Getting Healthier Around the World:

Information and Communication Technologies for Child Health and Development

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mHealth Alliance

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For this year's Universal Children's Day, it is my utmost desire that the content of this report will inform the strategic use and implementation of mobile and other information and communication technologies for children — to inspire them, to encourage them, and to create a new world of possibilities for them, in ways that will truly improve their futures because these two organizations cared about their wellbeing today.

Contents

Executive Summary

Objective. To celebrate Universal Children's Day 2013, this report was commissioned by Sesame Workshop to achieve two objectives: (1) to explore current and future opportunities in the use of mobile phones and other relevant information and communications technologies (ICTs) for improving the health and development of young children as investments for a better future, and (2) to provide guidance and recommendations for partnerships, institutions or organizations interested in contributing to this field.

Background. This Universal Children's Day is a reminder that every child deserves the opportunity to survive, thrive and participate in society. However, nearly eight million children under the age of five die every year from preventable or curable conditions, with about a third of these deaths linked to poor or inadequate nutrition.[1,2] Among those who survive, poor and inadequate nutrition, in addition to a lack of stimulation during early childhood, prevent nearly 200 million children from reaching their cognitive and socio-economic potential. With the number of mobile phone subscriptions expected to surpass the world population of over 7 billion in 2014,[3] the near ubiquity of mobile technologies and other ICTs provides exciting new opportunities to deliver health and educational interventions to children and their caretakers around the world.

Methods and Findings. A review of existing white and grey literature accrued from mHealth (the use of mobile technologies for health) and related projects, particularly in the context of child health and development (CHD), was conducted. Opportunities that strengthen interactions among children, their caregivers and health systems were identified. Additionally, two approaches for contributing to the field with mobile technologies are further discussed for partnerships, institutions or organizations: (1) a participatory approach, and (2) an advocacy approach. Creating appropriate and strategic partnerships will help realize the greatest impact from ICTs in CHD.

Recommendations for turning mobile opportunities into action and improved CHD outcomes include:

- >> Focus on high-impact, cost-effective health and educational interventions
- >> Integrate a complementary mobile messaging service for families and other caregivers of young children on various health topics that will help raise awareness of ways to be healthier and encourage healthier behaviors
- >> Inject inspiration into the daily lives of children through a packaged global platform that contains efforts to address a variety of conditions that, if improved, can result in better health and nutrition
- >> Provide a program where mothers or other family members and caretakers can receive phone calls or messages informing or reminding them of the importance of play interaction with their children
- >> Promote education, especially for girls
- >> Educate families and promote mHealth and eHealth (electronic health) services to help them increase trust in the health sector and help them maneuver through existing health systems
- >> Develop mobile games and other forms of mobile learning that can engage children and their families and offer a conduit for disseminating health messages
- >> Enable discussion or other forms of interaction to enhance civic engagement on local and regional health policies related to mHealth
- >> Collaborate with mobile and health sectors to make large and positive impacts that are scalable
- >> Append existing health efforts, especially those aligned with global agendas (e.g., the Millennium Development Goals or the United Nations' Every Woman, Every Child initiative)
- >> Work with mobile network companies and other partners to advocate for inclusion of premade programs loaded onto SIM cards for mobile phone use

To effectively and efficiently use appropriate ICTs, such as mobile technologies, for improving conditions that hinder CHD, this report describes how vision, an action plan, and monitoring and evaluation are critical. Additional aspects to consider for implementation are further discussed.

Conclusions. With the variety of technologies available around the world today, strategic and innovative efforts leveraging ICTs, particularly mobile technologies, can reap many gains in health, which can then lead to remarkable cognitive and socioeconomic benefits. This report captures how ICTs are being appropriately leveraged specifically for supporting health system efforts for child health, strengthening tools for health workers who interact with children and their caretakers, and encouraging healthier behaviors among children and others involved in their health and development.

Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
ASHA	Accredited Social Health Activists
BCC	Behavior Change and Communication
CBO	Community Based Organization
CDC	Centers for Disease Control and Prevention
CHD	Child Health and Development
CHW	Community Health Workers
ECD	Early Childhood Development
eHealth	Application of information and communication technologies to healthcare
EMR	Electronic Medical Records
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technologies
IRD	Interactive Research and Development
ITU	International Telecommunications Union
IYCF	Infant and Young Child Feeding
LMIC	Low- and Middle-Income Countries
M&E	Monitoring and Evaluation
MAMA	Mobile Alliance for Maternal Action
MCH	Maternal and Child Health
mHealth	Application of mobile technologies in health care
MoTeCH	Mobile Technology for Community Health
RFID	Radio-Frequency Identification
SMS	Short Message Service
TBA	Traditional Birth Attendants
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

We must do more to reach all children in need, wherever they live, wherever they are excluded and left behind. Some might ask whether we can afford to do this, especially at a time of austerity in national budgets and reduced aid allocations. But if we overcome the barriers that have kept these children from the services that they need and that are theirs by right, then millions more will grow up healthy, attend school and live more productive lives.

Can we afford not to do this?

— Anthony Lake, Executive Director, UNICEF[4]

Introduction

Today, there are technological options with a larger reach than ever before in world history. In 2014, the number of mobile phone subscriptions is expected to surpass the world population of over seven billion,[3] and currently, 90% of the world's people have mobile network coverage. In fact, there are more people with mobile phones than toilets in India, and mobile phone coverage is more accessible than electricity in Africa.[5,6] These technological options — information and communication technologies (ICTs), such as mobile devices, radio, tablets, and Internet — are increasingly becoming popular tools for complementing, accelerating, and leapfrogging current progress in health and development around the world. This translates into unprecedented opportunities to reach a tremendous number of children for health and education.

This report was commissioned to explore current and future opportunities in the use of mobile phones and other ICTs for improving the health of young children, since better health is an investment for a better future. The report also offers guidance to partnerships, institutions and organizations that are interested in ICTs and their impact on critical health issues related to early child health and development (CHD), particularly in low- and middle-income countries (LMICs).

