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Reducing Early Neonatal Mortality in Nigeria—The Solution

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Abstract

The West African nation of Nigeria seems to have run out of ideas on how their neonatal mortality rate may be lowered. This situation has become dare as the country could not make any significant progress even with the great supports of the last 10 years of Millennium Development Goal. Presently, one in every two deceased child under 5 years of age in Nigeria is a neonate. Literature reveals that most of these deceased neonates are classified preterm or low birthweight, of which nearly four in five must die within first 7 days. This clearly identified the categories and stages of highest mortality; however, it is disappointing that the authorities of the Nigerian health care system have for too long been unable to devise a solution for the neonates. Probably, inadequacy of climatic and cultural compatibilities might partly be responsible for the failure of their current conventional ideas and technologies—these being predominantly imported. Yet, there seems to be lack of interest in some home-grown unconventional ideas that have achieved the needed reduction at few centers. In this chapter, we present the unconventional approaches and encourage across-the-nation translation of the applications to achieve accelerated end to this situation.

Keywords: neonate, Nigeria, neonatal mortality, innovative technique, thermal distress

1. Introduction

Neonatology in the West African sub region, especially in Nigeria, will remain in a state of “scientific comma” until a decisive solution is found to reverse her high neonatal mortality that has continued to be the highest in the world. The solutions required might not necessarily be conventional, as practiced in developed countries of the world, since such imported

scientific methods and systems have failed to completely eliminate or drastically reduce the mortality rates. These certified foreign solutions have been probably rendered ineffective within the Nigerian practice due to complications of poor infrastructure, climate, and above all poor work ethics and cultural inadequacies. The effective solution might not necessarily be the “state-of-the-art” procedures that are applied in the United States of America, United Kingdom, and Europe as Nigerian practitioners continue their endless importation of all kinds of relevant and irrelevant ideas but without the necessary infrastructural base to effectively operate these. This country requires a new breed of scientists and neonatologists that can believe in themselves, look inwards, and apply research methods to develop culturally compatible neonatal solutions using easy-to-acquire and locally available materials.

The Nigeria neonatal record is among the worst in the world. There is no evidence to suggest that more neonates are surviving in Nigeria today as compared to 10 years ago, even with the very celebrated millennium development goal (MDG) campaign. Presently, neonatal contribution to mortality rate below 5 years of age in Nigeria has risen in the last 10 years from 40 to nearly 50% despite the huge expenditure of MDG in Nigeria on importation of ideas and systems [1]. The big questions before anyone who might attempt to solve the high neonatal mortality in Nigeria are:

1. What is *really* the primary factor(s) behind the failure to achieve improved overall neonatal survival in Nigeria?
2. Up to 18 morbidity factors contribute to neonatal deaths in Nigeria but are these contributing equally?
3. Is it needful to save time and resources from some factors and dedicate these to synthesize absolute solutions just for one factor or few that could bring about huge impact, and what could this one factor be?
4. Are there any cluster point(s) of highest mortality that might require in-depth investigation within the spectrum of neonatal life-span of 28 days from birth?
5. How may any locally grown “appropriate technological” solution be integrated into Nigeria's health care system; how may this be applicable both at the tertiary and primary health care levels and be made available to the hardest-to-reach neonates across the hinterlands of the country?

In this chapter, our research group of a team of young Nigerian neonatologists and technologists will discuss our vast experiences and progressive syntheses of ingenious local-content ideas that have drastically reduced the neonatal mortality rate at pockets of neonatal centers across Nigeria; thus, achieving an average facility-based mortality rate of 33/1000 presenting neonates as compared to the national average of 248/1000. We shall discuss the various applications that have restored hope to neonates within our practice—including the handy-approach and initial-setpoint-algorithm (ISA) techniques—and how all the applications have contributed to achieve nearly 100% facility-based survival of premature and low birthweight neonates (including 600-g birthweight) within their first 7 days of life.

2. Many are dying

In 2016, an estimated average of 248 neonates out of 1000 presenting at special care baby units (SCBUs) in Nigeria died. Most of these babies reportedly died of various causes during their first 1 week of life. These data were extracted from a collection of independent outcome publications during the 47th national conference of Paediatrics Association of Nigeria (PANCONF) in January 2016. It is a common practice in Nigeria that SCBUs try to use this annual conference to showcase their discoveries, best practices, and outcomes. Therefore, data that were presented could be taken to be what they considered the most impressive or the best of what the centers were prepared to let others know about. The beauty of the content of the proceeding of the PANCONF 2016 on this subject was that the seven coincidental reports came from centers spread equally across the entire country. This includes:

- (1) Yariman Bakura Specialist Hospital (YBSH) Gusau in the North-west [2]
- (2) University of Abuja Teaching Hospital (UATH) Gwagwalada in the North-central/middle-belt [3]
- (3) Lagos State University Teaching Hospital (LASUTH) Ikeja in the South-west [4]
- (4) Stella Obasanjo Specialist Hospital (SOSH) Benin-city in the Mid-west [5]
- (5) University of Port Harcourt Teaching Hospital (UPTH) in the South-south [6]
- (6) Federal Medical Centre (FMC) Owerri in the South-east [7]
- (7) Federal Medical Centre (FMC) Asaba in the South-south [8]

It is worthy of note that six of these independent outcomes came from data sets that were generated based on the conventional techniques of newborn care in Nigeria. This resulted in a national mortality average of 248/1000 [2–6, 8]. However, two of these independent centers presented outcome data that had been influenced by their adoption and practice of the various unconventional methods that were developed through the collaborative research of Neonatal Concerns for Africa [9]. In-between these two institutions, the average neonatal mortality crashed below 34/1000 [3, 7]. This translates to a national average reduction of facility-based mortality by a whopping 86%.

Previous publications on conventional practices within the last 10 years have reported facility-based averages such as 254/1000 and 250/1000 [9, 10]. These figures are quite similar to the present 248/1000; hence, this raises the question of why the custodians of neonatal health in Nigeria have been unable to articulate decisive solutions for such a national emergency situation. The scientists seem far too busy with other things than to own the blame, put on their thinking caps, and synthesize an affordable and sustainable home-grown solution to save their neonates. Instead, the over-dependence on unsustainable importation of foreign technologies and ideas have left the Nigerian health care professionals so scientifically lazy that the neonates are still far away from their hope for survival. It was expected that the high publicity and available funds during the last 10 years of the millennium development goals

(MDG) would have empowered a great success. Since this was an unfortunate failure for the neonatal sector at the national level, Nigeria could restore hopes by a humble study of what constituted the pockets of successes recorded by some few centers that adopted unconventional techniques.

