient follow-up only - No
	Epilepsy diagnosis and follow-up available	- Diagnoses and provides patient follow-up	- Diagnoses only - Provides patient follow-up only - No

Additional file 2. Comparing internship hospitals sampled in KHHFA and others

	61 KHHFA hospitals	12 other hospitals
Level		
- Level 4	44	11
- Level 5	15	1
- Level 6	2	0
Ownership		
- MoH	54	0
- Private	2	4
- FBO	5	8
Bed number		
- Mean (SD)	262.9 (213.4)	171.2 (71.0)
- Median (IQR)	200 (156, 276)	180 (106, 221)
Total delivery		
- Mean	4585.1 (2747.0)	1349.4 (945.7)
- Median (IQR)	3980.7 (2972.3, 5502.7)	1150.4 (649.7, 1683.5)
Live births		
- Mean	4466.9 (2691.9)	1321.3 (927.8)
- Median (IQR)	3814.3 (2844, 5384.3)	1138.4 (626.5, 1630)
C-section		
- Mean	1190.3 (917.6)	536.1 (270.7)
- Median (IQR)	987.3 (734.3, 1319.3)	536.6 (289, 708.5)

Additional file 3. All indicator heatmap by hospital bed number

	Level 4 small hospitals (n=23)	Level 4 large hospitals (n=23)	Level 5 & 6 hospitals (n=15)	Total (n=61)
Human resources for health				
At least five medical specialists	39%	44%	67%	48%
At least one surgeon	96%	96%	100%	97%
At least one internist	48%	57%	73%	57%
At least one paediatrician	70%	91%	100%	85%
At least one obstetrician-gynaecologist	87%	91%	100%	92%
At least one anaesthesiologist	44%	26%	93%	49%
Lab tests				
<i>Rapid test</i>				
HIV rapid test	87%	91%	87%	89%
Syphilis rapid test	96%	91%	100%	95%
Urine rapid test for pregnancy	100%	91%	100%	97%
Urine dipstick 3	35%	44%	53%	43%
Haemoglobin A1c rapid test	57%	57%	87%	64%
Colorimeter or haemoglobinometer	70%	61%	67%	66%
Glucometer	96%	96%	93%	95%
Glucometer test strips/discs	96%	100%	93%	97%
<i>Basic lab test</i>				
Any blood chemistry test	83%	78%	93%	84%
Renal function test	70%	74%	93%	77%
Other tests for bilirubin	65%	70%	67%	67%
ABO blood grouping testing	83%	74%	80%	79%
Rhesus blood grouping testing	83%	74%	87%	80%
Cross-match testing	57%	70%	80%	67%
<i>Infectious disease test</i>				
Onsite PCR for HIV viral load or HIV early-infant diagnosis	0%	4%	27%	8%
Xpert MTB/RIF rapid diagnostic testing for TB	61%	83%	87%	75%
Urine microscopy	91%	83%	93%	89%
Malaria smears	91%	83%	93%	89%
Microscopy test CSF body fluid counts	83%	78%	93%	84%
Cryptococcal antigen testing	74%	78%	80%	77%
Gram stain testing	91%	78%	93%	87%
Culture and sensitivity test	57%	74%	87%	71%
Blood cultures test	17%	22%	80%	34%
<i>Advanced lab test</i>				
Fine needle aspiration cytology	22%	44%	67%	41%
Core needle biopsy of lump specimen	35%	44%	67%	46%
Prostate Specific Antigen (PSA) Testing	48%	61%	80%	61%
Blood gas measurement	9%	13%	60%	23%
Cardiac marker (CK, Troponin) test	9%	30%	53%	28%
PAP smear read in facility	17%	13%	33%	20%
VIA/VILLI read in facility	96%	78%	73%	84%
Prepare and examine tissues or samples for cancer	0%	4%	53%	15%

Oxygen and respiratory support

Surgery oxygen equipment functioning - Oxygen tank/cylinder with attached pressure gauge, pressure regulator