To achieve its objective, this report lays out the following:

>> Background on child health in the context of early childhood development (ECD)[a]

>> Background on ICTs for health: mHealth and eHealth[a] (where mHealth is defined as *the application of mobile technology in health*, and eHealth is defined as *the application of information, computer, or communication technology to some aspect of health or healthcare*)

>> Guidance and recommendations for implementing mHealth and other ICTs for CHD

Throughout this report, it will be evident that improving the health and development of children will require the collaboration of the entire community. Thus, interventions ought to target children, families, caregivers, and a variety of other individuals who play a role in the lives of children. Additionally, better advocacy is needed to actualize the ICT possibilities in fully integrated and proven CHD efforts and age-specific interventions that are known to be most effective in children's lives. The recommendations provided in this report identify ways ICTs (e.g., mobile phones) and coordinated partnerships can both be leveraged to generate the most positive impacts.[8]

Background on Early Child Health and Development

Every child deserves the opportunity to survive, thrive, and participate in society. However, poverty, poor health conditions, malnutrition, and inadequate stimulation at home prevent this from happening for some children. Every year, nearly eight million children under the age of five die, primarily from preventable or curable causes[b] — pneumonia, diarrhea, birth complications, and other conditions.[1,2]

For the children who survive, nearly 200 million children fail to reach their cognitive, motor, and socio-emotional potential because of inadequate food and poor sanitation and hygiene, conditions that lead to increased infections and stunting among children.[1, 9, 10] Again, knowledge of effective and low-cost ways to remedy these issues exist, but political and global commitment is needed for mobilizing action on a large scale.[9]

In order to help improve the health of every child in every way, we must not only deliver effective health strategies with higher quality and better coverage, but also look towards innovative ways for children to be healthier while accounting for the consequences poor health can have on later development. Only then will we have a chance to reduce mortality related to preventable causes and to empower children, caregivers and family members to work together in creating conditions for better child development.

In CHD, a generous amount of evidence exists on how to create an effective response.[11 c] In fact, 30 developing countries have policies on early child development, and UNICEF is assisting governments

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a Other related terms include medical informatics, consumer health informatics, public health informatics, telemedicine, telehealth, and interactive health communication. The World Health Organization (WHO) has described eHealth as a driving force for cost-effectiveness in healthcare, as well as an opportunity to save patients' time and money.[7]

b Effective packages of MCH interventions along the continuum of care can be found in the report "Packages of Interventions for Family Planning, Safe Abortion care, Maternal, Newborn and Child Health" at: http://www.who.int/maternal_child_adolescent/documents/fch_10_06/en/index.html

c See Catholic Relief Services' report titled, "Programming for Impact: A review of the literature and lessons from the field on programming for vulnerable children" available at: http://www.crsprogramquality.org/storage/pubs/hivaids/pgm_for_impact.pdf

in supporting parenting programs in 60 countries.[11] The combination of family- and child-care-center-based interventions is not only known to be more effective, but cheaper and more efficient for delivery than each implemented independently.[11] Delivery to communities and households by frontline health workers, such as community health workers (CHWs), community health volunteers, traditional birth attendants (TBAs), and in India, accredited social health activists (ASHAs), can breach the access gap between the health system and households. A helpful framework is CARE's 5x5 model (**Figure 1**) which crosses five *areas of intervention* (food and nutrition, child development, economic strengthening, health, and child rights/protection) with five *levels of intervention* (individual child, caregiver/family, childcare settings, community, and national policy).[12]

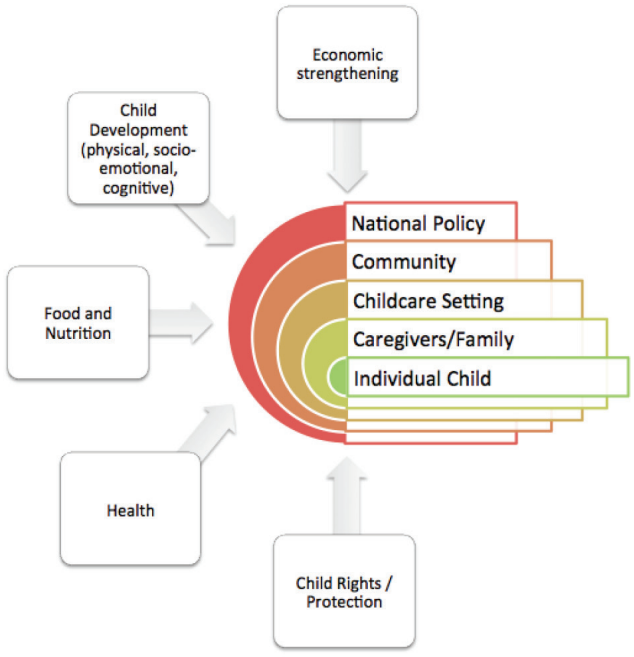

Figure 1. CARE's 5x5 model (Source CARE, 2007). This model demonstrates contextual issues that play an integrated role in early child development. The model was originally designed for ECD programs targeting orphans and vulnerable children in resource-limited settings.

CARE's experience while addressing ECD showed that intervention factors were so integrated that focusing on one or two areas of intervention was not sufficient to address the varied, interdependent needs of young children.[12]

Luckily, the recent and massive uptake of ICTs around the world offers unprecedented opportunities to account for these complexities. For the first time, segments of populations that could not be reached by standard health services and educational programs can now be reached by, for example, mobile phones.

But how exactly can ICTs better the health of children so they can reach their cognitive and socio-emotional potential? The next section goes into these strategies in more detail.

Background on ICTs for Health: mHealth and eHealth

The conditions that hinder CHD around the world differ from context to context, and thus, appropriate integration of ICTs in health interventions for children requires an understanding of the major causes of death, morbidity, and issues affecting child survival within a given context (Appendix A details vaccination; water, sanitation, and hygiene; emergency education; nutrition; and disease-specific knowledge and prevention). For example, malaria accounts for a large portion of deaths specifically in sub-Saharan Africa. HIV/AIDS also has a strong impact, such that it causes more than half of child deaths in certain countries (e.g., Botswana and Zimbabwe).[1] Taking into consideration the epidemiological profiles of different countries, child health programs

can adopt a spectrum of activities that range from prevention to treatment (See **Figure 2**) while leveraging different features of technology to augment information and communication channels. For prevention interventions, timely delivery at specific ages can increase effectiveness.

Along the spectrum, ICTs can be appropriately integrated for different health issues in two ways: (1) to expand coverage and improve the quality of existing, evidence-based CHD interventions, and (2) to improve education and promote healthier behaviors among children and the people who take care of them.

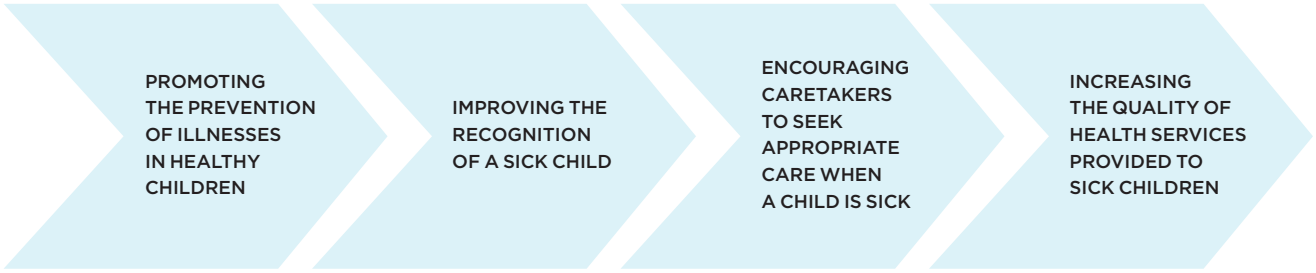

Figure 2. Child health programs can be adopted along a spectrum of activities that range from prevention to appropriate responses for when a child is sick.

