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Paediatric Emergency Departments in Nigeria: how prepared are they to provide emergency care?

By

Callistus Okwuchukwu Achuri Enyuma

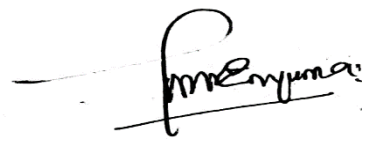
Student no: 1589723

A research report submitted to the Faculty of Health Sciences, University of The Witwatersrand Johannesburg in partial fulfilment of the requirements for the degree of Master of Science (Emergency Medicine)

Johannesburg, 2019

DECLARATION

I, **Dr Callistus Okwuchukwu Achuri Enyuma**, hereby declare that this research report is my own work. It is being submitted in partial fulfilment of the requirements for the degree of Master of Science (Emergency Medicine) to the University of the Witwatersrand, Johannesburg. It has not been submitted or presented for any other degree, diploma or professional qualification at this or any other University. The work presented in this research report was undertaken in the Division of Emergency Medicine, University of the Witwatersrand, Johannesburg.



Dr Callistus Okwuchukwu Achuri ENYUMA

Date: 25/03/ 2019

Johannesburg

DEDICATION

To God almighty

And

All Nigerian children that died from preventable conditions in the paediatric emergency department

As well as

In memory of the departed, my brother, Kingsley Emeka Enyuma and father, Prince Michael Ogar Enyuma

ACKNOWLEDGEMENTS

I humbly express all glory and praises solely to my God, the almighty who granted me the ability to complete this project and made this day a reality.

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I specially thank and appreciate my wife, Mrs Sophia Ijeoma Enyuma (nee Nwabueze) for calmly surmounting all the challenges back home which my absence posed and her prayers for my safety and success. I will not forget to appreciate my four lovely children; Desiré, Dereck, De-Vere and De-Andre Carl-Enyuma for their support, encouragement, understanding and patience with my absence throughout the study period.

Special greetings and prayers I offer to my mother, Mrs Pauline Uche Enyuma (nee Okoye) for her prayers, blessings and creating the enabling environment for me to reach this height today. It is a sad experience and painful that my Brother, late Mr Kingsley Emeka Enyuma and my father, late Prince Michael Ogar Enyuma, who stood by me through medical school did not live to witness this achievement.

Finally, I wish to thank Dr Cyril Agbor, his wife Grace and Dr Sunday J Aigbodion, for making my stay in Johannesburg “a home away from home”.

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ABSTRACT

Introduction: Paediatric emergency care is poorly developed in low and middle-income countries. Established Paediatric Emergency Department (PED) facilities face significant challenges. The magnitude of challenges facing the PED in Nigeria has not been well described. This study aimed to assess paediatric emergency care preparedness across PEDs in Nigeria.

Methods: This cross-sectional questionnaire-based study of PEDs in Nigeria recruited facilities across various regions of the country. A self-administered questionnaire and a check list were used to obtain information on the availability of skilled personnel, medications and equipment. Preparedness performance was assessed using a point score scale. Results were described, compared and correlated.

Results: Of the 34 studied PEDs, 52.9% (n=18) were located in the North region of Nigeria. The mean (SD) number of patient visits and admission to short-stay wards within the last 30-days prior to data collection was 253.2 (±261.2) and 116.4 (±68.3) patients respectively. Most (70.6%) PEDs ran 2 shift duties per day. Most of the resident doctors (70.4 %) and nurses (85.3%) did not have Basic Life Support certification. The mean managerial, medication, equipment and total performance scores of all 34 PEDs was 42.9%, 50.7%, 43.9% and 46.9% respectively. There was a significant difference in medication availability (p-value = 0.008) and performance scores (p-value = 0.035) across the geopolitical zones of the country.

Conclusions: This study reports a global remediable deficiency of emergency care preparedness among PEDs in tertiary care centres in Nigeria. This study highlights the need for training of PED staff in basic and advanced life support and improvement in medication and equipment procurement across Nigeria.

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LIST OF ABBREVIATIONS

AAP	American Academy of Paediatrics
ABEM	American Board of Emergency Medicine
ABMS	American Board of Medical Specialties
ABP	American Board of Paediatrics
ACEP	American College of Emergency Physicians
ACNO	Assistant Chief nursing officer
AED	Automated External Defibrillator
AIDS	Acquired Immune Deficiency Syndrome
ATLS	Advanced Trauma Life Support
BLS	Basic Life Support
CEM	College of Emergency Medicine
CFR	Certified First Responder
CNO	Chief nursing officer
ED	Emergency Department
EM	Emergency Medicine
EMSSA	Emergency Medicine Society of South Africa
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
ENT	Ear Nose Throat
ETAT	Emergency Triage Assessment and Treatment
EUSEM	European Society of Emergency Medicine
HIV	Human Immunodeficiency Virus
IEMF	International Emergency Medicine Fellowship
IFEM	International Federation of Emergency Medicine

IPEM	International Paediatric Emergency Medicine
JR	Junior registrar
LMIC	Low and middle-income countries
LOS	Length of stay
MED	Manual External Defibrillator
MO	Medical officer
NHA	National Health Act
NHIS	National Health Insurance Scheme
NO	Nursing officer
OPP	Out of Pocket Payment
PALS	Paediatric Advanced Life Support
PED	Paediatric Emergency Department
PEM	Paediatric Emergency Medicine
PI	Performance Improvement
QI	Quality Improvement
SATS	South African Triage Score
SR	Senior registrar
TTP	Time to physician
UNICEF	United Nations Children Education Fund
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION

1.1 Chapter overview

This chapter describes Nigeria's burden of child morbidity and mortality and the evolution and advancement in paediatric Emergency Medicine (EM) in the Country. The chapter describes the study significance coupled with its relevance to the policy makers in Nigeria. The chapter concludes by stating the objectives of the study.

1.2 Background

Nigeria has a population of about 182 202 000, of which 50.4% are children younger than 18-years (1). Despite constituting only 1% of the global population, Nigeria contributes nearly 10% of the world's disease burden among children. Childhood diseases account for the majority of preventable infectious diseases in Nigeria (2). Nigeria had one of the highest global child mortality rates of 104.3 deaths per 1 000 live births in 2016 (3). Late presentation to the ED, delayed interventions, financial constraints, unavailability of life-saving equipment and inadequate support services all contribute to high mortality rates (4–7).

Emergency Departments in most low and middle-income countries (LMIC) provide services for both children and adults (8). A systematic review of studies conducted in 59 LMICs, showed that about one-tenth of deaths in Nigeria occurred in the emergency department (ED). Over 50% of mortalities in paediatric emergency departments (PED) occurred within the first 24 hours after admission (7,9,10). The study further showed that only 17.6% (n=18/102) of EDs in LMICs s employed an emergency medicine specialist (8). Overall unit performance and outcomes are improved at PED that are managed by emergency medicine specialists (4,11). Most PED deaths in LMICs can be prevented with appropriate triaging, prioritizing and timely intervention by trained personnel (4).

Paediatric Emergency Medicine (PEM) is a medical subspecialty targeted at improving the pre-hospital and in-hospital management of children presenting to the PED with potentially life-threatening illnesses or injuries (8). PEM, though a well-recognized subspecialty in high-income countries, is still largely an under-developed specialty in LMICs. This is due to a number of factors such as the scarcity of specialists, poor infrastructure, financial constraints and poorly developed health policies (4,8,9,12).

On account of its peculiarities, PEDs are gradually being separated from adult EDs at most tertiary centres (4,11). Ideally, a PED facility should provide "around the clock" life-saving care to children and must be adequately staffed (4,11). To further improve the quality of care offered to children in the PED, validated international guidelines have been developed and reviewed periodically (11,13,14). For PEDs in resource-poor settings such as Nigeria to function optimally, priority should be placed on developing minimum guidelines for paediatric emergency medical care.

In Nigeria, the Federal Ministry of Health (FMOH) directly administers most of the tertiary healthcare facilities (15). Currently, all dedicated PEDs in Nigeria are located within these tertiary healthcare facilities. Most facilities in LMICs are manned by staff without specialty training in emergency medicine, whereas, PEDs in tertiary care facilities tend to be manned by general paediatricians (8). Due largely to lean healthcare funding, most of these facilities in LMICs are deficient in equipment, medication, consumables and support services (4,8,10,16). Furthermore, organized public pre-hospital emergency care services are not readily available in Nigeria (17).

Previous research in PEDs across Nigeria has predominantly focused on the morbidity and mortality patterns of specific disease presentations.(5–7) Although a study of PED preparedness was recently conducted in the Southern region of Nigeria (10), no other study has evaluated national PED preparedness in Nigeria. Preparedness is usually measured in terms of: adequacy of personnel, medication and equipment availability. Apart from periodic accreditation visits by relevant postgraduate medical colleges, there is no documented evidence of formal evaluation of PEDs across Nigeria for emergency preparedness. Therefore, this study sets out to assess the emergency preparedness of PEDs in tertiary healthcare facilities in Nigeria.

1.3 Significance of this study

The significance of the state of readiness of PEDs in providing care for ill or injured children cannot be overemphasized, as it impacts emergency response and child safety (18). Since there are no nationwide data on PED preparedness in Nigeria, this pioneer study sets out to assess the emergency preparedness of PEDs in tertiary healthcare facilities in Nigeria using a checklist that was adapted from various international guidelines (11,13,14). It is hoped that this baseline study will stimulate further research with the aim of developing national guidelines for improving paediatric patient outcomes.

1.4 Study aim

To conduct an audit of clinical staff, medication and equipment in the various tertiary level PED facilities across Nigeria.

1.5 Study objectives

The objectives of the study were:

1. To determine the qualifications and credentials of the clinical staff working across PEDs in Nigeria.
2. To describe the availability of medication and equipment at PEDs in Nigeria.
3. To determine managerial, medication, equipment and total performance scores across PEDs in Nigeria.
4. To compare and correlate the above-mentioned PED performance scores between various regions in Nigeria.

CHAPTER 2: LITERATURE REVIEW

2.1 Chapter overview

This chapter describes the literature search methods, the evolution and relevance of paediatric emergency medicine globally and its state of development in Nigeria. In addition, the required skill, manpower, training, guidelines to safe practice, recommended medications, equipment and challenges facing the emergency physician are also reviewed.

2.2 Literature search strategy

Information for this study was obtained from local and international literature, policy documents and guidelines. The scientific literature was explored for studies that focused on PED preparedness, especially in the developing world. Search engines such as PubMed, Scopus, Google and Google Scholar were searched using the following search terms: "emergency medicine AND paediatrics", "paediatric emergency medicine AND preparedness", "emergency care AND paediatrics AND resource poor countries", "paediatric emergency care AND practice guidelines".

2.3 The speciality of Emergency Medicine

The International Federation of Emergency Medicine (IFEM) defines emergency medicine as "a field of practice based on the knowledge and skills required for the prevention, diagnosis and management of acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of episodic, undifferentiated physical and behavioural disorders"(19). The field of emergency medicine was pioneered by James Mills in the US and dates back to the 1960's. A residency programme in emergency medicine was commenced by the University of Cincinnati in 1970. The specialty began to gain recognition in other developed countries much later (20).

The practice of emergency medicine is broad and spans through administration, academics and various subspecialties including sports medicine, critical care, paediatric emergency medicine, wilderness medicine, pre-hospital emergency medical services (EMS), disaster medicine, mass gathering medicine and aero-flight medicine (21). The field and practice of Emergency Medicine is dynamic and organised in developed countries but less structured in most LMICs (8).

2.4 The subspecialty of Paediatric Emergency Medicine

Paediatric emergency medicine (PEM), as a subspecialty, has been practiced in the US since 1976 by both paediatricians and emergency medicine physicians. The scope of PEM is broad and includes resuscitation, trauma, medical and surgical emergencies, toxicology, ethics and the care of physically and sexually abused children (11,22). In 1989, a 5-year combined residency programme in emergency medicine and PEM was approved by the American Board of Emergency Medicine and Paediatrics (23).

The field of PEM extended to Canada and Australasia and more recently to Europe (20,24), where the European Society of Emergency Medicine – Paediatric Emergency Medicine (EUSEM PEM) Section was established in 2006 (25). Paediatric Emergency Medicine has recently (March 2018) been gazetted as a subspecialty in South Africa (26). Paediatric Emergency Care South Africa (PECSA) has recently been formed as a special interest group under the Emergency Medicine Society of South Africa (EMSSA) (27). Although other regions such as South America, Spain, Sweden and Ireland do have the availability of PEM specialists, PEM may not have been formally recognized as a subspecialty (11).

PEM is not yet recognized as a subspecialty in most developing countries thus contributing to inequalities in accessing quality medical care globally (28). Children in resource-rich countries generally have access to high quality care while children in resource poor countries have poor access to basic emergency care (28). Interestingly, in some regions with developed healthcare systems, EDs are still managed by non-specialist doctors. In less developed health care systems, there is little or no delineated paediatric emergency care as children are still being managed in general EDs alongside adults (28–31). There is no database listing of paediatric emergency departments worldwide. Nonetheless, a growing commitment to PEM can be seen with emerging facilities dedicated to paediatric emergency care (28).

2.5 Guidelines for effective service delivery in the PED

Various international guidelines have been developed to ensure safe and quality care to children attending the PED (11,13). Joint policy guidelines for care of children in the emergency department by the American Academy of Paediatrics (AAP) in conjunction with the American College of Emergency Physicians and Emergency Nurses Association were developed in 2009 (32). This joint policy outlines the essential resources that are necessary for the smooth running of a PED. More recently, IFEM has published a consensus document that was aimed at assisting healthcare facilities around the world in defining minimum standards of care for children presenting to the emergency department (11). Although EUSEM recognises PEM and the peculiarities in practice, it does not have a separate guideline for PEM but rather aligns with the existing guidelines mentioned above. In Africa, EMSSA have developed guidelines for the EDs, however, the guideline did not focus on the requirements of a PED (14). Although the aforementioned guidelines were largely developed based on experience and evidence from resource rich countries, they can be adapted for resource poor countries like Nigeria by modifying these to suit the prevailing national

situation (28). Although most of the above guidelines have been available for over a decade, studies still report the global unpreparedness of PEDs (10,33).

2.6 Preparedness of PEDs to manage paediatric cases

Predictors of preparedness include awareness of current guidelines, type of PED (academic versus non-academic centre), availability of a dedicated PEM specialist, availability of a head of department and nursing manager, patient volumes and availability of infrastructure (33).

A cornerstone to successful service delivery in the PED is the availability of a skilled physician and nursing coordinator with an appropriate complement of support staff (32,34,35). The mere existence of global strategies and national PED guidelines in the absence of key personnel may not necessarily translate to safe and quality service delivery. Therefore, periodic competency evaluations of all PED clinical staff are of essence. Key concerns around preparedness of a PED to adequately manage paediatric cases include: volumes of cases presenting to the ED, length of stay in the ED, number of admissions, physician workload and staffing (36).

2.7 Volume of paediatric patient visits to emergency departments

Emergency departments offer emergency care "around the clock" and in most cases provide urgent and unscheduled care without discrimination on the bases of morbidity, social or economic circumstances of the patient (37). Data from the United States (US) showed that patient visits to PEDs vary across regions and categories of hospitals, with about 17% and 50% of hospitals respectively attending to 10,000 and 4,000 patients annually (38). Furthermore, paediatric patient visits to the PED account for about 20% of all visits to the ED (39). In the US, 17% of all children had at least one contact with an ED for emergency care

(40), while in the United Kingdom (UK) there are about 3.5 million emergency care visits (about 25-30% of all emergency department visits) by children annually (41).

In contrast to the volume of paediatric emergency visits in high-income countries, EDs and PEDs in LMICs appear to have lower volumes. A systematic review of EDs in LMICs showed a total median annual patient volume of 3 129 in PEDs in Sub-Saharan Africa compared to monthly 3 678 children in Taiwan (42) and 6 120 in Saudi Arabia (43). Obermeyer et al. reported a total median annual patient volume of 30 021 from 173 of the studied ED facilities (8), while Eroglu et al. in Turkey documented a median volume of 273 182 patients (44).

