

Integrated Management of Childhood Illness (IMCI) in the 21st Century

Present situational analysis, integration into health systems and innovations



April 2016
Maternal, Newborn and Child Health
Working Paper
UNICEF Health Section, Program Division

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**Integrated Management of Childhood Illness (IMCI) in the 21st Century:
Present situational analysis, integration into health systems and innovations**

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Knowledge Management and Implementation Research Unit, Health Section, Program Division
UNICEF
3 UN Plaza, New York, NY 10017
April 2016

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COVER PHOTO: Maternity clinic in Malawi. By Dr Alasdair Campbell, member of the Edinburgh University's Global Health Society (EUGHS).



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into health systems and innovations

Igor Rudan, Smruti Patel, Donald Waters, Kerri Wazny,
Iain Campbell, Devi Sridhar, Mickey Chopra and Harry Campbell

Centre for Global Health Research,
The Usher Institute for Population Health Sciences and Informatics,
University of Edinburgh, Scotland, UK

Keywords: Integrated Management of Childhood Illness (IMCI), Integrated Community Case Management (iCCM), situational analysis, health systems, integration, innovation, community health workers (CHWs), training, performance, motivation, supply, care seeking, referral, cost, private sector, coverage, quality, modelling, evaluations, priorities

Comments may be addressed by email to the authors: Igor.Rudan@ed.ac.uk
cc: asharkey@unicef.org

ACKNOWLEDGEMENTS

We acknowledge substantial help and support from several interviewees who helped us to develop the second part of this document, including (but not limited to) Professor Robert E. Black, Professor Zulfiqar A. Bhutta, Professor Cesar Victora and Dr Mariam Claeson. We also acknowledge substantial help in designing the report from Dr Mark Young and Dr Jerome Pfaffmann from UNICEF Headquarters in New York, USA. Finally, we acknowledge reliable and timely administrative support from Rachael Atherton.

We gratefully acknowledge funding support from UNICEF that allowed us to produce this report.



Stock supply in child health clinic in rural China. Photo by Dr Kit Yee Chan, member of the Edinburgh University's Global Health Society (EUGHS).

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Executive Summary

Integrated management of childhood illness (IMCI) was developed by the WHO and UNICEF in the mid-1990s as a strategy to reduce under-five mortality. Aimed at countries with mortalities >40/1000 live births, it has been adopted by more than 100 countries. Repeated evaluations have demonstrated that IMCI can improve the quality of clinical care for sick children, but problems related to implementation at scale in low-resource settings have too often prevented IMCI (and especially integrated management of neonatal and childhood illness - IMNCI, and integrated community case management - iCCM) from achieving expected or even demonstrable reductions in mortality.

In this report, we present a comprehensive review of the status of IMCI (and IMNCI and iCCM) in the 21st century. We address this issue in three parts: first, we performed present situational analysis, mainly based on the review of the relevant literature; second, we studied integration of IMCI, IMNCI and iCCM in health systems through a combination of literature review and interviews with key stakeholders who were willing to share the key lessons learned through IMCI implementation; and third, we reviewed the landscape of innovations that could support and expand the implementation of IMCI, IMNCI and iCCM in the coming decades.

In the first part, we were concerned with documenting the present status of IMCI in high burden settings. We reviewed the effectiveness of available interventions for IMCI, IMNCI and iCCM, particularly those for childhood pneumonia, diarrhoea and malaria. It is beyond doubt that highly effective interventions exist and that they could save lives of many children worldwide. There are many reasons why they are not being implemented in a way that would show demonstrable impact, and those reasons are extremely complex. We show, using examples, how challenges remain to be addressed in relation to access to health care, training community health workers (CHWs), ensuring and sustaining their performance and motivation. Maintaining and coordinating supplies is a constant challenge. Even when many of these problems are adequately addressed, there are further challenges related to low levels of parental care-seeking behaviour, resulting in diminished effectiveness of IMCI and iCCM programs. There are further issues with CHWs' recognition of children with danger signs and their referral to hospitals, which is often inadequate.

Challenges related to higher levels of health systems' operations, such as formulating health policy and launching implementation at the national level, or even noting and overcoming resistance to IMCI implementation, are also discussed using relevant examples. There are great difficulties with assessing costs related to IMCI programme implementation in different contexts and involving the private sector to commit more resources in support of IMCI programmes. Recent evaluations of IMCI, IMNCI and iCCM programmes in LMIC settings have shown mixed results. Moreover, the evaluations themselves often haven't been adequately designed and/or powered to show interpretable results. We also reflect upon a recent exercise, using the CHNRI method, where research priorities for iCCM were being set.

In further parts of the report, we studied the present status of coverage and quality of treatment of sick children (including neonates) in high burden settings. Indicators of coverage

and quality of treatment were critically assessed and we concluded that many of them were inadequate and required validation and improvement. Similar issues are relevant to indicators that could assist our understanding of the treatment gap and its contribution to excess mortality. The data that could allow detecting gender inequity and other inequities in IMCI coverage and utilization are scarce. To model the potential effects of addressing the gaps in treatment, an improved understanding of cost and effectiveness of various interventions in different contexts and by equity strata would be required, and these are rarely available. We presented two approaches to modelling: UNICEF's recent exercise and our own modelling of iCCM for pneumonia in 5 countries of the world using mainly DHS and MICS data. Although both models make a number of assumptions that are quite uncertain, the overall message seems to be that in many low and middle income countries the context should now favour prioritization of delivery to the poorest in the population as most cost-effective approach, rather than simply continuing with the approach that has been used up to this point.

A major part of this report focused on answering different questions related to how have countries or states overcome the financial and health systems constraints in implementing and sustaining IMCI at scale. Several key stakeholders and international experts have been interviewed to answer those questions. They identified issues related to political commitment and management capacity, ongoing reliable funding, early linkages and involvement with academia and international partners, effective training and supervision of health care staff, development of robust monitoring systems, ensuring reliable availability of necessary treatments, supplies and equipment, retention and motivation of skilled staff.

We also tried to explain the relationship with the community component of IMCI, including iCCM, through illustrative examples and interviewee's recollections. This raised the issues of political commitment and institutionalization, the problem that optimal design of CHW programmes may be very context-specific, the roads to successful community involvement and acceptance, ensuring more rational prescribing of medicines by CHWs, and attempts to reconcile community and facility-based approaches to achieve their synergistic implementation. Many open questions remained on the best approaches to secure supportive supervision of CHWs, implement reliable monitoring systems, ensure sufficient amount of treatments and supplies and strengthening health systems. Several examples pointed to the importance of inclusion of IMCI into national health plans and budgets, as financing is always a major struggle. There is a role for development partners and district involvement to secure a supply chain, while some contexts are experimenting with user fees.

In the third part of the report we focused on innovations, which are much needed within many aspects of IMCI programmes to secure their successful delivery and impact. We reviewed innovations in provision of training, sustaining quality improvements, and in reducing cost of implementation of protocols. Among many innovations, we analysed and discussed the place and value of several mHealth-based initiatives (including inSCALE, mTrack, c-Stock, mPneumonia, MAMA, mHelp, mCare and SMS for life), rapid diagnostic tests, Mentoring and Enhanced Supervision at Health Centres (MESH), Health Surveillance Assistants (HSAs), Community Health Supply Chain (CHSC) framework, Accredited Drug Dispensing Outlets (ADDO), "Living Goods", and "Drug Shop Attendants" (DSA). Finally, innovations in planning, monitoring and evaluating IMCI programmes are also much needed. We presented our own solution, called PLANET - "Planning, Monitoring and Evaluation Tool", which should allow "big data" approach to implementation research in the future.

PART 1. Present Situational Analysis

1.1. What is the present status of IMCI and IMNCI in high burden settings?

Integrated management of childhood illness (IMCI) was developed by the WHO and UNICEF in the mid-1990s as a strategy to reduce under-five mortality. Aimed at countries with mortalities >40/1000 live births, it has been adopted by more than 100 countries (**Chopra et al., 2012**). Repeated evaluations have demonstrated that IMCI can improve the quality of clinical care for sick children, but problems related to implementation at scale in low-resource have too often prevented IMCI (and especially IMNCI and iCCM) from achieving expected or even demonstrable reductions in mortality.

As a proof of principle for the large potential effect of IMCI, Egypt's case is often quoted as one of the best examples of successful implementation (**Rakha et al. 2013**). In Egypt, the Ministry of Health and Population scaled up the Integrated Management of Childhood Illness (IMCI) strategy between 1999 and 2007 in 84% of public health facilities. An evaluation based on routinely available data from vital registration assessed the impact of IMCI implementation between 2000 and 2006 on child mortality in Egypt. Annual levels of under-five mortality were compared in districts before and after they had started implementing IMCI, and mortality data were obtained from the National Bureau for Statistics for 254 districts for the years 2000-2006. IMCI programme activities were assessed in each district using information from the central IMCI data base, annual progress reports, follow-up after training visits and studies on quality of child care in public health facilities. Across 213 districts retained in the analysis, the estimated average annual rate of decline in under-five mortality was 3.3% before compared with 6.3% after IMCI implementation ($p=0.0001$). In a sub-sample of 127 districts that started implementing IMCI between 2002 and 2005, the average annual rate of decline of under-five mortality was 2.6% (95%CI: 1.1-4.1%) before compared with 7.3% (95%CI: 5.8-8.7%) after IMCI implementation ($p<0.0001$). IMCI implementation also led to marked improvements in the quality of child health services (**Rakha et al. 2013**). This was a very positive example showing that a well-designed and nationally scaled IMCI effort should be expected to lead to dramatic progress in child mortality reduction within a relatively short amount of time.