Then, the selection of an appropriate technology is necessary. Many nongovernmental organizations (NGOs) and community-based organizations (CBOs) are implementing projects that leverage mobile technologies, Internet, and other low-cost solutions, such as computers, printers, digital electrocardiographs, digital cameras, and webcams,[13] to deliver effective health strategies with higher quality and better coverage. Additionally, several countries are even formally integrating ICTs into national health policies. Kenya, Rwanda, Nigeria and Ethiopia have committed to implementing national eHealth programs that target HIV care, primary health care and maternal and child health (MCH).[14, 15] Kenya has an electronic medical record (EMR) standardization protocol that guides any eHealth and mHealth implementation in the country, addressing system security and minimum functional requirements of such systems. This is augmenting not only the field of health by transforming nationwide information systems, point-of-care support tools for frontline health workers, and ways individuals receive health services, but it is also strengthening old and creating new ways of interacting among people every day.

In **Table 1**, eHealth and mHealth strategies are categorized in three ways: supporting health system efforts for child health, strengthening tools for health workers who interact with children and their caretakers, and encouraging healthier behaviors among children and others involved in their health and development (e.g., the 5x5 model's five levels of intervention). The table describes the strategies within each approach and refers to examples of projects that implement some of the strategies. Later on in the text other projects are described in more detail.

Table 1. ICT strategies for different health approaches: supporting health system efforts for child health, strengthening tools for health workers who interact with children and their caretakers, and encouraging healthier behaviors among children and others involved in their health and development.

APPROACH	STRATEGIES (Examples, Location)
Supporting health system efforts for child health	> Real-time or near-real-time monitoring with mobile phones linked to strong back-end systems (OpenMRS, Multiple Countries) > Disease surveillance and outbreak notifications on mobile phones (TracPlus and TRACnet, Rwanda[15]) > National reporting with electronic documents, USBs, and open-source health information technology platforms (CAMERWA, Rwanda[15]) > Tracking for supply chains (SMS for Life, Kenya[16]) > Electronic health records, particularly using open-source software[17] (OpenMRS, Multiple Countries[18]) > Mobile-enabled devices to deliver information and collect data[19] (UNICEF Innovations Nutrition Surveillance, Malawi19)
Strengthening tools for health workers who interact with children and their caretakers	> Point-of-care standards and protocols on mobile phones and tablets[20] (e-IMCI, Tanzania[21]) > Decision support tools on mobile phones and tablets (CommCare by D-Tree International and Dimagi, Tanzania[22]) > eLearning for health workers (ICT instruction for A2-level nurses to promote to A1 status, Rwanda[15]) > Telehealth and multimedia messaging for diagnoses and remote consultations[13] > Emergency response calling, such as wireless options to link community-based health workers to emergency services > Financial incentives sent as mobile money to help improve health worker motivation (e.g., pay-for-performance)
Encouraging healthier behaviors among children and others involved in their health and development	> Text messaging/hotlines/websites for health information (VillageReach, Malawi[23]; Text to Change, Multiple Countries[24]) > Text messaging for quizzes on health topics (SexInfo, USA[24]) > Text messaging or voice calls to change behaviors (WelTel, Kenya[25]) > Text messaging or voice calls to improve care-seeking behaviors (Babycenter, USA; MAMA, Multiple Countries[26]) > Hotlines or other modes that allow dialogue exchange[27] (PSI, Democratic Republic of the Congo[27]) > Text messaging or voice calls for information on community-based events related to health > Vaccination/treatment/appointment reminders through voice or text messages > Emergency calls[28] > Demand creation for services, such as financial incentives (e.g., conditional cash transfers) or vouchers > Strengthening social networks on mobile platforms > Use of mobile in the financial sector to pay for health services (M-Pesa services in Kenya, India, Tanzania, and other countries; Changamka Microhealth, Ltd, Kenya)

The ICT strategies presented in Table 1 are only some of many ways to categorize eHealth and mHealth approaches in the context of CHD.[d] Although eHealth and mHealth strategies overlap within these three categories and can often be complementary, mHealth offers more promising opportunities for behavior change and communication (BCC), raising health awareness, enhancing preventive care, and supporting wellbeing and overall wellness.[29] **Several projects currently implementing strategies listed in Table 1 are described in more detail below.**

>> Leveraging ICTs with celebrity engagement to promote health

The campaign against malaria run by the NGO Malaria No More has developed *NightWatch*, a communication platform that transmits messages from local and international celebrities to vulnerable populations where malaria is a health issue.[30] *NightWatch* aims to improve the return on investments on delivery of mosquito nets, diagnostic tests and malaria treatments by sending out these messages to multiple media channels every night. The project started on radio and TV spots in Senegal, Chad, Tanzania and Cameroon, but immediately expanded to reach individuals through their mobile phones using SMS messages. Subsequent evaluation of the SMS interventions showed a critical need for the mobile-phone-based program to be more interactive and more engaging. The team has received funding to explore the use of prerecorded voice messages from celebrities to reach illiterate users, linking successful malaria anthems to ringtones and call tones, having a presence on social media and incorporating call-ins and SMS input into local radio programs.

>> Education and awareness spread by text messaging

In Tanzania, the Wazazi Nipendeni (meaning "Love me, parents" in Kiswahili) Safe Motherhood campaign began a multimedia effort for health services related to healthy pregnancy and safe delivery, including early and complete antenatal care attendance, malaria prevention, prevention of mother-to-child transmission of HIV (PMTCT), individual birth planning and safe delivery.[31] Individuals who wanted to opt-in to the service would text "mtoto" (the word for child in Kiswahili) to a short code for free. This would help them register for messages, which had all been developed and managed by the Ministry of Health and Social Welfare and Centers for Disease Control and Prevention (CDC) Foundation's mHealth Tanzania Public Private Partnership. All messages are sent at specific times along the pregnancy or based on the child's age. Key channels used for this campaign include radio and TV spots, clinic posters, billboards and other outdoor and promotional materials. However, messaging can be so successful in generating demand for services that the health system may not be equipped to respond properly to increases in demand. Such programs must ensure that there is coordination with the health system.

