Reducing Under-five Childhood Mortality using IMCI/e-IMCI: Implementation Approaches in Nigeria

By

Al-Mounawara Yaya

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[Signature goes here]
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Rohit Ramaswamy

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Date

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Ernest Loevinsohn

Date

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ABSTRACT

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To address the global issue of healthcare disparity and access to care, particularly in

children under-five years of age, Integrated Management of Childhood Illness (IMCI) was put in

place by WHO and UNICEF. To address poor adherence to IMCI that affects Under-five

Mortality Rates (U5MRs), e-IMCI was introduced [1]. With its three components: improvement of

case management skills of health-care staff, overall health systems, and family and community

health practices, IMCI/e-IMCI targets under-five children's health with a holistic approach [2].

While IMCI/e-IMCI helps to provide quality care, save cost and potentially time, inadequate

healthcare providers' training remains a primary challenge to the quality of implementation at

the global level especially in lower-middle income countries like Nigeria. This paper presents the

barriers to IMCI/e-IMCI from the policy makers, health workers and patient standpoint in

Nigeria. Also, the paper elaborates on various implementation approaches to address these

barriers in the context of the Nigerian health care system.

ACKNOWLEDGEMENTS

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CAH	Department of Child and Adolescent Health and Development of World Health Organization
EBF	Exclusive Breastfeeding
e-IMCI	Electronic Integrated Management of Childhood Illness
eHealth	Electronic Health
ICMT	IMCI case management training
IMCI	Integrated Management of Childhood Illness
ITNs	Insecticide-Treated bed Nets
PDA	Personal Digital Assistant
UNICEF	United Nations Children's Fund
SDG	Sustainable Development Goals
MCE	Multi-Country Evaluation
mCDSS	Mobile Clinical Decision Support Systems

MDG	Millennium Development Goals
mHealth	Mobile Health
NGOs	Non-Governmental Organizations
pIMCI	paper IMCI
U5MRs	Under-five Mortality Rates
YLS	Years of Life Saved
WHO	World Health Organization

Introduction

Globally, Under-Five Mortality Rates (U5MRs) went from 12.7 million a year in 1990 to 5.9 million in 2015, this being the first time these numbers have gone below 6 million [2]. While that seems promising and is a remarkable improvement, many developing countries were not able to meet the Millennium Development Goal (MDG) (now supplanted by the Sustainable Development Goals (SDG)) pertaining to the reduction of childhood mortality. Over the past few years, the progress in reduction of U5MRs has seen significant variations from one country to another. These variations have primarily been due to country differences in "maternal mortality...followed by lack of access to sanitation, lack of access to water, and lower female education" [4]

Since over a third of child death occurs within the first month of life, efforts to reduce child mortality have not just focused on children, but also on maternal health and perinatal care [5]. In addition, because six communicable diseases (pneumonia (19%), diarrhea (18%), malaria (8%), measles (4%), HIV/AIDS (3%), and three neonatal conditions, mainly preterm birth, birth asphyxia, and infections (37%)) account for 70% of all under-five children death, much of the success achieved in reducing U5MRs have been based on targeting these prominent causes [6]. These efforts include increased use of vaccination (Example: pneumonia, measles and rotavirus vaccines), and use of insecticide-treated bed nets (ITN) [6]. Thus "between 2000 and 2010, the global burden of deaths in children younger than 5 years decreased by 2 million, of which pneumonia, measles, and diarrhea contributed the most to the overall reduction" [7]. Various other measures have contributed to the changes seen in under-5 mortality depending on geographic location. For instance, in Africa, from 2000 to 2010, "tetanus, measles, AIDS, and malaria decreased at an annual rate sufficient" to affect the MDG [7]. Additional changes that contributed

to the decrease in childhood mortality rates include but are not limited to work on neonate and infant nutrition and overall wellness and development. While these are significant achievements, major armed conflicts, weak health care systems, and lack of funding have hampered more accelerated progress [5].