Monitoring the volume of visits to PEDs can assist in planning and prioritising PED financing. A high volume of visits to PEDs may result in overcrowding if there are insufficient resources. Furthermore, overcrowding may occur on account of a high number of non-urgent presentations (45). Unnecessary PED visits contributes to overcrowding, work overload, increase healthcare cost, prolonged hospital stay and patients/caregivers dissatisfaction (46,47). Habib et al reported that patients presenting with minor conditions (e.g. nebulisation, parenteral medications) overburden the admitting resident doctor thereby prolonging stay of sicker patients in the PED (48).

2.8 Patterns of admissions and length of stay in emergency departments

Emergency departments are usually organised to emergently assess ill or injured patients and provide lifesaving interventions. Although there may be regional variations, globally about 10-50% of patients presenting to an ED are admitted either to the short-stay ward of the ED, the general ward or a specialized unit for continuing care (8,48). Obermeyer et al.(8) in a LMIC study reported a median admission to the PED of 20% (IQR 10% – 43%) from 78

centres while a one year retrospective study by Habib et al. in Pakistan reported an admission rate of 39.27% (2 555/6 505) (48).

Variations in ED admission rates are largely related to the individual hospital infrastructure and standards of care. The attributes of the managing physicians in the ED and patient assessment can influence ED admission rates. Since most children are admitted through the ED, there is a need to standardize emergency care by encouraging the use of protocols and the judicious utilization of hospital scarce resources with the aim to reducing health care costs (49).

The length of stay (LOS) in the ED is calculated from the time of arrival of the patient to the ED to the time of disposal from the department. The maximum LOS set by different hospitals varies from region to region and between practices based on the prevailing circumstances. Obermeyer reported an average LOS of 7.7 hours (IQR 3.3 – 40.8) while most developed countries benchmark 4 - 8 hours as a maximum for LOS in the ED (50–52). The mean LOS in the ED in the US was 3.7 hours (50) while the mean LOS in a Taiwan study ranged between 0.5 - 2 hours (53). In a study by Chung-Chi et al. (44) among psychiatric emergency admission, 33.5% stayed longer than 24 hours on admission which is prolonged compared to the benchmark in developed countries. Prolonged LOS in patients could be caused by the acuity of patient presentations, PED admission and discharge processes and may be influenced by events in other parts of the hospital.

2.9 Physician workload in the emergency department

As EDs are usually considered to be high turnover units with an unexpected mix of patients requiring life-saving intervention, it is pertinent that quality care is rendered timeously. This may be compromised by high patient volumes causing work overload, tiredness from long

hours of shift duty and physician burnout (54). The number of hours clinical staff in the ED are scheduled to work vary between settings. Daily duty shifts may either be 12 hour day and night shifts, 8 hour day and 16 hour night shift, 3 daily shifts of 8 hours each or 24 hour shifts (both day and night on their call days) (57). There is conflicting evidence about the optimal type of daily shift. A study by Burgess et al. found the rotational 8-hourly 3 daily shifts with off duty days for recovery from fatigue to be the optimal shift type (56). In contrast, Parshuram et al. and co-workers in an ICU study in Toronto reported that the likelihood of adverse events per 1000 patient hours were 81.3, 78.2 and 76.3 for 24 hours, 12 hourly and 16 hour shift type (54). The study concluded that there were no statistical differences for negative patient outcomes based on the type of daily shift duty as practiced in the hospital. Another study reported disruption of circadian rhythm of staff on night shifts as responsible for most physician related negative events (54,55). Parshuram et al. found staff overnight alertness to be better among staff on 12 hourly rotational shift than the other schedule types (54). Using the Maslach Burnout Inventory scores (57), 56% (23/41) of resident doctors in the study by Parshuram et al. reported burnout in the emotional exhaustion domain, 59% (24/41) reported burnout in the depersonalization domain and 39% (16/41) reported burnout in the personal accomplishment domain. There were no statistically significant differences between shift types ($p > 0.05$) (54). A consensus document recommended 8 hourly shifts (with periods of rest) to ensure optimal clinician function and also long enough to provide the clinical staff with adequate clinical training exposure (58).

2.10 Quality of clinical staff in the PED

Globally, the practice of PEM is still in its infancy. In fact, PEM seldom forms part of most medical school curricula (19). In the US (28), Canada, UK, and Australia (24) there has been an increase in the number of accredited 2 – 3 year post residency PEM subspecialty training programmes (28). Moreover, in 2017, the European Society for Emergency Medicine revised

the syllabus for subspecialty training in PEM with the aim to harmonize PEM in the European countries, set knowledge and skills standards and promote a competent system of tertiary level paediatric emergency care (22).

Training programmes in emergency nursing exist in many countries. The length of training for most emergency nursing certifications is between 1-2 years post nursing qualifications. Thus, the UK royal college of nursing and the American College of Emergency Physicians recommend a 2-year training programme prior to certification. Nurses may also subspecialize into areas of interest like Paediatric emergency medicine (59,60).

Studies have shown improved patient outcomes and enhanced clinical staff confidence among doctors and nurses with the appropriate additional PED skills and certification (42,61). The World Health Organization, the United Nations Children's Fund, the World Bank and other development organizations have been collaborating with local agencies to upscale paediatric emergency care and services in the LMICs (16,62–64).

A critical skill in training is that of triage and life support. Triaging of the ill patient is a necessary tool that ED staff should be competent in as it not only identifies the child that requires urgent treatment, but it also helps improve patient flow and reduce overcrowding in the ED. The impact of this cannot be overemphasized. Studies have also shown improved indicators in the ED with triage training and implementation (9).

It is highly recommended for clinical staff in the PED to have competence in basic and advanced life support skills. Studies have shown better outcomes among clinical ED staff that had additional training in advanced life support and triaging (9,68). It is also recommended that clinical skills of staff to be regularly re-evaluated and updated (66,67).

Furthermore, attendances at professional conferences and continuous professional development (CPD) courses by ED staff can assist them to acquire contemporary skills, foster collaboration among colleagues and institutions (68). In a UK survey, 81% of respondents agreed that the knowledge and skills gained from conferences had resulted in better patient outcomes as well as improved their professional practice (69). However, institutional support may be necessary in LMICs for clinical staff to be able to attend conferences and CPD courses.

2.11 Clinical managers in the PED

The paediatric emergency department is expected to deliver effective and efficient management to a patient. The presence of a specialist (especially those with additional training in emergency medicine) in the ED can impact positively on patient outcomes. A study by Huang et al., which compared full-time and part-time specialists in the PED, reported that the presence of a specialist head in the PED was associated with a decrease in overall mortality rates (from 0.13% to 0.07%) and LOS (from 11.5 hours to 3.2 hours) in the PED (42). This article opined that rather than an extra ED rotating shift, the implementation of a full-time paediatric emergency specialist in the ED is a superior quality improvement measure. Furthermore, Melo et al. showed a decrease in the excessive use of diagnostic tests from 24.2% to 14.3% and shorter throughput time (LOS) among patients in EDs with a specialist head (61). A Canadian study further showed that the presence of a paediatric specialist in the ED had a positive impact on the availability of equipment for treating children (70).

The IFEM (11) and AAP (13) guidelines recommend that a PED should have a skilled specialist head and a nursing manager who will be responsible for supervision, training and

quality assurance of emergency care delivery. Similarly, the Royal College of Paediatrics and Child Health (RCPCH) standard of care for children in the UK requires that PEDs should have a specialist head of department (HOD) and Nursing manager (NM). RCPCH further stated that PEDs with more than 16 000 annual paediatric emergency cases should employ a paediatric specialist with additional training in paediatric emergency medicine as HOD (47,48). A systematic study of 192 EDs in LMICs reported that 66% (n=66/102) of facilities with available data are managed by none consultants (8). This was supported by Molyneux (4) in a similar setting. Likewise, a study in the southern region of Nigeria where 44.4% (n=4/9) of the included PEDs were managed by paediatric specialists (10). The current practice may impact on the outcome of patients admitted to EDs or PEDs in LMICs (8,10). In a Taiwanese study, the presence of a specialist head in the PED was associated with a decrease in overall mortality and LOS in the PED (42).

2.12 Medication requirements in the PED

Since the spectrum of emergency medicine is so broad and patients may present with diverse and undifferentiated pathologies that may be life-threatening, PEDs must be stocked with critical and paediatric-specific medications to provide safe emergency care to children. Essential medicine lists (EMLs) have been formulated by different organisations based on their applicability in public health, their efficacy, cost-benefit, and safety (71). Most available inventories are usually for general emergency practice while only a handful focus on paediatric emergency care (11,13). Most of these guidelines were developed in high-income countries which may not be applicable to LMICs.

Depending on the setting and guided by common population specific presentations, essential drug lists may be further streamlined to suit specific requirements (32). A study conducted in an ED in India showed that 84.5% of prescribed drugs were in the national list of essential

medicines of India while only 57.6% were in the World Health Organization list of essential medicines (72). Another study conducted by Brocolli et al. on essential medicines for emergency care in Africa showed that 25 of the essential drugs in Africa were not considered essential in the 2017 WHO Emergency Medicine list (71).

In a South African study in the emergency departments of primary health centres, all studied facilities had more than 80% of the items of medications and fluids as recommended by the EMSSA guidelines (73). In a study survey by Razzak et al. in Pakistan, 59% of healthcare providers attributed poor emergency outcomes to be largely due to a lack of life-saving drug s(31). Most PEDs in LMICs have poor access to essential medicines, hence most patients have to pay out of their pocket for emergency services, thereby restricting delivery of emergency care (74). There therefore exists a dire need for each country to develop a system of ensuring availability of essential medications (71,74).

For emergency medication in PEDs to be useful at the point of need, regular updating of emergency drug lists, routine checks for expiration dates and clear guidelines for restocking should be established. Both nursing, as well as medical staff should be well acquainted with the location and organisation of available emergency drugs in the PED. In addition, there must be clear protocols with regards to control and access to these drugs when required (11,33,35).

2.13 Equipment requirements in the PED

It is expected that size appropriate basic life-saving equipment as recommended by existing guidelines be readily available in all PEDs. For ease of access during emergencies, equipment should be well organized and appropriately classified (11,32). Prompt access to appropriate recommended emergency equipment is associated with a greater likelihood of a successful

resuscitation of a patient presenting to the ED. Availability of equipment in EDs in the US ranged between 85% to 91% (34, 76), whereas in Canada availability was poor and ranged between 5.4% to 37.8% (62).

Studies from LMIC have shown that emergency care in these countries is below international best practices as constant deficiencies in equipment and supplies remains a challenge (4,31). In a South African study, all the studied PHC EDs had more than 62% of the equipment recommended by EMSSA for safe healthcare provision (73). Khan et al. in a single tertiary centre study in Yugoslavia reported a deficiency in availability of recommended equipment in their emergency centres (75). This study was conducted through interviews and direct inspection. Available equipment was often non-functional.

In a study survey by Razzak et al. in Pakistan, 59% of the community respondents believed that fully equipped hospitals would improve emergency care rendered by Pakistan EDs, while 94% of healthcare providers believed that lack of appropriate equipment was responsible for their poor emergency care capacity (31). Ensuring that ED staff are well aware of the location of equipment, have hands-on training on equipment use, equipment lists are regularly updated and regular maintenance of equipment takes place are essential for the safe functioning of the PED (32).

2.14 Measurement of PED preparedness performance

In an emergency situation, most sick children are taken to the nearest hospitals by their parents. Little consideration is given to the capacity of that hospital to offer emergency care to their child. For this reason, professional bodies have advocated for a universal application of a minimum benchmark of supplies and resources needed to manage children presenting to the ED. The AAP guidelines (Care of Children in the Emergency Department: Guidelines for

Preparedness) (32), the guidelines on the standard of care of children by IFEM (11) and in Africa the EMSSA guidelines (though not specific for PED) (14) stipulate the prerequisites for treating children in emergencies.

There are no protocols for assessing PED preparedness performance. A point scoring of items (recommended emergency medications, equipment and personnel availability) was used by McGillivray et.al. in Canada (70) and Adamson in South Africa (73), while Edelu et al in Nigeria (10) used a questionnaire to collect the availability of selected items from the AAP guideline in the PED. The point score in Canada showed equipment availability ranging from 2.5% – 59.4%, the South African study had an overall availability score of 62% for equipment items and 80% for emergency drugs while the Nigerian study described which of the listed item was available in each studied PED and reported a fair state of personnel and basic equipment, while none had available cardiopulmonary monitors.

Furthermore, the Weighted Paediatric Readiness Score (WPRS) was used by Remick (76) and Gausche-Hill et al. in the US. The performance score used the APP guidelines and incorporated administration and coordination of care in the ED by physicians, nurses, and other health care providers, quality improvement, patient safety, policies, procedures and protocols, equipment and medication. The WPRS went further to assess the impact of the physician/nurse on readiness. The results from both studies showed an improved performance and advocated for more effort (77).

These studies have been a wake-up call to the profession. Also knowing which factors are related to the availability of these items may help hospital administrators and federal policymakers understand how the level of preparedness varies across the nation.

PEM, just like any other speciality faces numerous challenges. These challenges include, but are not limited to overcrowding, prolonged patient waiting times, poor patient-friendly facilities, lack of child-specific equipment/supplies, inadequately trained staff, lack of paediatric specific policies/guidelines and resource constraints (78,79).

2.15 Conclusion

Paediatric Emergency Medicine is a developing subspecialty that faces many challenges. In developing countries, the lack of acute care resources is a major limitation to the practice of evidence-based PEM.

CHAPTER 3: MATERIALS AND METHODS

3.1 Chapter overview

This chapter describes the study design, study sites, study population, sample size, inclusion criteria, data collection, data management, data analyses, ethical considerations, limitations and funding of the research.

3.2 Study design

This is a prospective, questionnaire-based cross-sectional study. The questionnaire was adapted from the 2009 AAP and IFEM checklists (11,13,14,32). The data collection and assessment tool was discussed and agreed upon amongst the primary investigator, study supervisors and the divisional protocol assessment committee. A decision was taken to assess PED preparedness using these standardized validated tools as opposed to adaptation of the tool to the study site requirements. It was generally agreed to focus the preparedness performance on only 3 (managerial, medication and equipment) out of the 7 described domains. Components of the questionnaire (Appendix A) included: the number of patients triaged into the PED in the last 30 days prior to administration of the questionnaire (01 June 2017) and categorized (<100, 100-500, >500), the number of patients admitted to the PED short-stay ward, the number of shift duties in the PED, the availability of various grades of doctors and nurses, qualifications of the HOD, nursing manager, doctors and nurses and the availability of recommended medications and equipment.

A point scale score assessment tool was generated. One point was awarded for each available item under the following sections; PED management (total=7 points), medication (total=81) and equipment (total=98 points) with an overall total score of 186 points. For the PED

managerial domain, a point was awarded for each positive response to; 1) presence of a dedicated HOD, 2) a HOD with at least one advanced life support course, 3) a HOD with any additional emergency medicine related qualifications, 4) a HOD who had attended any paediatric conference or continuous professional development activity, 5) a nursing manager with any advanced life support course, 6) a nursing manager with any additional emergency medicine related qualifications and 7) a nursing manager who had attended any paediatric conference or continuous professional development activity. The final score was reported as a percentage of the maximum achievable score.

3.3 Study sites

The study was conducted at 34 PEDs, each located in a different state of Nigeria (Figure 1). The Federal Republic of Nigeria is a LMIC with diverse cultures, languages and landscape. Nigeria has tropical rainforests in the south and dry savannah lands and desert in the north. The country has a landmass of 923 768 km² and a population of over 182 million inhabitants. It is divided into two regions (North and South) which are further subdivided into six geopolitical zones, and each zone is further subdivided into states as follows: South-East (5 States), South-South (6 States), South-West (6 states), North-East (6 States), North-Central (6 States and the FCT) and North-West (7 States). Hence comprising 36 states plus the Federal Capital Territory (Figure 1) (2).