Similarly, in Ghana, the Grameen Foundation's Mobile Technology for Community Health (MoTeCH) project aims to improve services attended by pregnant parents with a mobile-based application.[32] Once a pregnant woman is registered into the MoTeCH system, which has registered over 7000 pregnant women and children under five, she can receive information and action text messages or prerecorded voice messages through the application 'Mobile Midwife'. Information texts provide her information relative to her stage of pregnancy, and the action texts encourage her to attend appointments and receive shots. Both types of messaging can reduce

d For an extensive review of how mHealth findings and barriers to adoption and gaps in knowledge, see Mechael et al. (2010), accessible at: http://www.mhealthalliance.org/images/content/publications/barriers_and_gaps.pdf.[24] This report groups mHealth implementation in the following thematic areas: treatment compliance, data collection and disease surveillance, health information systems and point-of-care support tools for health workers, disease prevention and health promotion, and emergency medical response.

the risks surrounding labor and delivery into postnatal care.[33] The messages continue into the baby's first year of life, and these messages focus on good childcare practices and vaccination reminders. In 2013, the plan is to begin a new financing model where the urban areas will subsidize the rural areas via a fee-for-service model. This will happen as a sub-component of the larger MoTeCH business plan.

Another mHealth project related to education and awareness is the Mobile Alliance for Maternal Action (MAMA), with country programs in Bangladesh and South Africa, with plans for an India program already underway.[26] A partnership among the U.S. Agency for International Development (USAID), Johnson & Johnson, the United Nations Foundation, the mHealth Alliance and BabyCenter is designing ways to strengthen maternal and child health and nutrition interventions by applying mobile technologies. Messages are sent at specific moments, such as a woman's gestational age and certain months after an infant has been born, to correspond with critical health issues most relevant at specific times and ages.

>> Hotlines and mobile-phone-based messages with maternal and child health information

As part of a larger health program, VillageReach in partnership with Baobab Health Trust, PATH, and MoTeCH, has implemented a toll-free hotline in Malawi. When calling into the hotline, individuals are able to receive health information on maternal and child health issues from specially trained health workers. Additionally, callers can enroll themselves into the program to receive tips and reminders as personalized voice or text messages sent to their mobile phones, as well as options that link them to transportation services in the case of emergencies.

>> Vaccination text message reminders linked to conditional cash transfers

Interactive Research and Development (IRD)-Pakistan is implementing a scale-up of an mHealth vaccine registry with interactive alerts linked to radio-frequency identification (RFID) tags on governmentally issued vaccination cards for infants.[34] Text message reminders and conditional cash transfers for mothers are additional facets of the program to motivate higher rates of immunization.

>> Leveraging multimedia among community health workers

CommCare is an open-sourced platform that has been deployed to support CHW activities, initially for adherence to clinical protocols, in 10 countries.[35] In India, a multimedia component was added after health workers were observed to be more comfortable and effective with media and video support delivered on mobile technologies in different contexts. CHWs were able to discuss sensitive health topics with the aid of multimedia, and households were found to take health messages more seriously. Benefits include improved interaction between CHWs and clients and increased credibility for CHWs in their responsibilities. Implementation challenges included finding a good illustrator and speakers, creating appropriate imagery and audio messages, and finding the time needed to refine content. Additionally, multimedia was inappropriate for crowded and noisy places or for use by multiple clients.

>> Games and other types of mobile learning

In India, mobile phone games developed by ZMQ Software Systems India Ltd contain education and awareness messages on HIV/AIDS and tuberculosis. An assessment found that the youth who played these games found them for the most part interesting and engaging, which were simultaneously effective at improving awareness and knowledge of serious health issues in a fun way.[36]

In the near future, further development of cheaper, more rugged, and simple smartphones will accelerate these opportunities and trends. The upcoming decade may witness more development with tablets, mobile learning,[37-39] mobile money,[40, 41] wireless monitoring,[42, 43] context-aware platforms,[44] applications and games on both non-smartphones and smartphones, and radio and television program transmission to mobile handsets.[45] At the same time technological advancement will move quickly to enable faster wireless broadband through both new and existing technologies. These will have the following implications for eHealth: more portable mobile connectivity, wireless alternatives, more options for data and telecommunication services, additional options for Internet, and smarter grids.

Applying mHealth and ICTs for Child Health and Development

Currently, there is a shift in health that moves away from acute care and towards prevention and more holistic or integrated responses within a health system.[46, 47] One of the effects of this shift is stronger emphasis on behavior change and communication (BCC) and health that can be enabled through more education, awareness, and encouraging healthier behaviors. There is an opportunity in this, as well, for educational entertainment, defined as "the intentional placement of educational content in entertainment messages".[48, 49] Even though health education and awareness is common, BCC often does not make it onto health agendas as a technique formally implemented by the health system. Although health workers require the use of specific health information, one health worker trainer explains, "Just making information available to health workers by no means motivates them to use it. They need to know why to use it, how to use it, why it's personally relevant, and where to utilize it. Only then will it be of any use to them."[50] This quote is applicable, not just to health workers, but in the context of CHD.

In the digital age, the dynamics of learning are becoming augmented by technology, and technology is currently reshaping how health and educational interventions can be delivered to alter our everyday behaviors and activities in a way that can make individuals feel better and healthier. This does not mean coverage expansion and higher quality provision of existing, evidence-based child health interventions should be emphasized any less. Rather, health interventions that encourage wellbeing and the prevention of costly diseases should be increasingly considered, as rising ownership rates of televisions, radios, and now mobile technologies make these opportunities achievable.[49]

Currently, solid evidence indicates that benefits of educational media can include improvements in early cognitive skills, literacy, mathematics, health and safety knowledge, social development, environmental awareness, and cultural awareness.[8, 51] After a review of existing white and grey literature accrued from eHealth and mHealth projects, particularly in the context of CHD, two coordinated approaches in applying mobile technology and other appropriate ICTs are suggested to those who want to make an impact: (1) a participatory approach, and (2) an advocacy approach. Creating appropriate and strategic partnerships will help realize the true potential for making the most impact.

THEORETICAL FRAMEWORK

Participatory approach. While developing a global mHealth platform for ECD, partnerships, institutions and organizations should assess the following for implementation in different contexts: national plans, governmental health and development priorities, disease conditions, status of the health system, NGOs and CBOs implementing or capable of implementing eHealth and mHealth strategies, and implications for eHealth. Then, these stakeholders can help orient families to mHealth and to promote the efforts described above. Strategies that will have the most reach in LMICs — particularly those using mobile phones and radio, which is becoming increasingly accessible on mobile phones — should be employed to inform women and children that health and educational campaigns exist. In the case of radio, families and caretakers of children can be encouraged to call in to radio broadcasts to discuss pertinent health topics further; however, mobile phones provide a platform for more effective one-on-one dialogues across more people, including those who are not likely to call in.[52] Aside from call-ins, other participatory actions that utilize mobile phone features include: texting in comments, voting in polls, and joining a subscription list. Simultaneously, it may be worthwhile for these stakeholders to develop an online presence in social media, such as on Facebook, Twitter, and LinkedIn. More non-profits are developing their profiles on these channels (e.g., in the United States, a survey found 98% of non-profits are on Facebook, 72% on Twitter, and 44% on LinkedIn[e]).