Health system approaches to addressing under-five mortality

Over the years, various approaches to strengthen the health system have been taken to address under-five mortality. Some of those innovative approaches include eHealth and mHealth for general population health and Integrative Management of Childhood Illness (IMCI) focusing on under-five children's health. IMCI was developed by the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) in the 1990s to help address the global burden of high Under-five Mortality Rates (U5MRs) [8]. eHealth has progressively been integrated into the standard of care with 100 percent of South-East Asia and 80 percent of African WHO region member states reporting at least one mHealth intervention with an 85 percent global average in 2011[3].

IMCI is a holistic approach to addressing children's health while promoting development and growth; it also has a preventive and curative aspect that not only involves the health care team, but also the community as a whole. Thus, IMCI is designed to employ a strategy that works at three different levels: improvement of case management skills of health-care staff, overall health systems, and family and community health practices [2]. IMCI addresses children's health, development, and nutrition in relation to ongoing medical conditions, but also to prevent recurrence or acquisition of any other diseases or factors that might prevent adequate growth and development. In doing so, IMCI has been able to help achieve a higher quality of care and better health outcomes. In addition, IMCI has helped reduce the number of overall hospitalization

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among children under five years of age, reduced the burden and cost of diseases, especially preventable diseases. Despite these benefits, IMCI has had significant implementation barriers as described later in this paper.

To address these barriers, an electronic version of IMCI (called e-IMCI) has been introduced in several countries. Electronic Integrative Management of Childhood Illness (e-IMCI) has been expanding to facilitate adherence to under-five childhood care protocols, though it faces implementation barriers as well. Some of the limitations to the use of e-IMCI especially in low resource settings include but are not limited to issues with adequacy of training for e-IMCI use, patient's expectations of providers with e-IMCI, policy makers' support or lack thereof of this system along with funding. Other limitations to e-IMCI reflect barriers to mHealth implementation in general.

This paper will explore the use and limitations of IMCI/e-IMCI around the world and those specific to Nigeria. For Nigeria, various strategies and approaches for improving the effectiveness of IMCI/e-IMCI implementation will be presented. The proposed approaches and strategies are a combination of solutions already applied in other countries with similar settings to Nigeria.

Overview of the Nigerian health care system

The health care system in Nigeria is divided among the federal, state and local government tiers and ranks 187th out of 191 WHO member states in health system performance [9,10]. Despite the decentralization of provision of health care services in Nigeria to help ensure coverage for most of the country, there still is significant discrepancies that affect multiple aspects of population health, and children health is not an exception to that, with multiple defects in the system affecting implementation of efforts targeting reduction of

under-five childhood mortality.

Outside of the issues related to funding, which is common to most developing countries, Nigeria faces a deeper problem with the actual structure of the system with poor governance, lack of accountability and collaboration among relevant organizations to ensure collective efforts [11]. The Nigerian healthcare system remains weak due to "lack of coordination, fragmentation of services, dearth of resources, including drug and supplies, inadequate and decaying infrastructure, inequity in resource distribution, and access to care and very deplorable quality of care" [9]. In addition, there is a shortage of healthcare providers. Part of the problem can be attributed to flaws in the training system of healthcare workers with shortage of internship posts and postgraduate training for doctors, dentists, pharmacist and medical laboratory scientists [12]. These training opportunities are indispensable to transitioning from a student into the healthcare provider role to help a community in desperate need of more physicians with the current patient to physician ratio of 0.39 physician per 1000 people [13]. In addition, lack of coordination makes it quasi-impossible for efforts and health initiatives to be sustainable for longer periods of time. "Some of the major challenges of sustaining Nigeria healthcare system are: counterfeit and adulterated drugs, poor healthcare financing and sustainability, increased out-of-pocket expenditure, inadequate basic infrastructure/equipment/drugs and inequitable distribution, poor remuneration and other push factors, bribery and corruption and shortage of staff" [10].

Under-five mortality in Nigeria

Nigeria is Africa's most populous country with a population of approximately 186 million based on 2016 estimates [13]. 42.79% of this population is between the age of 0 and 14 with a population growth rate of 2.44% in 2016, a fertility rate of 5.13 children born/woman, a

birth rate of 37.3births/1000, and a death rate of 12.7 deaths/1000 [13]. Health expenditure represents 3.7% of the country's GDP with 0.39 physicians per 1000 people [13].