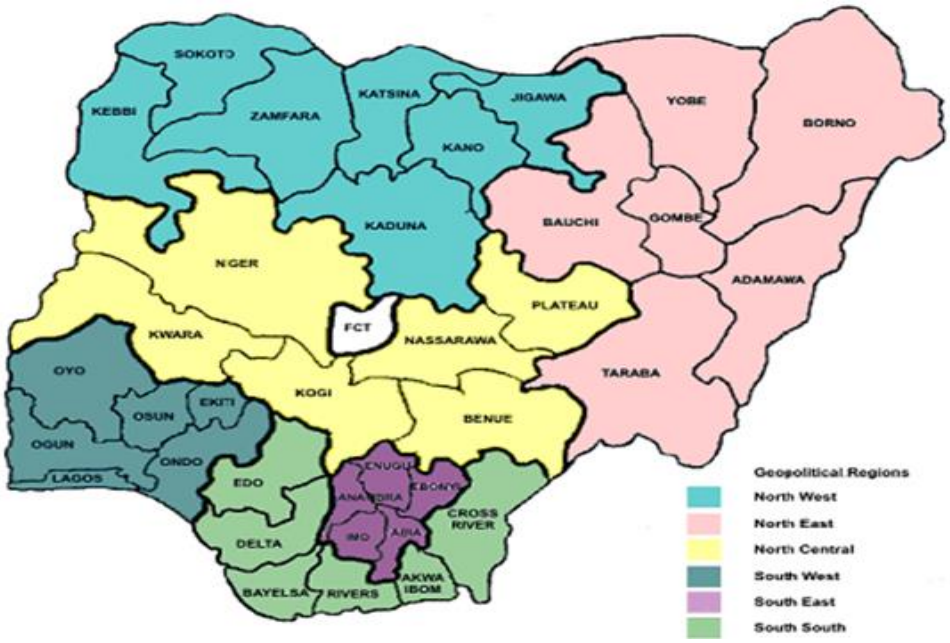
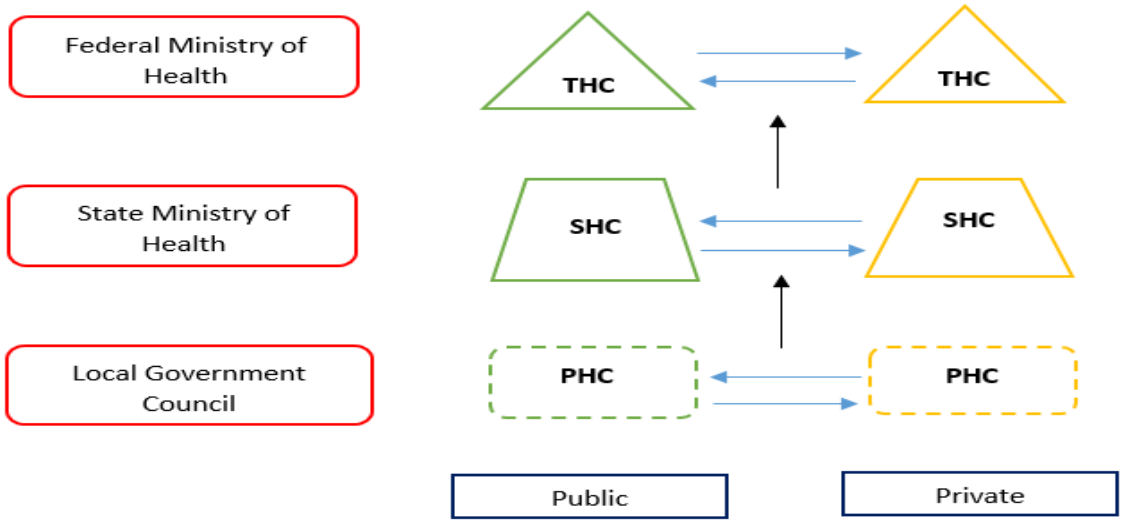


Figure 1: Map of Nigeria showing the 6 geopolitical zones, 36 states and the federal capital territory (Image reproduced with courtesy from: http://aboutnigerians.com/list-and-map-of-geopolitical-zones-with-their-states-in-nigeria/)

The provision of healthcare in Nigeria is a tripartite function of the federal, state and local governments. Primary health care facilities are predominantly located in villages and communities. They are managed by 774 local government areas and are supervised by the state ministry of health. Secondary level health care is administered by the state ministry of health. Tertiary level health care facilities, including academic teaching hospitals, specialist hospitals and federal medical centres are predominantly administered by the Federal Ministry of Health and are situated in urban cities of Nigeria (2,80). Patients may be referred up from a lower to a higher level of care. All three levels of healthcare are duplicated in the private sector (Figure 2).



PHC- Primary Health care; SHC- Secondary Health care; THC- Tertiary Health care

Arrow indicate referral pathway: blue- same level referrals; black- up referral

Figure 2: Organisation of the healthcare delivery system in Nigeria

PEDs in Nigeria are based in tertiary healthcare facilities (81) and are managed by paediatricians with no subspecialty training (8,38,75,78). There are 56 tertiary healthcare PED facilities in Nigeria. Thirty-six are located within University / Specialist Hospitals and 20 in Federal Medical Centres (80).

3.4 Study population

The questionnaire was administered to the HOD as well as the nursing manager or their respective designee at each participating hospital.

3.5 Inclusion criteria

Selected tertiary level hospitals with a dedicated PED that consented to study participation.

3.6 Sample size

This convenience sample aimed to recruit 37 PEDs across Nigeria (one PED facility from each of the 36 states and one PED from the FCT). Twenty states have only one PED. All PEDs in these states were approached for study recruitment. There are more than 1 PED in the remaining 16 states as well as the FCT. A simple random sampling method was used to select one PED from each of the 16 states and the FCT. The PEDs in each of these states and the FCT were assigned a random letter written on a piece of paper. These papers were folded and placed in a hat. A PED facility was selected by an independent person. If the chosen facility declined participation, this random sampling procedure was repeated with the remainder of the facilities in the state. Overall 34 PED were included in the final study sample (see results section)

3.7 Data collection

- Data collection was commenced after the protocol was approved and ethical clearance obtained.
- Data was collected by the primary investigator using a questionnaire.
- Data collection spanned 8 months, from 01 June 2017 to 31 January 2018.
- The HOD and unit nursing manager (or their designees) were briefed on the study protocol.
- They were then given an opportunity to read the participant information sheet prior to obtaining informed consent.
- Part 1 of the self-administered questionnaires (Appendix A; part A and B) were handed over to the HOD and unit nursing manager (or designee) and retrieved upon completion.

- Part 2 of the questionnaire (Appendix A: part C and D) was completed by the primary investigator after a formal inspection in conjunction with the unit nursing manager or designee.

3.8 Data analysis

Data was entered into an excel spreadsheet (Microsoft® Excel®) for sorting and thereafter exported to STATA version 14, (College Station, TX: Stata Corp LP) statistical software. Continuous variables (e.g. the number of doctors that were employed at each PED) were described using means and standard deviations. Categorical variables (e.g. presence or absence of recommended pieces of equipment) were reported using frequencies and percentages.

The independent t-test and analysis of variance (ANOVA) were used to compare the means of normally distributed continuous variables. Where needed Bonferroni test was used when ANOVA was significant. The Mann-Whitney test and the Kruskal-Wallis test were used to compare the median (interquartile range) of non-normally distributed continuous variables. Where appropriate, the Pearson correlation coefficient was used to determine the presence of a linear relationship between various continuous variables. The level of significance was set at $\alpha<0.05$, CI=95%.

3.9 Ethics and permission

Ethical clearance was granted by the University of The Witwatersrand Human Research Ethics Committee-medical [M 170445 (Appendix C)], and the Nigerian Federal Ministry of Health NHREC [NHREC/01/01/2007-21/05/2017 (Appendix D)]. Written permission and consent was obtained from the CEO of the participating hospital, the HOD and the nursing manager of the participating PED. Hospital and staff identifying information were blocked

out and replaced with a unique PIN number on the questionnaire for each participating hospital and staff. To track data, a master list of identifiers was stored in a computer protected by a password known only to the researcher.

3.10 Funding

The research was fully funded by the Federal Government of Nigeria's tertiary education trust (TET) fund.

CHAPTER 4: RESULTS

4.1 Chapter overview

This chapter presents findings of all the PEDs that participated in the study. The number of patients seen in the 30-days preceding completion of the questionnaire, the number of clinical staff and their qualifications, the availability of medications, the availability of emergency equipment and the calculated performance scores of all the facilities are described and compared. Correlations between various domains of the performance scores were also performed.

4.2 Final study sample

4.2.1 Process of achieving the final sample

Of the target of 37 PEDs, 34 were eventually recruited as shown in the figure below.

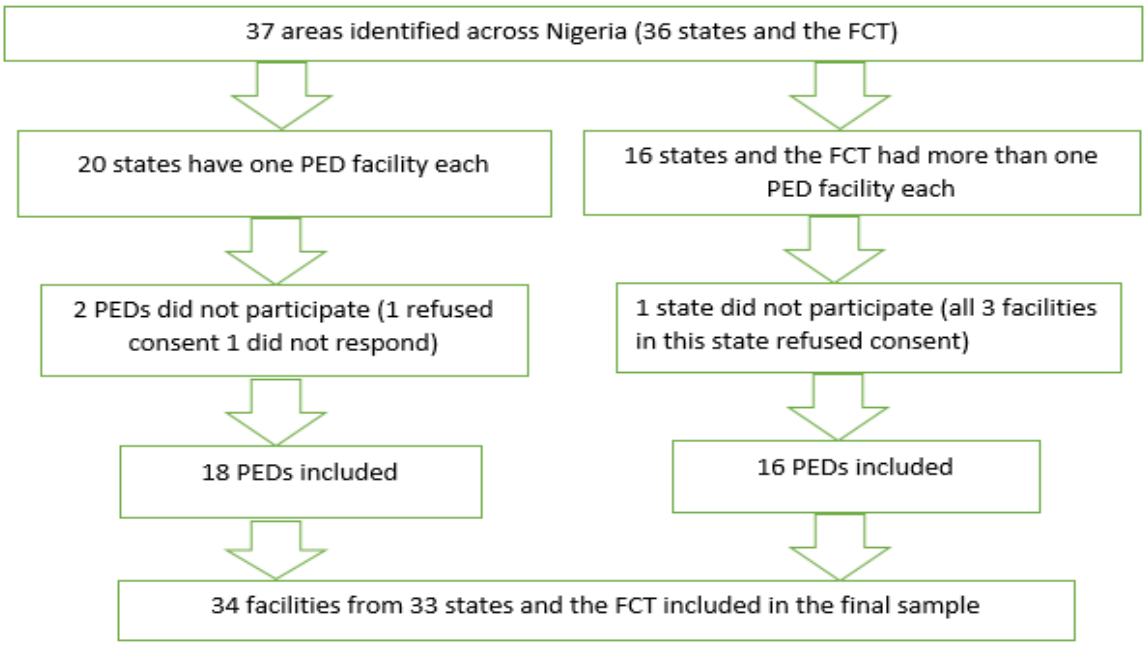


Figure 3: Flow diagram describing the process in achieving the final study sample

4.2.2 Number of PEDs enrolled from each of the six geopolitical zones of Nigeria

Figure 4 describes the number of included PEDs from each of the 6 geopolitical zones. Five to seven PEDs were included from each zone.

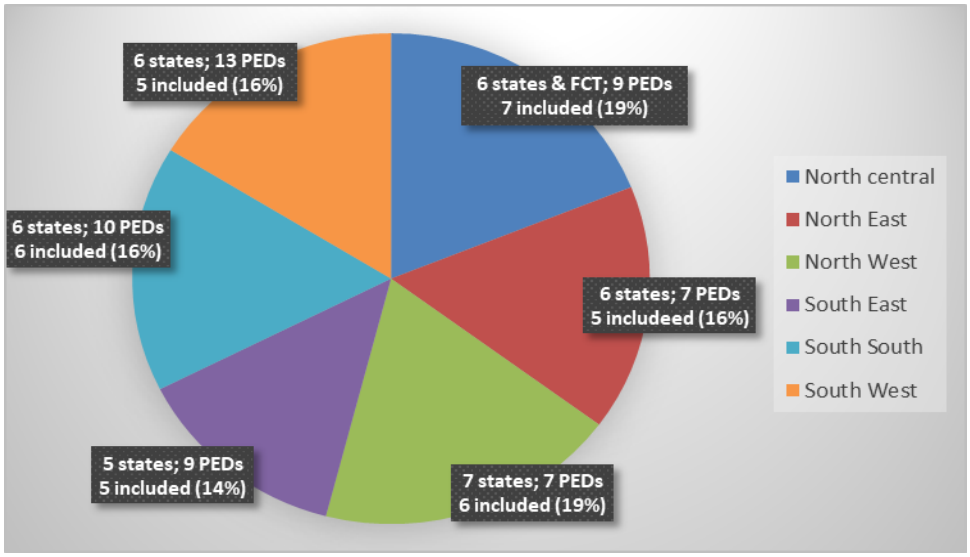


Figure 4: Number of PEDs included from each of the six geopolitical zones of Nigeria

4.3 Number of patient visits, short-stay admissions and daily duty shifts per PED

The number of patient visits to each of the PEDs over the 30-day period prior to data collection ranged from 20 – 1500 patients with a mean (SD) of 253.2 (±261.2) patients. The PEDs were sub-classified into 4 (11.8%) low paediatric volume hospitals (<100 patients/30 days), 26 (76.5%) medium paediatric volume hospitals (100-500 patients/30 days) and 4 (11.8%) high paediatric volume hospitals (>500 patients/30 days). The number of patients admitted to each of the PEDs short-stay wards ranged from 16 – 320 with a mean (SD) of 116.4 (±68.3) patients. Twenty-four (70.6%) PEDs had 2 shift duties per day while 10 (29.4%) had 3 shift duties per day. The breakdown for each facility of the above descriptors is described in table 1.

Table 1: Numbers of patient visits, short-stay admissions and daily shifts per PED

State where PED located (n=34)	Number of patients seen per PED over the 30-day period (n / %) (average of 9 visit /day)	Number of patients admitted to short-stay ward per PED over the 30-day period (n / %) (average of 4 patient/ day)	Number of daily shifts in each PED
Bayelsa	20 (0.23)	30 (0.76)	2
Benue	64 (0.74)	64 (1.62)	2
Delta	53 (0.62)	41 (1.04)	2
Imo	80 (0.93)	40 (1.01)	3
Abia	120 (1.40)	16 (0.40)	2
Adamawa	300 (3.50)	79 (2.00)	2
Akwa Ibom	110 (1.30)	106 (2.70)	3
Anambra	147 (1.71)	67 (1.70)	2
Bauchi	120 (1.40)	120 (3.03)	2
Cross River	117 (1.36)	98 (2.48)	3
Ebonyi	320 (3.72)	320 (8.10)	3
Ekiti	300 (3.50**)**	50 (1.26)	2
Enugu	108 (1.25)	50 (1.26)	3
FCT	200 (2.32)	120 (3.03)	2
Jigawa	100 (1.16)	100 (2.53)	2
Kaduna	200 (2.32)	120 (3.03)	2
Kebi	259 (3.00)	109 (2.75)	2
Kogi	150 (1.74)	45 (1.14)	2
Kwara	200 (2.32)	153 (3.90)	2
Nasarawa	175 (2.03)	123 (3.11)	2
Niger	131 (1.52)	131 (3.31)	2
Ondo	430 (5.00)	96 (2.43)	2
Osun	200 (2.32)	120 (3.03)	3
Oyo	223 (2.60)	200 (5.05)	2
Plateau	120 (1.40)	75 (1.90)	3
Rivers	138 (1.60)	101 (2.55)	2
Sokoto	200 (2.32)	150 (3.80)	2
Taraba	426 (4.95)	167 (4.22)	2
Yobe	250 (2.90)	130 (3.30)	2
Zamfara	140 (1.63)	110 (2.80)	2
Borno	500 (5.81)	200 (5.05)	3
Edo	659 (7.65)	96 (2.43)	3
Kano	1500 (17.42)	250 (6.32)	2
Lagos	550 (6.39)	280 (7.10)	3
mean (SD)	**253.2 (±261.2)**	**116.4 (±68.3)**	**2.3 (±0.46)**

4.4 Description of clinical staff employed at the included PEDs

4.4.1 Qualifications and training of HODs and nursing managers

Qualifications and training of HODs at the 34 PEDs are shown in table 2. All facilities had a medical doctor as HOD and a nursing manager at the time of study, but only 18 (52.9%) of the PEDs had a dedicated HOD. The remaining 16 (47.1%) PEDs were managed by multiple HODs on a rotational basis.

