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THE OPERATIONAL SETUP OF INTENSIVE CARE UNITS IN A LOW INCOME COUNTRY IN EAST AFRICA
U. K. Okech, MD, MMed, T. Chokwe, BSc, MBChB, MMed, Department of surgery, College of Health Sciences, University of Nairobi, P. O. Box 19676-00202, Nairobi, and V. Mung'ayi, MBChB, MMed, Department of Anaesthesia, Aga Khan University, East Africa, P. O. Box 30270-00100, Nairobi, Kenya

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U. K. OKECH, T. CHOKWE and V. MUNG'AYI

ABSTRACT

***Background*: Intensive care medicine is a medical specialty which focuses on management of critically ill patients. The majority of critically ill patients in less developed countries, harboring two thirds of world populations do not have access to intensive care.**
***Objectives*: Evaluate the current status of Intensive Care Unit setups and facilities in Kenya.**
***Design*: An observational cross sectional survey.**
***Setting*: The study was carried out in referral hospitals, provincial level 5 hospitals, mission hospitals and private hospitals with intensive care units.**
***Results*: A total of 21 hospitals were surveyed in the republic with a bed capacity of 6,551. The bed capacity of ICUs was 130. Availability and serviceability of ICU equipment, availability of essential drugs and diagnostic support services used in care of critically ill patients ranged from > 95% in private and mission hospitals to 60-80% in the other hospitals. There were 414 nurses working in the ICUs of which 204 had specialty training. Anaesthesiologists were the most common primary care clinicians in 47% of ICUs surveyed. Over a one year period, post-operative surgical cases at 1086 (30%) and trauma at 909 (26%) cases were the leading causes of ICU admissions.**
***Conclusion*: There is a low bed capacity in ICUs compounded by a universal deficit in human resource capacity and support infrastructure for the critical care services. Regionalisation, increased funding and more training opportunities for critical care services by the regional and central governments will go a long way in alleviating these challenges.**

INTRODUCTION

In the last few decades there has been a general trend to separate anaesthesiology from critical care medicine. Many professionals recognised the fact that critical care medicine is a multidisciplinary field of medicine, where the critically ill patient needed more than routine knowledge and skills of only one specialty and that there is a place for improving the patient's management by involving experts from other fields. Majority of hospitals in high income countries run more than general intensive care units (ICU) for example medical, paediatric, surgical and cardiac (1).

The majority of critically ill patients in less developed countries, harboring around two thirds of the world's population, still do not have access to ICUs. Little information exists on the current state of intensive care medicine in less developed countries. There seems to be a wide variability in the availability of ICUs in these countries, ranging from non–existent to sophisticated centres in selected private hospitals catering for few privileged patients (1).

In addition the medical profession in less developed countries is not setup to provide formal training in intensive care. These factors inevitably result in lack of recognition of intensive care medicine as a specialty in resource poor settings. Disease severity at ICU admission is typically higher at resource poor settings and leads to higher mortality rates in less developed than in high income countries (2).

ICUs in high income countries, despite being well equipped, with good material availability and adequate nurse ratio still face challenges of having full time intensivists coverage. This was shown in a stratified weighted survey study done by Agnus et al with the aim of describing the organization and distribution of services and to determine the ICU physician staffing (3). A follow up study by Khan JM et al looking at the barriers towards implementing the recommendations for intensivists physician staffing identified increased implementation cost to the hospital administration and convincing hospital organizations, medical staff regarding the benefits of adopting the standard in USA hospital ICUs (4).

Critical care remains in its infancy in many low income countries (1, 11). Dunser et al in a review and analysis of intensive care medicine in the least developed countries reported that the burden of critical illness is high in low income countries and little data exists on the current state of intensive care medicine (7).

In Kenya we have no existing data on critical care service provided by referral, provincial hospitals and faith based organization registered by Ministry of Health. This study will give a better picture of how ICU facilities are setup on the ground. This will also bring out data on bed capacity, staffing and training, equipment and maintenance, essential drugs.

Our primary objective was to evaluate the current status of ICU setups and facilities in Kenya. Our secondary objectives were; to assess the bed capacity; to assess the equipment used in patient care, essential drugs used in patient care, diagnostic support service; to assess work force in the intensive care unit and to assess the case admission pattern over the past one year.

MATERIALS AND METHODS

The survey was performed following approval from the Ethical and Scientific Research Committee at the Kenyatta National Hospital/University of Nairobi, Moi Referral and Teaching Hospital and permission from the Medical Superintendents of Provincial Hospitals, Mission Hospitals and Hospital Administrators of Private Hospitals.