3. Change is compulsorily needed

Neonatal health care professionals in West Africa, especially Nigeria, need to understand that the world expects them to apply whatever science they can manage to deliver a drastic reduction in the neonatal mortality rates as it has been known for the last 10 years. It ought to be a challenge to the health care providers in this country that no significant improvements have been achieved, even after ten years of accelerated campaigning and spending—from the 2007 demographic data of the World Health Organization (WHO) to that of Nigeria's Federal Ministry of Health (FMoH) of 2010, to that of UNICEF's 2012, and perhaps up to the indices of 2017 (**Figure 1**) [1, 11–14].

The question that remained unanswered is whether there are any more untried ideas left for the Nigeria's FMoH and the other custodians of neonatal health in Nigeria that can help lower their well-known horrible indices, including:

- (a) Neonatal deaths accounting for nearly 50% of all deaths of children under 5 years of age [1, 15]
- (b) Nearly 80% of all deceased neonates dying within their first 1 week of life [14, 16]

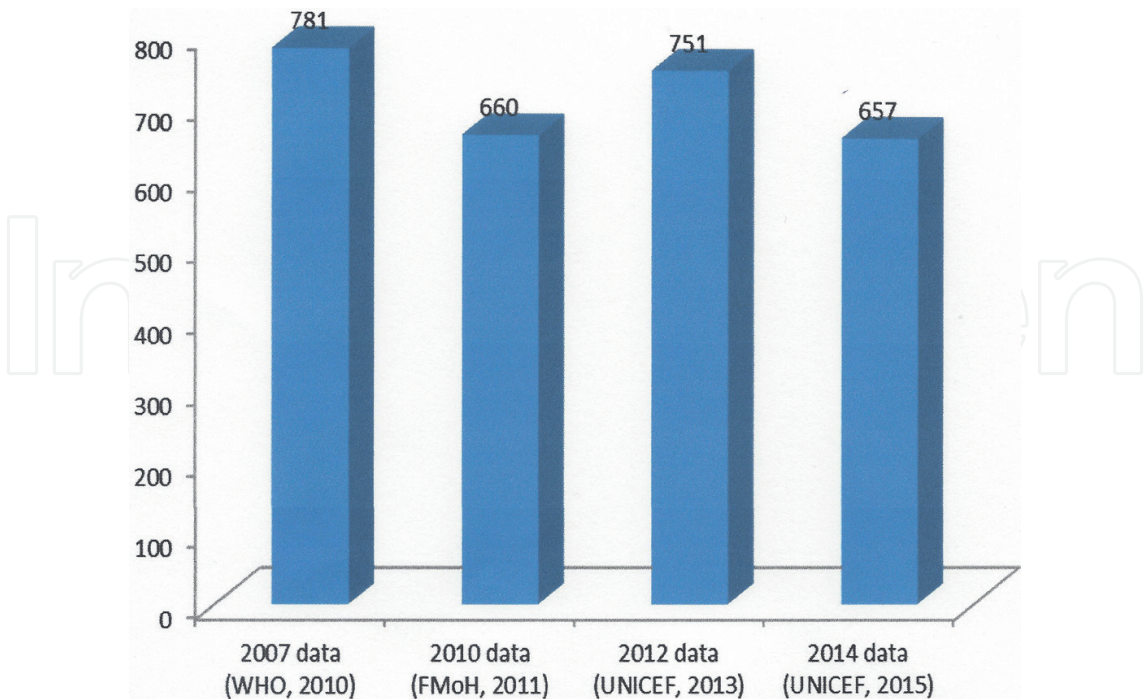


Figure 1. Daily newborn mortality over last 8 years of MDG.

This showed that most deceased neonates died before their 7th postnatal day, beyond which most surviving neonates would successfully go home alive. We hypothesize that after the first quarter of neonatal life, i.e., 7 of 28 days, most Nigerian neonates are strong enough to contribute their minimal quotas in resisting and fighting their various debilitating morbidities, howbeit, within a conducive and stable physiological state. The first few days after birth are their greatest period of need for external life support systems and procedures. Inadequate support and procedures during this period would normally be associated with such high rate of death as reported in Nigeria. The most vulnerable of the neonates is the premature ones who may necessarily require knowledgeable support for survival. Nigerian authors have shown that mortality for very preterm and extremely low birthweight neonates at some hospital centers can be quite high, even as high as 933/1000 [17–20]. It is our opinion that the current Nigerian conventional facility-based practices during early neonatal life is inadequate or fundamentally faulty. Our resonating questions remain: Has Nigeria got any other ideas for preventing such high rate of early neonatal deaths that has not yet been tried since the last 10 years as these are urgently needed? Is it time for the FMoH and the establishments to come out openly to accept the failure? Is it time to have compassion on the neonates and search for other sustainable, and perhaps, unconventional methods as have been demonstrated in few pockets of Nigerian centers? The time cannot be any sooner than now.

4. Wholesale importation is unsustainable

It is always attractive to import latest technologies for application in Nigeria. However, poor infrastructural development makes such applications unsustainable. Modern medical equipment is quite expensive and unaffordable to many medical institutions that must look after the neonates. However, the procurement of these systems is not necessarily the main problem. Sadly, the age long pattern at these mostly government-owned referral centers is such that after many years of impoverished neonatal outcomes and political harassments, the government manages to provide appropriate funds to purchase only few of the required equipment. However, no sooner this is done, the center goes back into comatose due to inability to maintain the systems. The efficiency of a system or procedure can often depend on factors relating to infrastructural base, climate, peoples' culture, work attitude, manpower, maintenance supply chain, etc. It is essential that these factors are carefully considered, or else a wholesale adoption of a foreign idea may not yield same result as expected. Nigeria's 100% reliance on importation of needed technologies and ideas are unsustainable due to these factors. The best options forward are either adaptation or synthesis of own solutions.