Most (n=32, 94%) of PEDs were managed by a HOD with a specialist / fellowship qualification in paediatrics. None of the HODs had a specialist / fellowship qualification in

emergency medicine or a sub-speciality fellowship / certificate in Paediatric Emergency Medicine. Of all HODs, 6.3% (n=2/32) had a master's qualification in emergency medicine. All 34 (100%) nursing managers were qualified as registered nurses, whilst 27 (79.4%) of them also had a qualification in paediatric nursing training. Only 4 (11.8%) nursing managers had a qualification in paediatric emergency nursing training, while none had any related additional qualifications.

Attendance at refresher activities and completion of various advanced life support courses are described in table 2. Of note, the majority of the HODs and nursing managers had not completed advanced life support courses.

Table 2: Qualifications and training of HODs and nursing managers across the 34 PEDs

	Number of PEDs (n / %)
Heads of department's (n=34)	
Qualifications of HODs	
MBBCh (or equivalent)	34 (100)
Fellowship in Paediatrics	32 (94.1)
Fellowship in Paediatric Emergency Medicine	0 (0)
Fellowship in Emergency Medicine	0 (0)
Additional related post graduate qualification	2 (5.9)
Refresher activities in the last year	
Paediatric conferences	13 (38.2)
Other continuing professional development activities	20 (58.8)
Current Advanced life support courses	
Neonatal Resuscitation	2 (5.1)
Basic Life Support	10 (25.6)
Advanced Paediatric Life Support / Paediatric advanced life support	16 (41.0)
Advanced Trauma Life Support	4 (10.2)
Nursing manager (n=34)	
Qualifications of nursing managers	
Registered Nurse	34 (100)
Paediatric Nursing Training	27 (79.4)
Paediatric Emergency Nursing Training	4 (11.8)
Additional related post graduate qualification	0 (0)
Refresher activities in the last year.	
Paediatric conferences	10 (29.4)
Other continuing professional development activities	14 (41.2)
Current Advanced life support courses	
Neonatal Resuscitation	7 (20.6)
Basic Life Support	15 (44.1)
Advanced Paediatric Life Support / Paediatric advanced life support	0 (0)
Advanced Trauma Life Support	0 (0)

4.4.2 Number of clinical staff employed

Tables 3 and 4 respectively describe the number of doctors and nurses employed at the 34 PEDs. There was an average (range) of 5 (1-12) consultants, 4 (0-8) senior resident doctor, 5 (0-12) junior resident doctors, 4 (0-10) medical officers and 8 (2-20) intern doctors employed at each of the PEDs. Also, there was an average of 3 (0-6) chief nursing officers, 3 (0-7) assistant chief nursing officers, 6 (0-11) nursing officers and 9 (0-30) nursing officers employed per facility.

Table 3: Number of doctors employed at the 34 PEDs

Number of doctors	Number of PEDs (n / %) that employ each of the following doctor categories				
	Consultants	**Senior registrars**	**Junior registrars**	**Medical officers**	**Intern doctors**
0-5	32 (92.1)	28 (82.4)	29 (85.3)	32 (94.1)	19 (55.9)
6-10	2 (5.9)	6 (17.7)	4 (11.8)	2 (5.9)	12 (35.3)
≥ 11	1 (2.9)	0 (0)	1 (2.9)	0 (0)	3 (8.8)

Table 4: Number of nurses employed at the 34 PEDs

Number of nurses	Number of PEDs (n / %) that employ each of the following nurse categories			
	Chief nursing officer	**Assistant chief nursing officer**	**Nursing officer 1**	**Nursing officer 2**
0-2	26 (76.5)	25 (73.5)	7 (20.6)	7 (20.6)
3-5	7 (20.6)	8 (23.5)	12 (35.3)	10 (29.4)
≥6	1 (2.9)	1 (2.9)	15 ()44.1	17 (50)

4.4.3 Life support training amongst clinical staff

Amongst doctors, none of the consultants at 18 (52.9%) and 30 (88.2%) PEDs were trained in Advanced Paediatric Life Support / Paediatric Advanced Life Support (APLS/PALS) or Advanced Trauma Life Support (ATLS) respectively. With regards to senior registrars and junior registrars, more than 50% of facilities did not have Neonatal Resuscitation (NNR) or Basic Life Support (BLS) trained personnel, whereas >90% of facilities did not have APLS/PALS or ATLS trained personnel. Also, >90% of facilities did not have medical officers that were trained in NNR and >90% of facilities did not have interns that were trained in NNR or BLS. None of the medical officers or interns at any of the facilities was trained in APLS/PALS or ATLS.

Amongst nurses, none of the facilities had any nurse trained in ATLS, only 3 facilities had one or more nurses trained in APLS/PALS, more than 85% of the facilities did not have a nurse trained in BLS and more than two-thirds of facilities did not have nurses trained in NNR. Details of the above findings are described in tables 5 & 6.

Table 5: Life support courses amongst doctors at the 34 PEDs

Life support course	Number of PEDs (n / %) with quantity of doctors as per doctor level that had completed each life support course														
	Consultant			Senior registrar			Junior registrar			Medical officer			Intern		
	0	1-5	>5	0	1-5	>5	0	1-5	>5	0	1-5	>5	0	1-5	>5
NNR	5 (14.7)	27 (79.4)	2 (5.9)	18 (52.9)	13 (38.2)	3 (8.8)	20 (58.8)	2 (5.9)	12 (35.3)	32 (94.1)	2 (5.9)	0 (0)	32 (94.1)	0 (0)	2 (5.9)
BLS	9 (26.5)	23 (67.7)	2 (5.9)	27 (70.4)	5 (14.7)	2 (5.9)	28 (82.4)	1 (2.9)	5 (14.7)	34 (100)	0 (0)	0 (0)	31 (91.2)	0 (0)	3 (8.8)
APLS/PALS	18 (52.9)	14 (41.2)	2 (5.9)	31 (91.2)	3 (8.8)	0 (0)	32 (94.1)	0 (0)	2 (5.9)	34 (100)	0 (0)	0 (0)	34 (100)	0 (0)	0 (0)
ATLS	30 (88.2)	4 (11.8)	0 (0)	33 (97.1)	1 (2.9)	0 (0)	33 (97.1)	0 (0)	1 (2.9)	34 (100)	0 (0)	0 (0)	34 (100)	0 (0)	0 (0)

Table 6: Life support courses amongst nurses at the 34 PEDs

Life support course	Number of PEDs (n / %) with quantity of nurses as per nurse level that had completed each life support course											
	Chief nursing officer			Assistant chief nursing officer			Nursing officer 1			Nursing officer 2		
	0	1-2	>2	0	1-2	>2	0	1-2	>2	0	1-2	>2
NNR	23 (67.7)	10 (29.4)	1 (2.9)	24 (70.6)	8 (23.5)	2 (5.9)	26 (76.5)	2 (5.9)	6 (17.6)	29 (85.3)	2 (5.9)	3 (8.8)
BLS	29 (85.3)	5 (14.7)	0 (0)	31 (91.2)	2 (5.9)	1 (2.9)	31 (91.2)	2 (5.9)	1 (2.9)	30 (88.2)	1 (2.9)	3 (8.8)
APLS/PALS	34 (100)	0 (0)	0 (0)	34 (100)	0 (0)	0 (0)	32 (94.1)	1 (2.9)	1 (2.9)	33 (97.1)	0 (0)	1 (2.9)
ATLS	34 (100)	0 (0)	0 (0)	34 (100)	0 (0)	0 (0)	34 (100)	0 (0)	0 (0)	34 (100)	0 (0)	0 (0)

4.4.4 Number of clinical staff per duty shift.

Tables 7 & 8 describe the number of doctors and nurses per duty shift at the 34 PEDs respectively. Most of the PEDs had only one intern (n=15, 44.1%), one medical officer (n=11, 32.3%), one junior registrar (n=18, 52.9%), one senior registrar (n=22, 64.7%) and one consultant (n=32, 94.1%) per duty shift. Only 9 (26.5%) PEDs had senior registrars who sleep-in while on call.

On the other hand, most of the PEDs had only two nursing officers 2 (n=18, 52.9%), one nursing officer 1 (n=18, 52.9%), one assistant chief nursing officer (n=23, 67.7%) and one chief nursing officer (n=19, 55.9%) per duty shift.

Table 7: Number of doctors per duty shift at the 34 PEDs

Number of doctors	Number of PEDs (n / %)				
	Consultant	**Senior registrar**	**Junior registrar**	**Medical officer**	**Intern**
0	1 (2.9)	7 (20.6)	7 (20.6)	20 (58.8)	13 (38.2)
1	32 (94.1)	22 (64.7)	18 (52.9)	11 (32.3)	15 (44.1)
2	1 (2.9)	5 (14.7)	7 (20.6)	2 (5.9)	5 (14.7)
3	0 (0)	0 (0)	1 (2.9)	1 (2.9)	1 (2.9)
≥4	0 (0)	0 (0)	1 (2.9)	0 (0)	0 (0)

Table 8: Number of nurses per duty shift at the 34 PEDs

Number of nurses	Number of PEDs (n / %)			
	Chief nursing officer	**Assistant chief nursing officer**	**Nursing officer 1**	**Nursing officer 2**
0	14 (41.2)	10 (29.4)	4 (11.8)	3 (8.8)
1	19 (55.9)	23 (67.7)	18 (52.9)	9 (26.5)
2	1 (2.9)	1 (2.9)	9 (26.5)	18 (52.9)
3	0 (0)	0 (0)	2 (5.9)	3 (8.8)
≥4	0 (0)	0 (0)	1 (2.9)	1 (2.9)

4.5 Availability of recommended emergency medications at the included PED

All 34 PEDs reported that staff were made aware of the location of emergency medications in the PED and have availability of a pre-calculated chart and formula to ensure correct dosing. Tables 9 & 10 describe the availability of recommended emergency medications at the 34 PEDs. Besides adrenaline (n=32, 94.1%), furosemide (n=31, 91.2%), dexamethasone (n=31, 91.2%), hydrocortisone (n=32, 94.1%), diazepam (n=33, 97.1%), dextrose 10% or 20% (n=34, 100%), normal saline (n=34, 100%), ringers lactate (n=34, 100%), and oxygen (n=33, 97.1%) all of the other emergency medications were available in less than 90% of PEDs.

Table 9: Availability of the recommended cardiovascular, bronchodilator, anti-allergy, anticonvulsant, analgesic and sedation medications at the 34 PEDs

	Number of PEDs with availability (n / %)
Cardiovascular agents (n=81)	
Adrenaline	32 (94.1)
Furosemide	31 (91.2)
Vitamin K	25 (73.5)
Digoxin	24 (70.6)
Hydralazine	20 (58.8)
Propranolol	20 (58.8)
Atropine	17 (50.0)
Aspirin	14 (41.2)
Dopamine	11 (32.4)
Labetalol	9 (26.5)
Dobutamine	7 (20.6)
Heparin	7 (20.6)
Clopidogrel	4 (11.8)
Adenosine	3 (8.8)
Amiodarone	2 (5.9)
Nitroglycerine	2 (5.9)
Prostaglandin E1	2 (5.9)
Fibrinolytic agents	1 (2.9)
Nitroprusside	1 (2.9)
Verapamil	1 (2.9)
Bronchodilators / anti-allergy medications	
Hydrocortisone	32 (94.1)
Dexamethasone	31 (91.2)
Aminophylline	30 (88.2)
Salbutamol	30 (88.2)
Antihistamines	29 (85.3)
Ipratropium bromide	10 (29.4)
Corticosteroid inhaler	6 (17.7)
Anticonvulsants	
Diazepam	33 (97.1)
Phenobarbitone	29 (85.3)
Paraldehyde	24 (70.6)
Chlorpromazine	19 (55.9)
Phenytoin	19 (55.9)
MgSO4	17 (50.0)
Lorazepam	3 (8.8)
Midazolam	1 (2.9)
Analgesia / sedation	
Lignocaine	26 (76.5)
Dihydrocodiene (DF118)	15 (44.1)
Non-steroidal anti-inflammatory drugs	15 (44.1)
Morphine	10 (29.4)
Ketamine	8 (23.5)
Haloperidol	6 (17.7)
Thiopentone	5 (14.7)
Propofol	1 (2.9)
Vercuronium	1 (2.9)

Table 10: Availability of the recommended fluid and electrolytes, antidotes, vaccines, ophthalmic agents and other medications at the 34 PEDs

	Number of PEDs with availability (n / %)
Fluids and electrolytes	
Dextrose 10%/20%	34 (100)
Normal saline	34 (100)
Ringers lactate	34 (100)
Dextrose 5%	30 (88.2)
Dextrose saline	30 (88.2)
Oral Rehydration Solution/Zinc	30 (88.2)
Darrow's	29 (85.3)
Mannitol	29 (85.3)
Sodium bicarbonate	29 (85.3)
Calcium Gluconate	27 (79.4)
Potassium Chloride	23 (67.7)
Calcium Chloride	15 (44.1)
Balsol	1 (2.9)
Antidotes and vaccines	
Antitetanus serum	18 (52.9)
Antirabies	6 (26.5)
Antivenom	9 (26.5)
Naloxone	7 (20.6)
Flumazenil	5 (14.7)
Protamine	5 (14.7)
Activated charcoal	4 (11.8)
Acetyl cysteine	1 (2.9)
Ophthalmic medications	
Antibiotic eye drops	13 (38.2)
Anti-allergy eye drops	12 (35.3)
Mydriatics	8 (23.5)
Silver nitrate eye drops	7 (20.6)
Steroid eye drop	7 (20.6)
Analgesic eye drops	6 (17.7)
Other medications	
Oxygen supply	33 (97.1)
Antimalarial	25 (73.5)
Antibiotics	24 (70.6)
Emergency drug list	22 (64.7)
Post Exposure Prophylaxis	21 (61.8)
Emetics/ anti-emetics	18 (52.9)
Insulin	17 (50.0)
Antacids	16 (47.1)
Laxatives	10 (29.4)
Glucagon	4 (11.8)

4.6 Availability of the recommended equipment and consumables at the included PEDs

4.6.1 Availability of equipment and consumables for airway, breathing and circulation

All 34 PEDs reported that staff were made aware of the location of paediatric equipment in the PED and that they had a pre-calculated chart to ensure proper sizing of resuscitation equipment. Tables 11 & 12 describes the availability of recommended equipment and

consumables for airway, breathing and circulation as well as recommended monitoring equipment at the 34 PEDs.

The following equipment was available at <30% of facilities: nasopharyngeal airway, meconium adaptor and Magill forceps, whilst <20% of facilities had a tracheostomy tube, intercostal drain catheter, bone marrow needle, intraosseous needle, central venous access set, vein finder device, fluid warmer, infusion pump set, umbilical vein catheter and a defibrillator with ECG monitor and accessories. Less than 10% of facilities had a cricothyroidotomy set, gum elastic bougie, laryngeal mask, tracheostomy set, PEEP valve with adaptor for bag mask ventilation, high flow infusion catheter, cardiac arrest board, transcutaneous pacing set, biochemistry device, blood gas analyser and cardiopulmonary monitoring device. None of the facilities had a colorimeter device, $ETCO_2$ monitor, oesophageal detector device, video laryngoscope, ventilator and chest decompression set.