Advocacy approach. Partnerships, institutions and organizations should also advocate for more efforts that use ICTs for CHD to be introduced across the world. For example, appealing to international bodies and governments will not only strategically enhance coordination for better child survival and health outcomes, but also may enhance the value other stakeholders, such as the private sector, have to offer in the future of children around the world.

APPLYING THE FRAMEWORK

For the participatory approach, recommendations include using appropriate ICTs to:

- Raise awareness of health issues
- Promote and encourage healthier behaviors
- Enhance preventive care
- Support wellbeing and overall wellness
- Build upon life skills[f], particularly those related to health, such as coping with being sick, building interaction skills with caretakers and health workers
- Address sadness and feelings of isolation, particularly among the poor and most vulnerable children, such as those infected or affected by HIV/AIDS
- Empower parents and other caregivers with hopeful messages and insights related to health, sadness and feelings of isolation

More specific recommendations include:

Create a Packaged Global Platform. Design and implement a meaningful global platform package that contains efforts addressing a variety of conditions that, if improved, can result in better health and nutrition for children. The conditions addressed should depend on the local context and epidemiological profile, as well as take into consideration the gaps in service coverage. To set a framework, partnerships, institutions and organizations can use a model

e See http://www.impatientoptimists.org/en/Posts/2012/12/My-Top-10-Communications-Stories-in-Global-Health-and-Poverty-for-201

f Examples include communication, household management, self-care, relationships, work and study skills, coping with loss.

developed by Labrique et al. (2013) that sets interventions along the maternal-newborn-child continuum of care.[53, 54] The framework emphasizes specific health touch points, or parts along the continuum of care where women and children interact with the health system, as effective entry points for receiving effective health interventions. Additionally, segmenting the target population into distinct subgroups can help address different needs that can be met with different approaches in mHealth. Segmenting the target population is often based on age, gender, urban/rural location, existing knowledge and attitudes, or different needs. Other important elements to consider when developing a locally appropriate eHealth program targeting vulnerable populations are literacy rates[g] (particularly when considering a text messaging program), sharing of mobile phones among household members, and confidentiality and privacy issues. A situational analysis or formative research[56] can quickly provide invaluable insight into these matters (described later). For example, in a needs analysis on contextual factors related to motivation and persuasion in accessing maternal health services in rural India, ICTs were explored, and the study found that traditional practices and power dynamics affected at village and household levels were the main barriers to change.[57] These are valuable insights that need to be considered in developing a larger intervention.

Develop a Mobile Messaging Service. Integrate a complementary mobile messaging service for families on various health topics to help raise awareness of ways to be healthier. Mass communication through voice or text messages has helped stimulate conversation about stigmatized conditions, particularly HIV, when conversation wouldn't have happened otherwise.[h] Additionally, videos on mobile phones help recall concrete actions as opposed to specific details; whereas, text messages facilitate details when procedures can be laid out instruction-by-instruction. An assessment of the context will help determine the appropriateness of having text messages developed in local languages.

Focus on Proven Cost-effective Health Interventions for Scalable Impact. Interventions such as growth monitoring, oral rehydration therapy, breastfeeding counseling[i] to reduce the transmission of HIV from mother to baby, increasing vaccination rates, proper nutrition within the global strategy for infant and young child feeding (IYCF)[j], female education, cognitive, socio-emotional and motor stimulation, Vitamin A and Zinc and other micronutrient supplementation and distribution, deworming, safe water, proper sanitation and hygiene behaviors such as hand washing, vision and hearing screening, male involvement (in caregiving), traffic and road safety, as well as malaria prevention with insecticide treated bed nets in relevant areas, are all potential domains. Health benefits can also be gained by building upon life skills related to health, such as coping with being sick or interaction skills with caretakers and health workers, and improving and encouraging education including early education, especially among girls.

Engender Civic Engagement. Enable discussion or other forms of interaction to enhance civic engagement on local and regional health policies with mHealth.

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g For illiteracy, text messages or text on mobile phone screens may not be the best option for the end users of a mHealth project. However, there are appropriate alternatives. In an assessment of an mHealth application in India, developers adapted the application to prompt health workers with voice (for prompts) or pictorials (for screen navigation), rather than text.[55]

h See Project Masulileke in South Africa on p. 22 of the Vital Wave Consulting report *mHealth for Development: The opportunity of mobile technology for healthcare in the developing world*, accessible at: http://www.unfoundation.org/news-and-media/publications-and-speeches/mhealth-for-development-1.html

i Exclusive breastfeeding is defined by the WHO as giving no other food or drink — not even water — except breast milk. This recommendation allows for babies to receive oral rehydration salts, drops and syrups for vitamin, minerals, or medicine intake. WHO advises for infants to begin receiving complementary foods at 6 months with breast milk, and usually this transition is a vulnerable period when infants become malnourished. For particular ages, the Global Strategy for Infant and Young Child Feeding, which includes the specific recommendations for breastfeeding in the HIV context, can be found here: http://www.who.int/nutrition/topics/exclusive_breastfeeding/en/

j Indicators constructed by the WHO for measuring IYCF can be found at: http://whqlibdoc.who.int/publications/2010/9789241599290_eng.pdf

Build Partnerships. Collaborate with mobile and health sectors to make large and positive impacts.

Extend Existing Efforts. Append an mHealth component to existing health efforts, such as after-school health education programs or complementary efforts being implemented by governments and local NGOs or CBOs. An mHealth program could also be designed to link into existing events unrelated to health.

Create Effective Messaging in Mobile Applications. Provide a program where mothers or other family members and caretakers can receive phone calls or messages informing or reminding them of the importance of play interaction with their children.

Promote Education with New Technologies. Promote eHealth and mHealth services to families to help increase trust towards health[k] and help them maneuver through existing health systems.[l]

Promote Girls' Education. Education, especially for girls, is one of the indicators most linked to poor health.

Partner with Mobile Providers. Work with mobile network companies and other partners to advocate for inclusion of premade programs loaded onto SIM cards to be used in mobile phones (e.g., in the mPesa menu).

Develop Engaging Content. There is a need for the creation of mobile games and other forms of mobile learning that can engage children and their families while offering a conduit for disseminating health messages.

Design Messaging for Vulnerable Groups. Provide messaging to meet specific needs of children in vulnerable groups, such as orphans, children infected or affected by HIV/AIDS, or children with long hospital stays (e.g., burn patients, patients with fractures, patients with chronic illnesses like malnutrition or cancer), to allow continuous education and reduce lost education time during long hospitalization periods, or children in refugee camps or emergency shelters (to provide education services in situations where children lack regular access to school).