This was an observational; Cross Sectional Survey. It was conducted at the Kenyatta National Hospital (referral hospital I), Moi Teaching and Referral (referral hospital II), five Provincial Hospitals, three Mission Hospitals and 11 Private Hospitals. The inclusion criteria was all public, mission and private hospitals registered with the Ministry of Health Services with ICUs. Those that did not have ICUs or declined to give permission to be included in the survey were excluded. The area of study was the intensive care unit of each of these hospitals.

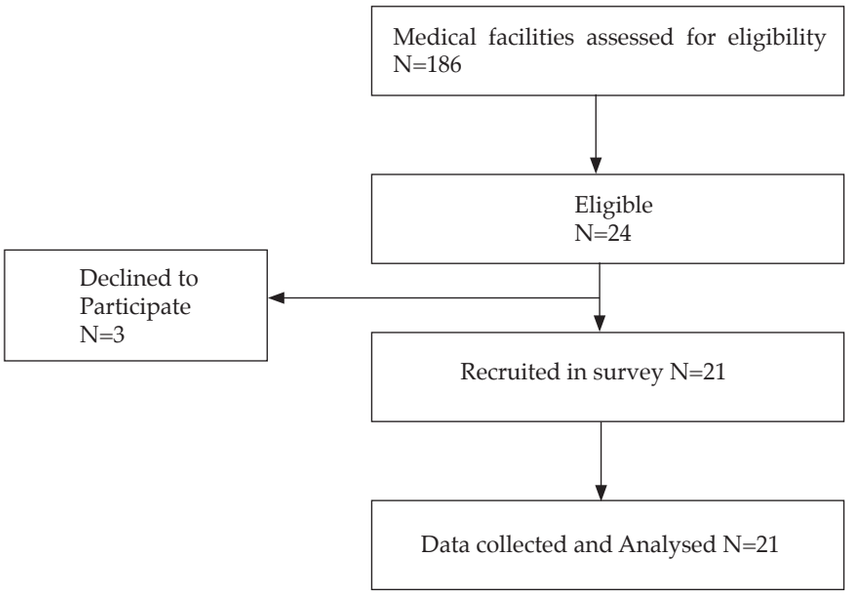
The target population was the intensive care units of these survey hospitals including their nursing personnel and primary care clinicians. In this survey the sampling procedure was Purposive thus the calculation of sample size was not be applicable. The nature of the study was explained to hospital personnel in charge of the ICUs. A written informed consent was sought from hospital personnel in charge of the ICUs. Confidentiality of participating hospitals was maintained. The study did not constitute harm to staff and patients in ICU.

A survey tool was used to evaluate aspects of bed capacity, equipment used in patient care, laboratory service and diagnostic imaging, staffing workforce of the intensive care unit and case admissions over a one year period. Data collected from the survey tool was used for analysis and publishing of results. The data quantitative data collected from survey tool was electronically captured using Microsoft access database. The data was validated and then transferred to the Statistical Product Service Solution version 20(SPSS) for analysis. Descriptive and inferential statistics was used to analyze the data. To describe characteristics of the population, univariate analysis was used to extract simple frequencies and various aspects presented graphically. To look for association and effectiveness, inferential statistics was carried out.

A flow diagram for the survey is shown in Figure 1

Figure 1

Flow Diagram of Survey



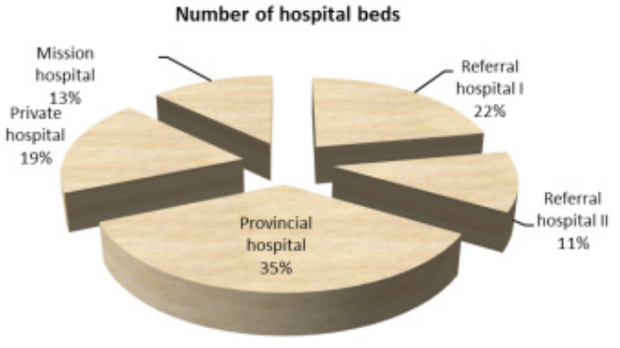
RESULTS

Data collection was carried out between January and May 2014. A total of 21 hospitals were surveyed. They included two referral, five provincial, three mission hospitals and 11 private hospitals. The total bed capacity of the 21 hospitals that were surveyed was 6,551.