Table 11: Availability of recommended equipment and consumables for airway, breathing and circulation at the 34 PEDs

	Number of PEDs with availability (n / %)
Devices to open and protect the airway	
10 ml syringe	34 (100)
Adhesive tape	34 (100)
KY jelly	33 (97.1)
Laryngoscope blade	31 (91.2)
Laryngoscope handle	31 (91.2)
Laryngoscope spare battery	26 (76.5)
Laryngoscope spare bulb	25 (73.5)
Endotracheal tubes- uncuffed	25 (73.5)
Oropharyngeal airway	25 (73.5)
Endotracheal tubes- cuffed	21 (61.8)
Meconium adaptor	10 (29.4)
Nasopharyngeal airway	10 (29.4)
Tracheostomy tube	6 (17.7)
Devices to confirm tracheal intubation	
Colorimeter device	0 (0)
$ETCO_2$ monitor	0 (0)
Oesophageal detector device	0 (0)
Equipment for difficult intubation	
Stylet (infant/paediatric/adult	11 (32.4)
Magill forceps	7 (20.6)
Laryngeal mask	3 (8.8)
Cricothyroidotomy set	1 (2.9)
Gum elastic bougie; paediatric /adult	1 (2.9)
Tracheostomy set	1 (2.9)
Video laryngoscope	0 (0)
Devices to deliver oxygen and ventilate	
Bag valve mask device with oxygen reservoir /mask (infant/paediatric/adult)	34 (100)
Oxygen delivery devices (e.g. face mask, nasal prongs)	34 (100)
Oxygen supply with flow regulator and tubing	33 (97.1)
PEEP valve with adaptor for BMV	1 (2.9)
Ventilator machine	0 (0)
Equipment for decompression of the thorax	
Scalpel / Dissecting forceps	14 (41.2)
Under water seal bottle	13 (38.2)
Intercostal drain catheter (12-36 Fr)	4 (11.8)
Chest decompression set	0 (0)
Devices to gain intravascular access	
Hypodermic syringes (insulin- 50mls)	34 (100)
IV cannula (14-24G)	34 (100)
Needles (18-27G)	34 (100)
Sharp containers	34 (100)
Sterile gloves	34 (100)
Strapping	34 (100)
Intraosseous needle (paediatric/ adult)	6 (17.7)
Vein finder device	5 (14.7)
Central venous access set	4 (11.8)
Bone marrow needles	4 (11.8)
High flow infusion catheter (8.5F)	2 (5.9)
Equipment for safe infusion of fluids and blood	
Intravenous fluid and blood administration set	34 (100)
Umbilical vein catheter	10 (29.4)
Fluid warmer	5 (14.7)
Infusion pump	4 (11.8)
Equipment to diagnose and treat cardiac dysrhythmias	
ECG monitor with defibrillator and accessories (paste, pads, electrodes, razor)	4 (11.8)
Cardiac arrest board	2 (5.9)
Transcutaneous pacing	1 (2.9)

Table 12: Availability of recommended equipment for monitoring at the 34 PEDs

	Number of PEDs with availability (n / %)
Equipment for monitoring	
Blood pressure cuffs (neonatal, paediatric / adult	34 (100)
Thermometer (normal/low reading)	34 (100)
Collection tubes	33 (97.1)
Pulse oximeter (paediatric / adult probe)	33 (97.1)
Stethoscope	33 (97.1)
Glucometer	32 (94.1)
Blood pressure monitoring device	18 (52.4)
Automatic blood pressure device/ spare battery	11 (32.4)
Doppler device	5 (14.7)
Cardiopulmonary monitoring device	2 (5.9)
Biochemistry analyser (U/E/Cr)	1 (2.9)
Blood gas analyser	1 (2.9)

4.6.2 Availability of recommended hardware equipment and other miscellaneous items

Hardware equipment for patient safety, to aid diagnosis and other hardware are described in table 13. Less than 15% of PEDs had critical items like resuscitation algorithms (n=5, 14.7%) and neck collars (n=5, 14.7%), whereas 61.8% (n=21) and 82.35% (n=28) of the PEDs had an equipment list or an equipment check-book respectively.

Overall, over two-thirds of facilities had items like an X-ray viewing board (n=25, 73.5%) and otorhinolaryngology diagnostic kit (n=29, 85.3%) whilst an incision & drainage set was present in less than 50% of the PEDs. In addition, <30% of the facilities had a heating source (n=8, 23.5%), spine board (n=1, 2.9%) and resuscitation trolley (n=4, 11.8%).

Table 13: Availability of recommended hardware equipment and other miscellaneous items at the 34 PEDs

	Number of PEDs with availability (n, %)
Clock	34 (100)
Meter rule	34 (100)
Weighing scale	34 (100)
Drip stands	33 (97.1)
Stretcher	33 (97.1)
Suctioning devices	33 (97.1)
Nasogastric tubes	32 (94.1)
Otorhinolaryngology diagnostic kit	29 (85.3)
Equipment check book	28 (82.4)
Urinary catheter	28 (82.4)
Urine bags	28 (82.4)
X-ray viewing board	25 (73.5)
Personal protective equipment hardware	23 (67.7)
Equipment check list	21 (61.8)
Blankets	17 (50.0)
Lumbar Puncture set	15 (44.1)
Restraint device	15 (44.1)
Suture materials	15 (44.1)
Incision and drainage (I&D) set	14 (41.2)
Heavy duty scissors	10 (29.4)
Cord clamps	8 (23.5)
Heat sources	8 (23.5)
Delivery pack	7 (20.6)
Neck collar	5 (14.7)
Resuscitation algorithm	5 (14.7)
Resuscitation documentation record	5 (14.7)
Limb traction	4 (11.8)
Resuscitation trolley	4 (11.8)
Broselow tape	1 (2.9)
Cast applicator	1 (2.9)
Dental set	1 (2.9)
Eye speculum	1 (2.9)
Medication labels	1 (2.9)
Spine board	1 (2.9)
Vacuum mattress	1 (2.9)
Wire cutter	2 (5.9)

4.7 PED performance scores

4.7.1 Managerial, medication, equipment and total performance scores at each of the included PEDs

The mean (SD) managerial, medication, equipment and total performance scores of all 34 PEDs was 3 (±1.0), 41.1 (±18.1), 43 (±11.6) and 87.2 (±28.4) respectively. This equated to the following percentages: managerial – 42.9%, medication – 50.7%, equipment – 43.9% and total performance score – 46.9%. Only 13 PEDs had a total performance score >50%.

Managerial, medication, equipment and total performance scores at each of the 34 PEDs are described in table 14.

Table 14: Managerial, medication, equipment and total performance scores at each of the 34 PEDs

State where PED located (n=34)	Managerial score (max=7 points)	Medication score (max=81 points)	Equipment score (max=98 points)	Total score (max=186)	Total score (%)
Bayelsa	4	20	41	65	35.0
Benue	1	16	30	47	25.3
Delta	2	27	35	64	34.4
Imo	3	90	87	180	96.8
Abia	2	63	46	111	59.7
Adamawa	1	50	32	83	44.6
Akwa Ibom	3	21	37	61	32.8
Anambra	4	42	35	81	43.6
Bauchi	4	11	29	44	23.7
Cross River	5	49	56	110	59.1
Ebonyi	4	60	50	114	61.3
Ekiti	2	41	50	93	50.0
Enugu	4	64	44	112	60.2
FCT	3	36	39	78	41.9
Jigawa	2	14	32	48	25.8
Kaduna	5	32	37	74	39.8
Kebi	3	29	33	65	35.0
Kogi	3	41	37	81	43.6
Kwara	2	43	42	87	46.8
Nasarawa	2	47	41	90	48.4
Niger	2	42	53	97	52.2
Ondo	3	43	45	91	48.9
Osun	3	41	44	88	47.3
Oyo	4	65	46	115	61.8
Plateau	4	28	32	64	34.4
Rivers	4	25	50	79	42.5
Sokoto	3	13	20	36	19.4
Taraba	3	39	36	78	41.9
Yobe	5	57	50	112	60.2
Zamfara	3	52	52	107	57.5
Borno	1	44	57	102	54.8
Edo	2	23	41	66	35.5
Kano	3	67	49	119	64.0
Lagos	3	63	55	121	65.1
Mean (SD) scores	**3 (±1.1)**	**41.1 (±18.4)**	**43 (±11.8)**	**87.2 (±28.4)**	**46.9 (±15.0)**

4.7.2 Comparison of the mean managerial, medication, equipment and total performance scores between the 6 geopolitical zones of Nigeria

Table 15 describes the comparison of the mean managerial, medication, equipment and total performance scores between the six geopolitical zones of Nigeria. There were statistically significant differences in mean medication performance scores across the zones. Post hoc pairwise Bonferroni analysis showed the difference to be a significantly lower score for the

South-South zone compared to the South-East zone (p=0.008). Furthermore, there was a significant difference in the mean total performance scores (p=0.035) across the zones. However, there were no significant differences in the post-hoc tests.

Table 15: Comparison of the mean managerial, medication, equipment and total performance scores between the 6 geopolitical zones of Nigeria

	Managerial Mean (SD)	Medication Mean (SD)	Equipment Mean (SD)	Total score (%) Mean (SD)
North-Central zone	2.4 (0.98)	36.1 (10.76)	39.1 (7.56)	41.8 (9.19)
North-East zone	2.8 (1.79)	40.2 (17.66)	40.8 (12.11)	45.0 (14.06)
North-West zone	3.2 (0.98)	34.5 (21.36)	37.2 (11.82)	40.3 (17.51)
South-East zone	3.4 (0.89)	63.8 (17.15)	52.4 (20.11)	64.3 (19.57)
South-West zone	3 (0.71)	50.6 (12.28)	48.0 (4.53)	54.6 (8.20)
South-South zone	3.3 (1.21)	27.5 (10.84)	43.3 (8.10)	39.9 (9.99)
p-value	0.6690	**0.0084**[a]	0.2619	**0.0352**[b]

a- Post hoc pairwise Bonferroni test identified the difference to be between South-East and South-South
b- Post hoc pairwise Bonferroni test identified no differences

4.7.3 Comparison of the mean managerial, medication, equipment and total performance scores between the North and South regions of Nigeria

The table showed a statistically significant higher mean score in equipment availability (p = 0.029) in the South region of the country compared to the North region (table 16).

Table 16: Comparison of the mean managerial, medication, equipment and total performance scores between the North and South regions of Nigeria

	Managerial Mean (SD)	Medication Mean (SD)	Equipment Mean (SD)	Total score (%) Mean (SD)
North region	2.8 (±0.3)	26.8 (±3.1)	38.9 (2.3)	50.1 (4.0)
South region	3.3(±0.2)	34.1 (±4.1)	47.6 (3.1)	43.2 (3.1)
p-value	0.217	0.166	**0.029***	0.195

*- statistically significant difference

4.7.4 Comparison of overall and regional median performance scores between PEDs with and without a dedicated HOD

There were no statistically significant differences between the overall and regional mean medication, equipment and total performance scores in PEDs with a dedicated HOD compared to those PEDs with a rotating HOD (table 17).

Table 17: Comparison of overall and regional mean performance scores between PEDs with and without a dedicated HOD

Performance score	Dedicated HOD present Median (Interquartile range)	Dedicated HOD absent Median (Interquartile range)	Significance level
All PEDs combined			
Medication score	32.0 (17.0 – 47.0)	30.0 (17.5 – 32.0)	p = 0.2134
Equipment score	42.5 (37.0 – 50.0)	40.5 (32.5 – 49.5)	p = 0.4266
Total score (%)	44.1 (35.0 – 50.0)	51.1 (38.7 – 60.8)	p = 0.2547
North region			
Medication score	22.0 (19.0 – 36.0)	30.0 (20.0 – 32.0)	p = 0.8822
Equipment score	37.0 (32.0 – 41.0)	37.0 (32.0 – 49.0)	p = 0.7669
Total score (%)	46.8 (43.6 – 48.9)	54.8 (42.5 – 60.2)	p = 0.5873
South region			
Medication score	33.0 (17.0 – 47.0)	30.0 (15.0 – 32.0)	p = 0.2497
Equipment score	46.0 (41.0 – 50.0)	45.0 (44.0 – 50.0)	p = 0.8923
Total score (%)	41.9 (25.3 – 50.0)	41.9 (34.4 – 61.8)	p = 0.7876

4.7.5 Correlation of the overall mean managerial, medication, equipment and total performance scores

The overall mean medication score strongly and significantly correlated with the overall mean equipment score (r=0.73, p=<0.001). There were no other statistically significant correlations (table 18).

Table 18: Correlation of the overall mean managerial, medication, equipment and total performance scores

	Managerial score		Medication score		Equipment score		Total score (%)	
	r	**p-value**	**r**	**p-value**	**r**	**p-value**	**r**	**p-value**
Managerial score	1.00	1.00						
Medication score	0.10	0.59	1.00	1.00				
Equipment score	0.08	0.65	0.73	**<0.0001***	1.00	1.000		
Total score (%)	- 0.26	0.132	- 0.18	0.301	- 0.203	0.249	1.00	1.000

4.7.6 Correlation of the mean managerial, medication, equipment and total performance scores across each of the 6 geopolitical zones of Nigeria

When the means score of the three studied domains of preparedness (managerial, medication and equipment) were correlated against the mean total score, there was no statistical

significant relationship (all p-values were above 0.05) in each of the six geopolitical zones of Nigeria.

However, when each of the domains were correlated individually, the mean medication score correlated significantly and strongly with the mean equipment score in the North-West (r=0.92, p=0.010) and the South-East (r=0.94, p=0.017) zones, while the mean managerial score correlated strongly and significantly with the mean equipment score in the South-West (r=0.83, p=0.043) zone. These findings are described in table 19.

Table 19: Correlation of the mean managerial, medication, equipment and total performance scores across each of the 6 geopolitical zones of Nigeria

	Managerial score		**Medication score**		**Equipment score**		**Total Score (%)**	
	r	**p-value**	**r**	**p-value**	**r**	**p-value**	**r**	**p-value**
North-Central zone								
Managerial score	1.00	1.000						
Medication score	0.05	0.91	1.00	1.000				
Equipment score	- 0.17	0.719	0.69	0.084	1.00	1.000		
Total score (%)	0.24	0.606	0.28	0.541	- 0.21	0.649	1.00	1.000
North-East zone								
Managerial score	1.00	1.000						
Medication score	- 0.15	0.804	1.00	1.000				
Equipment score	- 0.10	0.880	0.53	0.355	1.00	1.000		
Total score (%)	- 0.60	0.284	0.81	0.097	0.44	0.464	1.00	1.000
North-West zone								
Managerial score	1.00	1.000						
Medication score	0.14	0.790	1.00	1.000				
Equipment score	0.08	0.876	0.92	**0.010***	1.00	1.000		
Total score (%)	- 0.30	0.566	- 0.60	0.206	- 0.74	0.096	1.00	1.000
South-East zone								
Managerial score	1.00	1.000						
Medication score	- 0.32	0.600	1.00	1.000				
Equipment score	-0.30	0.620	0.94	**0.017***	1.00	1.000		
Total score (%)	0.10	0.878	0.69	0.197	0.60	0.290	1.00	1.000
South-West zone								
Managerial score	1.00	1.000						
Medication score	0.64	0.169	1.00	1.000				
Equipment score	0.83	**0.043***	0.71	0.113	1.00	1.000		
Total score (%)	- 0.58	0.224	- 0.44	0.378	- 0.34	0.509	1.00	1.000
South-South zone								
Managerial score	1.00	1.000						
Medication score	0.68	0.207	1.00	1.000				
Equipment score	- 0.31	0.609	0.45	0.443	1.00	1.000		
Total score (%)	- 0.46	0.434	- 0.57	0.319	- 0.13	0.835	1.00	1.000

4.7.7 Correlation of the mean managerial, medication, equipment and total performance scores in the North and South regions of Nigeria

The correlation of the mean managerial, medication, equipment and total performance score in each of the 2 regions of Nigeria are described in table 18. In both the North and South regions, the mean medication and equipment performance scores correlated strongly with the mean total performance scores for the region. Also, the mean medication performance score correlated strongly and significantly with the mean equipment performance score in both the North (r=0.76, p=0.0003) and South (r=0.71, p=0.002) regions of the country.

Table 20: Correlation of the mean managerial, medication, equipment and total performance scores in the North and South regions of Nigeria

	Managerial score		**Medication score**		**Equipment score**		**Total Score (%)**	
	R	**p-value**	**r**	**p-value**	**r**	**p-value**	**R**	**p-value**
North region								
Managerial score	1.00	1.000						
Medication score	0.13	0.64	1.00	1.000				
Equipment score	0.10	0.74	0.76	**0.0003***	1.00	1.000		
Total score (%)	0.15	0.58	0.95	**<0.0001***	0.90	**<0.0001***	1.00	1.000
South region								
Managerial score	1.00	1.000						
Medication score	-0.15	0.804	1.00	1.000				
Equipment score	-0.10	0.880	0.71	**0.002***	1.00	1.000		
Total score (%)	-0.60	0.284	0.88	**<0.0001***	0.88	**<0.0001***	1.00	1.000

*- statistically significant difference

CHAPTER 5: DISCUSSION

5.1 Chapter overview

This chapter discusses the study background and study finding with regards to patient load, number of shift duties, qualification and experience of clinical staff, number of clinical staff per duty shift and the availability of recommended emergency medications and equipment. In addition, performance scores are also discussed.