In 2015, Nigeria was once again classified as one of the countries that contribute to almost half the world's deaths in children under five years of age, along with India, the Democratic Republic of the Congo, Pakistan, and Ethiopia [14]. In Nigeria, in 2015, U5MRs was estimated to be 109 deaths per 1000 live births and infants (less than 1 year-old) mortality was estimated to be 71.2 deaths per 1000 live births [13,15]. As in other countries, in Nigeria, the little progress achieved in the reduction of U5MRs over the past 2 decades can be attributed to efforts in promoting maternal health and reduction of communicable diseases that mostly affect neonates (within the first month of life). Particularly, interventions such as the use of insecticide-treated bed nets (ITNs) had a major impact given that in Sub-Saharan Africa, " the use of insecticide-treated bed nets, [is] shown to reduce under-five mortality rates by up to 20%" [5,15]. Nigeria is one of the countries with the lowest vaccination uptake and efforts toward reduction of U5MRs had also targeted vaccinations. Adherence levels vary and the lowest vaccination adherence is seen in Northern Nigeria, the region that also has the nation's highest U5MRs [16,17]

Global Experience with implementing IMCI: A literature review

Global Impact of IMCI

IMCI has been evaluated using Multi-Country Evaluation (MCE) to determine effectiveness, cost, impact and the best delivery method [18]. MCE is a global impact evaluation coordinated by the Department of Child and Adolescent Health and Development (CAH) of the World Health Organization in collaboration with various organizations and ministries in different countries. Based on MCE evaluations, one of the factors used to evaluate the cost effectiveness

of IMCI is YLS (Years of Life Saved) to determine the progress by IMCI, but mainly to help decision making in whether or not investment of government resources in IMCI is truly valuable when it comes to addressing under-five childhood mortality [18].

In Egypt, analysis of IMCI implementation between 2000 and 2007 showed doubling in the reduction of the annual rate of under-five mortality reduction (3.3% vs 6.3%), although other socioeconomic factors might have contributed to these statistics as well[19]. "IMCI is likely to be associated with positive changes in all input, output, and outcome indicators, including increased prevalence of EBF (Exclusive Breastfeeding) and decreased stunting" [20]. In Sudan, implementation of IMCI has improved the compliance with follow up treatment plan which contributed to the improvement in reduction of the burden of disease among children under-five years of age [21]. Based on 1996 estimates, in Nigeria, the introduction of IMCI reduced the cost of prescriptions compared to traditional practice [22]. The use of IMCI helped countries like Malawi achieve MDG 4 [6]. In Tanzania for instance, hospital costs were 2.5 times higher for children under-five years of age among districts that did not adopt IMCI compared to those that did.[22]

Global barriers to IMCI implementation

Despite these successes, challenges to implementation have prevented many countries from having sustained benefits of IMCI. Overall, resistance to adoption of IMCI has been relatively minimal, and countries have accepted IMCI as the standard of care to treat symptoms of diseases like malaria, pneumonia, diarrhea, measles and other childhood illnesses [23]. However, adherence to IMCI's recommended treatment/prevention plans is a major issue in the effectiveness of IMCI.

The major barriers to IMCI implementation can be categorized as follows:

- *Barriers affecting health care workers*

IMCI as a system is viewed by some health care workers as requiring more work if properly executed since it takes time to follow IMCI chart booklet [24,25]. At the health care workers' level, barriers to implementation of IMCI include but are not limited to problems with adequate initial and follow up training, lack of supervision, lack of resources (medical supplies) and cognitive barriers in the form of poor literacy of health workers in certain settings [23]. Even when there is initial training, over time, there is less rigor to adherence to IMCI protocols due to lack of follow up training and supervision [23,26]. This problem affects IMCI globally and is pronounced even in lower-middle income countries like Nigeria. Part of the problem associated with lack of training can be attributed to lack of funding to train all healthcare workers for the 11 days recommended by WHO.

- *Barriers affecting patients*

One of the challenges that patients face is being able to physically access the care facilities, being able to afford the services offered and in some cases having facilities close. Although the above-mentioned challenges are generic and apply to almost any healthcare service, IMCI is no exception. Even when access and cost do not represent a barrier there is a problem of compliance with treatment plans along with failure to follow up. In addition, individually, culturally and sometimes based on religious beliefs there is resistance that might not be specific to IMCI but that nonetheless constitute a limitation to the proper execution of IMCI recommended care plan. One of the limitations is the refusal to allow children to receive immunization [27].