5. Adaption requires scientific thinking

Most of Nigeria's neonatal systems, techniques, and procedures are imported from the United Kingdom, Europe, or America where these are well-proven to be very effective, reliable, and sustainable. Unfortunately, similar outcomes would depend on the abilities of the importing

country to adapt the application within their own variables of culture, climate, and infrastructure. This requires some scientific thinking. There may be a need to understand the basic physics of the application in order to know the aspect of the application that needs tweaking; and how best to do this to make the application reliably operable in the setting. The Nigerian scientific and research community must be alive, active, and confident to create such intermediate technologies. We think that a quicker success could be made if technologies are tweaked to fit the Nigerian weather and culture rather than the more difficult route of “tweaking culture for a piece of imported technology”. This challenge is both for the Nigerian government but much more for the Universities, research institutions, and their Professors.

6. Syntheses of unconventional techniques

Our hypothesis created the drive to search for the possible factor that could be secretly at work or that might provide a huge positive impact for the neonates if isolated. The search began with a nationally circulated questionnaire that identified lack of functional incubators as a major factor militating against neonatal survival in Nigeria [17]. However, advancing consistently with various careful comparative investigations, our research can presently reveal a strong association of “thermoneutral instability”, hiding behind a host of co-morbid conditions that had been said to be responsible for high rate of neonatal mortality in Nigeria [15]. Consistent thermal stability within body temperatures of 36.5–37.4°C is essential for the neonate's physiological wellness to fight disabling conditions, maintain positive progress, and for survival. Lack of thermal stability leaves the neonates so moribund that the other presenting co-morbid factors become excessively too powerful for the neonates in their fights for survival. Hence, unbroken provision of neonatal thermoneutral environment—without excuses of unfavorable weather, climate, cultural, and work attitudes—could be the one-factor game-changer that has eluded neonatal practice in Nigeria.

We developed and tested applications as we investigated various phenomena that were very evident in the Nigerian setting. Methods that applied locally available materials were more easily sustainable, affordable, and maintainable. We opted for these, thereby introducing applications, procedures, and advocacies at various times as published in Ref. [9]. We hence created a package of stand-alone activities that supplemented each other to produce the reported great outcomes at Special Care Baby Units of the Federal Medical Centre Owerri and University of Abuja Teaching Hospital in 2016 [3, 7]. These applications were:

6.1. The Recycled incubator technology (RIT)

In a period of economic recession such as Nigeria is currently experiencing, neonatal incubators are increasingly unaffordable due to skyrocketing foreign exchange. Dysfunctional and broken-down incubators litter the hospitals, yet the preterm babies are arriving in their thousands every day. We developed some techniques that Nigeria could use to re-engineer and activate these dysfunctional systems, offering up to 10 fresh years of life-expectancy at costs that are less than 20% of selling price of modern incubators. Recycled incubator technology (RIT) has worked very well for our collaborating hospitals centers, ensuring consistent

availability of over 15 functional incubators at all times. This grants them an outstanding position when compared with the other government centers that hide behind lack of funds to deny the neonates of this vital system. Any Nigerian hospital with any available casing of broken-down incubator does not actually have excuses to give in support of their denial and neglect for this basic neonatal need. The RIT upgrading or conversion is affordable and does not necessarily require special government subvention as many of our collaborating centers fund this from their internally generated revenue. This simple unconventional technology of the RIT is saving huge amount of lives in Nigeria without huge spending; hence, the Nigerian government and the custodians of neonatal health in Nigerian should pay attention.

6.2. The failure-preventive audit culture (FAC)

One wonders why routine maintenance of these items of neonatal equipment in Nigeria is so neglected. Neonatal systems such as the incubator, as a life support machine, works nonstop, day-in and day-out, yet the conventional Nigerian practice does not involve a compulsory regular maintenance by qualified personnel. Regular professional maintenance of neonatal systems, even in their countries of manufacture, is a routine never to be compromised. Yet anyone wonders why there are so many broken-down systems at Nigerian centers where machines are run continuously without servicing until they are destroyed. The systems at our centers are always functionally available because the hospitals run a six monthly mandatory failure-preventive audit culture (FAC) for the incubators. Similar assiduous care must be made compulsory at all SCBUs operating in Nigeria. Suffice to mention that many of the incubators are homes for the microbes that infect the dying neonates as a result of lack of routine technical cleaning and decontamination. As this is an unlawful life-threatening exposure of a neonate to harmful environment, the seriousness of the Nigerian government should be measured by their willingness to prosecute defaulting professionals and institutions.

6.3. The power banking system (PBS)

The widespread exposure of the neonate to hypothermia even when functional incubators are available can be due to epileptic power supply or outright power failures that last hours unending. The incubator becomes useless when there is no power to run it. Grid power failure can even last for days in Nigeria such that a standby fossil fuel generator becomes inadequate and unsustainable to provide uninterrupted incubator care. Nigeria is yet to provide a decisive solution for her inability to deliver uninterrupted grid power to the nation. Many centers rely on this limitation to offer excuses for the high neonatal mortality. In our few centers, however, the incubators run uninterrupted by the application of our power banking system (PBS) initiative. We used batteries to store up power from the grid and generators whenever these were available. This was in addition to trickling recharging of the batteries using photovoltaic cells mounted on the rooftops, especially when there was failure of both grid and fossil generator powers that lasted longer than necessary.

6.4. Evening-fever syndrome (EFS) antidote

The Nigerian climate can get excessively hot with a higher temperature of up to 47°C in some cities during the dry season [21, 22]. Preterm neonates are often unable to regulate their body

temperatures downward from the high room temperatures in excess of 38°C. This leads to periodic fever that sets in during late afternoons and abates later in the evening, long after sunset. This phenomenon of evening-fever syndrome (EFS) was investigated leading to the proposal of a weather-resilient building technique for neonatal nurseries in Nigeria [22, 23]. We discovered that the periodic hyperthermia due to EFS, often misdiagnosed as a disease process, has the consequences of neonatal thermal distress that drastically slowed down baby's response to treatment. It was hence essential that all our nurseries were renovated or properly relocated within the hospital complexes so as to eliminate or minimize this phenomenon. Neonates in our centers were hence kept within allowable physiological temperatures even when climatic ambient temperatures soared higher above 45°C.