Referral hospital I had a bed capacity of 1,445 (22%), Referral hospital II had 734 beds (11%), Provincial hospitals had 2316 beds (35%), Private hospitals had 1203 beds (19%) and Mission hospitals had 853 (13%). This is shown in Figure 2.

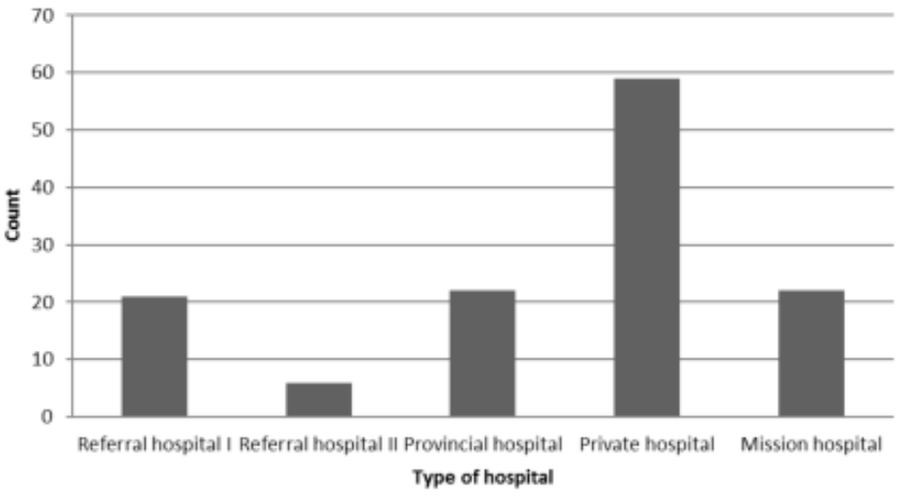
Figure 2

Number of hospital beds expressed as percentage



The total number of ICU beds from the 21 hospitals surveyed was 130. This was 2 % of the total bed capacity of the hospitals surveyed. Referral hospital I had 21 beds (16 %), Referral hospital II, 6 beds (5%), Provincial hospitals had 22 beds (17%), Mission hospitals had 22 beds (17%) and private hospitals 59 beds (45%). This is shown in Figure 3.

Figure 3
Number ICU beds



The percentage of ICU beds to hospital beds was low in most categories of hospitals as shown in the Table 1.

Table 1
Percentage of ICU beds to hospital beds

Type of Hospital	ICU beds	Hospital beds	Ratio of ICU to Hospital beds	% of ICU beds
Referral hospital I	21	1455	7 : 485	1.44%
Referral hospital II	6	734	3 : 367	0.82%
Provincial hospital	22	2316	11 : 1158	0.95%
Private hospital	59	1203	59 : 1203	4.90%
Mission hospital	22	853	22 : 853	2.58%

There were 414 nurses working in the ICU from the sampled hospitals. Nurses working in ICU per shift were 81 in all hospitals as shown in Table 2.

Table 2
Nurses working in ICU and number in shift

Type of Hospital	Total nurses working in ICU	Total nurses per shift
Referral hospital I	112	15
Referral hospital II	20	3
Provincial hospital	56	10
Private hospital	179	41
Mission hospital	47	12

The nurse to patient ratio was variable in different categories of hospitals. The two referral hospitals had a ratio of 1:2.In the private hospitals 6 had a ratio of 1:1, 3 had a 1:2 ratio and 2 had a ratio of 1:3. The 3 mission hospitals surveyed had a ratio of 1:2. Among the seven provincial hospitals 3 had 1:2 ratios while two others had a ratio of 1:3

There were 204 ICU trained nurses, 223 basic trained nurses, 32 renal trained nurses and 6 paediatric trained nurses in the ICUs of sampled hospitals. Referral hospital I had 106 trained ICU nurses (52%), Referral hospital II had 10 (5%) trained ICU nurses, Provincial hospitals had 24 (12%) trained ICU nurses, Private hospitals had 54 (26%) trained ICU nurses and Mission hospitals had 10 (5%) trained ICU nurses. Three Private hospitals did not have ICU trained

nurses. The Referral hospital I had one renal trained nurse while referral hospital II did not have renal trained nurses. The two referral hospitals did not have paediatric trained nurses.

Four Provincial hospitals did not have renal trained nurses and all lacked paediatric trained nurses. In the private hospitals four lacked renal trained nurses and eight lacked paediatric trained nurses. Two private hospitals did not have basic trained nurses in their ICUs. All Mission hospitals sampled did not have renal and paediatric trained nurses.