Another good example of successful child mortality reduction is Malawi. **Kanyuka et al. (2016)** conducted a "Countdown to 2015 country case study" of Malawi's progress towards the Millennium Development Goal 4. The Malawi National Statistical Office lead an in-depth country case study which aimed to explain the country's success in improving child survival. Child and neonatal mortality for the years 2000-14 were estimated using five district-representative household surveys and used the Lives Saved Tool (LiST) to attribute the child lives saved in the years from 2000 to 2013 to various interventions. The adoption and implementation of policies and programmes affecting the health of women and children was documented and the estimates of financing were developed. The estimated mortality rate in children younger than 5 years declined from 247 deaths (90% CI 234-262) per 1000 livebirths in 1990 to 71 deaths (58-83) in 2013, with an annual rate of decline of 5.4%. The most rapid mortality decline occurred in the 1-59 months age group, while neonatal mortality declined more slowly (from 50 to 23 deaths per 1000 livebirths), representing an annual rate of decline of 3.3%. Nearly half of the coverage indicators have increased by more than 20 percentage points between 2000 and 2014. Results from the LiST analysis showed that about 280.000 children's lives were saved between 2000 and 2013. This was attributable to interventions including treatment for diarrhoea, pneumonia,

and malaria (23%), insecticide-treated bednets (20%), vaccines (17%), reductions in wasting (11%) and stunting (9%), facility birth care (7%), and prevention and treatment of HIV (7%). The amount of funding allocated to the health sector has increased substantially, particularly to child health and HIV and from external sources, but it remained below internationally agreed targets. Key policies to address the major causes of child mortality and deliver high-impact interventions at scale throughout Malawi began in the late 1990s and intensified in the latter half of the 2000s and into the 2010s, backed by health-sector-wide policies to improve women's and children's health. The authors concluded that the result was achieved mainly through the scale-up of interventions that are effective against the major causes of child deaths (malaria, pneumonia, and diarrhoea), programmes to reduce child undernutrition and mother-to-child transmission of HIV, and some improvements in the quality of care provided around birth. They praised the Government of Malawi as being among the first in sub-Saharan Africa to adopt evidence-based policies and implement programmes at scale to prevent unnecessary child deaths.

1.1.1. Effectiveness of available interventions for IMCI, IMNCI and iCCM

There is every reason to expect that mortality reduction should follow the implementation of interventions embedded in IMCI, which should prevent or treat childhood illnesses. In their systematic reviews of the effectiveness of interventions that are available against pneumonia, diarrhoea and malaria, which Child Health Epidemiology Reference Group conducted to populate the Lives Saved Tool (LiST) with information necessary to model mortality reduction within countries, the expectations of intervention effectiveness under favourable conditions were defined. **Walker et al. (2010)** introduced a set of standardized rules, in a form of guidelines, developed for the purpose of populating the LiST with required parameters, such as the expected effectiveness of available interventions. Their guidelines dealt with the issues of comparability of the studies in a uniform way across a spectrum of childhood conditions. The guidelines build on and extend those developed by the Cochrane Collaboration and the Working Group for Grading of Recommendations Assessment, Development and Evaluation (GRADE). They reflect the experience gained by the CHERG intervention review groups in conducting the reviews on intervention effectiveness.

Theodoratou et al. (2010) conducted a systematic review of the literature assessing the effect of pneumonia case management on mortality from childhood pneumonia. Their review covered the following interventions: community case management with antibiotic treatment, and hospital treatment with antibiotics, oxygen, zinc and vitamin A. They summarized results from randomized controlled trials (RCTs), cluster RCTs, quasi-experimental studies and observational studies across outcome measures using standard meta-analysis methods. They estimated that community case management of pneumonia could result in a 70% reduction in mortality from pneumonia in 0-5-year-old children. In contrast, treatment of pneumonia episodes with zinc and vitamin A is ineffective and there was insufficient evidence to make a quantitative estimate of the effect of hospital case management or oxygen on pneumonia mortality based on the published data.

In addition, **Munos et al. (2010)** looked into effects of oral rehydration solution (ORS), which should prevent dehydration and reduce the mortality from diarrhoea. They conducted a systematic review to identify studies evaluating the efficacy and effectiveness of ORS and RHF. A total of 157 papers were included in the meta-analyses of ORS outcomes. They estimated that ORS may prevent 93% of diarrhoea deaths. ORS is effective against diarrhoea mortality in home, community and facility settings. **Walker et**

al. (2010) studied the effects of zinc supplementation on diarrhoea mortality. Using diarrhoea hospitalizations as the closest and most conservative possible proxy for diarrhoea mortality, the authors estimated that zinc as the treatment of diarrhoea could decrease diarrhoea mortality by 23%. **Traa et al. (2010)** established that ciprofloxacin, ceftriaxone and pivmecillinam, i.e. the antibiotics currently recommended by the World Health Organization (WHO) for the treatment of dysentery in children, should result in a childhood dysentery cure rate of >99%. Thus, they should be expected to decrease diarrhoea mortality attributable to dysentery.

Finally, **Eisele et al. (2010)** explored the evidence towards the effectiveness of interventions against childhood malaria deaths. Insecticide-treated mosquito nets (ITNs) and indoor-residual spraying (IRS) are recommended strategies for preventing malaria in children. The authors performed two systematic literature reviews in *Plasmodium falciparum* endemic settings; one to estimate the effect of ITNs and IRS on preventing malaria-attributable mortality in children 1-59 months, and another to estimate the effect of ITNs and IPTp in pregnant mothers and thus preventing neonatal and child mortality through improvements in birth outcomes. Their estimate of the protective efficacy of ITNs and IRS on reducing malaria-attributable mortality in children aged 1-59 months was 55%, (95%CI: 49-61%) in *P. falciparum* settings, while the effect of the interventions in pregnancy (IPTp and ITNs) was estimated to 35% (95%CI: 23-45%) on reducing the prevalence of low birth weight (LBW) in the first or second pregnancy in areas of stable *P. falciparum* transmission.

1.1.2. Challenges with access to health care

All of the reviews showed rather dramatic potential for pneumonia case management, ORS, zinc, antibiotic treatment of dysentery, ITNs, IRS and IPTp in reducing the mortality from childhood pneumonia, diarrhoea and malaria, respectively. Clearly, both the IMCI, IMNCI and iCCM are strategies that should work well, at least in principle. Unfortunately, in practice, implementation, scaling-up and evaluation of IMCI, IMNCI and iCCM programmes are far from simple. IMCI and IMNCI will critically depend on some level of access to health care provision, which in many regions simply isn't a realistic prospect. The success of iCCM in high-burden settings rely on training, performance and motivation of community health workers (CHW) to sustain these programmes. It also critically depends on the support the CHWs receive and the availability of ORS, antibiotics, zinc, ITNs and IRS. Finally, the parents themselves should be aware of the symptoms and danger signs and seek care. Several recent reviews attempted to address these bottlenecks and describe the reality of the high-burden context with respect to these critical parameters.

Chandran et al. (2011) assessed the proportion of neonates and children under five years of age in low and middle-income countries (LMIC) with any access to a healthcare facility. In their this paper, "utilization" was used as a proxy for "access" to a healthcare facility, and the term "facility" was used for any clinic or hospital outside of a person's home staffed by a "medical professional". A systematic literature search was conducted together with information from available Demographic and Health Surveys (DHS). The community-based neonatal studies conducted in the Southeast Asia region with the goal of enhancing care-seeking for neonates with sepsis showed that 10-48% of sick neonates in the studies' control arms utilized a healthcare facility. Cross-sectional surveys involving young children indicated that 12 to 86% utilized healthcare facilities when sick. The DHS surveys suggested a global median of 58.1% for infants < 6 months taken to a facility for

symptoms of ARI. Their data suggest that up to 30-40% of all children globally may lack access to health care when sick, making IMCI implementation difficult.

1.1.3. Challenges with training CHWs, their performance, motivation and supply

Where access to health care is lacking, iCCM proposes training of community health workers to recognize danger signs and administer treatment at scale. In several well designed trials, this approach was shown to be both safe and effective, but those trials were performed in a limited setting and under ideal conditions of training, supervision and support to CHWs. To obtain a realistic picture for LMIC, **Lee et al. (2014)** studied inadequate illness recognition and lack of access to antibiotics ("stock-out") for young infants (<2 months). They studied whether frontline health workers can accurately diagnose possible bacterial infection (pBI), how available and affordable were antibiotics, and how often were antibiotics procured without a prescription? They searched academic databases, Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), and grey literature with no date restriction until May 2014. They were able to use data from 37 published studies, 46 HAI national surveys, and eight SPAs. Their meta-analysis showed that clinical sign-based algorithms predicted bacterial infection in young infants with high sensitivity (87%, 95% CI 82%-91%) and lower specificity (62%, 95% CI 48%-75%), based on six studies and 14,254 cases. In comparison to physicians, frontline health workers diagnosed pBI in young infants with an average sensitivity of 82% (95% CI 76%-88%) and specificity of 69% (95% CI 54%-83%), based on eight studies and 11,857 cases. First-line injectable agents (ampicillin, gentamicin, and penicillin) had low variable availability in first-level health facilities in Africa and South Asia. Oral amoxicillin and cotrimoxazole were widely available at low cost in most regions. About 25% of pediatric antibiotic purchases in LMICs were obtained without a prescription (based on 11 studies, 95% CI 18%-34%), with lower rates among infants <1 year. In conclusion, trained frontline health workers may screen for pBI in young infants with relatively high sensitivity and lower specificity, while availability of first-line injectable antibiotics appears low in many health facilities in Africa and Asia.