6.5. SCBU nurses retention advocacy

One obnoxious common practice in Nigerian tertiary hospitals is the periodic reshuffling of nurses around various departments of the hospital irrespective of specialities. This practice has such huge negative impact on neonatal outcome that some managers have refused to pay attention to. The practice might be useful in adult wards, some may argue, but this is definitely counterproductive in the special care baby units. It takes much longer than 1 year to transform a general nursing practitioner into one with enough skills to effectively manage the neonates. Learning on the job comes along with its own consequences of blunders that are often committed, some leading to neonatal deaths. However, just as some of these, on-the-job trainees are about to become useful, they are asked to move on while a new bunch of starters are brought in to continue with the devastation. This practice of replacing trained and knowledgeable nurses with learners and starters might sound unbelievable to readers of this article from developed nations; however, this is really one of those practices that have quietly contributed to huge numbers of preventable neonatal deaths in Nigeria. The parochial views of the nursing establishments in Nigeria, including such arguments as “any qualified nurse could work in any department of the hospital”, are so powerful that nursing managers seem to have completely lost their senses of reasoning to protect these poor neonates. The management of our few hospital centers has standing rules, after many advocacies, to limit this nurses' reshufflings within only 10% of the entire SCBUs nursing crew. This posting is, however, forbidden to affect the best of the crew members. The challenge here is that members of the SCBU crew are so overworked that many often seek to be posted away. So to minimize this, special incentives other than what all nurses received were given to SCBU crew members in appreciation. This allowed incentives and privileges are still hotly contested in some of our hospitals by supporters of other greedy nurses who would not even want to work at the SCBUs themselves.

6.6. Breathing/apnoea monitors

Lack of adequate number of nursing staff in Nigerian hospitals is an age-long problem that has remained unsolved. This has a huge negative impact on neonatal outcome at Nigerian newborn centers. Hospital managements quickly agree with the need for more staff whenever confronted. However, they easily argue their ways through with the use of Government's endless

embargo on employment. This problem is as bad as having only two nurses to look after 38 neonates during a work-shift in one of Nigeria's busy University Teaching Hospital where this corresponding author once worked as a visiting consultant. How on earth would anyone explain what happens to four neonates that could be undergoing apnoeic attack simultaneously during such a shift? Sure, many of them died from the apnoeic attacks without ever being noticed - most of these from easily preventable causes. Yet, the nursing managements would not reason that the SCBUs needed more nurses relative to the other adult and adolescent wards. The use of affordable simple devices for neonatal chest and body movements monitoring hence became inevitable to use in our centers. Our standard practice of the use of only incubators and cots with installed apnoea monitors for all critically ill neonates and all other premature neonates—especially during their first-seven-days (F7D) of life—must, hence, never be compromised. By this practice, nurses were easily alerted as soon as such neonates go into apnoeic mode. The job of keeping such neonate alive, awaiting proper intervention, becomes the job of any available staff and not just the overworked nurses. For our centers, the apnoea monitor has become the inevitable “third eye” of our nurses to frustrate neonatal “sudden death syndrome” until proper intervention is administered to correct the underlying fault.

6.7. The handy approach

Careful examination of various plots of neonatal body temperature against lifetime, especially during the first few days of life, revealed a startling consistent physiological inadequacy. We created a “regional band” on the graphs, representing the physiological safe-zone temperatures of 36.5–37.4°C (**Figure 2**). This enabled easy assessment of how well the neonates had been assisted to maintain this safezone temperature that is essentially required for thermoneutrality, and hence neonatal survival. We investigated this in many hospitals across the regions of Nigeria—from the South to the North—and we concluded that this was a national problem [9]. It was however more disturbing that the nonphysiological temperature profile also emerged from some neonates that could be seen to have undergone incubator care.

We began to investigate this and quickly discover the complete absence of any standard protocol or algorithm for achieving neonatal normotherm in the Nigerian practice. This led to the synthesis of the handy-approach algorithm, developed as a set of rules that could guide the normalization of a deviating neonatal body temperature back to its safezone temperatures [21]. Ability to use this application became compulsory, and, a necessary requirement for all the nursing and clinical staff of the SCBUs within our neonatal research network (**Figure 3**). Subsequently, a validation study was carried out. This showed that the technique led to greatly improved neonatal temperature profiles and also for better overall outcome [9]. The handy approach is an easy-to-handle tool that practitioners at the rest of Nigeria's SCBU should study for the sake of the multitudes of Nigerian neonates under their care.

6.8. The ISA

The initial set-point algorithm (ISA) was developed as a supplementary temperature control protocol to maximize the impact of the handy approach. This targets a quick attainment of normotherm at the onset of incubator intervention (**Figure 4**). This effectively removes the