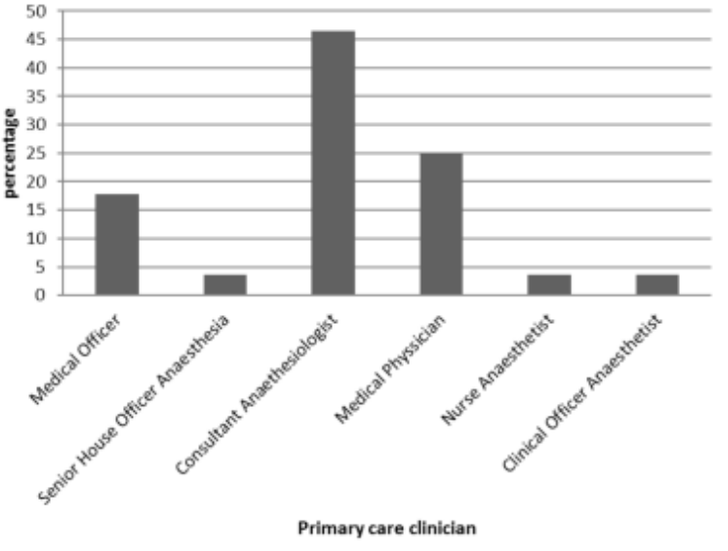
The percentage of ICU trained nurses to other nurses in ICU was highest in Referral hospital I at 94%, Referral hospital II 50%, Provincial hospitals 41 %, Private hospitals 24 % and lowest in Mission hospitals at 21 %. This is shown in Table 3.

Table 3
Training experience of nurses in ICU

Type of Hospital	Number of trained nurses				Statistics	
	Basic nursing only	ICU further training	Renal trained	Paediatric trained	Ratio of ICU to Basic nursing trained nurses	% of ICU trained nurses among trained nurses in ICU
Referral hospital I	6	106	1	0	53 : 3	94 %
Referral hospital II	10	10	0	0	1 : 1	50 %
Provincial hospital	32	24	2	0	3 : 4	41 %
Private hospital	138	54	29	6	9 : 23	24 %
Mission hospital	37	10	0	0	10 : 37	21 %

The primary care clinicians in the ICU at Referral Hospital I were senior house officers in anaesthesia and consultant anaesthesiologists. At Referral Hospital II, medical officers and consultant anaesthesiologists provided primary care. At provincial hospitals consultant anaesthesiologists performed this function. In private hospitals, medical officers, internal medicine physicians and consultant anaesthesiologists provided primary ICU care. At mission hospitals, internal medicine physicians, nurse anaesthetists, medical officers and clinical officer anaesthetists performed this role as shown in Figure 4.

Figure 4
Primary Care Clinician In ICU

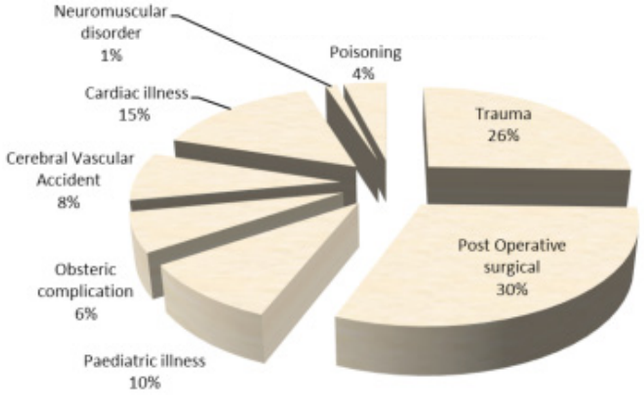


There was consultant support in other fields of general surgery, paediatrics, obstetrics & gynaecology and internal medicine in all hospitals surveyed. Post-operative surgical cases took a big proportion of ICU admissions in the past one year of 1086 (30%) , trauma cases were 909(26%), cardiac disease cases were 538(15%), paediatric illness cases were 345(10%), cerebral vascular accident cases were 281(8%), obstetric complication cases were 228(6%), poisoning cases were 141(4%) and neuromuscular disorder cases were 38(1%). However, some records on ICU admission cases were missing in Private and Mission hospitals. This is illustrated in Figure 5 and Table 4.