- *Barriers affecting policy makers*

Policy makers face challenges in acquisition of funding. In addition, in many countries especially lower-middle income countries like Nigeria, there is little country specific statistical evidence and reliable data to help guide decision-making or to promote IMCI as an effective way to reduce U5MRs based on evidence. Policy makers then face the dilemma of having to decide funding allocations in already resource scarce settings. Political barriers influence policy making and governmental support, which in turn impacts IMCI implementation funding, presenting an economic barrier.

The predominant category of barriers differ from one country to another, so in some places, cultural barriers can translate into poor communication that could "in part be a result of health workers' (especially males) discomfort with spending too much time speaking with someone else's wife" [27]. Some of the cultural barriers overlap with religious belief and could be directed toward specific components or IMCI protocol. For instance, "in Nigeria, the greatest challenge to the acceptance of immunization is a religious one especially among the northern Nigerian Muslims" [17]. Healthcare workers in Tanzania highlight lack of essential drugs and supplies, lack of onsite mentoring and refresher courses as challenges to implementation of IMCI [28]. In Kenya, IMCI implementation challenges include low training coverage, lack of adherence to guidelines by health workers and barriers to accessing IMCI by the community [25].

Addressing IMCI implementation barriers with e-IMCI

e-IMCI is an electronic system that aims to improve the use of IMCI and facilitate the provision of healthcare services for children under-five years of age. This electronic system requires the use of mobile devices (cell phones, tablets or Personal Digital Assistant (PDA)) or other technology including but not limited to laptops and desktops. As a system, e-IMCI is still

not as uniform as needed, however, it attempts to standardize protocols based on most common

childhood illnesses by country or region. e-IMCI focuses on the same three components of

IMCI: improvement of case management skills of health-care staff, overall health systems, and

family and community health practices. Riding on the explosion in mobile phone usage, e-IMCI

aims to reach a larger portion of the population since 7 billion people live in an area covered by

mobile-cellular network as of 2016 [29]. e-IMCI also helps with better adherence to treatment and

prevention of under-five childhood diseases [28]. e-IMCI can do so by walking the health care

worker through the consultation as there is no longer the need to consult different algorithms in

the IMCI booklet, therefore there are fewer skipped steps, errors, and miscalculations [23].

Studies show that the use of e-IMCI improves the quality of care in different ways. In

Tanzania, "using the e-IMCI prototype, clinicians performed 84.7% of investigations required by

IMCI, a significant improvement over the 61% of investigations seen with the chart booklet ($p <$

0.01)" [23]. In another Tanzanian study, "the proportion assessed under [paper IMCI] (pIMCI)

ranged from 61% to 98% compared to 92% to 100% under e-IMCI ($p < 0.05$ for each of the ten

assessment items)" [30]. In addition, as compared to IMCI, e-IMCI "improves ... the quality of

care, and also affords the health worker enough flexibility to apply their skills on a case-by-case

basis" [31]. In Sub-Saharan Africa, the use of Mobile Clinical Decision Support Systems (mCDSS)

which include e-IMCI plays a role in improving trust between patients and providers as patients

believe that the mobile device provides care instruction from specialized clinicians [24]. "Health

workers were generally reported to have positive attitudes toward the use of mCDSS" [24].

When it comes to the time factor, it is unclear and still debatable whether e-IMCI saves

consultation time as compared to IMCI. "In 2005, Tanzanian clinicians trained in paper IMCI

took on average 8.2 minutes per child for a consultation [while] clinicians used on average 8.7

minutes (2–38 minutes) per child for consultation with tablets" [32]. However, another study "analyzed 18 trials comparing the time by the same clinician in a traditional IMCI session to one using e-IMCI; the average for both was about 12.5 minutes" [23]. Even if e-IMCI does not affect consultation time, "e-IMCI can reduce skipped steps, branching-logic errors, and miscalculations. In addition, training time can be reduced because the algorithm itself does not need to be as rigorously taught" [23].