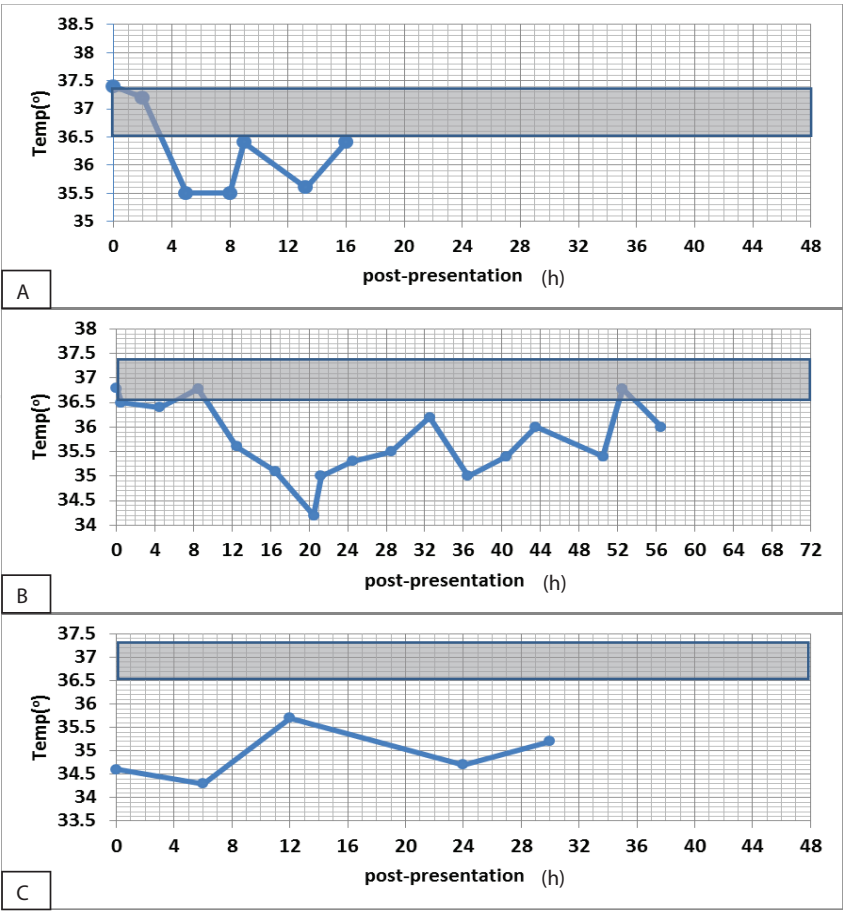


Figure 2. Temperature—Lifetime plot revealing safezone band. (Plots of deceased incubator-nursed neonates from 3 different regional teaching hospitals in Nigeria, A—south: BW = 2000 g admitted 16/01/2013; B—middlebelt: BW = 1580 g admitted 17/11/2012; C—north: BW = 600 g admitted 02/08/2012).

often long postnatal exposure of neonates to temperatures outside the safezone, as this has been argued to inflict a lasting damage that trails some of them to death within their first week of life [15]. The ISA was such a powerful tool that might have coincidentally led to the reduction of F7D contribution to mortality, from 71 to 0%, in a set of studied neonatal cohorts at the University of Abuja Teaching Hospital Nigeria [15]. The devastating postnatal thermal shock described in the research was widespread across Nigerian centers and explained the reason behind the WHO figure of 79% for the mortalities happening before the seventh postnatal day; this figure has never changed between the 2008 and 2013 demographic survey reports [14]. ISA application enabled clinicians at our center to achieve neonatal normotherm in an average of 28 min as compared to conventional average outcome of 12 h and 24 min. The thermal devastation of almost 12½ h long in a hostile environment is unbearable for the poor neonates, especially the preterms, as they are coming from the well-regulated comforts of the womb [15]. Thus, the ISA has been demonstrated to be an effective tool for the care of preterm neonates and a dependable response to this problem. Having also been scientifically validated and peer-reviewed, this has remained a compulsory tool to apply while admitting premature neonates at many of our centers. This has led to drastic overall reduction in the mortality of premature neonates at these few centers; figures falling from 63 to 7% at

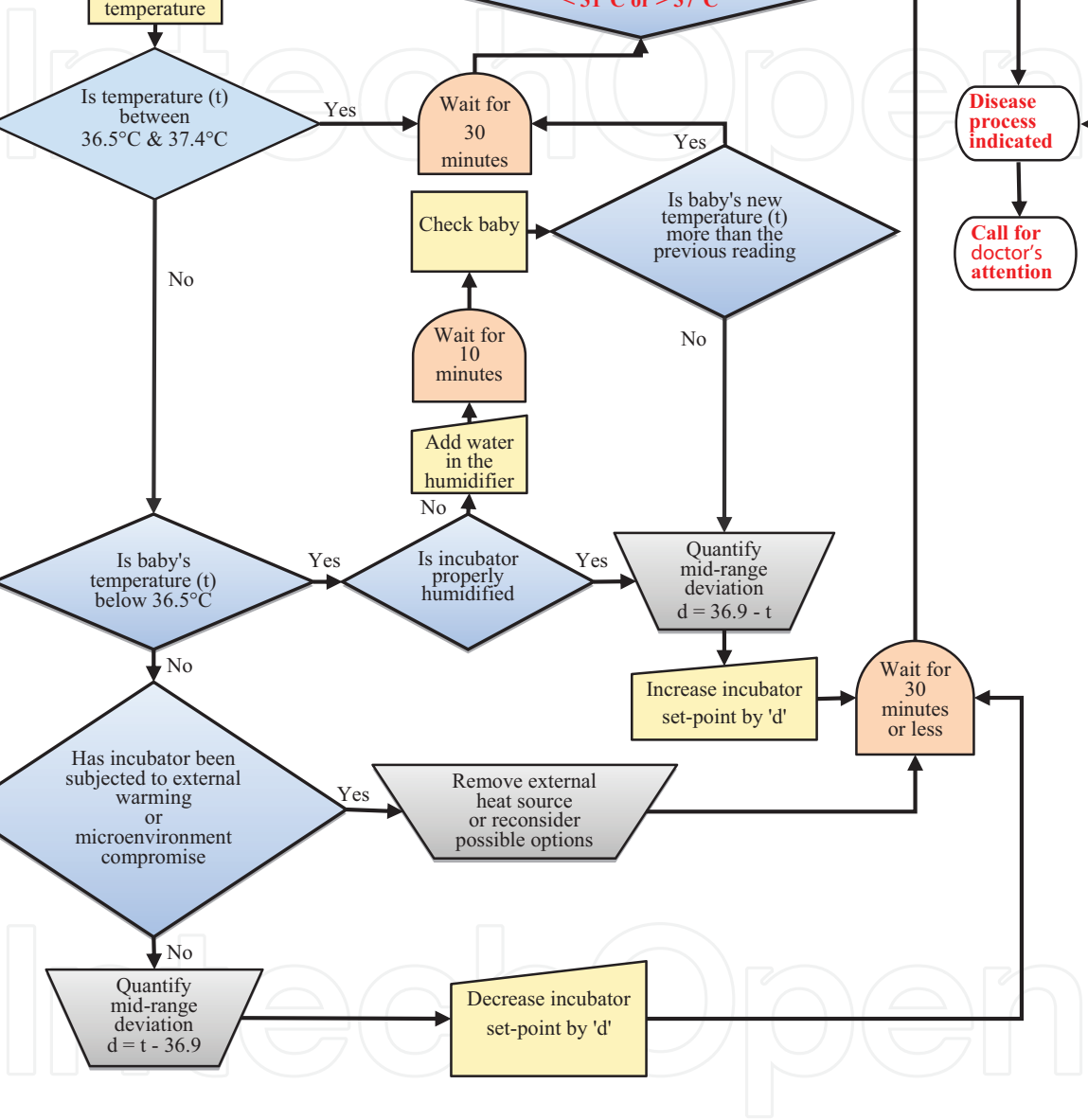


Figure 3. The handy approach. Modified from Amadi [21].

the University of Abuja Teaching Hospital, Gwagwalada Nigeria, for example. The ISA is an unconventional step, all Nigerian and West African centers might have to adopt if they must lower their high facility-based mortality rate of premature neonates. In addition to this excellent overall outcomes with the handy-approach and ISA procedures developed, the Federal Medical Centre (FMC) Owerri Nigeria, became the hospital that nursed the tiniest baby ever to survive in a Nigerian hospital with the use of these applications—baby “Majesty,” as they nicknamed her, was born after 26 weeks GA weighing 550 g and went home after 83 days of nursing care on the 26th of April 2015 (**Figure 4**).