How to Develop a Global Mobile Platform for Child Health and Development

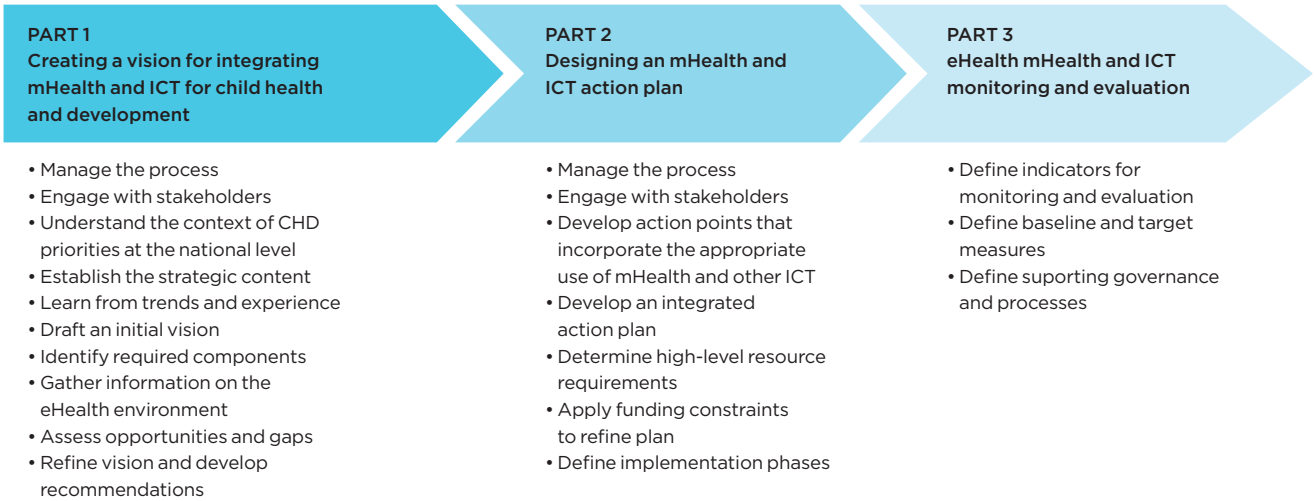
This section will focus on how to build a global mobile platform for CHD. Emphasis will be placed on context, partnerships, sustainability, scalability, and monitoring and evaluation. A partnership

k In the context of rural communities in India not finding ASHAs helpful, Ramachandran[50] developed three videos delivered on mobile phones which ASHAs could use during their visits to pregnant women at their households: (1) a series of testimonial videos where village personalities supported the work of ASHAs, (2) persuasive videos with information in health handbooks, and (3) a video with dialogue that addressed myths and barriers that hindered ASHA acceptance. Not only were the pregnant women more trusting of ASHAs, the videos improved the ability of ASHAs to deliver effective counseling while increasing engagement with women and their families.

l See Salud Responde in Chile.[58]

between the International Telecommunications Union (ITU) and World Health Organization (WHO) has produced a National eHealth strategy toolkit targeted primarily for governments and other stakeholders. Although the original framework is meant to assist the development of a national eHealth plan, the toolkit offers many valuable ideas that can be used to inform a multimedia platform strategy for CHD. Such a plan needs to leverage ICTs and reflect country priorities, provide for monitoring and implementation and manage associated risks.[59] **Figure 3** represents the framework adapted for this context. The importance of aligning eHealth efforts with governmental[m] or regional[n] policies cannot be emphasized enough, since this alignment has been a driving force in sustainably diffusing eHealth innovations.[61]

Figure 3. An adapted version of ITU-WHO's Toolkit for developing a National eHealth Strategy (image recreated and adapted from ITU, 2012).[59]



To guide success when developing interventions leveraging ICTs for CHD, there are a few more related aspects to further emphasize:

>> Understand the context

Integrated solutions are better than a single solution. Understanding how a global platform for improving health can fit into the context of national plans, governmental health and development priorities, disease conditions, existing efforts of health systems, NGOs, or CBOs, and cultural practices implications will prove absolutely crucial for determining success, especially when trying to leverage technologies. To increase understanding of national priorities in the field of health, a pre-implementation evaluation, which could involve a situational analysis, can be conducted.

- For example, over 40 countries have developed or received parliamentary approval for ECD policies, and UNICEF has supported 53 countries to prepare their own standards for what preschool children should know and be able to do.[49]

>> Tailor ICT strategies to the end users and their health needs

Similar to understanding the context, understanding the children who will often be the end

m South Africa eHealth Strategy can be found at: http://www.doh.gov.za/docs/stratdocs/2012/eHealth_Strategy_South_Africa_2012-2016.pdf

n Refer to Jimenez Marroquin [60] for a systematic review and content analysis of national eHealth policies in Latin America and the Caribbean.

users of ECD-related mHealth programs is essential to the success of the mHealth programs. Formative research can yield insight and information on end users that cannot be easily elicited through other strategies and that can have an impact on the success of the project. When designing the type of information to include, very important components to consider are the end users, message content and the frequency of sending messages.

- End users — In developing an mHealth program for ECD, the most obvious end users and primary beneficiaries are children. Other potential end users could be those mentioned in CARE's 5x5 Model: the caregiver/family, childcare setting, the community, and national policy. For ECD, effective programs "provide direct learning experiences to children and families, are targeted toward younger and disadvantaged children, are of longer duration, high quality, and high intensity, and are integrated with family support, health, nutrition, or educational systems and services".[11] Target populations for these programs include children or parents/caregivers. For children, programs are often focused on growth monitoring, early childcare centers, or improved hygiene or health services. Programs aimed at parents/caregivers focus on improving parenting skills and resources through home visits, group sessions, or behavior change and communication strategies. In the context of health, healthcare workers, both frontline and facility-based, can be considered.
- Message content and frequency — There is no algorithm that outputs the best message content or the perfect number of messages to send, but procedural lessons can be learned from existing mHealth interventions. For content, one place to start is MAMA, which has released a database of adaptable messages based on WHO and UNICEF guidelines.[o] Additionally, to design messages, rapid prototyping helps quickly test assumptions and define what works and what doesn't with regard to message content. Determining an effective and appropriate number of messages to send must also undergo a similar process that depends on the objective of the mHealth intervention (e.g., to increase awareness, to reduce stigma, to increase healthier behaviors, etc.) and is strongly dependent on the context. One method to determine the right frequency is described in a study called "SMS to Test" conducted by Cell-Life in South Africa, which found that motivational text messages increased HIV testing rates. [52]

>> Engage in appropriate partnerships

Leveraging high-impact, large-scale eHealth opportunities must start with strategic and integrated action at national levels. Government involvement from the beginning is important, and not just with Ministries of Health, as improving ECD has implications for other ministries, such as the Ministry of Education and any ministry that deals with gender and social welfare issues. Since the challenge will be to get all the relevant stakeholders around the same table, the best strategy is to not start from scratch, but instead look to existing projects that can benefit from the value each stakeholder can contribute to discussions and implementation.