Clearly, appropriate training and motivation of CHWs is one of the main prerequisites to a successful implementation of iCCM. Several authors were interested in this particular component of the programme and tried to obtain a better understanding. **Rowe et al. (2012a,b)** took a particular interest in this issue. They assumed that training health workers to use Integrated Management of Childhood Illness (IMCI) guidelines can improve care for ill children in outpatient settings in developing countries, but that even after IMCI training important performance gaps would exist. Being concerned that the effect of training of CHWs can rapidly wane, they aimed to determine if the performance of IMCI-trained health workers deteriorated over 3 years, studying two departments in Benin. Primary outcomes were the proportion of children under 5 years old with potentially life-threatening illnesses who received either recommended or adequate treatment, and among all children, an index of overall guideline adherence. They reviewed 9393 consultations and their surveys included 411 consultations performed by 105 health workers. For both data sources, performance trends were essentially flat for nearly all outcomes, suggesting no evidence that performance declined over 3 years after IMCI training. However, important performance gaps found immediately after IMCI training persisted and these should be addressed. Moreover, they were interested if shortening the training on Integrated Management of Childhood Illness guidelines reduced its effectiveness? The 11-day course duration is recommended by the World Health Organization (which developed

IMCI), but shortening of the training would to reduce a fixed cost in IMCI programmes. **Rowe et al. (2012b)** conducted a systematic review to compare IMCI's effectiveness with standard training (duration \geq 11 days) versus shortened training (5-10 days). Direct comparisons from three studies showed little difference between standard and shortened training. Indirect comparisons from 26 studies revealed that effect sizes for standard training versus no IMCI were greater than shortened training versus no IMCI. Across all comparisons, differences ranged from -3 to +23 percentage-points, and their best estimate was a 2 to 16 percentage-point advantage for standard training, with no result reaching statistical significance. They concluded that standard IMCI training seemed more effective than shortened training, although the difference might be small.

Kane et al. (2010) conducted a "realist synthesis" of randomised control trials involving use of community health workers for delivering child health interventions in LMIC. Their work was followed by **Paranhos et al. (2011)**, who performed an integrative literature review on IMCI with the focus on caregivers. **Kane et al. (2010)** started with an assumption that the key constraint to saturating coverage of interventions for reducing the burden of childhood illnesses in LMIC is the lack of human resources, and that CHW could be potentially important actors in bridging this gap. They examined evidence from randomized control trials (RCT) on CHW interventions in IMCI in LMIC from a realist perspective, with the aim to see if they can yield insight into the working of the interventions. Their "realist approach" involved educing the mechanisms through which an intervention produced an outcome in a particular context. Those "mechanisms" are reactions, triggered by the interaction of the intervention and a certain context, which lead to change. They noted that interventions to improve CHW performance included 'Skills based training of CHW', 'Supervision and referral support from public health services', 'Positioning of CHW in the community'. When interventions were applied in context of CHW programs embedded in local health services, with beneficiaries who valued services and had unmet needs, the interventions worked if following mechanisms were triggered: anticipation of being valued by the community; perception of improvement in social status; sense of relatedness with beneficiaries and public services; increase in self esteem; sense of self efficacy and enactive mastery of tasks; sense of credibility, legitimacy and assurance that there was a system for back-up support. Studies also showed that if context differed, even with similar interventions, negative mechanisms could be triggered, compromising CHW performance. **Paranhos et al. (2011)** added that caregivers would typically know one or more warning signs for acute respiratory infections, but not for diarrhea, and that communication skills among health professionals trained in the IMCI strategy were different to those in untrained professionals. The outcomes would improve with education level of the caregiver, and availability of the medications supplied in the consultation and in the follow-up.

More recently, two studies in Uganda were focused on CHWs and their performance and motivation within iCCM programmes. **Bagonza et al. (2014)** assessed factors influencing performance of CHWs managing malaria, pneumonia and diarrhoea under the Integrated Community Case Management (iCCM) programme in Wakiso district, central Uganda, using a cross sectional study among 336 CHWs. Performance was measured using composite scores based on the core activities of CHWs under the iCCM programme, which included treating children under five years, referring severely sick children including newborns, home visits, counseling caregivers on home care, record keeping and community sensitization. The overall level of good performance was 21.7% (95% CI, 17.3-26.1%). Factors significantly associated with performance were: sex (females) (AOR 2.65; 95% CI, 1.29 -5.43), community support (AOR 2.29; 95% CI, 1.27-4.14), receiving feedback from health facilities (AOR 4.90; 95% CI, 2.52-9.51) and having drugs in the

previous three months (AOR 2.99; 95% CI, 1.64-5.42). Only one in every five CHWs performed optimally under the iCCM programme, indicating that strategies to improve drug supply, community support and feedback provision from the formal health system are necessary to improve the performance of CHWs. Furthermore, **Banek et al. (2015)** focused on community case management of malaria and explored support, capacity and motivation of community medicine distributors in Uganda. They interviewed community medicine distributors (CMDs), who had been involved in the HBMF programme in Tororo district, shortly before ICCM was adopted. Between October 2009 and April 2010, they recruited 100 CMDs to participate by convenience sampling. They concluded that CMDs faced multiple challenges including high patient load, limited knowledge and supervision, lack of compensation, limited drugs and supplies, and unrealistic expectations of community members. CMDs described being motivated to volunteer for altruistic reasons; however, the main benefits of their work appeared related to 'becoming someone important', with the potential for social mobility for self and family, including building relationships with health workers. At the time of the survey, over half of CMDs felt demotivated due to limited support from communities and the health system. The authors concluded that, if complex community interventions are the most realistic solution to improving access to primary health care, then greater attention to what motivates CHWs and ways to strengthen their support are required.

1.1.4. Challenges with parental care-seeking behaviour and CHWs referral

Although the organization, training and performance of CHWs is certainly critical for the success of the iCCM strategy, an increasingly appreciated factor that is also required for achieving a desired impact is parental care seeking. **Herbert et al. (2012)** hypothesized that limitations in care seeking for ill neonates and children contribute to high mortality rates. They reviewed care seeking for neonatal illnesses in LMICs, with particular attention to type of care sought. Of the 9,098 neonates in 22 studies who were ill or suspected to be ill, 4,320 caregivers sought some type of care, including care from a health facility (n=370) or provider (n=1,813). Care seeking ranged between 10% and 100% among caregivers with a median of 59%. Care seeking from a health care provider yielded a similar range and median, while care seeking at a health care facility ranged between 1% and 100%, with a median of 20%. The authors concluded that there was a lack of consistency regarding illness, care-seeking, and care provider definitions, and a paucity of data regarding newborn care-seeking behaviors. They noted a clear need for representative data to describe care-seeking patterns in different geographic regions and better understand mechanisms to enhance care seeking during this vulnerable time period. In addition, **Seidenberg et al. (2012)** sought to assess how iCCM availability influenced care-seeking behavior in rural Zambia. In areas where two different iCCM approaches were implemented, they conducted baseline and post-study household surveys on healthcare-seeking practices among women who were caring for children ≤ 5 years in their homes. For children presenting with fever, there was an increase in care sought from CHWs and a decrease in care sought at formal health centers between baseline and post-study periods. For children with fast/difficulty breathing, an increase in care sought from CHWs was only noted in areas where CHWs were trained and supplied with amoxicillin to treat non-severe pneumonia. Their findings suggested that iCCM access influences local care-seeking practices and reduces workload at primary health centers.

1.1.5. Challenges with health policy, implementation and resistance to IMCI

In addition to the above bottlenecks, further challenges remain with respect to national-level policy formulation and institutional support, planning and monitoring of IMCI and iCCM programs, and overcoming concerns and even resistance to IMCU programs. **Rasanathan et al. (2014)** reported findings from a cross-sectional survey on policy and implementation of iCCM in sub-Saharan Africa. They established that CCM involves training, supporting, and supplying community health workers (CHWs) to assess, classify and manage sick children with limited access to care at health facilities, in their communities. They provided an overview of the status in 2013 of CCM policy and implementation in sub-Saharan African countries, after they undertook a cross-sectional, descriptive, quantitative survey amongst technical officers in Ministries of Health and UNICEF offices in 2013 in 45 countries in sub-Saharan Africa. They focused on CHW profile, CHW activities and financing, and obtained responses from 42 countries. Among those, 35 reported implementing CCM for diarrhoea, 33 for malaria, 28 for pneumonia, 6 for neonatal sepsis, 31 for malnutrition and 28 for integrated CCM (which involves treatment of 3 conditions: diarrhoea, malaria and pneumonia). This represented a noted increase in uptake in comparison to 2010. In 27 countries, volunteers were providing CCM, compared to 14 countries with paid CHWs. User fees persisted for CCM in 6 countries and mark-ups on commodities in 10 countries. Most countries had a national policy, memo or written guidelines for CCM implementation for diarrhoea, malaria and pneumonia, with further 20 countries also having this for neonatal sepsis. It was favourable to note that most countries plan gradual expansion of CCM, but it was also very clear that many countries' plans were heavily reliant on their development partners. A large group of countries had no plans for CCM for neonatal sepsis. The scale of implementation varies widely, so a focus on implementation is now required, including monitoring and evaluation of performance, quality and impact. There is also a considerable scope for expansion for newborn care. The key issues raised by countries include financing and sustainability (with development partners still providing most funding), gaps in data on CCM activities, and the persistence of user fees and mark-ups in several countries. The authors concluded that national health management information systems should also incorporate CCM activities.