87% 83% 73% 82%

Maternity paediatric-sized oxygen delivery apparatus functioning

87% 74% 93% 84%

Outpatient pulse oximeter functioning

39% 48% 60% 48%

Maternity pulse oximeter functioning

35% 52% 67% 49%

Paediatrics/neonatal oxygen functioning

100% 100% 100% 100%

Emergency pulse oximeter functioning

65% 65% 100% 74%

Ventilator available

52% 52% 87% 61%

Chest tubes available

30% 61% 80% 54%

Adult CPAP equipment available

13% 30% 40% 26%

Emergency paediatrics and neonatal CPAP available

17% 26% 20% 21%

Equipment

ECG offered

39% 35% 93% 51%

ECG equipment functioning

26% 35% 87% 44%

Ultrasound offered

83% 91% 100% 90%

Ultrasound equipment functioning

83% 91% 100% 90%

X-ray offered

87% 87% 100% 90%

X-ray equipment functioning

87% 83% 100% 89%

CT scan offered

26% 22% 80% 38%

CT scan equipment functioning

26% 17% 73% 34%

24 7 availability

Emergency service 24/7

26% 13% 47% 26%

Medical officer onsite or oncall in facility 24/7

78% 70% 93% 79%

Formal triage tool used 24/7

26% 17% 47% 28%

Emergency surgery and anaesthesia 24/7

17% 13% 40% 21%

Emergency radiology 24/7

91% 87% 100% 92%

Emergency diagnostics 24/7

96% 87% 93% 92%

Emergency pharmacy 24/7

87% 83% 93% 87%

Blood transfusion

91% 83% 100% 90%

Infection prevention and control

Facility has IPC guideline

87% 70% 87% 80%

Technical IPC committee

96% 100% 93% 97%

Dedicated (full-time) IPC staff

57% 52% 73% 59%

Guidelines for cleaning

48% 57% 33% 48%

Step-by-step techniques for specific tasks

44% 57% 60% 53%

Cleaning roster or schedule specifying responsibility

48% 61% 73% 59%

Cleaning beds observed

44% 61% 67% 56%

Cleaning counters/tables observed

48% 61% 60% 56%

Cleaning toilets observed

48% 70% 67% 61%

Quality and safety

Monthly quality assurance committee meeting

26% 35% 53% 36%

Documentation of quality assurance information reviewed

52% 44% 67% 53%

Ongoing quality improvement using Plan-Do-Check-Study-Act approach

64% 67% 67% 66%

Multi-disciplinary quality improvement team

65% 61% 80% 67%

Departmental specific work improvement teams

65% 61% 80% 67%

Documentation of improvement achieved as a result of quality improvement process

48% 52% 33% 46%

Kenya Quality Model for Health completed in 2017 or 2018	48%	44%	60%	49%
Formal case reviews carried out at least monthly	57%	57%	67%	59%
Death reviews results recorded	91%	91%	100%	93%
Guidelines of events that are considered adverse and required to be reported	22%	35%	33%	30%
Notes or reports that show evidence of review and plan of action for the reports about adverse events	22%	39%	27%	30%
Written guidelines that define nosocomial infections and the process for reporting	9%	9%	40%	16%
Report or record shows nosocomial infections reported over the past 6 months	9%	4%	33%	13%
Written policies and procedures for identifying and managing drug-use problems	70%	65%	67%	67%
Surgery related mortality and morbidity review meetings at least monthly	44%	39%	60%	46%
Surgery related mortality and morbidity review meeting results recorded	44%	57%	53%	51%
Written guidelines or instructions for reporting on adverse events related to surgery	9%	26%	33%	21%
Notes or reports that show evidence of review and plan of action for the surgery reports	9%	17%	27%	16%
Guidelines of postoperative infection definition	17%	26%	33%	25%
Notes or reports that show evidence of review and plan of action for the reports about postoperative infection	13%	17%	13%	15%
Indicator on deaths prior to discharge among patients who had a procedure in a surgical theater monitored	9%	22%	53%	25%
Indicator on deaths prior to discharge among < 15 year old patients who had a procedure in a surgical theater monitored	9%	17%	47%	21%
Indicator on post-operative surgical wound infection numbers monitored	9%	17%	40%	20%
Facility monitor unplanned and unexpected hospital readmissions for any conditions	30%	26%	40%	31%

Surgery**Surgery equipment & medication**

Basic operating table functioning	96%	96%	100%	97%
Overhead operating light functioning	96%	96%	100%	97%
Cardiac monitor functioning	87%	83%	100%	89%
EKG electrodes functioning	83%	70%	100%	82%
Thermometer functioning	96%	87%	93%	92%
Blood pressure apparatus functioning	70%	91%	93%	84%
Suction apparatus functioning	100%	96%	100%	98%
Anaesthesia machine available	83%	74%	93%	82%