5.2 Study overview

This study evaluated paediatric emergency care preparedness of 34 tertiary level PEDs recruited from all the 6 geopolitical zones in Nigeria. Out of the 37 facilities that were initially approached for study participation, 34 (91.9%) were recruited. This is slightly higher than the 82.5% of facilities that were recruited in a similar nationwide web-based assessment of EDs in the USA (77) and 88.3% in Canada (70). To our knowledge, this study is the first and most comprehensive nationwide evaluation of PEDs preparedness across Nigeria.

This study reports a below average score in all domains of preparedness for paediatric emergency care across the PEDs in Nigeria. The most striking areas identified were the lack of medications for cardiovascular emergencies, equipment to confirm endotracheal intubation, ventilator devices, cardiopulmonary monitors and point-of-care diagnostics. Our study findings are similar to findings of a study that reported a gross deficiency in essential paediatric resuscitation equipment in a good number of EDs in Canada (70). However, in contrast to this study, the Canadian study included general EDs that managed both adults and children and it focused only on equipment.

Our study findings differ from a recent study in Southern Nigeria by Edelu et al. that reported a high availability of basic equipment and other consumables (10) and the study by Gausche-Hill et al. in the US which reported an improved availability of equipment for paediatric patients in the EDs (77). The contrast may be due to differences in our study methodology as the study by Edelu et al. focused only on PEDs in southern Nigeria, whereas the by Gausche-Hill et al. was a follow-up study after intervention by the government following an earlier study that demonstrated poor paediatric preparedness in US EDs. Remick et al. also reported a better preparedness in Paediatric verified EDs than other EDs where children may be treated (76). Although Adamson, despite reporting an average preparedness score of 62%, adjudged emergency rooms at community health centres in the Western Cape of South Africa to be inadequately prepared for emergencies (73), our study results were worse off with a mean preparedness score of only 46.9%. The difference in perception of preparedness and availability of recommended equipment and medications at the centres they studied, which were primary level centres compared to the tertiary level hospitals in our study, could be a result of emergency medicine being a recognised and structured speciality in South Africa.

5.3 The number of patient visits, short-stay admissions and daily duty shifts per PED

This study only included patients that were triaged to be seen in the PED and excluded patients that were re-directed to out-patient clinics. The majority (76.5%) of PEDs across the country fell in the medium volume category that saw between 100-500 patients visits during the studied 30 days. This contrast with a US study that reported a higher proportion of low volume category hospitals (<150 visits/month) (77).

The mean number of patient visits was 253.2 per month (8.4 per day) which is similar to a study that was conducted by Ejeze et al. in a similar setting that managed a maximum of 300 patients per month (5) but much lower than a Pakistani single centre study that triaged a total

of 1269 patients per month to the PED (82). Even though the study from Pakistan was conducted in a similar setting (LMIC) and over a similar study period (28-day study) to ours, the differences reported could be due to a higher number (fifty) of available patient beds. Also, their study was conducted in secondary level facilities compared to ours that was conducted in tertiary level facilities were access is somewhat limited. Furthermore, the cost of healthcare could explain the difference as our PEDs offered out of pocket expenditure compared to government-funded health care in their study.

Finding from this study when compared to those from other developed countries, saw a fewer number of patients compared to the study in California and in a nationwide study in the USA that reported 10 to 14 patient visits per day (76, 77). Also, a 2 year retrospective study in Taiwan reported an average monthly paediatric visit rate of 122.6/day (42), while a study in a Saudi Arabian ED with a 12 bed PED section saw 204 patients per day during the study period (43). This paediatric visit volume is obviously higher than our study and may be due to differences in study methodology.

There was a mean of 116.4 patients that were admitted into the short-stay ward per month (3.88 per day). This is lower than studies in Saudi Arabia (43), Brazil (83) and Pakistan (82) that admitted 8, 13.7 and 19 patients/ day respectively while the study in Taiwan (42) reported an admission rate of 18% – 25%. Reason for the higher admission rate may be that they saw higher acuity patients, or their populations had higher accessibility to the hospitals. The lower rate in our study may be related to health access limitation likely due to out of pocket health care expenditure. Furthermore, the difference could also be due to differences in admission criteria to the short-stay ward in other settings.

In this study, a few (29.4%) of the PEDs conformed to the recommended eight hourly shift routines while the majority still operate the traditional 2 shifts of 8 am to 4 pm and night call duty from 4 pm to 8 am. The reason could be due to ED manpower shortages as three daily shifts will require additional number of skilled staffs. Prolonged shifts has been shown to predispose staff to burnout syndrome and may compromise the quality of care rendered while shorter 8-hour) shifts engender improved patient care and satisfaction as well as ensure the well-being of clinical staff (58). The Saudi Arabian study centre ran a three-shift duty as prevalent in most developed countries while the Taiwan study ran two-shift-duty days as was observed in most of our study centres (70.6%).

These lower paediatric volume visits and admissions, as well as the fewer centres that ran 3 duty shift rosters in this study may be because more ill children are being treated in centres with limited capacity and requires further study.

5.4 Description of clinical staff employed at the included PEDs

5.4.1 Qualifications and training of HODs and nursing managers

In this study, almost all the facilities were managed by a paediatrician (94.1%), with a handful having additional training in Paediatric Emergency Medicine. It is desirable that PEDs should be coordinated by emergency medicine trained personnel as this will improve overall services by improving the level of care, facilitating closer supervision of junior staff, increasing in-service training and improving patient flow (8).

A majority of the HODs had not completed all the advanced life support training and attendance at paediatric conferences (38.2%), while an appreciable number were compliant with continuing professional development (CPD) activities (58.8%). Although all the PEDs have a nursing manager, the lack of conference and CPD attendance was even more

pronounced among the nursing managers. The relatively low percentage of appropriate qualification and training is in keeping with other similar studies that were conducted in Nigeria (10) and Yugoslavia (75) where children are co-managed in general EDs by non-paediatricians. This is also the same with studies from other low and middle-income countries where PEDs tend to be managed by non-specialists and inadequately skilled staff (8,84–86).

The poor findings above are likely due to the fact that PEM as a subspecialty is non-existent in Nigeria. These inadequacies are not only detrimental to quality service delivery for critically ill children but also highlight the urgent need for PEM recognition, structured training and retention of PEM specialist across facilities.

The presence of a dedicated coordinator in the PED is highly recommended (4,11,14,87) and while all the studied PEDs had a nursing manager present, only 52.9% of the facilities had a dedicated physician HOD . This result is marginally higher than a nation-wide web-based study in the US that reported the availability of a nurse, a physician emergency care co-ordinator or both in 59.3%, 47.5% and 42% of EDs respectively (77). Another US study conducted in California, reported the availability of a nurse, a physician emergency care co-ordinator or both in 43.3%, 42.7% and 33.3% of EDs respectively (76). The reason for higher percentages in this study may be because this study was conducted in dedicated tertiary level PEDs while others were in general EDs.

When compared to studies conducted in a similar setting there was still an improvement on the 44.4% reported in Nigeria (10) and much higher than the 28% reported by Obermeyer et al. in various LMIC settings (8). Although the study in Nigeria included only tertiary level PEDs, it was limited to the South region of Nigeria while this was a nation-wide study. The study by Obermeyer et al. did not include paediatric specific EDs (8).

The availability of a full-time paediatrician in the PED has been associated with an improvement in the quality of care (42). The study finding of 53% availability of a dedicated physician coordinating care is lower than the Canadian study where 70.4% of their EDs had a paediatrician on call (70). In the UK, PEDs have a nominated paediatric consultant as HOD as well as a nursing manager while facilities that have more than 16 000 annual visits have a paediatrician with training in PEM as HOD (41). The reason for the lower number of dedicated HODs in this study may be due to healthcare skilled staff shortages and lean healthcare funding.

5.4.2 Number of clinical staff employed

This study showed a mean deployment of 21 nursing staff and 26 doctors per PED facility. There was no available study to compare these findings. However, employing more doctors than nurses is not the expected and is not in keeping with the 2006 WHO report on human resources for healthcare in Nigeria which reported 0.3 doctors and 1.03 nurses per 1000 population (88). The reason for more doctors in the PED could be attributed to doctors in other paediatric units taking calls in the PEDs and in addition to the interns that are posted to the PEDs. For the optimal management of sick children, an adequate number of clinical staff working as a team with appropriate emergency care competence is necessary. The actual number of physicians required in the PED is dependent on patient volume and acuity. Approximately 1.5 - 2.5 patients per doctor per hour is regarded as the optimal ratio (89). The staff volume in this study was in keeping with a recent regional study in Nigeria (10) and appears marginally sufficient considering the average of 9 paediatric visits per day with at least 3 doctors per shift (4,85).

5.4.3 Life support training and certification amongst clinical staff

From this study, a very small percentage of all the included PEDs had staff (doctors and nurses) who had completed the various life support courses (NNR, BLS, APLS/PALS, ATLS). Not surprisingly, the frequency was lower amongst lower qualified doctors and was even more pronounced amongst nurses. These skills when possessed by clinical staff are vital to delivering quality acute care to children presenting emergently and requiring life-saving interventions.

The finding that doctors had low levels of training in advanced life support in our study are in keeping with studies conducted in other similar settings (10,31,90). Also, a study in Yugoslavia reported limited training in advanced life support amongst the doctors (75). This is not very different from the Canadian ED study that reported that only 29.7% of ED physicians had PALS or other advanced life support training (70). Our study finding is very poor compared to that in the UK where all clinical staff in the PED had received advanced life support training (41).

Amongst nurses, between 8.8% - 14.7% of the PEDs had nursing staff that were trained in BLS. This study finding is better than a report from the study in Yugoslavia (75) where the nurses had no training at all, but is in contrast to the 33.3% reported by a previous regional centre study in Nigeria (10). Our study result is lower than the nurses advanced life support training rate of 48% and 77.5% reported by studies in three district hospitals in Botswana (91) and South Africa respectively (92). Furthermore, it is very low when compared to the UK where all nurses in the PED had advanced life support training (41).

The reason for the lower rates in relation to other studies may be attributed to the cost of advanced life support training courses, the absence of a requirement of certification in these

courses and the infantile stage of PEM in Nigeria. An increase in the number of ATLS trained staff in the ED has been associated with a drop in the rates of preventable mortality (65).

5.4.4 Number of clinical staff per duty shift

All the studied facilities had the full complement of all clinical staff cadres. There were on average three junior doctors (2 interns, a junior resident doctor and or medical officers) per shift covered by at least a senior resident and a consultant. This study finding of two residents and a consultant was slightly better than the Taiwan study that had one resident and a physician per shift (42) while lower than a Saudi Arabian study that had 6 residents with a physician from all subspecialties available for consultation in the PED (43). The reason for the differences in the number of doctors could be related to the number of patients presenting, the efficiency of a triaging system and the availability of support resources.

Only 26.5% of the include PEDs had an on-site senior resident during night shift, while the remainder of facilities would call in senior residents when needed. The on-site rate was low compared to 77.8% previously reported in a Nigeria study (10). The differences in the on-site rate may be because the previous study included only 9 centres from the South of Nigeria, while this study included 34 centres across all regions of the country.

The PEDs had on the average 5 doctors per day shift and 3 per night shift, giving an overall doctor-patient ratio of 1:4 in the day and 1:6.6 during the night shift. This is very low compared to an Irish study that reported a doctor-patient number per shift of 2:3.5 in the morning and 5:14 in the night (93). Obviously, the acute shortage of healthcare workers in Nigeria could account for this.

On the other hand, there was an average of 5 nursing staff per shift. This is low compared to the Saudi Arabian study with 12 nurses per PED (43). This study found a nurse-patient ratio of 1:4, which falls within the 1:3-15 reported by another regional study in Nigeria (10) and similar to the 1:4 reported by studies in California, USA (94) and Australia (95). The figure was lower when compared to the nursing-patient ratio of 1:2.6 reported by Rossetti et al. in Brazil (83). The reason for the differences is likely due to shortages of skilled staff in Nigeria and freezing of posts by the government due to poor funding of healthcare in most developing counties. There are recommendations on the ratio of nurses to patients based on certain factors which include patient acuity, admission rates, disposal rates, staff expertise, in-ward space and other resources available in the ED (94). To maintain and improve on these indices, the ministry should equip the already existing nursing institutes to increase the quantity and quality of nurses in Nigeria.

5.5 Availability of recommended emergency medications at the included PEDs

Nationally, PED respondents reported that staff were trained on the location of paediatric emergency medications and fluids and that all units had a weight based pre-calculated chart or dosing formulae to ensure proper paediatric-dosing of medications. This study found that some medications were consistently available across the PEDS (over 70% of PEDs had antimalarial, antibiotics, bronchodilators, anticonvulsants, intravenous fluids and oral rehydration solution. This is similar to reports by Oyekale in the primary health care facilities in Nigeria (96). The availability of certain medications over others may be attributed to the disproportionately high burden of infectious diseases requiring these therapies in Nigerian PEDs.

The study also identified a deficiency in the availability of critical medications. The non-availability of medication in our study was similar to other study findings in similar LMIC

settings (10,12,31,86,96). Possible reasons for this are that some of these medications may be infrequently prescribed, physicians may not be familiar with their use or alternative medication may be used (e.g. lignocaine instead of bupivacaine). Also, some of these medications are only available in specialized units of the hospital such as ICU or not readily available in Nigeria (e.g. amiodarone). However, drug availability of 80% reported by Adamson in South Africa (73), was better compared to our mean medication score of 41.1% while a survey by Razzak et al. in Parkistan reported that 42% of respondent were not satisfied with the ED care due to lack of medication (31).

From this study, only 22 (64.7%) PEDs had an emergency drug list. This can result in shortages of critical medications when required and delayed identification of expired medication in stock. In practical terms, most of the critical items on the recommended medication list are geared for the management of cardiac arrest. But since infections is regarded to be more prevalent in the local setting, antimicrobials availability should be given additional emphasis when designing local checklists. The checklist used in this study was not weighted as per local requirements as this study aimed to assess all PEDs with a standardized validated tool.

A conscious and concerted effort by the health department to develop a paediatric emergency care essential drug list, strengthening of the existing drug revolving scheme in Nigeria and the provision of a PED dedicated pharmacy will be a good starting point to address this issue.

5.6 Availability of recommended equipment and consumables at the included PEDs

In preparation for an emergency in the PED, the availability of equipment to manage the airway, breathing and circulation is vital. The non-availability, malfunction and unfamiliarity

with life-saving equipment and monitors have been associated with poor outcomes in emergencies (73).

This study found a below average state of preparedness in terms of recommended equipment across the country. The items most commonly reported missing included items to confirm tracheal intubation, perform chest decompression, manage dysrhythmias and apply mechanical ventilation. The low availability of equipment is similar to other studies in LMICs as reported by Oyekale in Nigeria (96), Razzak et al. in Pakistan (31) and Japiong in Ghana (97). It is also similar to reports of a low availability of equipment in high-income countries reported by McGillivray et al. in Canada (70). The reason for equipment deficiencies in this study may be attributed to the low advanced life support and PEM training rate among clinical staff in the studied PEDs.

A study by Remick et al. reported that 60% of facilities had 90% of recommended equipment (76), while Adamson reported that all the emergency centres in their study had more than 63% of required equipment (73), which is much better than our study finding where the equipment mean score was 43%. Both studies also reported on the items commonly reported missing which was similar to our study findings.

In this study, accessory equipment such as equipment for safety (e.g. suction machine), basic airway adjuncts (e.g. laryngoscope), oxygen supplies (e.g. bag valve mask device), safe intravenous access (e.g. cannulas) and basic diagnostic tools (e.g. glucometer) were available in over 90% of facilities. This also is in keeping with studies by Oyekale et al. (96) and Edelu et al (10) in Nigeria and Adamson (73) in South Africa. This finding may be due to the affordability and accessibility of basic equipment in both low and high-income settings. Also, cutting-edge equipment may not be readily available due to high cost as well as staff not

being familiar with their use and thus not including them in requisition orders for the units. None the less, it is worth nothing that the non-availability of certain recommended equipment or consumables may not always translate to the expected care not being carried out. It is possible that other improvised methods may be used in its place. A good example is the widespread use of 21G needles for interosseous access in place of commercialised interosseous needles.