- Examples of existing, large-scale efforts in mHealth include a recent public-private partnership in Nigeria related to Saving One Million Lives[p] and an effort in Bangladesh

o Request for access to MAMA content for message development at: http://www.healthunbound.org/mama/adaptable-messages

p This public-private partnership is among the Nigerian Federal Ministry of Health, Saving One Million Lives Initiative, Intel, and the mHealth Alliance. This initiative is an intensive scale up of access to essential primary health services. and commodities for women and children. See the press release: http://www.mhealthalliance.org/news/press-releases/54-new-public-private-initiative-leverages-mobile-technologies-to-save-one-million-lives-in-nigeria-

that aims to reach two million moms by 2015 called "Aponjon".[q, r] Other examples of national initiatives that reach children but do not have formal ICT components are the National Rural Health Mission in India and Safe Motherhood in Malawi.

>> Keep sustainability and scalability in mind

Many projects disappear after receiving a few years of funding because clear business models and plans have not been developed. There are two types of sustainability that are necessary in successful projects using ICT for health — sustainability generated from the audience (the project's "end users") and financial sustainability. For both, it is important to involve the government from the beginning so that they are able to feel ownership for eHealth efforts; however, partnerships with the private sector must also be emphasized. Then, as Sarah Emerson of CDC Foundation mentions, it is crucial to create mutual benefit and have realistic expectations.[s]

- For sustainability generated from the audience, an eHealth initiative must truly meet the needs of the people it attempts to benefit. To help monitor this, assessments should be built into the initiative that can help gauge this. Also, translating many lessons learned from failures and successes of other projects will be vital so as to not reinvent the wheel. After Ramachandran designed audio-visual aids delivered through the mobile phone, six important guiding lessons for developing persuasive messages emerged:[50]
    1. Focus the message on action items, not on broad topics of information
    2. Address local myths and barriers, and provide convincing corrections and solutions respectively
    3. Create opportunities for structured, persuasive dialogue between humans, keeping in mind that persuasion is a largely social phenomenon in rural communities
    4. Include reminders about the positive rewards for changing behavior, paying close attention to local values
    5. Capture the most persuasive local language and prosody style, even if it is counterintuitive
    6. Do not assume reactions are honest — persuasion takes time
- For financial sustainability, if considering the development of an mHealth project, it will be critical to engage with the business sector to develop a business case for partnership. Also for the initial years of implementation, leveraging donor funding is a good option for both eHealth and mHealth initiatives[t]; however, donor funding is often more restrictive when attempting to scale a project for many reasons, the most obvious reasons being the general 2-5 year funding length of awards and the tendency for donors to fund projects in pilot stages. Other options in the medium and long terms

q http://www.mhealthalliance.org/news/press-releases/56-bangladesh-launches-national-mobile-health-service-aponjon-to-reach-2-million-moms-by-2015

r This effort launched in Bangladesh by MAMA currently has 12,000 mothers, family members, and organizations – the majority of whom were registered through community health workers. More information here: http://www.mhealthalliance.org/news/press-releases/56-bangladesh-launches-national-mobile-health-service-aponjon-to-reach-2-million-moms-by-2015

s For more, see http://healthmarketinnovations.org/blog/2012/dec/5/sustainable-financing-mhealth-what-it-and-how-do-we-achieve-it

t One currently available opportunity can be found at: http://www.savinglivesatbirth.net/apply

include governmental funding, mobile provider support,[u] or user-generated revenues. For user-generated revenues, it is important to identify the "big opportunity" in the market — and these may be able to support the success across a broader base of consumers. For programs that utilize text messaging, even the successful ones are difficult to fund as SMS costs increase. Negotiating with network providers is strongly encouraged when sending or making higher volumes of messages or calls.

>> Apply practical theory, incorporate a Monitoring & Evaluation (M&E) component and generate evidence from rigorous evaluation

In a book on behavior change in mHealth, Mechael states that the hype surrounding mHealth currently ought to be "tempered with research, methodical approaches, and the sharing of real stories of success and failure".[29] Even though technology can catalyze efforts at a speed much faster than research, rigorous evaluations on the impact of mHealth and other ICTs on health outcomes and intervention efficiencies should be conducted, and all interventions integrating ICTs must move the evidence space forward. Only with rigorous studies and ongoing M&E is it possible to understand the actual progress an mHealth or ICT intervention is making, or more importantly, not making. When adding an M&E or evaluation component to a project, it is advised to obtain expertise from evaluation experts and keep in mind the objective that, in the future, evaluation findings will drive forward the ability to obtain future funding and campaign for stronger support from governments and the private sector. MAMA, for example, possesses a strong global M&E framework .[v, 26]

>> Ensure standards and interoperability[w]

Standards and interoperability can help a wider deployment of efforts, and in time reduce the cost of devices through economies of scale. The development of international standards for a multimedia framework leveraging mobile technologies or other ICTs is currently occurring with major stakeholders.[x] For a global platform, efforts must have a way to communicate with each other across countries within a campaign and also with other systems that exist in the environment. In other words, a space for this must exist where actors can interact with each other and offer transferable solutions from their own experiences. For this to work, standards must be set, and data across sources must be able to communicate. An example of an interoperable system is that of the Millennium Villages Global Network, which was able to support the communication of multiple project sites.[62]

>> Spread the word

Families are the best sponsors for effective campaigns that target early child development; however, previous mHealth projects have not realized their full potential because those who could benefit most were not aware the program existed.

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u For example, the project Switchboard teams up with large telecom providers to allow doctors in various African countries to call each other for free. Telecom providers find value for this since the providers use the same network when making paid calls to family and friends.[61]

v Available for download at: http://www.mchip.net/node/1317

w http://www.itu.int/en/ITU-T/techwatch/Pages/ehealth-standards.aspx

x http://www.itu.int/ITU-T/studygroups/com16/sg16-q28.html

Conclusions: Realizing the Potential

With the variety of technologies available around the world today, strategic and innovative efforts leveraging ICTs, particularly mobile technologies, can reap many gains in child health and survival, which can then lead to remarkable cognitive and socioeconomic gains for the future of children around the world.

This report has captured how ICTs are being appropriately leveraged specifically for supporting health system efforts for child health, strengthening tools for health workers who interact with children and their caretakers, and encouraging healthier behaviors among children and others involved in their health and development. With the current shift towards encouraging behaviors that enable better health and wellbeing, there is a space where technologies can play an even larger role — in inspiring children to be healthier.

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Appendix A.

Issues affecting child health and development: Vaccination; Water, sanitation, and hygiene; Emergency education; Nutrition; and Disease-specific Knowledge and Prevention.