George et al. (2015) followed with a comprehensive iCCM policy analysis, focusing on its character, design and scale up in sub-Saharan Africa. They examined the policy processes underpinning iCCM through qualitative case study research in six purposively identified countries (Niger, Burkina Faso, Mali, Kenya, Malawi and Mozambique) and in the global context. They reviewed how policy analysis can inform how iCCM is framed, and negotiate its boundaries negotiated; how it can be tailored for national health systems; and how can accountability and learning for iCCM be fostered. The authors concluded that adaptation to contextual realities may lead to unintended consequences not foreseen by technical or managerial expertise alone, and that further scaling up of iCCM requires understanding of the political accountabilities involved. Fostering of ownership and learning how to improve policies and sustain programs are very important. Similarly, **Rodríguez et al. (2015)** explored how evidence-informed policymaking can be implemented in practice, studying country-level examples of use of evidence for iCCM policy in Niger, Kenya and Mozambique. The authors used Carol Weiss' models of research utilization to further explain the use of evidence in these contexts. The authors used documentary review and in-depth stakeholder interviews as part of retrospective case studies in each study country. Findings indicate that all three countries used national monitoring data to identify the issue of children dying in the community prior to reaching health facilities, whereas international research evidence was used to identify policy options. Nevertheless, policymakers greatly valued local evidence and pilot projects proved critical in advancing iCCM. World Health Organization and United Nations Children's Fund (UNICEF) functioned as knowledge brokers, bringing research evidence

and experiences from other countries to the attention of local policymakers as well as sponsoring site visits and meetings. In terms of country-specific findings, Niger demonstrated both "Interactive" and "Political" models of research utilization by using iCCM to capitalize on the existing health infrastructure. Both Mozambique and Kenya exhibited "Problem-Solving" research utilization with different outcomes. Furthermore, the persistent quest for additional evidence suggests a "Tactical" use of research in Kenya. The authors suggested that, while evidence from research studies and other contexts can be critical to policy development, local evidence is often needed to answer key policymaker questions. They conclude that evidence may not be enough to overcome resistance if the policy is viewed as incompatible with national goals.

Further case studies of national-level policy analysis provided additional useful insights. **DalGLISH et al. (2015)** looked at the relationship between power and pro-poor policies studying the case of iCCM in Niger. The authors postulated that power dynamics is rarely adequately explored, whether or not the policy in question targets the poor. They focused on three dimensions of power in policymaking: political authority, financial resources and technical expertise. They found that political authorities, namely President Mamadou Tandja, created the underlying health infrastructure for the policy ('health huts') as a way to distribute rents from development aid through client networks while claiming the mantle of political legitimacy. Conditional influxes of financial resources created an incentive to declare fee exemptions for children below 5 years, which was a key condition for the policy's success. Technical expertise was concentrated among international actors from multi-lateral and bilateral agencies who packaged and delivered scientific arguments in support of iCCM to Nigerien policymakers, whose input was limited mainly to operational decisions. More recently, **Mupara et al. (2016)** reported on challenges and recommendations relevant to implementation of the IMCI in Botswana, which started to implement the IMCI strategy in 1998. Reductions in the under-five mortality rate (U5MR) have been documented, although they do not follow the expectations under the Millennium Development Goal 4. A quantitative study that they conducted to identify the challenges that IMCI implementers face in the Gaborone Health District of Botswana pointed to challenges related to low training coverage, inefficient health systems, and the unique features of the IMCI strategy in Botswana.

Concerns exist over open resistance to IMCI implementation in certain places. **Juma et al. (2015)** tried to document and explain policy resistance in Kenya, where iCCM policy development has been slow in Kenya in comparison to other Sub-Saharan African countries. At the time of their study, the Government had just completed the Community Health Training Manual, which incorporated iCCM as a module, but this was the only formal expression of iCCM in Kenya. The authors found that technical considerations, most notably concerns about community health workers dispensing antibiotics, to be a key factor slowing iCCM policy development. In addition, there was an additional overlap with bureaucratic considerations, such as how the development of community health worker cadres may affect clinicians. Concerns were also voiced about how an integrated approach might affect vertically oriented programs. The promoting forces for iCCM in Kenya are international actors, whose advertising of Millennium Development Goals helped to get child survival onto the national policy agenda. Those actors are the active promoters of iCCM policy change, but international funders had not committed funding to scale-up iCCM policy, which is likely to constrain their influence on the ongoing iCCM policy debate in Kenya.

1.1.6. Challenges with cost assessment and involving the private sector

In most evaluations of IMCI and iCCM programmes through surveys, the lack of financial resources is often quoted as the main problem. **Collins et al. (2014)** attempted to cost integrated community case management (iCCM) programs in several countries. Data on coverage, utilization, and costs were collected as part of two sets of studies conducted between 2011 and 2013 for iCCM programs in seven sub-Saharan African countries (Cameroon, DR Congo, Malawi, Senegal, Sierra Leone, South Sudan and Zambia). The collected data were used to compare elements of program performance, costs per capita and costs per service, i.e. the key indicators of resource allocation and efficiency. Among the seven countries, iCCM utilization ranged from a total of 0.26 to 3.05 contacts per capita (children 2-59 months) per year for the diseases treated, representing a range of 2.7% to 36.7% of the expected numbers of cases. The total recurrent cost per treatment ranged from US\$ 2.44 to US\$ 13.71 for diarrhea; from US\$ 2.17 to US\$ 17.54 for malaria (excluding rapid diagnostic testing); and from US\$ 1.70 to US\$ 12.94 for pneumonia. In some of the country programs, the utilization of iCCM services was quite low and this, together with significant fixed costs, particularly for management and supervision, resulted in services being quite costly. The authors also noted that the differences across the countries and programs imply that these results should be treated as indicative, rather than definitive. They concluded that, in order to be cost-effective and affordable, iCCM programs must be well utilized. Moreover, program management and supervision should be organized to minimize costs and ensure quality of care. There is a concern that iCCM programs can not always be low-cost, particularly in small and remote villages where supervision and supply challenges are greater.

The problems related to funding of IMCI and iCCM programmes raise questions on the possible role for private sector in supporting such programmes. **Awor et al. (2014)** conducted a systematic literature review of iCCM and the private sector in Africa, setting out to determine the extent to which the private sector has been utilized in providing integrated care for sick children under 5 years of age with common infections. The large majority of identified studies were related to malaria, mainly evaluating introduction of malaria drugs and/or diagnostics into the private sector. The authors concluded that the private sector is an important potential source of care for children in low income countries, but also that little has been done to harness the potential of this sector in improving access to care for non-malaria-associated fever in children within the community. They suggest that iCCM programs should consider expanding their activities to include the private sector to achieve higher population coverage. This will necessitate the development of implementation research agenda for private sector.

1.1.7. Recent evaluations of IMCI, IMNCI and iCCM programmes in LMIC settings

In the past 3-4 years, several large-scale evaluations of IMCI and iCCM programs have been conducted and published. Firstly, in a theme issue of the "Journal of Global Health" (Dec 2014), Diaz et al. introduced the theme through providing an overview of the current scientific evidence for integrated community case management (iCCM) in Africa, summarizing the findings from the iCCM Evidence Symposium that took part in Accra, Ghana earlier that year (**Diaz et al., 2014**). In March 2014, over 400 individuals from 35 countries in sub-Saharan Africa and 59 international partner organizations gathered in Accra for an integrated Community Case Management (iCCM) Evidence Review Symposium. The objective of their meeting was two-fold: to review the current state of the art of iCCM implementation and to assist African countries to integrate lessons learned and

best practices presented during the symposium into their programmes. Based on the findings from the symposium, the theme issue presented the latest evidence for improving iCCM programs and ways to better monitor and evaluate such programs.