Overall, e-IMCI has been effective in improving adherence to children healthcare protocols. In doing so, it has helped increase the quality of care, reduced cost and addressed childhood illnesses in a timelier manner [33]. However, these outcomes have not been uniform across the board in every country, and unlike the Multi-Country Evaluation (MCE) to determine effectiveness, cost, impact and the best delivery method for IMCI, there is no such uniform evaluation method in place for e-IMCI yet. So, effectiveness and progress made with e-IMCI, for the most part, must be determined based on individual country data. Also, the success of e-IMCI does not imply that barriers to implementation do not exist. For example, the hallmark of e-IMCI is in the ease to follow the proposed protocols, but that depends significantly on the level and quality of training of the healthcare providers using this system. Despite all the accomplishments and remediation that e-IMCI has brought to address IMCI barriers, on a global level training of healthcare workers is a problem that persists even with e-IMCI. Figures 1 and 2 below compare the barriers to mHealth applications between African nations, lower middle-income countries and the rest of the world. Figure 1 indicates operating costs, knowledge and infrastructure as the largest barriers to mHealth in African countries. While not as pronounced, both Figures 1 and 2 show policy as barriers to implementation. These are barriers that e-IMCI is likely to face too.

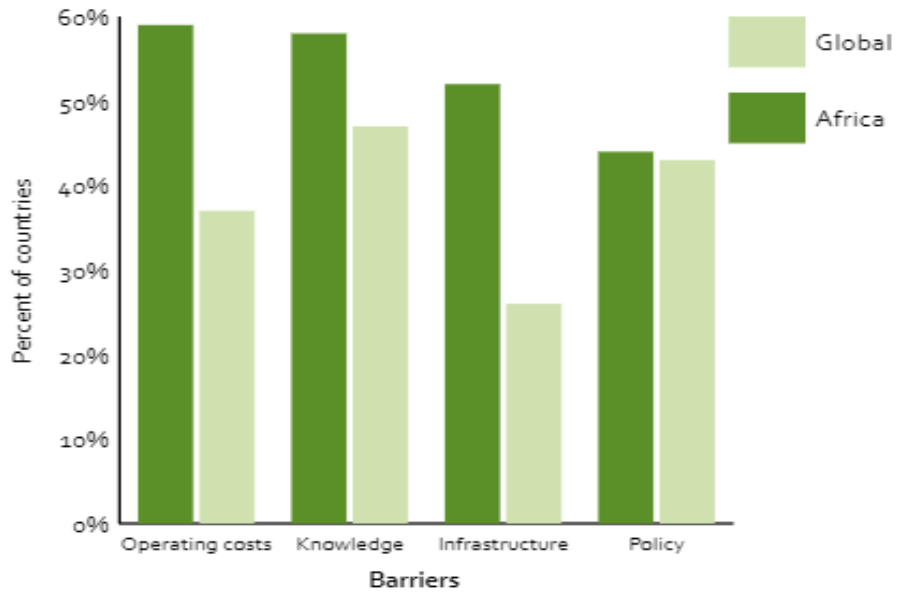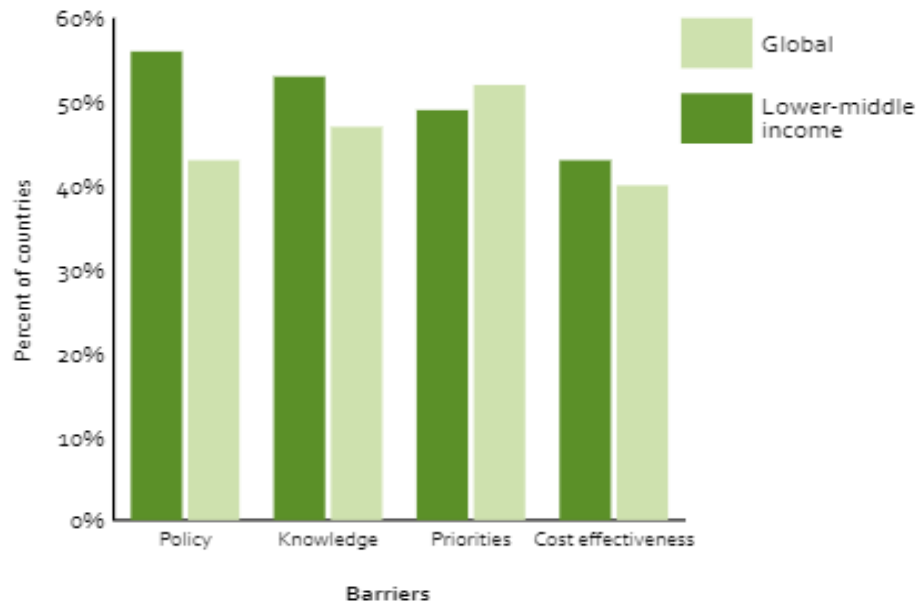Figure 1: Barriers to mHealth: Global vs Africa [3]