Vaccination About 20% of children in the world do not receive any type of immunization. Additionally, tens of thousands of children suffer from severe or disabling illnesses that can also be prevented by vaccines. The good news is that immunization coverage has never been higher as over 100 million children are immunized per year for tuberculosis, polio, measles, diphtheria, tetanus, pertussis, hepatitis B, *Haemophilus influenzae* type B vaccine, yellow fever, and more recently, pneumococcal disease and rotavirus, which cause pneumonia and diarrhea, respectively. Partners that generally work on immunization strategies include WHO, UNICEF, and the GAVI Alliance. Parents and caretakers of children must be informed of the benefits from vaccinating their children so that they bring their children according to vaccination schedules and recommendations (e.g. measles immunization as soon as possible after the age of 9 months; child immunization even when he or she is sick).

Water, Sanitation, and Hygiene Water, sanitation, and hygiene issues (e.g. taking in unsafe water, inadequate water for proper hygiene, poor access to sanitation, and no access to toilet facilities) contribute to approximately 1.5 million child deaths and around 88% cases of diarrhea.[63] Chronic diarrhea also prevents proper absorption of essential nutrients, as well as life-saving vaccines, that influence child development. Often, programs can include pit latrine construction,

installed water stations, water treatment, safe water storage as households will store water in the home making it vulnerable to contamination during transport and storage, and proper training or behavior change strategies towards proper hygiene (e.g. keeping animals out of the kitchen, handwashing, trimming nails, advice on correct disposal of human feces, digging pits to bury garbage). Evidence exists that supports how improvements in water, sanitation, and hygiene can reduce absentee rates among children.[64]

Emergency Education For young children, some strategies can be implemented to mitigate the compounding effects of natural disasters or complex emergencies to reduce suffering, disease, and death. Natural disasters, as well as conflicts that emerge in some contexts can leave an area more prone to disease outbreaks, food shortages, drought, violence, and displacement. Additionally, children can be left emotionally affected. Emergency preparation is a difficult task, but it can help recovery.

In Indonesia, which has experienced ethnic violence and large-scale natural disasters in the past decades, *Jalan Sesama* was found to improve early cognitive skills, literacy, mathematics, health and safety knowledge, social development, and both environmental and cultural awareness among children between 3-6 years of age.[51] Emergency preparation can include ways to allow communication to happen better among individuals who need help and those who can help, including international relief agencies and governments. For young children, there is a need to make sure they know their full name and the plan of action in the event of any emergency. Supporting children with helping them understand that it's ok to feel sad or afraid during crises is also helpful.

Nutrition An individual's nutrition early in life dramatically influences economic and educational prospects later on with spillover effects into future generations.[65] A third of child deaths can be attributed to under nutrition. This makes under nutrition the largest risk factor of any age group. However, nutrition is often overlooked in national priorities, even in the 20 countries where 80% of the world's undernourished children live.[66] Stunting, which is caused by poor nutrition and infection, has a large influence on later child development, particularly later cognition, school progress, or both. Of the 559 million children under 5 years of age in developing countries, 156 million are stunted and 126 million live in absolute poverty. Grantham-McGregor et al. determined that the top ten countries with the largest number of disadvantaged children (defined as children who are stunted and non-stunted living in poverty with calculations to avoid double counting) in millions are: India 65, Nigeria 16, China 15, Bangladesh 10, Ethiopia 8, Indonesia 8, Pakistan 8, DRC 6, Uganda 5, and Tanzania 4. With stunting and education data from 79 countries, Grantham-McGregor et al. found for every 10% increase in stunting, the proportion of children reaching the final grade of primary school dropped by 7.9%.[9]

The benefits of nutrition begins in utero with maternal nutrients, and continues with breastfeeding exclusively or at longer durations, which offers not only nutrients, but also improves motor development, reduces infant mortality and is an opportunity for mother-child bonding.[11, 67] Food supplementation during the first 2-3 years of life has been shown to improve cognition at 3 years of age and beyond. Other effective nutrition-related interventions such as Vitamin A, iron supplementation, and iodized salt provisions as routine preventive treatments are core interventions to improve child survival. The prevalence of anemia among children under 4 years in developing countries is estimated at 46-66%, where half is attributed to iron deficiency.[67] Conclusive evidence demonstrates that iron deficiency is related to lower motor scores, social problems, long-term

IQ effects, and anxiety or depression; however, iron supplementation for prevention is effective whereas iron therapy is inconclusive at reversing deficiency. For iodine deficiencies, salt iodization is the most cost-effective way to deliver iodine and improve cognition on a large scale.[11] Other interventions include zinc in the management of diarrhea, treatment of severe acute malnutrition in hospitals, behavior change communications to improve complementary feeding, and interventions to improve hygiene. Interventions can be directly delivered (e.g. delivery of micronutrients), focused on behavior change (e.g. feeding practices), or supportive (e.g. conditional cash transfers) and can be impacted heavily by governmental action in other sectors, such as poverty, trade, and agriculture.[66]

There is an emphasis that interventions that do not have direct effects on reducing under nutrition in mothers or young children, such as stand-alone growth monitoring (unless linked to adequate nutrition counseling and referrals), preschool feeding programs targeting children over 24 months, or school feeding programs targeting children over 5, should not divert nutrition resources (though these may be effective for education — in this situation, these programs should be supported by education sectors); however, those that have proven effectiveness should be implemented rapidly at scale[66] since the period from pregnancy to 24 months of age is a "crucial window of opportunity for reducing under nutrition and its adverse effects". Nutrition recommendations include packaging interventions by delivery method and integrating them into existing maternal, neonatal, and child health programs.

Disease-specific Knowledge and Prevention

MALARIA Malaria has been associated with poor child development and effective strategies include usage of insecticide-treated bed nets (ITNs) and artemisinin-based combination therapies.[11] Use of the most effective prevention strategy for ITNs is at approximately 1%. UNICEF estimates that if every African child slept under an ITN, approximately 500,000 child deaths could be prevented each year. In 2002, the government of Malawi purchased ITNs in mass for a national scale up of ITN distribution. Heavily subsidized nets were given to maternal and child health clinics, as well as distributed through communities and available for purchase from the private sector. Health education for malaria generally includes informing pregnant women of medicine for preventing and treating malaria and educating and training families on proper home malaria management.

HIV At the end of 2011, 3.4 million children were living with HIV, and more than two million are infected under 15. Additionally, the impact of the disease further affects children who have lost one or two parents from HIV. The number of children orphaned by AIDS in sub-Saharan Africa was approximately 18 million in 2010. These children are more vulnerable to malnutrition and disease, and they are likely to fall behind in school. Effective schooling, psychosocial support, and access to health services can help improve these conditions. After being exposed to *Kilimani Sesame* for six weeks, children in Tanzania knew more about malaria and HIV/AIDS than those who were not.[68]

PNEUMONIA WHO and UNICEF recommend a three-pronged approach to address child pneumonia that includes protection (exclusive breastfeeding and improved nutrition), prevention efforts (including routine use of measles, DTP3, Hepatitis B and pneumococcal vaccines), and treatment (appropriate antibiotics).