It is worth noting that equipment lists, and check-books were available in over two-thirds of the PEDs. These quality improvement tool may not only ensure the availability of critical devices but also ensure that they are in good working condition. These study findings support the need for a review of the state of equipment availability and functionality in PEDs across the country.

5.7 Performance scores

5.7.1 Managerial, medication, equipment and total performance scores at each of the included PEDs

The audit tool used to score PED preparedness strictly adhered to the validated AAP/IFEM checklist. Although the challenges in healthcare delivery in our study setting differs greatly from that of the resource rich countries where the checklist was developed, the included items were not weighted locally. This is because this study is a pioneer study and hence serves to assess the included PEDs based on international best practice. A similar adapted point scale score was used in a previous study (73).

Overall, the mean preparedness performance score was 46.9% in terms of availability of medication, equipment and a managerial head. It can be concluded that the PEDs in Nigeria are not generally prepared to render emergency care services to acutely ill children. This

conclusion concurs with the report by Oyekale that the majority of healthcare facilities failed to meet the minimum standard to deliver primary health care service in Nigeria (96). A study by Burt et al. on preparedness measures showed that the volume of PED visits, location of ED in a teaching hospital, geographic region in which the ED is located and per capita income correlated strongly with each of these preparedness domains (38). This is in contrast to finding of this study where all included facilities, despite being tertiary level care facilities that were located in urban settings with the majority being medium volume hospitals, still had low performance measures. These findings may be attributed to several factors including poor health financing, administrative weaknesses, inadequate infrastructure, poor service delivery, household poverty and inefficient health care coverage (98) that negatively impact health services in Nigeria.

In a study of primary health care emergency centres, Adamson reported that 62% of all recommended emergency equipment items, 80% of all emergency drugs and 52.4% of all emergency trolley were available (73). The study by Remick et al. reported a weighted score of 89.6% for paediatric verified EDs. In their study, a national working committee selected 100 items from the 2009 AAP guidelines and weighted the 7 domains using the Delphi approach. A mean point score was assigned to each section with items in each domain being assigned a low, medium, or high importance based perceived clinical relevance. Only those items with medium to high average scores were weighted and included in the assessment tool. The group also agreed not to include the support services domain (76).

Gausche-Hill et al. reported an overall median weighted score of 68.9% (77). Prior to initiation of their study, a national steering committee developed a 55-question web-based assessment based on the 2009 AAP guidelines. A subpanel of the experts developed weighting criteria for the assessment. Twenty-four questions were weighted to generate an

overall weighted paediatric readiness score (WPRS) for each hospital. The WPRS was normalized to a 100-point scale awarding 19 points to coordination, 10 points to staffing, 7 points to quality improvement, 14 points to patient safety, 17 points to policies/procedures, and 33 points to equipment and supplies.

Although, the performance scores in these previous studies were much better than this study, the authors concluded that their centres still required improvement. This conclusion suggests differences in regional perception of paediatric readiness which may relate to their level of PEM recognition, prevalent morbidity in their setting and local health authority's efforts at improving preparedness for emergencies. It also highlights the fact that weighting of internationally generated checklist to local epidemiology, workload and available resources influences the importance placed on each items/domain assessed and also the interpretation of results in relation to settings.

The low performance scores identified in the PEDs in Nigeria calls for a focused effort by the federal government to adequately equip the nation's PEDs by implementing a uniform medication and equipment supply chain, strengthening healthcare human capacity development and setting up an advisory technical committee with representation from all PEDs. Also, there is a need to encourage a periodic ranking system among the PEDs that will promote standard-practice with on-site accreditation visitations and the implementation of emergency preparedness drills. Further research with a locally weighted assessment tool is recommended.

5.7.2 Comparison of the mean managerial, medication, equipment and total performance scores between the 6 geopolitical zones of Nigeria

This study showed that there were significant differences between the mean score of medication and total performance amongst the PEDs in the 6 geopolitical zones. Individual zones score showed a higher score in the South-East followed by the South-West zone compared to the rest of the 4 zones for the entire studied domain. This result literally translates to a better preparedness to deliver emergency care in the South East zones of Nigeria. These findings are in keeping with the study by Oyekale (96) carried out in the PHCs in Nigeria that reported a higher availability of medication ($p<0.05$) and equipment (<0.01) in the Southern states compared to the North. Similarly, the study found that facilities in rural areas had less medication and equipment available ($p < 0.05$) compared to urban areas. Omoluabi similarly noted that healthcare facilities in urban and southern Nigeria were better equipped with medication and equipment than most of the states in northern Nigeria. He concluded that better working condition and availability of medical equipment in the south when compared to insurgencies and high poverty rate in northern Nigeria could also affect the ability to retain qualified medical staff in the north (99). These studies support the possible reasons for this difference to include the skewed distribution of high-level clinical staff, increased awareness amongst the population and the two southern zones being the commercial nerve zones of Nigeria (100,101). These findings require further investigation to determine the factors that may have contributed to their better performance.

5.7.3 Comparison of the mean managerial, medication, equipment and total performance scores between the North and South regions of Nigeria

When performance scores per region were compared, there was significantly higher availability of equipment in the southern region of the country when compared to the northern region. This finding is in keeping with studies by Oyekale (96) and Omoluabi (99).

Again, the reasons for this difference may be due to insecurity, higher poverty and illiteracy rates, lower retention of highly skilled clinical staff and lower health-seeking behaviour in the northern states. These findings require further investigation to determine the factors that may have contributed to their better availability in the south.

5.7.4 Comparison of overall and regional median performance scores between PEDs with and without a dedicated HOD

Although there was a trend suggesting improved performance scores when a dedicated HOD was available in the PED, the differences were not statistically significant. In contrast, a Canadian study reported that having an on-call paediatrician, with or without at least one PALS-trained physician in the ED, had a positive impact on equipment availability (70). Also, a study in the US reported that the presence of a paediatrician and nurse emergency care coordinator was associated with improved likelihood of a PED having availability of all the recommended equipment and medication including a paediatric quality improvement process (adjusted relative risk, 4.11 [95% CI, 3.37-5.02]). Furthermore, it was associated with improved preparedness scores (a higher adjusted median weighted paediatric performance score (WPRS) of 82.2 (IQR, 69.7-92.5) compared with the WPRS (66.5; IQR, 56.0-76.9) of facilities with no emergency care coordinator (77). Furthermore, in a study by Remick, et al. 53% of the ED respondents reported that the presence of a paediatric emergency care coordinator improved quality of care (76). The lack of a significant difference in this study may be explained by the small overall sample size and requires future exploration.

5.7.5 Correlation of the overall mean managerial, medication, equipment and total performance scores

Nationally, the various individual domains (managerial, medication and equipment) correlated negatively but not significantly with the mean total performance score. This is not as expected and may be due to the study power and the small number of domains correlated against performance score. Individually only the medication score correlated strongly and significantly with the equipment domain ($p = <0.0001$). This is as expected as medication and equipment are both resources which may be affected by underfunding There was no correlation between managerial scores and medication or equipment scores unlike the study in the US where the presence of a physician and nurse paediatric emergency care coordination had a significant impact on the paediatric readiness of EDs and was associated with adherence to emergency care guidelines. Furthermore, the Canadian study showed that the presence of an on-call paediatrician to coordinate care had a positive impact on equipment availability as well as a higher preparedness score (70). The reasons for this unexpected non-conformity in this study is unclear but may be attributed to the low rates of related additional qualifications in EM or PEM, life support course certification and attendance at conferences amongst managers. The health ministry should consider implementing systems whereby some of these activities are included in continuous professional development programmes aimed at health professionals working in the PED environment.

5.7.6 Correlation of the mean managerial, medication, equipment and total performances scores across each of the 6 geopolitical zones of Nigeria

Apart from the South-West zone where the mean managerial score and the mean equipment score correlated and the North-West and South-East zones where the mean medication scores and mean equipment scores correlated strongly and significantly, all the other domains studied did not correlate significantly. There are no available studies with which to compare

our findings. The finding of the managerial domain correlating with equipment only in the South West zone is as expected and should encourage further study to determine the reason. Possible reasons may relate to the fact that the majority of hospitals are big centres with high volumes of patients and therefore attract highly skilled manpower (96). Also, the managerial score not correlating with other domains in other zones may be clinically relevant and a cause of concern. However, this may also be due to the small sample size. A further study to ascertain the veracity of finding of this study is recommended. Introspection within zones and possible cross-pollination of ideas between sister zones should be encouraged.

5.7.7 Correlation of the mean managerial, medication, equipment and total performances scores in the North and South regions of Nigeria

In this study, mean medication scores correlated significantly with mean equipment and mean total scores in both the North and South regions of Nigeria. This outcome is as expected; however, the mean managerial scores did not display any correlations with the other studied domains which have clinical relevance but not significant correlations. There are no available studies to compare with but a possible reason for this may be due to the low rates of additional qualifications and advanced life support training amongst the HODs or that the study is not powered enough to test this relationship. However, studies by McGillivray et al. (70) and Gausche-Hill et al. (77) have shown that the presence of a skilled-lead doctor in the ED is associated with increased availability of equipment in the ED.

There have been concerted efforts from the Federal Government of Nigeria to improve infrastructure and service delivery across health services in Nigeria. There are also efforts by the Tertiary Education Trust Fund to train and thereby increase the number of specialists and subspecialists in Nigeria. Postgraduate medical colleges as well as the nursing council, have

also made great efforts in maintaining the quality of staff and ensuring the availability of medications and equipment by conducting periodic accreditation visits to facilities (102).

5.8 Strengths and study limitation

This is the first nationwide audit of emergency preparedness among dedicated paediatric emergency departments in Nigeria. However, study limitations should be considered when interpreting the study findings. Firstly, aspects of the questionnaire were self-completed by managers, thereby increasing the chances of self-reporting bias. Efforts to mitigate this bias included; multiple telephonic calls and sending of telephone and email messages to the respondents to ascertain and verify their answers. Secondly, since this was a pioneer study, the AAP and IFEM checklist was modified and used as the audit tool to score PED preparedness. Lack of adaptation to local context and practices can thus also be deemed as a possible limitation of the study. Thirdly, it may seem biased that random PEDs from different states with varying number of patients that were measured at varying times of the year were compared against each other. However, to mitigate this, we therefore only selected PEDs from the 56 dedicated tertiary healthcare facilities in Nigeria. Since all of these PEDs were expected to be at the same academic and clinical level, it was reasonable to compare PEDs between regions and zones. Also the random sampling method employed in this study was aimed to have a fair spread of PEDs and to avoid selection bias. Fourthly, due to the relatively small sample size, this study may not be powered enough to assess certain relationships such as the effectiveness of a dedicated HOD on improving performance scores.

CHAPTER 6: CONCLUSION

This nation-wide study assessed the preparedness of Paediatric Emergency Departments in Nigeria to render quality emergency care to children with undifferentiated emergency presentations. Although the availability of a paediatrician as HOD in most PEDs is commendable, the deficiency in emergency medicine related qualifications, advanced life support certification and conference participation are concerning. Also, advanced life support training was deficient amongst clinical staff and worst amongst nurses. This together with deficiencies in the availability of medications and equipment depicts a state of poor preparedness by the clinical staff and facilities to deliver quality care to children attending PEDs across Nigeria. A global poor total performance score of 46.9% was reported by this study with only 13 of 34 studied PEDs scoring above 50%. This finding of poor PED preparedness is in keeping with findings of other studies in similar low and middle-income countries. Efforts should be geared towards ameliorating this deficient state of preparedness as well as the poor access to quality healthcare and the skewed spatial distribution of facilities, medication, equipment and skilled manpower across the nation.

CHAPTER 7: RECOMMENDATIONS

Based on our study finding, there is a need for the Federal Ministry of Health to conduct an official audit to determine preparedness across PEDs in Nigeria. A nationwide assessment in all PEDs of the state of skilled personnel and access to essential acute care medication and equipment should be conducted. This will serve to guide policymakers with the allocation of resources that will be required to improve the state of PED services across the country. In addition, efforts should be channelled at developing national essential guidelines and checklists that are specific to the needs of the Nigerian population. This will facilitate the provision of all listed items. Other recommendations include; the implementation of a structured subspecialty training programme in paediatric emergency medicine, rollout of compulsory advanced life support training courses for all PED staff, quality checks on the availability of medications as well as the availability and functionality of equipment. In addition, the introduction of a peer ranking system for PEDs across the country will engender healthy competition and foster the delivery of quality care.

CHAPTER 8: SUGGESTED FUTURE RESEARCH

Suggested future research topics in this field include:

1. The competency of emergency care providers and their impact on the provision of paediatric emergency care
2. Designing and implementing a resource-tailored standard practice guideline to achieve quality emergency care in Nigeria
3. The impact of regionalized practice guidelines on delivery of paediatric emergency care in Nigeria.

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APPENDICES

APPENDIX A: QUESTIONNAIRE / DATA COLLECTION SHEET

Kindly answer all questions and add comments/explanation where necessary. Please mark [x] in the boxes or circle the item(s) that best describe your answer where indicated. Thank you for your time

PART A: PHYSICIAN STAFFS CHARACTERISTICS

HEAD OF DEPARTMENT (HOD), PAEDIATRIC EMERGENCY DEPARTMENT (PED) PARTICULARS					
MBBS		Fellowship in Paediatric		Attended PED conference this year	
BLS		Fellowship in Emergency Medicine		CPD up to date	
APLS/PALS		Fellowship in Paediatric emergency medicine		Others……	
ATLS		Others…….			
PED patient load and shift duty					
How many daily shifts does your unit have? _____ How many patients did you see in last 30 days _____ How many patients admitted in the last 30 days _____					
UNIT /DOCTORS PARTICULARS					
How many **interns** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many interns per shift on the average? _____					
How many **medical officers** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many medical officers per shift on the average? _____					
How many **junior registrars** employed on the average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many junior registrars per shift on average? _____					
How many **senior registrars** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many senior registrars per shift on average? _____					
How many **consultants** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ What are the qualifications of each consultant? _____ How many consultants per shift on the average? _____					

BLS+ Basic Life Support, PALS= Paediatric Advanced Life Support, APLS= Advanced Paediatric Life Support, ACLS= Advanced Cardiovascular Life Support, ATLS= Advanced Trauma Life Support, NNR= neonatal resuscitation, CPD= Continuous Professional Development

PART B. NURSING STAFFS CHARACTERISTICS

UNIT NURSING MANAGER PARTICULARS					
RN		Paediatric nursing training		Attended PED conference this year	
BLS		Emergency Medicine nursing training		CPD up to date	
APLS/PALS		Paediatric emergency medicine nursing training		Others……	
ATLS		Others…….			
UNIT NURSES PARTICULARS					
How many **nursing officer's 2** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many nursing officer's 2 per shift on average? _____					
How many **nursing officer's 1** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many nursing officer's 1 per shift on average? _____					
How many **ACNO's** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many nursing ACNO's per shift on average? _____					
How many **CNO's** employed on average? _____ How many have a current certificate in 1) BLS ____ 2) PALS/APLS ____ 3) ACLS ____ 4) ATLS ____ 5) NNR ____ 6) Other (Specify) _____ How many CNO's per shift on average? _____					
How many patients have been seen over the last 30 days on average at the PED? _____					

BLS+ Basic Life Support, PALS= Paediatric Advanced Life Support, APLS= Advanced Paediatric Life Support, ACLS= Advanced Cardiovascular Life Support, ATLS= Advanced Trauma Life Support, NNR= neonatal resuscitation, ACNO= Assistant Chief Nursing Officer, CNO= Chief Nursing Officer, CPD= Continuous Professional Development

PART C. EMERGENCY DRUGS LIST (please mark [X] and circle where appropriate)

ESSENTIAL DRUGS					
Nitroglycerine (spray / sublingual / oral / IV)		Activated charcoal		Fibrinolytic agents	
Adrenaline (1:1000 / 1:10 000)		Hydrocortisone/ Dexamethasone		Vitamin K	
Dopamine/ Dobutamine/ Clopidogrel		Diazepam (rectal, IV)/Flumazenil		Heparin / Protamine	
Hydralazine/Verapamil/labetalol/Nitroprusside		Lorazepam / Midazolam		Morphine/Naloxone	
Digoxin (oral / parenteral)/ Amiodarone		Magnesium sulphate/Paraldehyde		Atropine/Adenosine	
Antihistamines (e.g. promethazine)		Benztropine / Diphenhydramine		ORS/Zinc sulphate	
Ipratropium (nebules / inhaler/spacer / mask)		Calcium chloride 10%		Fluorescein	
Salbutamol (nebules / Aminophylline		Calcium gluconate 10%		Antibiotic	
Corticosteriod nebules/inhaler/spacer/mask)		Sodium bicarbonate;8.4% / 4.2%		Antiallergen	
Medical oxygen (cylinder / piped)		Potassium chloride; oral / IV		Mydriatrics	
Lignocaine (IV / local infiltration)		Insulin (soluble)/Glucagon		Anaesthetics	
Thiopentone / Ketamine/ Propofol		Post Exposure ARV Prophylaxis		Silver nitrate	
Phenytoin sodium (oral / parenteral)		Antibiotics (oral / parenteral)		0.9% saline	
Chlorpromazine;oral/parenteral/ Haloperidol		Antimalarial; artesunate/Quinine		Steroids	
Phenobarbitone (oral / parenteral)		Antipyretics /Acetylcysteine		Analgesics	
Rocuronium/Vecuronium/Scoline/Atracurium		Dihydrocodeine (DF118)/NSAID		Antacid/H2 blocker	
Anti-rabies vaccine/ Immunoglobulin		Furosemide/ spirinololactone		Emetics/Antiemetics	
Antitetanus serum/ tetanus toxoid		Propranolol / Prostaglandin E1		Laxative/antidiarrhea	
Antivenom;snake/spider/scorpion)		Others……		Others…….	