Surgery service

Wound debridement service available	100%	100%	100%	100%
Acute burn management service available	96%	96%	100%	97%
Closed repair of fracture service available	96%	91%	100%	95%
Closed reduction of dislocated joint service available	96%	91%	100%	95%
Cricothyroidotomy service available	78%	57%	80%	71%
Male circumcision service available	100%	96%	93%	97%
Hydrocele reduction service available	100%	91%	93%	95%
Biopsy of lymph node or mass service available	100%	100%	100%	100%
Appendectomy service available	100%	96%	100%	98%
Hernia repair service available	100%	96%	100%	98%
Open reduction and fixation service available	100%	83%	100%	93%
Any procedures using laparotomy service available	100%	96%	100%	98%

Internal medicine

Internal medicine equipment & medication

Defibrillator available	57%	39%	73%	54%
Renal dialysis/haemodialysis machine available	44%	65%	93%	64%
Lumbar puncture kit available	22%	26%	80%	38%

Internal medicine service

ART prescription and follow-up for U5 children service available	96%	96%	93%	95%
HIV/AIDS care and support service available	100%	96%	100%	98%
Diagnose and/or manage diabetes available	100%	100%	100%	100%
Diagnose and/or manage acute myocardial infraction available	83%	74%	93%	82%
Diagnose and/or manage chronic respiratory disease available	100%	100%	100%	100%
Diagnose and/or manage chronic kidney disease available	83%	91%	100%	90%
Screening, diagnosis and/or treatment services for breast cancer available	78%	87%	93%	85%
Screening, diagnosis and/or treatment services for colorectal cancer available	35%	30%	60%	39%
Screening, diagnosis and/or treatment services for prostate cancer available	61%	83%	87%	75%
Palliative care service available	48%	65%	100%	67%

Paediatrics**Paediatrics equipment & medication**

Phototherapy machine available	52%	52%	67%	56%
Infant incubator available	74%	78%	87%	79%
Bed or location for KMC caregiver overnight	61%	70%	80%	69%
Exchange transfusion blood available today	26%	17%	60%	31%
Incubator available today	96%	100%	100%	98%
Radiant warmer available today	91%	96%	93%	93%
Artificial ventilation available today	48%	57%	73%	57%
Device for intraosseous access available	17%	30%	53%	31%

Paediatrics service

KMC for premature or LBW used	83%	87%	93%	87%
Newborn sepsis service available	100%	96%	100%	98%
Newborn sepsis full antibiotics regimen and follow-up always available	91%	87%	87%	89%

OBGYN**OBGYN equipment & medication**

Blood pressure apparatus functioning	91%	100%	100%	97%
Infant scale (with 100 gram gradation) functioning	87%	96%	100%	93%
Resuscitation table (with heat source) functioning	91%	100%	93%	95%
Self-inflating bag and mask for resuscitation functioning	87%	91%	80%	87%
Newborn bag and mask size 0 for resuscitation of pre-term babies functioning	91%	91%	87%	90%
Newborn bag and mask size 1 for resuscitation of term babies functioning	96%	96%	93%	95%
Magnesium sulphate injection available	96%	96%	100%	97%
Dexamethasone injection available	91%	91%	73%	87%
Misoprostol tablet 200 mcg available	74%	70%	73%	72%
Oxytocin injection available	100%	96%	100%	98%

OBGYN service

Active management of third stage labour (AMTSL) service available	100%	100%	100%	100%
Monitoring and management of labor using a partograph service available	96%	96%	100%	97%
Hygienic cord care service available	100%	91%	93%	95%

Parenteral administration of antibiotics carried out	100%	100%	100%	100%
Parenteral administration of oxytocic for treatment of postpartum haemorrhage carried out	100%	100%	100%	100%
Assisted vaginal delivery using manual vacuum extraction (MVE) or forceps carried out	57%	74%	73%	67%
Manual removal of placenta carried out	100%	100%	100%	100%
Removal of retained products of conception using D&C or manual vacuum aspiration carried out	83%	83%	100%	87%
PMTCT available	100%	100%	100%	100%
Treatment of pre-invasive cervical cancer available	44%	48%	53%	48%
Mental health / neurology				
Any mental/neurological services offered	65%	96%	93%	84%
Mental health inpatient ward available	26%	48%	80%	48%
Neurological health inpatient ward available	13%	22%	67%	30%
Depression diagnosis and follow-up available	48%	87%	87%	72%
Psychosis diagnosis and follow-up available	52%	91%	87%	75%
Epilepsy diagnosis and follow-up available	57%	91%	87%	77%