Within this effort, **Oliphant et al. (2014)** reported on the multi-country analysis of routine data from iCCM programs in sub-Saharan Africa (SSA). They examined 15 evaluations or studies of iCCM programs in SSA conducted between 2008 and 2013. All evaluations had information about the program; routine data on treatments, supervision, and stockouts; and, where available, data from community health worker (CHW) surveys on supervision and stockouts. The median percent of annual expected cases treated was 27% (1-74%) for total iCCM, 37% (1-80%) for malaria, 155% (7-552%) for pneumonia, and 27% (1-74%) for diarrhoea. Larger populations under-five targeted were negatively associated with treatment rates for fever, malaria, diarrhea, and total iCCM, while the ratio of CHWs per population was positively associated with diarrhoea treatment rates. Use of rapid diagnostic tests (RDTs) was negatively associated with treatment rates for pneumonia. Important conclusions of this analysis were that there was large variation in iCCM program performance in SSA. Treatment rates for diarrhoea were lower than expected across most programmes, while pneumonia was being overtreated (**Oliphant et al., 2014**). Interestingly, treatment rates and percent of annual expected cases treated were equivalent between programs with volunteer CHWs and programs with salaried CHWs (**Oliphant et al., 2014**).

Amouzou et al. (2014) assessed the impact of integrated community case management (iCCM) programs on child mortality in SSA. They identified eight recent studies and assessed those studies in terms of design, mortality measurement and results among children age 2-59 months. Using a "difference in differences" approach and random effect Poisson regression, their outcome variable (child mortality) was measured through demographic surveillance or household survey, with full birth history conducted at the end of program implementation. Six of the eight studies showed a higher decline in mortality among children 2-59 months in program areas compared to comparison areas, although this acceleration was statistically significant in only one study (with a decline of 76% larger in intervention than in comparison areas). They noted that evaluations of large scale iCCM programs in terms of mortality impact must ensure an appropriate study design, with required sample sizes and sufficient number of program and comparison districts to allow adequate attribution of impact. Failure to take those important issues into account will inevitably result in inconclusive mortality impact evaluations.

Another theme issue was published more recently - in the "American Journal of Tropical Medicine and Hygiene". In this issue, the results of evaluations of the iCCM Strategy in Burkina Faso, Ethiopia, and Malawi were reported. **Hazel et al. (2016)** summarized the independent iCCM evaluations that were designed in 2009–2010, as a part of the Catalytic Initiative to Save a Million Lives. This initiative was spearheaded by Canada and involved the Bill & Melinda Gates Foundation, the U.K. Department for International Development, the United Nations Children's Fund, the World Health Organization, the Doris Duke Charitable Foundation, and other donors. The goal of the Catalytic Initiative was to support and measure the impact of strong, coordinated efforts to deliver high-impact interventions to reduce under-five mortality in low-income, high-burden countries, with a particular focus on providing treatment for childhood pneumonia, diarrhea, and malaria at community level using iCCM.

The evaluation in each setting was conducted in collaboration with local research institutions, based on a locally adapted version of the common evaluation framework for

maternal, newborn, and child health (MNCH). The three studies found that iCCM was not associated with accelerated mortality declines in children aged 2–59 months during the 2- to 4-year evaluation periods. The reasons for this lack of demonstrable effect was likely to differ across settings (**Hazel et al., 2016**). In Burkina Faso, iCCM implementation relied on community health worker (CHW) lay volunteers. The initial training was organized as a “cascade” in which representatives from districts were trained and then requested to organize subdistrict-level training sessions to train over 3,000 CHWs in the space of a few months, with minimal support or supervision. The training included written materials, even though many of the CHWs were illiterate. Systems for ensuring the availability of drugs and reinforcing health worker performance were not consistently in place at the time of training, or indeed throughout the evaluated implementation period. There were no systematic efforts to generate community demand for and utilization of iCCM services. As a result, the quality of iCCM service provision was poor, the services were grossly underutilized, and there was no improvement in intervention areas in the proportion of sick children who received correct treatment of their disease. Estimated under-five mortality declined by 6.2% (from 110 to 103 deaths per 1,000 live births) in the "Rapid Scale-Up" area and 4.2% (from 114 to 109 per 1,000 live births) in the comparison area. The authors concluded that Burkina Faso iCCM program will not have an impact unless it is redesigned to fully capacitate health workers and educate the community to increase demand (**Hazel et al., 2016; Munos et al., 2016**).

However, **Hazel et al. (2016)** report that "...in both Malawi and Ethiopia iCCM was implemented more strongly and achieved important intermediate outputs. In both settings, government policies were in place to support full implementation of the strategy, and high numbers of paid community-level workers were well trained and initially well equipped. The percent of children receiving correct treatment from CHW for iCCM illnesses was moderately high in Ethiopia (78%) and lower in Malawi (63%), but it was at least as good as the care received in first-level health facilities. In both settings, unfortunately, children with more severe illnesses were less likely than those without life-threatening conditions to be managed correctly, pointing to continuing needs for refinement of the iCCM approach to improve and sustain health worker performance. Health systems supports for iCCM were quite strong in Ethiopia, particularly high levels of clinical supervision, which requires further investigation to generate best practice models. Careful monitoring was used to generate remedial actions when problems were identified. In Malawi, only 58% of iCCM workers received clinical supervision and only 38% reported no stock-outs of essential iCCM drugs in the previous 3 months. Although far from perfect, both Ethiopia and Malawi implemented iCCM strongly and at scale, providing an important foundation for continued improvement."

In Malawi, **Amouzou et al. (2016a)** identified likely contributors to the failure to demonstrate impact. With fewer than one iCCM-ready provider per 1,000 under-five children per district, about 70% of sick children were taken outside the home for care. Careseeking from iCCM providers increased over time from about 2% to 10%, while careseeking from other providers fell by a similar amount. The key issues were low density of iCCM providers, geographic targeting of iCCM to "hard-to-reach" areas although women did not identify distance from a provider as a barrier to health care, and displacement of facility careseeking by iCCM careseeking. In Ethiopia, **Amouzou et al. (2016b)** conducted a cluster randomized trial of the effects of iCCM strategy on careseeking for and coverage of correct treatment of suspected pneumonia, diarrhea, and malaria. They conducted baseline and endline coverage and mortality surveys approximately 2 years apart, and assessed program strength after about 1 year of implementation. Results showed strong iCCM implementation, with iCCM-trained

workers providing generally good quality of care. However, few sick children were taken to iCCM providers (average 16 per month). Difference in differences analyses revealed that careseeking for childhood illness was low and similar in both study arms at baseline and endline, and increased only marginally in intervention (22.9-25.7%) and comparison (23.3-29.3%) areas over the study period ($P = 0.77$). Mortality declined at similar rates in both study arms, implying that Ethiopia's iCCM program did not generate levels of demand and utilization sufficient to achieve significant increases in intervention coverage and a resulting acceleration in reductions in child mortality.

Hazel et al. (2016) conclude that, in both Ethiopia and Malawi, there was no change in overall care seeking for iCCM illnesses and no impact on mortality, meaning that the potential effectiveness of iCCM was capped by low utilization. Care seeking rates simply did not increase over time. No matter how strong iCCM service provision may be, the strategy cannot save lives unless mothers and other caregivers take their children for care. They suggest that future iCCM programs must be designed with this in mind, and include strong, locally defined components designed to increase care seeking and utilization (**Hazel et al., 2016**).

Based on evaluations from Burkina Faso, Malawi and Ethiopia, **Hazel et al. (2016)** concluded that "iCCM programs will require steadfast attention, investment, and developmental guidance to mature and achieve their mortality-reduction potential. iCCM is not the answer in all settings—where first-level facilities are accessible and can be improved to provide quality services, such as in urban settings, there may be no need for iCCM, unless it can be demonstrated that the strategy overcomes barriers to care seeking that go beyond physical access. In settings where iCCM is needed, further research, development, and investment will be required to ensure that implementation plans reflect an accurate understanding of “which” women and children are not using services, “how best” to reach and motivate them to seek care, and “what role” iCCM can play in this pathway to survival. Local capacity to collect and analyze relevant data is a prerequisite for generating essential knowledge and putting this knowledge to use in the service of women and children".

Further useful examples of evaluation were conducted in Benin (**Rowe et al., 2011**), Ethiopia (**Tadesse et al., 2014**) and Uganda (**Mubiru et al., 2015**). **Rowe et al. (2011)** studied the impact of a malaria-control project in Benin, that included the IMCI strategy. They evaluated a malaria-control project in Benin that implemented IMCI and promoted insecticide-treated nets (ITNs), conducting a before-and-after intervention study with a non-randomized comparison group. They used the preceding birth technique to measure early-childhood mortality (risk of dying before age 30 months), and health facility surveys and household surveys to measure process indicators. Most process indicators improved in the area covered by the intervention. As ITNs were also promoted in the comparison area, children's ITN use increased by about 20% in both areas. Regarding early-childhood mortality, the trend from baseline (median year 2000) to follow-up (median year 2003) for the intervention area (13.0% decrease; $P < .001$) was 14.1% ($P < .001$) lower than was the trend for the comparison area (1.3% increase; $P = .46$). Mortality decreased in the intervention area after IMCI and ITN promotion, while ITN use increased similarly in both study areas, suggesting that the mortality impact of ITNs in the 2 areas might have canceled each other out. The authors conclude that the mortality reduction could have been primarily attributable to IMCI's effect on health care quality and care-seeking.