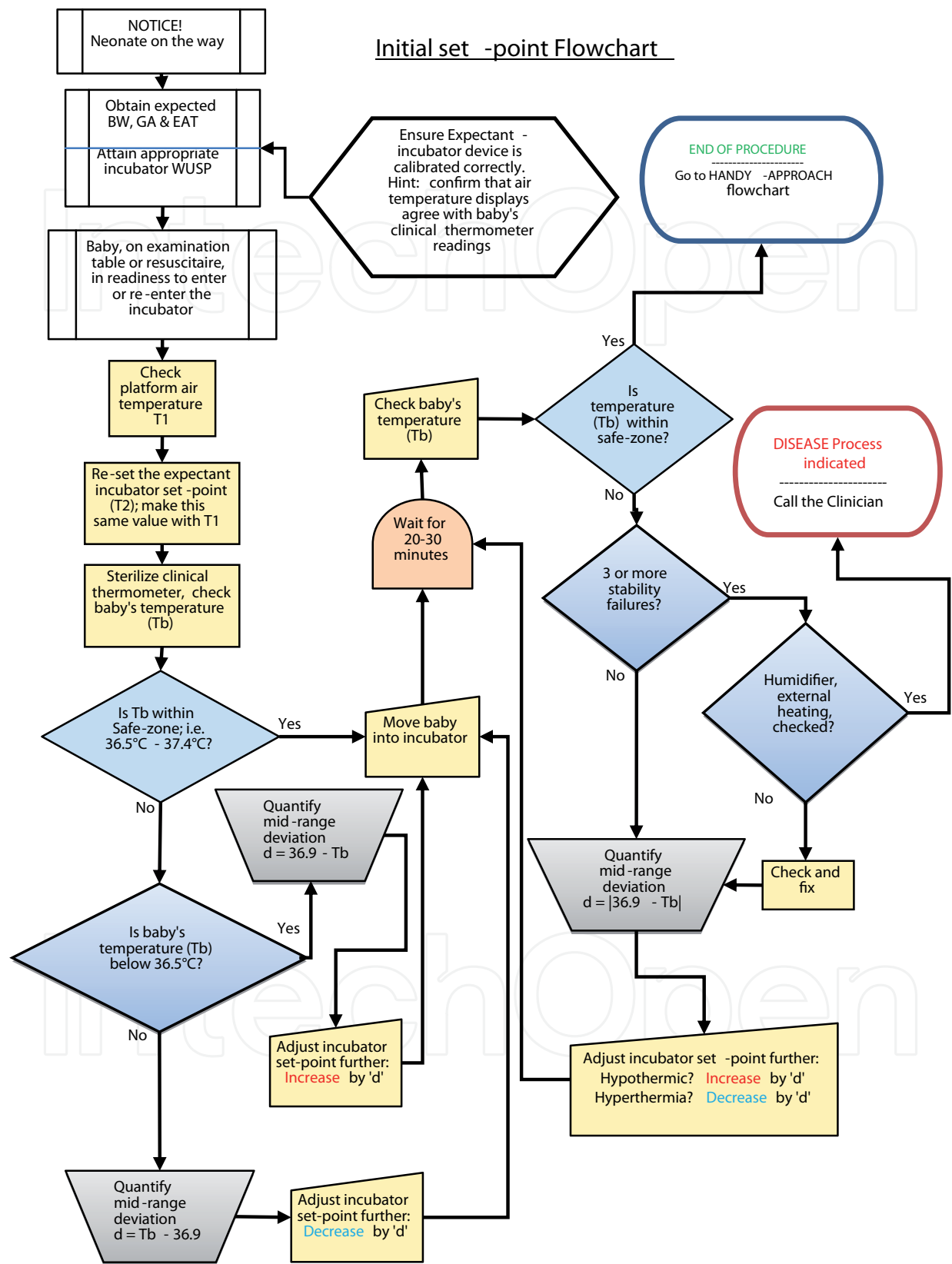


Figure 4. The ISA flowchart. Modified from Amadi et al. [15].

6.9. Pediatrics incubation technique (PIT) courses

Within the limits of our research findings, we can strongly affirm that poor thermal control is largely to blame for the high rate of mortality of premature neonates in Nigeria, especially during the first few days of life. It therefore became essential that the theories and etiology of neonatal thermal shock was well-understood and communicated to would be and practicing neonatal nurses and doctors. These were the roles expected of the pediatrics incubation technique (PIT) courses that were introduced very early in this research group. The PIT courses isolate the Nigerian peculiar climate, weather, culture, and financial dispositions, relating these factors to the neonatal need of adequate warmth for survival. The courses were used to teach practitioners on the best incubator practices within the Nigerian tropical contexts. In Nigeria, being a technologically dependent country in medical devices including incubators, the PIT discusses the tweaks that are appropriately necessary in order to get the best out of these foreign systems. The courses are elective at the Pediatrics Departments of our partner hospitals; however, it is mandatory for the SCBU staff of our centers. There is the desire for zero tolerance to the devastating effect of early neonatal thermal shock at our centers. Therefore, all staff of some of our SCBUs are required to achieve a minimum grade of “Merit” (65% or above) at both PIT level-1 and PIT level-2 courses to guarantee a good career progress at the centers.

7. Conclusions and recommendations

The Nigerian neonatal records are among the worst in the world. This has remained high for far too long, and there seems to be no fresh ideas—those that had not been previously tried or any immediate sustainable solutions from the government, health institutions, or the academia. In our work, we have carefully investigated the mortalities and struggles of the early days of premature neonates in Nigeria and can conclude that this is more than a “nightmare” for them. In the course of our various investigations and publications, we have identified that thermal inadequacies is one factor that must be tackled and decisively resolved before the Nigerian neonates that can be liberated.