Figure 2: Barriers to mHealth: Global vs Lower-Middle Income Countries [3]

IMCI and e-IMCI in Nigeria

IMCI and e-IMCI have been introduced at various levels in the health care system in Nigeria and have been found to contribute to various improvements in the health care system particularly related to child and maternal health. For instance, compared to communities without IMCI, mothers in communities where IMCI is implemented were found to be more likely to practice exclusive breastfeeding and attend antenatal care [20]. In Nigeria, IMCI has helped address the problem of low vaccination uptake [34].

Despite these achievements, some of the global barriers such as lack of supervision, inadequate training, and lack of follow up training of healthcare workers in the domain of prevention of childhood illnesses and reduction of U5MRs are even more pronounced in Nigeria [12]. The implementation approaches and strategies used in Nigeria to address the lingering IMCI barriers are very poorly documented. There is one study conducted in Enugu, Nigeria showing that to address the lack of training of health care workers on IMCI given the scarcity of resources, a shorter training (4 days instead of 11) was better than no training at all [35]. However, it is unclear whether this approach has been applied in any other region of the country. In general, the significant shortage of health care providers in Nigeria worsens barriers like lack of supervision that prevent adherence to IMCI. Cultural barriers are also significant, with the entire Northern region of the country having a higher U5MRs partly due to opposition to children immunization and cultural norms that might prevent adequate communication between parents and health care workers [27]. Also, even though IMCI has been adopted as the standard of care for children health since 1997, the system in Nigeria has fail to coordinate a collaboration of that initiative with other Federal Ministry of Health programs in the same domain such as the Malaria Control Program , the National AIDs and Tuberculosis Control programs, and the Better Health

for All program [36].

As far as e-IMCI is concerned, there is little to no official or uniform reporting or recording of the progress or lack thereof made with the use of e-IMCI in Nigeria. Given the experience with IMCI, it is reasonable to assume that the barriers facing mHealth applications in Africa shown in Figures 1 and 2 (operating cost, knowledge, infrastructure, and policy) apply in the case of e-IMCI implementation in Nigeria as well. Overall, the flawed healthcare system in Nigeria has made proper implementation and sustainability of IMCI/e-IMCI a challenge, with a limited number of healthcare workers to implement IMCI protocols, not enough accountability and transparency from government officials to obtain buy-in and supports, and various resource related issues from shortage to inadequacy of available resources.

Proposed strategy to address IMCI/e-IMCI implementation barriers in Nigeria

The overall strategy to address the problem with implementation of IMCI/e-IMCI in Nigeria should be focused on addressing deficits in the healthcare system and dealing with the two primary mhealth barriers affecting this country, which are knowledge and policy. The approach to address implementation barriers should target three main groups: healthcare workers, patients, and government/policy makers.