Tadesse et al. (2014) reported on utilization of iCCM services in three regions in Ethiopia after two years of implementation. They analyzed all 60,452 encounters (58,341 [98.2%]

for children 2-59 months of age and 2079 [1.8%] for children < 2 months of age) recorded in iCCM registration books from 2012 to 2013 in 622 randomly sampled health posts. Children 2-23 months constituted more than half (58.9%) of the total children treated, and about half of the registered infants < 2 months were not sick since some Health Extension Workers (HEWs) were recording well-infant visits. On average, sick children had 1.3 symptoms, more among children 2-59 months than among young infants (1.4 vs. 1.04, respectively). The main classifications for children 2-59 months were diarrhea with some or no dehydration (29.8%), pneumonia (20.7%), severe uncomplicated malnutrition (18.5%), malaria (11.2%), and other severe diseases (4.0%). More than half the sick children < 2 months had very severe disease. Treatment rates (per 1000 children per year) were low for all classifications: 11.9% for malaria (in malarious kebeles only), 20.3% for malnutrition, 21.2% for pneumonia, and 29.2% for diarrhea, with wide regional variations for all diseases except pneumonia. Nearly two-thirds of health posts treated \leq 5 cases/month, but some treated up to 40. Health Extension Workers saw 60% more sick children 2-59 months in the third quarter of 2012 than in the third quarter of 2011. The authors concluded that the use of iCCM services is low and increasing slowly, while recording healthy young infants in sick registers complicates tracking this vulnerable group.

Mubiru et al. (2015) evaluated iCCM in Central Uganda between 2010 and 2012 through a pre-post quasi-experimental study, while 3 districts without iCCM served as controls. A two-stage household cluster survey at baseline (n = 1036 and 1042) and end line (n = 3890 and 3844) was done in the intervention and comparison groups, respectively, with changes in treatment coverage and timeliness assessed using difference in differences analysis. More than 5,500 Village Health Team members delivered nearly 2 million treatments to children under age five. Use of oral rehydration solution (ORS) and zinc treatment of diarrhoea increased in the intervention area, while there was a decrease in the comparison area. National stock-outs of amoxicillin led to a decrease in antibiotic treatment for ARI in both areas, with the decrease significantly greater in the comparison area. There was a greater increase in Artemisinin Combination Therapy treatment for fever in the intervention areas than in the comparison area, although this difference was not significant. In the intervention area, timeliness of treatments for fever and ARI increased significantly. Modelling based on LiST tool implied that an estimated 106 lives were saved in the intervention area, while 611 lives were lost in the comparison area as a result of worsened intervention coverage. The authors concluded that iCCM significantly increased treatment coverage for diarrhoea and fever, mitigated the effect of national stock outs of amoxicillin on ARI treatment, improved timeliness of treatments for fever and ARI and saved lives.

1.1.8. Research priorities for iCCM

Wazny et al. (2014) led an expert-driven exercise that attempted to set global research priorities for integrated community case management (iCCM) using the CHNRI (Child Health and Nutrition Research Initiative) method. Research questions involving increasing the uptake of iCCM services, research questions concerning the motivation, retention, training and supervision of Community Health Workers (CHWs) and concerning adding additional responsibilities including counseling for infant and young child feeding (IYCF) and treatment of severe acute malnutrition (SAM) ranked highly. Operational research to determine optimal training, supervision and modes of motivation and retention for the CHW is vital for improving iCCM, globally, as is research to motivate caregivers to take advantage of iCCM services. The authors also noted that experts working in-country or

regionally in LMICs prioritized different research questions than those working in organization headquarters in HICs.

1.2. What is the present status of coverage and quality of treatment of sick children (including neonates) in high burden settings?

Since 1996 more than 100 countries have adopted IMCI. IMCI case management training (ICMT) is one of three IMCI components and training is usually residential over 11 consecutive days. Follow-up after ICMT is an essential part of training. Goga et al. (2011) wrote of global challenges with scale-up of the IMCI strategy, trying to take the issues of scaling-up coverage and treatment quality into account. They used multi-country survey to describe the barriers to rapid acceleration of ICMT and reviewed country perspectives on how to address these barriers, involving 27 countries from all six WHO regions and obtaining feedback from the selected national focal IMCI persons/programme officers, course directors/facilitators and IMCI trainees. The most common challenges to ICMT scale-up related to funding, quoting high cost and long duration of the residential ICMT. Further barriers were poor literacy of health workers, differing opinions about the role of IMCI in improving child health, lack of political support, frequent changes in staff or rules at Ministries of Health and lack of skilled facilitators.

Countries addressed these challenges in several ways including increased advocacy, developing strategic linkages with other priorities, intensifying pre-service training, re-distribution of funds and shortening course duration. The commonest challenges to follow-up after ICMT were, again, lack of funding, insufficient funds for travelling or planning, shortage of gas for travelling, inadequately trained or few supervisors, and inadequate job aids for follow-up. In several countries, some of these problems were being addressed through linking IMCI follow-up with routine supervisory visits. The authors proposed reviewing core competencies, followed by competency-driven shortened training duration or 'on the job' training, 'distance learning' or training using mobile phones. Moreover, linkages with other 'better-funded' programmes, such as HIV or malaria, should be considered to improve coverage and quality of IMCI programmes (**Goga et al., 2011**).

1.2.1. Indicators of coverage and quality of treatment

In addition to surveys among the key stakeholders within the IMCI programmes, as described in the introduction to this section, there is a growing need for better measurement tools and indicators of coverage and quality of treatment of IMCI programmes. **Roberton et al. (2016)** conducted a feasibility study of the indicator guide for monitoring and evaluating iCCM, which was published in 2014 by the iCCM Task Force. This "Indicator Guide for Monitoring and Evaluating iCCM" was designed a "menu" of recommended indicators with globally agreed definitions and methodology, to guide countries in developing robust iCCM monitoring systems. It was conceived as an evolving document that would incorporate collective experience and learning as iCCM programmes themselves evolve, with 18 routine monitoring indicators. The analyses highlighted challenges of using supervision checklists as a data source and that some of the recommended indicators need revising. The authors concluded that routine monitoring systems would be more feasible, effective and efficient if iCCM programmes focused on a smaller set of high-value indicators that are easy to measure, reliably interpreted and useful both for global and national stakeholders and for frontline health workers themselves.

Similarly to this effort, **Mamo et al. (2014)** assessed the monitoring and evaluation system for iCCM in Ethiopia, which also assessed global iCCM Task Force's benchmark indicators. The authors tried to determine the availability and feasibility of the iCCM benchmark indicators. They concluded that Ethiopia currently collects data to inform most (70%) of the iCCM benchmark indicators, and that a modest additional effort could boost this to 83%, while eight indicators (17%) are not available under the current system. Most benchmark indicators that track coordination and policy, human resources, service delivery and referral, supervision, and quality assurance are available through the routine monitoring systems or periodic surveys. Indicators for supply chain management are less available due to limited consumption data and a weak link with treatment data. Hardly any information is available on iCCM costs (**Mamo et al., 2014**).

An important sub-section of the recently awarded Bill and Melinda Gates Foundation grant on Maternal and Childhood Epidemiology Estimates (MCEE) is focused on validating the existing indicators and improving understanding of their value in tracking the coverage and assessing quality of treatment. Moreover, an international consortium of researchers, led by Johns Hopkins University scientists, attempt to develop and validate better indicators within their work on the MCEE grant (**Munos, Campbell et al., personal communication, 2016**). Postulating that regular monitoring of coverage for Reproductive, Maternal, Neonatal, and Child Health (RMNCH) is central to assessing progress toward national and international health goals, the group aim to analyze "the current state of coverage measurement for interventions across the RMNCH continuum of care, including direct measurement of coverage, health provider readiness and/or the quality of intervention delivery". Their approach includes reviewing the standard household surveys and providing assessments whether they provide measures of intervention coverage or quality of intervention delivery. For facility-based interventions, the group plans to assess the feasibility of linking information from providers to household surveys, to obtain estimates of intervention coverage. Their initial results suggest that there is a need for continued improvement in validity and reliability of coverage estimates provided by household surveys, then for development and testing of new approaches for measuring coverage of facility-based interventions that are feasible for use at scale in low-income countries, and for interventions that are not delivered through health facilities. **Do, Munos and Campbell (2016, personal communication)** concluded that many measures of service coverage obtained from household surveys do not measure actual service delivery, resulting in a need for studies that link reports of where care is sought with assessments of the service environment in order to improve measurements. Different linking methods have been reported in the literature, which can be classified into two broad categories - indirect ("ecological") linking and direct linking (i.e., exact matching). Both categories have their own set of advantages and limitations, both in terms of methodology and practicality for scale-up.

At the moment, it seems that fewer than half of effective RMNCH interventions have a well-defined coverage measurements indicator in standard household surveys. This is particularly true for peri-conceptual, antenatal, and intrapartum periods, which seem as the greatest urgency in terms of development and validation of appropriate indicators. Moreover, diarrhoea is usually seen as a disease for which correct diagnosis is much easier to establish than for other childhood illnesses, and indicators of intervention coverage (ORS and zinc) are also relatively straightforward. However, pneumonia and malaria represent much greater challenges, as we will show in further text.