Table 4
ICU cases admission in different categories for the past one year (2013)

	Number of cases in ICU in past one year							
Type of Hospital	Trauma	Post-Operative Surgery	Paediatric illness	Obsteric complication	Cerebral Vascular Accident	Cardiac illness	Neuro-muscular disorder	Poisoning
Referral hospital I	189	59	57	47	22	20	10	8
Referral hospital II	70	447	37	31	21	11	13	30
Provincial hospital	197	249	52	95	26	15	2	23
Private hospital	435	298	194	53	200	482	12	68
Mission hospital	18	33	5	2	12	10	1	12

Figure 5
Percentage Of ICU case admission for the past one year (2013) in all ICUs



All of sampled hospitals had ventilators, monitors, suction machines and piped oxygen. Infusion pumps were fully available in all referral, private and mission hospitals but missing in one provincial hospital. Defibrillators were fully available in all referral, provincial and private hospitals but missing in one mission hospital.

Oxygen concentrators as an additional source to piped oxygen were seen in one private hospital, one mission hospital and one provincial hospital. Hemodialysis equipment in the ICUs was not available in the referral, mission, three private hospitals and four provincial hospitals. It was mainly available in the remaining eight private hospitals and one provincial hospital. Invasive monitoring for blood pressure / intracranial pressure (iabp / iicp) was unavailable in two private hospitals, all provincial hospital and two mission hospitals. Only two private hospitals could perform both iabp / iicp.

In terms of operating conditions of equipment in the different hospital categories surveyed, it was found that private and mission hospitals ICU equipment achieved 95-100% serviceability as compared to other hospital groups.

Resuscitation drugs (adrenaline and atropine), sedatives (benzodiazepines) and analgesics (opioids and non-steroidal anti-inflammatories) were fully available in all ICUs of the hospitals surveyed. Anticonvulsants (diazepam and phenytoin) were fully available in referral, private, mission and partially available in provincial hospitals (missing in one provincial hospital). Antibiotics namely penicillin's and aminoglycosides were fully available in all of the hospitals surveyed. Cephalosporin's and tetracycline's were fully available in referral, mission and partially available in provincial (missing in one hospital), and private (missing in one hospital) hospitals. Carbapenems and floroquinolones were fully available in referral and private hospitals, partially available in mission hospitals (missing in one hospital) and unavailable in all provincial hospitals.

Adrenaline inotropes were fully available in all of the hospitals whereas Dopamine and Dobutamine were fully available in referral, private and mission hospitals and not available in provincial hospitals. The antiarrhythmic amiodarone was fully available in all referral, private and mission hospitals and unavailable in provincial hospitals.

Biochemical investigations (renal function test, serum electrolytes and liver function test), microbiological (microscopy, culture and sensitivity) and haematological investigations (full blood count) were available in all of the hospitals. Coagulation profile was fully available in all types of hospitals apart from one provincial hospital. Arterial blood gas analyses was fully available in referral hospitals, most private hospital (missing in one hospital) and partially available in mission hospitals (missing in two hospitals) and absent in all provincial hospitals. Portable X-ray imaging was available in all of the hospitals. Portable ultrasound was fully available in all referral hospitals, present in two mission hospital and absent in one private hospital. Provincial hospitals lacked portable ultrasound services.

DISCUSSION

The findings in this survey demonstrate the status of critical care services in Kenya. Only a minority of hospitals in Kenya provide ICU services. The WHO states that every hospital performing surgery and anaesthesia must have an ICU (8). On the aspect of bed capacity comparing ICU beds and hospital beds in the hospitals surveyed it fell short of the required 20-40% of total hospital beds recommended by Society of Critical Care Medicine (12). From the hospitals surveyed we found a total of 130 beds in the whole country for a population of 44,000,000 million. If this is broken down to ICU beds per 100000 populations it would be 0.29. This means there is a shortage of ICU beds to serve the Kenyan population. This finding is similar to Kwizera et al who did a study on the national bed capacity in Uganda which he found 33 adult ICU beds for a 33 million population (9). Having fewer ICU beds can lead to delayed admission of critically ill patients.

The nurse to patient ratio varied in different hospitals but it was noted that there were shortages at some hospitals. The ideal 1:1 ratio recommended by the European Society of intensive Care medicine (13) could only be met in six private hospitals surveyed. Inadequate nursing staff leads to increased burn out and can affect quality of nursing care (14). The provincial hospitals, private hospitals and mission hospitals showed an imbalance between ICU trained nurses and nurses who had a basic training. This meant that there were more nurses who had only undergone basic training working in ICUs as opposed to those who had gone further for training in ICU. This demonstrates a shortage of nurses specialised in critical care. These findings are similar to a study by Dunser *et al*. where he noted one of the challenges facing ICUs in low income countries was a shortage of staff (11). Baker T *et al* also noted this problem in their study on the aspect of quality of care being affected by acute shortage and burnout (1, 21).There was also a shortage of nurses in fields of paediatric and renal nursing who could add valuable care to these cases on ICU admission.