- *Knowledge and accountability of policy makers*

For systems like IMCI/e-IMCI or any other health related intervention to obtain funding, there is the need for governmental support especially if that funding is coming from the state's budget, which is the case in Nigeria. However, government support does not come without government understanding, knowledge and data to prove the worthiness of such support for a project or intervention. In a system like that of Nigeria where there is very little data

management in general, it becomes a significant challenge to be able to prove the need for government support or to hold appropriate entities accountable when necessary. This has caused significant problems in terms of funding allocation and reporting of what funds have been used for, thus a relative deterrent for funders. So, to be able to get the Nigerian healthcare system all the help needed and address areas like childhood diseases, it is important that there be a system to uphold accountability. This accountability starts with the regulation of counterfeit medications and medical supplies in Nigeria. The government should put in place policies to insure more strict verification and authentication process for medications and medical supplies for population safety. Also, the Nigerian government should ensure that rural areas are not left behind in any health initiative being taken; in order to achieve this, the decentralized system applied in countries such as Tanzania and Malawi should be applied to Nigeria as well at the local level. Government officials should be held accountable to put in place the necessary tools for uniform data collection much like the case in Tanzania and to make the knowledge available to guide their decision-making process. Part of holding officials accountable will have to come from funders and donors who will need to enforce requirements to obtain detailed budgets with frequent reporting of progress and fund allocations. Some of these changes are already being implemented in many Sub-Saharan African countries and even in Nigeria, however, there still is the need for a uniform data collection and reporting system with each project being implemented to truly evaluate governmental efforts and the country's stands and therefore restructure infrastructures if need be. It should be the responsibility of policy makers to put in place measures to generate the country specific statistical evidence needed to be able to establish funding priorities with regards to addressing under-five childhood mortality. In the meantime, until Nigeria can get its own data and analyze them, data from established and successful

systems with similar economic, political and cultural setting like that of Tanzania or Malawi can be used to help in decision making instead of blind attempts. However, the use of such data should not slow down Nigeria's own efforts to study its population, progress with e-IMCI and other health related programs and determine where the most effort needs to be invested. Overall, in Nigeria, "the national health system needs a solid administrative policy foundation that allows coordination of priorities and partnerships in the health workforce and among various stakeholders" [37]. The high impact intervention at lower levels of health system approach applied by Tanzania might also be beneficial for Nigeria as smaller rural and remote areas have been most neglected in various interventions and have been suffering most from the consequence of poor children healthcare.

- *Knowledge of healthcare workers*

The problem of health care providers training for use of IMCI/e-IMCI can be an issue with initial training, follow up training or both. Since it may be difficult to address all aspects of training simultaneously, an approach focusing on one aspect at a time may be beneficial. For example, a starting point may be just to target improvement of case management skills of health-care staff. This could then be followed up with training to address other issues such as work supervision, and cognitive problem solving. IMCI Training has been shown to be effective in Benin, a neighboring country with similar infrastructure as Nigeria, where "63.6 % of children received treatment for all potentially life-threatening illnesses in accordance with IMCI guidelines, and 77.8 % received life-saving treatment" [38].

Training is expensive, and limited funds may need to be stretched by decreasing the length of e-IMCI training. Based on limited evidence, "standard IMCI training seemed more effective than shortened training, although the difference between regular and shortened training

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was small" [39]. So, given that the difference in the performance of a health care worker trained for 11 days versus that trained for 5-6 days is minimal, in a resource limited setting providing a 6 days training could be the solution, at least until the unlikely event that enough funding will be secured soon to cover training for all healthcare workers involved in the care of children under-five years of age. With a shorter training, it is even more important that the current training curriculum be reviewed to determine aspects of the training that need to be emphasized in order to appeal more to the healthcare providers to promote adherence to treatment/ preventive recommendations and patients/parents/community education [25]. In addition to initial training of healthcare providers on IMCI/e-IMCI, methods to sustain follow up training are indispensable. In the case of IMCI, "even after IMCI training (of any duration), typically one-third of ill children needing oral antimicrobials or rehydration were not receiving these treatments according to IMCI guidelines; thus, it is critical in all circumstances to implement strategies in addition to training to improve health worker adherence to guidelines" [39]. IMCI/e-IMCI training can also be introduced in the curricula of medical, nursing and health technology schools in Nigeria as done in Uganda [35].