We have synthesized unconventional solutions, tried, and validated these using rigorous methodologies to generate our often multicenter- and center-controlled data. The various comparative analyses against conventional techniques in Nigeria have also revealed that our unconventional approaches have succeeded where these failed irrespective of disabling policies and social factors at work. In a center-controlled cohorts study that tested a package of the developed unconventional techniques on extremely premature neonates (**Figure 5**), overall mortality rate (NNMR) fell from 63/100 for conventional techniques to 7/100; the fraction of neonates that would not see their seventh day after birth (f7dMR) fell from 51/100 to 0; and the fraction of the deceased neonates that died before the seventh day (f7d-in-NNM) in the conventional technique cohorts was quite similar to the World Health Organization demographic figure for this [15]. It is still a puzzle that the Nigerian health authorities and their corporate institutions have turned a blind eye to a package of methods so reliable; thereby

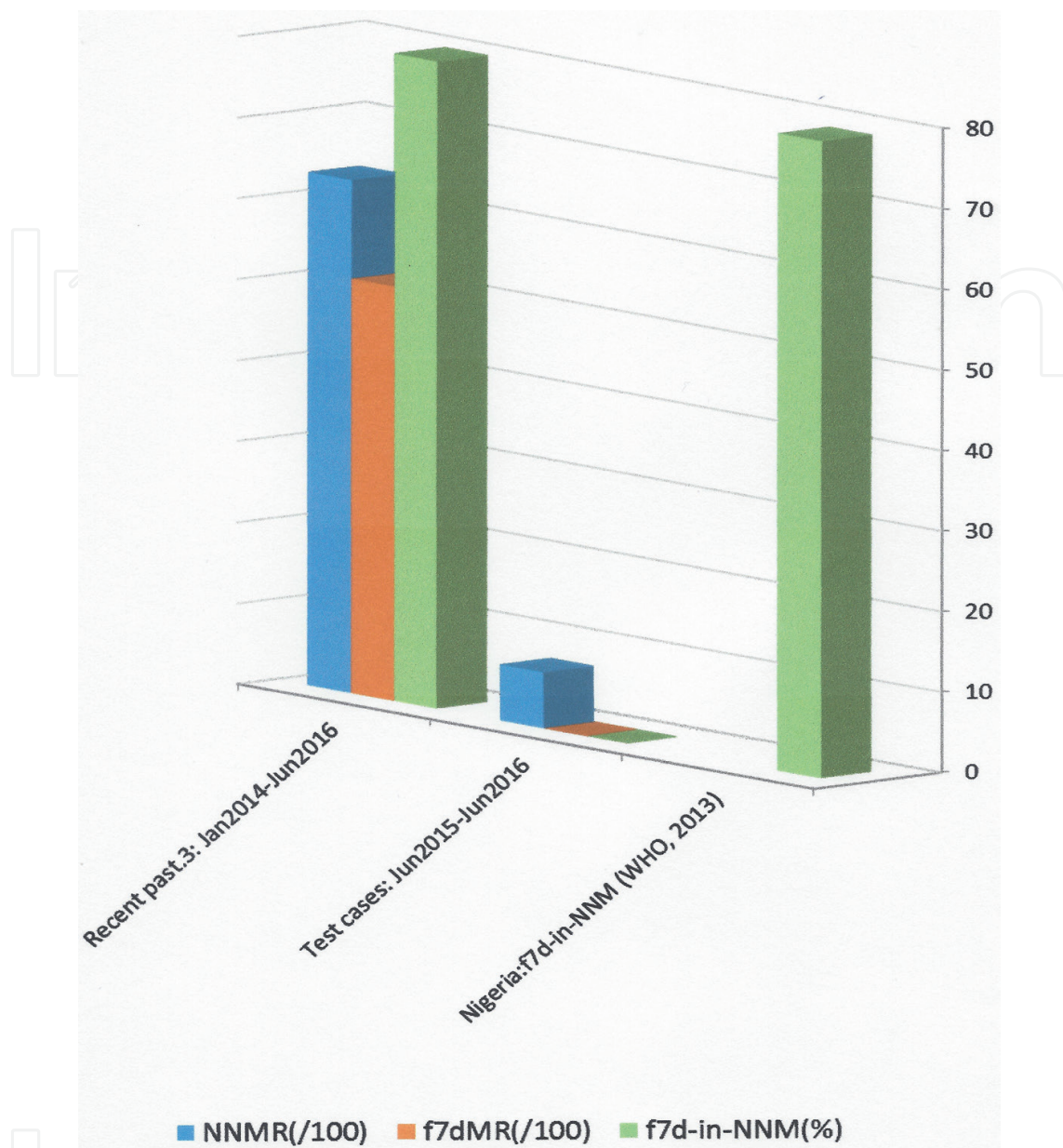


Figure 5. Comparative outcome of a centre-controlled cohort study of ELBW neonates managed with conventional techniques in “recent past” as against unconventional techniques on “test cases”; modified from Amadi et al. [15].

being uncompassionate as thousands of these neonates are sent to their untimely graves. If a set of techniques could so-smash the W.H.O.'s “f7d-in-NNM” demographic figure of 79% for Nigeria, literally eradicating this on a cohort of extremely premature neonates, what are they still waiting for before translating this idea into their national practice?

In the face of ever dwindling and crashing Nigerian economy, we think that our unconventional techniques as presented in our various publications have a great role to play if Nigeria must emancipate from this age long neonatal situation. The use of these affordable systems and ideas are recommended to replace the insatiable crave for unsustainable importation of ideas and technologies that are not consistent with the Nigerian climate, weather, and infra-structural development.

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Conflicts of interest

Both authors declare no conflicts of interests concerning this publication.