Campbell et al. (2013) studied challenges in monitoring the proportion of young children with pneumonia who receive antibiotic treatment. Currently, progress in improving the

global coverage of antibiotic treatment is monitored through large household surveys such as the Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS), which estimate antibiotic treatment rates of pneumonia based on two-week recall of pneumonia by caregivers. Given that DHS and MICS survey tools identify children with reported symptoms of pneumonia, and because the prevalence of pneumonia over a two-week period in community settings is low, the majority of these children do not have true pneumonia. Because of this, the denominator of pneumonia cases for monitoring antibiotic treatment rates is not accurate. The authors suggested that the performance of survey tools could be improved by increasing the survey recall period, or by improving either overall discriminative power or specificity. However, even at a test specificity of 95% and a test sensitivity of 80%, the proportion of children with reported symptoms of pneumonia who truly have pneumonia is only 22%, reflecting a very low positive predictive value of the survey tool. Thus, although DHS and MICS survey data on rates of care seeking for children with reported symptoms of pneumonia and other childhood illnesses remain valid and important, the authors remain very pessimistic about the ability of DHS and MICS surveys to provide valid estimates of antibiotic treatment rates in children with pneumonia.

Linked to those considerations, **Hazir et al. (2013)** conducted a prospective validation study in Pakistan and Bangladesh on measuring correct treatment of childhood pneumonia in urban and rural settings in Pakistan and Bangladesh. Caregivers of 950 children under 5 years with pneumonia and 980 with "no pneumonia" were identified in urban and rural settings and allocated for DHS/MICS questions 2 or 4 weeks later. Study physicians assigned a diagnosis of pneumonia as reference standard; the predictive ability of DHS/MICS questions and additional measurement tools to identify pneumonia versus non-pneumonia cases was evaluated. Results at both sites showed suboptimal discriminative power, with no difference between 2- or 4-week recall. Individual patterns of sensitivity and specificity varied substantially across study sites (sensitivity 66.9% and 45.5%, and specificity 68.8% and 69.5%, for DHS in Pakistan and Bangladesh, respectively). Prescribed antibiotics for pneumonia were correctly recalled by about two-thirds of caregivers using DHS questions, increasing to 72% and 82% in Pakistan and Bangladesh, respectively, using a drug chart and detailed enquiry. The authors conclude that the current DHS/MICS questions and proposed new (video and pneumonia score) methods of identifying pneumonia based on maternal recall are both shown to discriminate poorly between pneumonia and children with cough. Reported antibiotic treatment rates among these children cannot be considered a valid proxy indicator of pneumonia treatment rates, implying that the data from DHS/MICS surveys should not be used for monitoring antibiotic treatment rates in children with pneumonia.

For malaria, Baiden et al. (2012) quoted WHO's recommendation for a test-based management of malaria across all transmission settings. Similarly to pneumonia case, the accuracy of rapid diagnostic test (RDT) will influence the performance and assessment of new guidelines. The authors conducted a study in rural Ghana to evaluate the performance of CareStart, which is a HRP-2 based RDT, using microscopy as reference and applied IMCI treatment guidelines: they restricted treatment to RDT-positive children and followed-up both RDT-positive (malaria) and RDT-negative (non-malaria) cases over 28 days in a sample of 436 children. Sensitivity and specificity of the RDT were 100.0% and 73.0%, respectively. Over the follow-up period, 18.5% RDT-negative children converted to positive, with 4.0% of them presenting with fever. Reports of unfavourable treatment outcomes by caregivers were higher among the non-malaria group than the malaria group. The RDT had good sensitivity and specificity, but a minority of children who will not receive treatment based on RDT results may develop clinical malaria within a short period in high transmission settings, which could undermine caregivers' and health workers'

confidence in the new guidelines. The authors concluded that improving the quality of management of non-malarial febrile illnesses should be a priority in the era of test-based management of malaria.

A growing additional challenge for the IMCI and iCCM programmes is introducing newborn care, and very few studies exist on the related challenges. Nalwadda Kayemba et al. (2012) assessed the introduction of newborn care within iCCM programme in Uganda. Almost all Village Health Team (VHT) members reported that they refer sick newborns to facilities, and that they could identify at least three newborn danger signs. However, in this study they did not identify the most important clinical indicators of severe illness, so the extent of compliance with newborn referral and quality of care for newborns at facilities is not clear. Overall, iCCM is perceived as beneficial, but caregivers, VHTs, and health workers want to do more for sick babies at facilities and in communities. The authors concluded that additional research would be needed to assess the ability of VHTs to identify newborn danger signs, referral compliance, and quality of newborn treatment at facilities.

1.2.2. Measuring coverage

In terms of measuring coverage of interventions critical for IMCI and iCCM programs, household surveys remain the primary data source of coverage indicators for children and women for most developing countries. Among the existing surveys, most of the information is generated by two global household survey programmes. One is the USAID-supported Demographic and Health Surveys (DHS), and the other one UNICEF-supported Multiple Indicator Cluster Surveys (MICS). **Hancioglu et al. (2013)** provided an overview of these two programmes, which provide the most valuable resource for tracking many Millennium Development Goal indicators. MICS and DHS collaborate closely and work through interagency processes to ensure that survey tools are harmonized and comparable as far as possible. They differ in the population covered and the reference periods used to measure coverage, which need to be considered when comparing estimates of reproductive, maternal, newborn, and child health indicators across countries and over time. Both surveys certainly have a remarkable value as a resource for global health research, but they also suffer from limitations and constraints. There are issues related to sampling and quality control which will require continuing efforts to improve and refine survey methods and analytical techniques. Both DHS and MICS surveys also serve the needs of the Commission on Accountability for Women's and Children's Health and they underlie the estimates of the indicators for the "Countdown to 2015" initiative. We will describe the "Countdown to 2015" effort in detail in this section, because it has emerged as the paramount effort for monitoring the progress in coverage of interventions.

Requejo et al. (2013) studied the challenges and opportunities in the selection of coverage indicators for global monitoring through household surveys such as DHS and MICS. As the group closely involved with the "Countdown to 2015" monitoring effort, they underscore that global monitoring of intervention coverage is a cornerstone of international efforts to improve reproductive, maternal, newborn, and child health. They described how the generation of data for global monitoring involves five iterative steps: (i) development of standard indicator definitions and measurement approaches to ensure comparability across countries; (ii) collection of high-quality data at the country level; (iii) compilation of country data at the global level; (iv) organization of global databases; and (v) rounds of data quality checking. Because of this, they propose that regular and rigorous technical review processes are needed to maximize uptake. Such processes should involve high-level

decision makers and experts familiar with indicator measurement. They should ensure that indicators used for global monitoring are selected on the basis of available evidence of intervention effectiveness, feasibility of measurement, and data availability as well as programmatic relevance. The authors suggested that more attention and continued investment should be directed to global monitoring, to support both the process of global database development and the selection of sets of coverage indicators to promote accountability. These indicators can drive policy and program development at the country and global level, and ultimately impact the health of women and children globally.

At this point, we will mention the "Countdown to 2015" initiative, which has been a leading effort in tracking progress for maternal, newborn, and child survival for more than a decade. It was first conceived in 2003 and then formally launched in 2005, with its first report and published country profiles. Over the 10 years between 2005 and 2015, major reductions in the deaths of mothers and children have occurred, although most of the 75 priority countries failed to achieve Millennium Development Goals 4 and 5 (**Victora et al., 2015**). Importantly, the coverage of life-saving interventions tracked in Countdown increased steadily over time, although wide inequalities still persist both between and within countries. Key drivers of coverage such as financing, human resources, commodities, and conducive health policies also showed important, albeit insufficient increases. As a multi-stakeholder initiative of more than 40 academic, international, bilateral, and civil society institutions, "Countdown to 2015" was successful in monitoring progress and raising the visibility of the health of mothers, newborns, and children. The lessons from this initiative will have direct bearing on monitoring progress during the Sustainable Development Goals era.

Requejo et al. (2014), on behalf of the Scientific Review Group of Countdown to 2015, published the so-called "data resource profile" for the Countdown to 2015 effort - i.e. they characterized in detail the evidence upon the entire scientific effort is based. Their country profiles present, in one place, comprehensive evidence to enable an assessment of a country's progress in improving reproductive, maternal, newborn and child health. Those profiles are available for each of the 75 countries that jointly account for more than 95% of all maternal and child deaths. The two-page country profiles are updated approximately every 2 years with any new data, analyses or other information that becomes available. Profile data include demographics, mortality, nutritional status, coverage of evidence-based interventions, within-countries inequalities in coverage, measures of health system functionality, supportive policies and financing indicators. Summarizing all these numbers would not be possible in this report, so we will simply refer any reader to the publication by Requejo et al. in *International Journal of Epidemiology* in 2014.

As indicated already, the main sources of data for the coverage, nutritional status and equity indicators are the US Agency for Internal Development (USAID)-supported DHS and the United Nations Children's Fund (UNICEF)-supported MICS. All data on coverage are first summarized and checked for quality by UNICEF, and data on equity in intervention coverage are summarized and checked by the Federal University of Pelotas in Brazil. The mortality estimates are developed by the Inter-agency Group for Child Mortality Estimation (IGME) and the Maternal Mortality Estimation Inter-Agency Group. The financing data are abstracted from datasets maintained by the Organization for Economic Co-operation and Development (OECD) Assistance Committee, and the policies and health systems data are derived from a special compilation prepared by the World Health Organization (WHO). Associated country profiles include equity-specific profiles and one-page profiles prepared annually that report on the 11 indicators selected by the Commission on Information and Accountability for Women's and Children's Health.