ESSENTIAL IV SOLUTIONS			
Saline (0.9% / 0.45%)		Ringers lactate	
Dextrose (10% / 50%)		5% dextrose in 0.45% saline	
Darrows (half strength / full strength)		5% dextrose in water	
Mannitol (10% / 20%)		Balsol	
Other (specify)			
Do you have standard list for Emergency department medications/fluids?		Yes / No	
Are clinical staff trained on location of medicine/fluid and paediatric dosing chart and formula		Yes / No	

PART D. EMERGENCY EQUIPEMEN / CONSUMABLES LIST (please mark [X] and circle where appropriate)

DEVICES TO OPEN AND PROTECT AIRWAY			
Laryngoscope handle (how many? _____)		Laryngoscope spare bulbs	
Laryngoscope blades: straight or Miller 0/1/2/3 and Macintosh; 1/2/3/4		Laryngoscope spare batteries	
Endotracheal tubes: uncuffed; 2.5/3.0/3.5/4.0/4.5/5/5.5/6.0/6.5/7.0/7.5/8.0 mm		Meconium adaptor / aspirator	
Endotracheal tubes: cuffed; 6.5/7.0/7.5/8.0/9.0 mm		10 ml syringe	
Oropharyngeal airways sizes: 0/1/2/3/4/5		Water-soluble lubricant; KY jelly	
Tracheostomy tubes sizes: 00 / 1/ 2/ 3/ 4/ 5/ 6		Tape or plaster	
Nasopharyngeal airways: 3/4/5/6/7			
DEVICES TO CONFIRM TRACHEAL INTUBATION			
Oesophageal detector device		Single use colorimetric devices	
End tidal CO2 monitor			
EQUIPMENT FOR DIFFICULT INTUBATION			
Stylets (infant / paediatric / adult)		Cricothyroidotomy set	
Magill's forceps (paediatric / adult)		Tracheostomy set	
Laryngeal mask airway (sizes 1/ 1.5 /2 /2.5 /3 /4 /5)		Gum elastic bougie; adult / paediatric	
Video laryngoscopy			
Other (specify): _____			
DEVICES TO DELIVER OXYGEN AND TO VENTILATE PATIENTS			
Bag valve mask ventilation devices with oxygen reservoir & adult/paediatric/neonatal masks			

Oxygen delivery devices: non-rebreather mask / partial rebreather masks / venturi mask / nebulizer masks/ nasal prongs/ T-piece/ Laryngeal mask airway; sizes 1/ 1.5 /2 /2.5 /3 /4 /5, oxygen hood			
Oxygen supply with flow regulator and oxygen tubing			
PEEP valve with adaptor for bag valve device			
Portable ventilator			
EQUIPMENT FOR DECOMPRESSION OF THE THORAX			
Chest decompression sets minimum of a 14G Jelco		scalpel, dissecting forceps,	
Intercostal drains sizes: 10 /12/ 14/ 16/ 18/ 20/22/24/26/28/30/32/3436		Under water seal bottles	
EQUIPMENT TO DIAGNOSE AND TREAT CARDIAC DYSRHYTHMIAS			
ECG monitor defibrillator with conductive paste/ pads/ paddles/ electrodes /razor			
Cardiac arrest board		Transcutaneous pacing ability	
DEVICES TO GAIN INTRAVASCULAR ACCESS			
I.V. cannulae: 14 / 16 / 18 / 20 / 22 / 24 G		Appropriate strapping	
Needles: 20 / 21 / 22 / 23 / 24 G		Bone marrow needles	
Hypodermic Syringes: insulin / 2 / 5/ 10 / 20/ 50 ml		High flow infusion catheters 8.5F	
Packs and lines for central venous access		Sterile gloves / Sharps container	
Intraosseous needles: paediatric / adult		Vein finders	
EQUIPMENT FOR THE SAFE INFUSION OF FLUIDS AND BLOOD			
I.V. administration sets: blood &products/fluids		Fluid warmer / Arm board	
Infusion pumps		Umbilical vein catheters	
EQUIPMENT FOR MONITORING AIRWAY, BREATHING AND CIRCULATION			
Pulse oximeter with adult / paediatric probes		Stethoscope/ cardio pulmonary monitors	
Blood pressure cuff: neonatal/paediatric/ adult		blood pressure monitoring device	
Thermometer: normal / low reading/ axilla/TM/rectal		Glucometer and strips	
Automatic blood pressure device / spare battery		Ultrasound with vascular Doppler	
Collection tubes for investigations		Bed side blood gas/electrolytes test machine	
APPROPRIATE HARDWARE			
Heavy duty scissors to cut clothing/ Wire cutters		Therapeutic heating source	
Drip stand or equivalent hanging device		Maternity delivery pack/ Cord clamps	
Suction devices and suction catheters		Eye speculum/ De mere eye retractors	
Otoscope/ophthalmoscope/ tonometer/ visual chart		Suture material/ forceps/ I & D set/ LP set	
Limb traction devices; femoral /extremities / clutches		Cast application supplies/spreader/cutter	
PPE: gloves /goggles/ gown / face mask		Medication stickers	
Vacuum mattress / Scoop stretcher		dental set / nasal speculum/ jobsen ear probe	
Resuscitation trolley capable of high Fowlers and Trendelenberg			
Paediatric Broselow tape / equivalent (specify) _____ _____			
adult & paediatric semi-rigid cervical collars		restraining devices	
head blocks / spine boards		blankets & towel rolls	
X-ray view board		Clock/ weighing scale/ meter rule/	
TUBES AND CATHETERS			
Lumbar puncture set		Drainage bags	
Urinary catheters: sizes 8 – 18		Resuscitation Algorithms	
Nasogastric tubes: sizes 5 – 18		Resuscitation documentation record	
Do you have standard list for Emergency room equipment / consumables?			Yes / No
Do you check if the equipment's are functional and cleaned			Yes / No
Are clinical staff trained on location of equipment and paediatric size chart			

APPENDIX B: POINT SCORE SCALE

Managerial domain (maximum score 7)	**No (=0)**	**Yes (=1)**
Presence of dedicated head of department (HOD)		
HOD with any of the advanced life support training		
Possession of Additional Emergency Medicine related qualifications		
HOD attended any of Paediatric conference or Refresher activities in the last one year.		
Nursing manager (NM) with any advanced life support training		
a nursing manager with any additional Emergency Medicine related qualifications		
NM attended any of Paediatric conference or Refresher activities in the last one year		
Total score		

Medication domain (maximum score 81)	**No (0)**	**Yes (1)**
Acetyl cysteine		
Activated charcoal		
Adenosine		
Adrenaline		
Aminophylline		
Amiodarone		
Analgesic eye drops		
Antacids		
Anti-allergy eye drops		
Antibiotic eye drops		
Antibiotics		
Antidiarrhoeal		
Antihistamines		
Antimalarial		
Antirabies		
Antitetanus serum		
Antivenom		
Aspirin		
Atropine		
Balsol		
Calcium Chloride		
Calcium Gluconate		
Chlorpromazine		
Clopidogrel		
Corticosteroid inhaler		
Curoniun		
Darrow's		
Dexamethasone		
Dextrose 10%/20%		
Dextrose 5%		
Dextrose saline		
Diazepam		
Digoxin		
Dihydrocodiene (DF118)		
Dobutamine		
Dopamine		
Emetics/ anti-emetics		
Fibrinolytic agents		
Flumazenil		
Furosemide		
Glucagon		
Haloperidol		
Heparin		

Hydralazine		
Hydrocortisone		
Insulin		
Ipratropium bromide		
Ketamine		
Labetalol		
Laxatives		
Lignocaine		
Lorazepam		
Mannitol		
MgSO4		
Midazolam		
Morphine		
Mydriatics		
Naloxone		
Nitroglycerine		
Nitroprusside		
Non-steroidal anti-inflammatory drugs		
Normal saline		
Oral Rehydration Solution/Zinc		
Oxygen supply		
Paraldehyde		
Phenobarbitone		
Phenytoin		
Post Exposure Prophylaxis		
Potassium Chloride		
Propofol		
Propranolol		
Prostaglandin E1		
Protamine		
Ringers lactate		
Salbutamol		
Silver nitrate eye drops		
Sodium bicarbonate		
Steroid eye drop		
Thiopentone		
Verapamil		
Total score		

Equipment domain (maximum score 98)	**No (=0)**	**Yes (=1)**
10 ml syringe		
Adhesive tape		
Automatic blood pressure device/ spare battery		
Bag valve mask device with oxygen reservoir /mask (infant/paediatric/adult)		
Biochemistry analyser (U/E/Cr)		
Blankets		
Blood gas analyser		
Blood pressure cuffs (neonatal, paediatric / adult		
Blood pressure monitoring device		
Bone marrow needles		
Broselow tape		
Cardiac arrest board		
Cardiopulmonary monitoring device		
Cast applicator		
Central venous access set		
Chest decompression set		

Clock		
Collection tubes		
Colorimeter device		
Cord clamps		
Cricothyroidotomy set		
Delivery pack		
Dental set		
Doppler device		
Drip stands		
ECG monitor with defibrillator and accessories (paste, pads, electrodes, razor)		
Endotracheal tubes- cuffed		
Endotracheal tubes- uncuffed		
Equipment check book		
Equipment check list		
ETCO2 monitor		
Eye speculum		
Fluid warmer		
Glucometer		
Gum elastic bougie; paediatric /adult		
Heat sources		
Heavy duty scissors		
High flow infusion catheter (8.5F)		
Hypodermic syringes (insulin- 50mls)		
Incision and drainage (I&D) set		
Infusion pump		
Intercostal drain catheter (12-36 Fr)		
Intraosseous needle (paediatric/ adult)		
Intravenous fluid and blood administration set		
IV cannula (14-24G)		
KY jelly		
Laryngeal mask		
Laryngoscope blade		
Laryngoscope handle		
Laryngoscope spare battery		
Laryngoscope spare bulb		
Limb traction		
Lumbar Puncture set		
Magill forceps		
Meconium adaptor		
Medication labels		
Meter rule		
Nasogastric tubes		
Nasopharyngeal airway		
Neck collar		
Needles (18-27G)		
Oesophageal detector device		
Oropharyngeal airway		
Otorhinolaryngology diagnostic kit		
Oxygen delivery devices (e.g. face mask, nasal prongs)		
Oxygen supply with flow regulator and tubing		
PEEP valve with adaptor for BMV		
Personal protective equipment hardware		
Pulse oximeter (paediatric / adult probe)		
Restraint device		
Resuscitation algorithm		
Resuscitation documentation record		
Resuscitation trolley		
Scalpel / Dissecting forceps		
Sharp containers		

Spine board		
Sterile gloves		
Stethoscope		
Strapping		
Stretcher		
Stylet (infant/paediatric/adult		
Suctioning devices		
Suture materials		
Thermometer (normal/low reading)		
Tracheostomy set		
Tracheostomy tube		
Transcutaneous pacing		
Umbilical vein catheter		
Under water seal bottle		
Urinary catheter		
Urine bags		
Vacuum mattress		
Vein finder device		
Ventilator machine		
Video laryngoscope		
weighing scale		
Wire cutter		
X-ray viewing board		
Total score		

Overall Performance score

Managerial domain Total score	**Medication domain total score**	**Equipment domain total score**	**Overall total score**	**Total score % (Sum total /186 x 100)**

APPENDIX C: UNIVERSITY OF THE WITWATERRAND ETHICS CLEARANCE CERTIFICATE

R14/49 Dr Callistus Okwuchukwu Achuri Enyuma

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170445

NAME: (Principal Investigator)	Dr Callistus Okwuchukwu Achuri Enyuma
DEPARTMENT:	Emergency Medicine Paediatric Emergency Departments of the 45 Tertiary Health Care Facilities in Nigeria
PROJECT TITLE:	Paediatric Emergency Departments in Nigeria: How Prepared Are They to Provide Emergency Care
DATE CONSIDERED:	05/05/2017
DECISION:	Approved
CONDITIONS:	South African Human Research Ethics Committees (HRECs) have no standing outside South Africa. Ethics approval is also required from local HRECs in Nigeria
SUPERVISOR:	Dr Abdullah Laher
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	26/05/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in April and will therefore be due in the month of April each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX D: FEDERAL MINISTRY OF HEALTH OF NIGERIA ETHICS

CLEARANCE CERTIFICATE

National Health Research Ethics Committee of Nigeria (NHREC)

Promoting Highest Ethical and Scientific Standards for Health Research in Nigeria

Federal Ministry of Health

NHREC Protocol Number NHREC/01/01/2007-11/04/2017
NHREC Approval Number NHREC/01/01/2007-21/05/2017
Date: 21 May 2017

Re: Paediatric Emergency Departments in Nigeria: How Prepared are they to provide Emergency Care?

Health Research Committee assigned number: NHREC/01/01/2007
Name of Student Investigator: Callistus O.A. Enyuma
Address of Student Investigator: Division of Emergency Medicine
Faculty of Health Sciences
University of the Witwatersrand
Johannesburg
South Africa
Date of receipt of valid application: 11/04/2017
Date when final determination of research was made: 21/05/2017

Notice of Expedited Committee Review and Approval
This is to inform you that the research described in the submitted protocol, the consent forms, advertisements and other participant information materials have been reviewed and *given expedited committee approval by the National Health Research Ethics Committee.*
This approval dates from 21/05/2017 to 20/05/2018. If there is delay in starting the research, please inform the HREC so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used in this study must carry the HREC assigned number and duration of HREC approval of the study.* In multiyear research, endeavour to submit your annual report to the HREC early in order to obtain renewal of your approval and avoid disruption of your research.
The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the HREC. No changes are permitted in the research without prior approval by the HREC except in circumstances outlined in the Code.
The HREC reserves the right to conduct compliance visit your research site without previous notification.



Signed
Professor Zubairu Iliyasu. MBBS (UniMaid), MPH (Glasg.), PhD (Shef.), FWACP, FMCPH
Chairman, National Health Research Ethics Committee of Nigeria (NHREC)

Department of Health Planning, Research & Statistics
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Tel: +234-09-523-8367
E-mail: chairman@nhrec.net, secretary@nhrec.net, deskofficer@nhrec.net,
URL: http://www.nhrec.net,

APPENDIX E: TURN-IT-IN REPORT

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ORIGINALITY REPORT

6%	5%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	"2015 ACR/ARHP Annual Meeting Abstract Supplement", Arthritis & Rheumatology, 2015. Publication	<1%
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