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References

- [1] UNICEF, WHO, World Bank, UN Pop Div. Levels and Trends in Child Mortality Report 2015 [Internet]. 2015 [Updated: 2015]. [Accessed: 02-02-2017]
- [2] Garba BI. Prevalence, risk factors and outcome of preterms at a specialist hospital in Gusau, Nigeria. In: Alikor EA, editor. 47th Annual Conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria. Port Harcourt; 2016. p. 25
- [3] Adesina TC, Olateju EK, Okechukwu AA, Alabi P, Amadi HO. The impact of an initial set-point prediction tool for prompt attainment of stability during neonatal incubator care—A comparative study. In: Alikor EA, editor. 47th Annual conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria; 2016. p. 35

- [4] Animasahun AB, Ubuane OP, Gbelee O, Njokanma F. A two-year review of outcome of neonatal admissions at the children emergency room of the Lagos State University Teaching Hospital Ikeja. In: Alikor EA, editor. 47th Annual conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria. Port Harcourt; 2016; p. 27
- [5] Mbarie IA, Blessing I, Iyoha A. Morbidity profile and outcome of newborns admitted into the neonatal unit of a secondary health care centre in Benin City. In: Alikor EA, editor. 47th Annual conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria. Port Harcourt; 2016. p. 29
- [6] Obikwu U, Okagua J, Opara PI, Eneh AU. Morbidity and mortality patterns of admission into the special care baby unit of University of Port Harcourt Teaching Hospital. In: Alikor EA, editor. 47th Annual Conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria; 2016. p. 50
- [7] Emerenini FC, Ezeofor TC. Outcome of newborn admissions in the special care baby unit of Federal Medical Centre Owerri. In: Alikor EA, editor. 47th Annual Conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria; 2016. p. 38
- [8] Nwankwo O, Uche C, Okolo AA. Burden of severe birth asphyxia at Federal Medical Centre Asaba—Lessons and proposal for alleviation. In: Alikor EA, editor. 47th Annual Conference of the Paediatrics Association of Nigeria; 19-23 January 2016; Port Harcourt Nigeria. Port Harcourt; 2016. p. 36
- [9] Amadi HO, Osibogun A, Olateju EK, Kawuwa MB, Uwakwem AC, Ibekwe MU, Alabi P, Ezeaka VC, Eleshin DG, Ibadin MO. Challenges and frugal remedies for lowering facility based neonatal mortality—A comparative study. *International Journal of Pediatrics*. 2014;2014:986716
- [10] Amadi HO, Azubuike JC, Etawo US, Offiong UR, Ezeaka C, Eyinade O, Adimora GN, Osibogun AO, Ibeziako N, Iroha EO, Dutse AI, Chukwu CO, Okpere EE, Kawuwa MB, El-Nafaty AU, Kuranga SA, Mokuolu OA. The impact of recycled neonatal incubators in Nigeria: A 6-year follow-up study. *International Journal of Pediatrics*. 2010;2010:269293. DOI: 10.1155/2010/269293
- [11] WHO, UNICEF. Progress Towards Millennium Development Goals 4 and 5—Countdown to 2015 Decade Report. [Internet]. 2010 [Updated: 2010]. Available from: http://whqlibdoc.who.int/publications/2010/9789241599573_eng.pdf [Accessed: 02-02-2017]
- [12] Federal Ministry of Health Nigeria, Save the Children, Jhpiego. Saving Newborn Lives in Nigeria: Newborn Health in the Context of the Integrated Maternal, Newborn and Child Health Strategy, 2nd edition [Internet]. 2011 [Updated: 2011]. Available from: <http://resourcecentre.savethechildren.se/content/library/documents/nigeria-newborn-health-report-context-integrated-maternal-newborn-and-chil>. [Accessed: 12-08-2016]
- [13] UNICEF. Statistics at a Glance – Nigeria [Internet]. 2013. Available from: https://www.unicef.org/infobycountry/nigeria_statistics.html?p=printme [Accessed: 02-02-2017]

- [14] MCA, World Health Organisation. Maternal and Perinatal Health Profile of Nigeria, Africa Region. Maternal and Perinatal Country Profile [Internet]. 2014 [Updated: 2014]. Available from: http://www.who.int/maternal_child_adolescent/epidemiology/profiles/maternal/nga.pdf [Accessed: 02-02-2017]
- [15] Amadi HO, Adesina TC, Olateju EK, Omokaro S, Okechukwu AA, Alabi P, Haruna AS. Validation of a novel technique that minimises early neonatal deaths – A comparative study. *Journal of Paediatrics and Neonatal Care*. 2017;**6**(1):00232
- [16] Orobato N. Selected findings: The mother–newborn dyad: Community-based distribution of misoprostol and chlorhexidine in Sokoto State, Nigeria [Internet]. 2014 [Updated: 2014]. Available from: <http://wordpress.sph.harvard.edu/mhtf-2/wp-content/uploads/sites/32/2014/09/NOSA.Harvard-MHTF.SEPT2014.pdf> [Accessed: 02-02-2017]
- [17] Amadi HO, Mokuolu OA, Adimora GN, Pam SD, Etawo US, Ohadugha CO, Adesiyun OO. Digitally recycled incubators: Better economic alternatives to modern systems in low-income countries. *Annals of Tropical Paediatrics*. 2007;**27**:207-214
- [18] Okechukwu AA, Achonwa A. Morbidity and mortality patterns of admissions into the special care baby unit of University of Abuja Teaching Hospital, Gwagwalada Nigeria. *Nigeria Journal of Clinical Practice*. 2009;**12**:389-394
- [19] Onalo R, Olateju EK. A four-year retrospective review of very low birth weight babies seen at the University of Abuja Teaching Hospital Nigeria. *Nigerian Postgraduate Medical Journal*. 2015;**22**:93-99
- [20] Ogunlesi TA. Factors influencing the survival of newborn babies weighing <1.5 kg in Sagamu, Nigeria. *Archives of Gynecology and Obstetrics*. 2011;**284**:1351-1357
- [21] Amadi HO. Neonatal thermoneutrality in a tropical climate. In: Rodriguez-Morales AJ, editor. *Current Topics in Tropical Medicine*. 1st ed. Intech: Rijeka Croatia; 2012. pp. 513-544. Available from: <http://www.intechopen.com/books/current-topics-in-tropical-medicine/neonatal-thermoneutrality> [Accessed: 02-02-2017]
- [22] Amadi HO, Mohammed IL, Kawuwa MB, Oyedokun A, Mohammed H. Synthesis and validation of a weatherproof nursery design that eliminates tropical evening-fever-syndrome in neonates. *International Journal of Paediatrics*. 2014;**2014**:986760. DOI: 10.1155/2014/986760
- [23] Amadi HO, Mokuolu AO, Obasa T. The effect of high sunlight intensity on the neonatal incubator functionality. *Journal of Neonatal Nursing*. 2013;**19**:122-128