Anaesthesiologists were noted to be main primary care clinicians in ICUs compared to other medical specialists. This could be related to critical care exposure during their post graduate training. The nurse anaesthetists were seen to play a role in managing ventilated patients in one mission hospital due to critical care exposure and working in a rural setting where specialist physicians are very few. Medical Officers and Medical Physicians also played part in ICU management. In all hospitals there was Consultant support from other fields in patient management. This shows that in Kenya ICUs operate on the "open" model. This is different from the American Leap Frog criteria of ICU physician staffing where 80% of patients were cared for by a critical care physician (intensivist) providing some form of in-house physician coverage during all hours (3). This is currently being taken up in most ICUs in the USA (15) Organization of ICUs as closed units, including the presence of an intensivist, has been shown to result in lower mortality, less complication, a reduced length of stay and lower costs as compared to open ICUs (16).

It was noted that post-operative surgical cases were the leading cause of admission in 2013. Main factors influencing admission were slow or failed recovery from anaesthesia and need for close monitoring depending on the nature of surgery. In the private hospitals cardiac illness took the lead in ICU admission. This could be explained by patient culture groups and lifestyle factors compared to public

facilities. These cases were mainly acute myocardial infarction with its complications. The numbers of obstetric complications admitted were higher in provincial hospitals compared to other hospital groups. Contributing cases were patients who had severe pre-eclampsia, severe obstetric hemorrhage and post-partum sepsis. This was comparable to findings of Githae et al on course and outcome of obstetric patients in a university hospital in a developing country (17). Trauma had more cases per bed in Referral Hospital I. Most of the referrals to this hospital were from its home county and neighboring county facilities that don't have ICUs. The findings of post operative surgical admissions taking lead admissions in 2013 are similar to a study by Towey in Uganda at St Marys Hospital Lacor,Gulu (18). Towey noted that this surgical emphasis was also present in published data from Burkina Faso, Nigeria, Malawi, Zambia, Tanzania and Democratic republic of Congo. In western countries most frequent pathologies leading to ICU admission are cardiovascular, major surgery, sepsis and respiratory failure (5).

Equipment availability and serviceability was another challenge in these ICUs. The mission and private hospitals had the best equipped facilities, followed by Referral hospitals. These challenges in equipment were comparable to those highlighted by Baker et al and Jochberger et al when reviewing critical care in low income countries (1,7). Intensive care units in low income should strive to have basic resource requirements to support the patients and ICU work staff as discussed by Dunser (11). These include monitors, suction machines, mechanical ventilators and oxygen source. Alternatives to infusion pumps can be mechanical drop regulators.

On essential drug support it was noted that first line inotropic agents dopamine and dobutamine, were lacking in all provincial hospitals. Implementing surviving sepsis campaign guidelines in these facilities can pose a challenge (20). Baelani *et al* in his study, noted that drugs , equipment and disposable materials required to implement the surving sepsis campaign bundles were less frequent in African than high income counties (19). The antiarrhythmic agent amiodarone was unavailable in all provincial hospitals yet it is included in the advanced cardiac life support algorithm in managing shockable rhythms.

Most of the ICUs in republic had access to laboratory services to perform biochemistry and microbiology investigations. Blood gas analysis was not universally available yet it plays a key role in managing respiratory failure in mechanically ventilated patients. This poses a challenge to hospitals managing these patients in terms of achieving goal targets and weaning patients from ventilators. Portable ultrasound equipment was lacking in most hospitals,. Baker *et al* noted that inadequate laboratory facilities affected quality of ICU hospital care in low income countries (1). As noted by Baker even the most simple basic laboratory investigation like serum electrolytes were not measured in some facilities in low income countries.

In conclusion, there is an overall deficit in operations of intensive care units in the Republic Of Kenya. The bed capacity of these units is low. There are deficits in availability of equipment, essential drugs and diagnostic laboratory and radiological imaging support used in patient care. There is a shortage in the critical care workforce in areas of critical care nursing and specialised ICU physicians. Post-operative surgical cases are the leading cause of ICU admission in Kenya.

STUDY LIMITATIONS

During the survey there were three hospitals that had opened new intensive care units over a period of three to five months. Data on staffing and case admissions was not conclusive.

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