Despite the uncertainty about the benefits of shorter IMCI/e-IMCI training, combining shorter training with other efforts such as supervised work, peer education, and accountability might bring a better outcome. Nigeria's significant healthcare worker shortage can interfere with professional work supervision. To increase the number of well-trained healthcare providers, Nigeria can apply a program like the Emergency Human Resource Program launched in Malawi in 2004 that lead to a doubling of professional health workers (including doctors, clinical officers and nurses) [6]. This emergency plan focuses on "retention, deployment, recruitment, training and tutor incentives for 11 priority cadres (doctors, nurses, clinical officers, medical assistants,

pharmacists, laboratory technicians, radiographers, physiotherapists, dentists, environmental health officers and medical engineers)" [40]. To ensure that there is supervision of healthcare workers' performance, Nigerian healthcare workers shortage could also be addressed by promoting peer education and a more stringent accountability policy at the health care providers level. The importance of having supervision or supervision like component here is that in a supervised work environment, healthcare workers stayed adherent to the IMCI/ e-IMCI protocols longer even without follow up training and there was improvement of performance in certain outcomes [23, 38].

- *Knowledge for patients*

Patient's knowledge is relatively limited and can be clouded by cultural norms and assumptions. Adequate healthcare workers' training will help address patient's knowledge as the healthcare workers will be well equipped to address the patient's health concerns, but also implement patient's education to help with limited knowledge. In addition, local government should try to be transparent and communicate relevant information regarding progress made within each community regarding health care initiatives. In the case of Nigeria, where there is a lack of knowledge partially due to lack of trust in government based on corruption propensities, transparency will help build trust between community members and government officials, thus supporting communication to further patients' knowledge.

Improvement with immunization in Tanzania and Malawi has significant contribution in the progress seen in these countries in the domain of children health. With adherence to immunization being a problem in Nigeria, being able to address that in all parts of the country can better help make progress in the reduction of U5MRs and this effort can be facilitated with IMCI/e-IMCI both of which were proven to improve adherence to vaccinations [27]. Because part

of the problem with adherence to immunization in Nigeria is related to cultural/religious beliefs, being able to break the stigma and provide adequate patient education will also rest on well-trained healthcare workers that patients can trust.

For adoption of e-IMCI, not only is a basic knowledge of the components of IMCI required, but also a certain familiarity with technology in form of a computer or electronic devices (cell phone, tablet ETC…). So, barriers to mHealth in general presents in the form of cognition, particularly prominent in developing countries with education limitations which translate into computer illiteracy [26]. Therefore, addressing literacy could also eventually contribute to improvement in the use of e-IMCI and thus reduce U5MRs

Finally, given that some of the IMCI/ e-IMCI consultations recommend referral to a specialist, future efforts will need to put measures in place to help expedite the referral process as the outcome in such cases might not solely dependent on the competence of the healthcare worker or the medical supplies present at the treatment centers. In addition to these sustainable measures, in a low resource setting like Nigeria, efforts should be made to secure more funding to ensure that lack of medical and pharmaceutical supply does not represent a barrier to adoption and implementation of IMCI/e-IMCI.

Conclusion

Child health and reduction of U5MRs have seen a lot of progress at the global level over the past couple of years. Some of that progress has been attributed to the introduction of IMCI and e-IMCI, and while these systems contribute to positive change, they also come with their own barriers. From problems with lack of knowledge at various stakeholders levels to issues with policy making, Nigeria struggle even as a lower-middle income country to keep up with the adequate implementation of IMCI/e-IMCI. The primary intervention to address IMCI/e-IMCI

implementation barriers in Nigeria is addressing the flaws in the country's healthcare system in addition to dealing with the two main barriers to mhealth, which are the lack of adequate knowledge and policy.

If able to receive the proper level of attention and be embedded in the health care system in Nigeria, IMCI and e-IMCI can help further increase adherence to child care treatment/ preventive plans. With Nigeria, it is indispensable that the country's healthcare system be reviewed and reorganized in order to minimize corruption, counterfeit medical supplies and the current lack of accountability. Implementing the proposed interventions, will improve the quality of care, reduce cost and time involved in care and overall reduce the burden of childhood diseases. Regardless of the community, once IMCI or e-IMCI is adopted obtaining government support, community buy-in and targeting healthcare providers skills in using and implementing these systems are the first steps towards improvement and scaling.

Future evaluations should consider specific family and community-based barriers and how those can be addressed concomitantly with barriers to the other two components of IMCI/e-IMCI (improvement of case management skills of health-care staff and overall health systems) to further lessen the burden of childhood illnesses.

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