In the target year of the "Countdown to 2015", **Requejo et al. (2015)** summarized and evaluated the entire effort. The report published by the group in 2014 analysed the achievements in intervention coverage and strategies to best sustain, focus, and intensify efforts to progress for this and future generations. The analyses implied unfinished business in achieving high, sustained, and equitable coverage of essential interventions. Progress has accelerated in the past decade in most Countdown countries, suggesting that further gains are possible with intensified actions. Some of the greatest coverage gaps are in family planning, interventions addressing newborn mortality, and case management of childhood diseases. Although inequities are pervasive, country successes in reaching of the poorest populations provide lessons for other countries to follow. During the transition to the next set of global goals - the "Sustainable development goals" - the centrality of data to accountability and the importance of support of country capacity to collect and use high-quality data on intervention coverage and inequities for decision-making should increasingly come into focus.

Finally, projections up to 2035 have already been made based on the trends in coverage observed in the past two decades. **Walker et al. (2013)** analyzed historical trends and patterns in coverage of maternal, newborn, and child health interventions with proven effectiveness and used them to project rates of child and neonatal mortality in 2035 in 74 "Countdown to 2015" priority countries. The authors reanalysed coverage data from 312 nationally-representative household surveys done between 1990 and 2011 in 69 countries, including 58 Countdown countries. They constructed models that included baseline coverage, region, gross domestic product, conflict, and governance to examine country-specific annual percentage coverage change for each group of indicators, using the Lives Saved Tool (LiST) to predict mortality rates of children younger than 5 years and in the neonatal period in 2035. The scenarios that were considered were unchanged continuation of coverage (i.e., "historical trends" scenario) and accelerated intervention coverage to the highest level achieved by a Countdown country with similar baseline coverage level ("best performer" scenario).

Odds of coverage of most interventions have slowly increased, with a mean annual increase of 5.3%. Contrary to this prevailing trend, odds of coverage of three interventions (antimalarial treatment, skilled attendant at birth, and use of improved sanitation facilities) have decreased since 1990, with a mean annual decrease of 5.5%. Odds of coverage of four interventions--all related to the prevention of malaria--have increased rapidly, with a mean annual increase of 27.9%. Rates of coverage change varied widely across countries, and the differences could not be explained by measures of gross domestic product, conflict, or governance. LiST-based modeling predicted that the number of Countdown countries with an under-5 mortality rate of fewer than 20 deaths per 1000 livebirths per year would increase from four (5%) of the 74 in 2010, to nine (12%) by 2035 under the historical trends scenario, and to 15 (20%) under the best performer scenario. The number of countries with neonatal mortality rates of fewer than 11 per 1000 livebirths per year would increase from three (4%) in 2010, to ten (14%) by 2035 under the historical trends scenario, and 67 (91%) under the best performer scenario. The number of under-5 deaths per year would decrease from an estimated 7.6 million in 2010, to 5.4 million (28% decrease) if historical trends continue, and to 2.3 million (71% decrease) under the best performer scenario. The authors concluded that substantial reductions in child deaths are possible, but only if intensified efforts to achieve intervention coverage are implemented successfully within each of the "Countdown to 2015" countries.

1.2.3. Measuring quality of treatment

Although quality of delivered interventions is an extremely important variable to consider in planning, monitoring and evaluating IMCI and iCCM programmes, as will be shown in the last segment of this part of the report (section 1.3.), very little is known about how the quality of treatment varies according to different contexts and study settings. We will present here a very rare studies that shed some light on this issue. **Teferi et al. (2014)** assessed the caseload and quality of IMNCI services in under-five clinics in Ethiopian health centres after iCCM was implemented. Their cross-sectional study used register review to assess the IMNCI service use (before and after iCCM, in 2010 and 2012, respectively) and quality throughout the period in randomly selected health centers in three regions of the Integrated Family Health Program. Caseload of sick children at 28 health centers increased by 16% after iCCM implementation (21,443 vs. 24,882 children in 2010 and 2012, respectively). The consistency of IMNVC I treatment with classification for pneumonia, diarrhea and malaria was low (78, 45, and 67%, respectively) compared to iCCM treatment (86, 80, and 91%, respectively). Health center caseload increased modestly after iCCM was introduced, but was lower than expected, even when combined with health post use from other studies. The authors concluded that demand strategy for sick children was in a need of review and that the quality of IMNCI needs improving even to bring it to the quality of iCCM at health posts, as measured by the same methods. Successful quality assurance approaches from iCCM, e.g., the Performance Review and Clinical Mentoring Meeting, could be adapted for IMNCI.

Moreover, **Nanyonjo et al. (2015)** studied the impact of an iCCM programme on uptake of appropriate diarrhoea and pneumonia treatments in Uganda. They measured the impact using a propensity score matching and conducted equity analysis. Their outcomes of interest were the uptake of appropriate treatment for children with a classification of pneumonia (cough and fast breathing) and/or diarrhoea and the magnitude and distribution of socioeconomic status related inequality in use of iCCM. Following introduction of iCCM, data from cross-sectional household surveys were examined for socioeconomic inequalities in uptake of treatment and use of iCCM among children with a classification of pneumonia or diarrhoea using the Erreygers' corrected concentration index (CCI). Propensity score matching methods were used to estimate the average treatment effects on the treated (ATT) for children treated under the iCCM programme with recommended antibiotics for pneumonia, and ORS plus or minus zinc for diarrhoea. Their study showed that more children treated under iCCM received appropriate antibiotics for pneumonia (ATT = 34.7%, $p < 0.001$) and ORS for diarrhoea (ATT = 41.2%, $p < 0.001$) compared to children not attending iCCM, but that no such increase was observed for children receiving ORS-zinc combination (ATT = -0.145, $p < 0.05$). There were no obvious inequalities in the uptake of appropriate treatment for pneumonia among the poorest and least poor (CCI = -0.070; SE = 0.083). Receiving ORS for diarrhoea was more prevalent among the least poor groups (CCI = 0.199; SE = 0.118), while the use of iCCM for pneumonia was more prevalent among the poorest groups (CCI = -0.099; SE = 0.073). The use of iCCM for diarrhoea was not significantly different among the poorest and least poor (CCI = -0.073; SE = 0.085). The authors concluded that iCCM was a potentially equitable strategy in the studied communities and that it significantly increased the uptake of appropriate antibiotic treatment for pneumonia and ORS for diarrhoea, but not the uptake of zinc for diarrhoea.

We conclude this part of the report with a statement that there are many concerns over the validity of indicators currently used for monitoring intervention coverage, that there is very little information of cost of IMCI and iCCM programmes and the quality of intervention

delivery, and that the little information that is available gives many reasons for concern and suggests that there is still a lot to be done in order to optimize the ongoing programs.

1.3. What is the treatment gap and its contribution to excess mortality (including suboptimal quality; gender and other inequities)?

In order to answer this question, it would be necessary to have very precise information on a wide range of parameters: from cost of intervention delivery, which would need to be intervention-specific and context-specific, to context-specific understanding of the quality of intervention delivery, existing and feasible levels of coverage, then context-specific burden of disease and understanding of acceptability of intervention in the population and care-seeking issues. Given that these parameters are frequently unavailable, implementation of innovative strategies to improve coverage of evidence-based interventions, especially in the most marginalised populations, is a key focus of policy makers and planners aiming to improve child survival, health, and nutrition. **Chopra et al. (2012)** and UNICEF's Equity in Child Survival, Health and Nutrition Analysis Team considered various strategies to improve health coverage and narrow the equity gap in child survival, health, and nutrition. They presented a three-step approach to improvement of the effective coverage of essential interventions. First, they identified four different intervention delivery channels - clinical or curative, outreach, community-based preventive or promotional, and legislative (or mass media). Second, they classified which interventions' deliveries can be improved or changed within their channel or by switching to another channel. Finally, they performed a meta-review of both published and unpublished reviews to examine the evidence for a range of strategies designed to overcome supply and demand bottlenecks to effective coverage of interventions that improve child survival, health, and nutrition. Although knowledge gaps exist, several strategies showed promise for improving coverage of effective interventions, including expanded roles for lay health workers, task shifting, reduction of financial barriers, increases in human-resource availability and geographical access, and use of the private sector.

In their considerations, they identified inequities within the population of children as the important underlying factors that prevented further progress in child survival reduction. Among several "classes" of inequity among children, one of the most disturbing is gender-based inequity. UNICEF's special report on gender equity (**UNICEF, 2015**) studied the available gender-specific mortality data, which were consistent with reducing levels of disadvantage in young girls globally. However, there was evidence against this general trend, showing substantial and increasing mortality differentials in some countries. The report concluded that it was important that these countries and their sub-national regions are clearly identified, and that relevant data are further explored, so that gender biases can be described in detail and tracked over time. Underlying causes of gender inequity need to be better understood, so that effective UNICEF policies can be formed and appropriate actions taken. This could include stratified analyses of MICS data by gender (e.g., by socio-economic and educational strata); on-going regular monitoring and reporting of gender-specific mortality data; and assembling large datasets of gender-specific information on hospital admissions and deaths from low and middle income countries. Attention should be focused on countries and sub-national regions where significant gender biases exist, with follow-up actions including awareness raising globally, nationally and in local populations, and establishment of key indicators which are monitored and reported and actions to address underlying causes.

1.3.1. Approaches to modeling: UNICEF

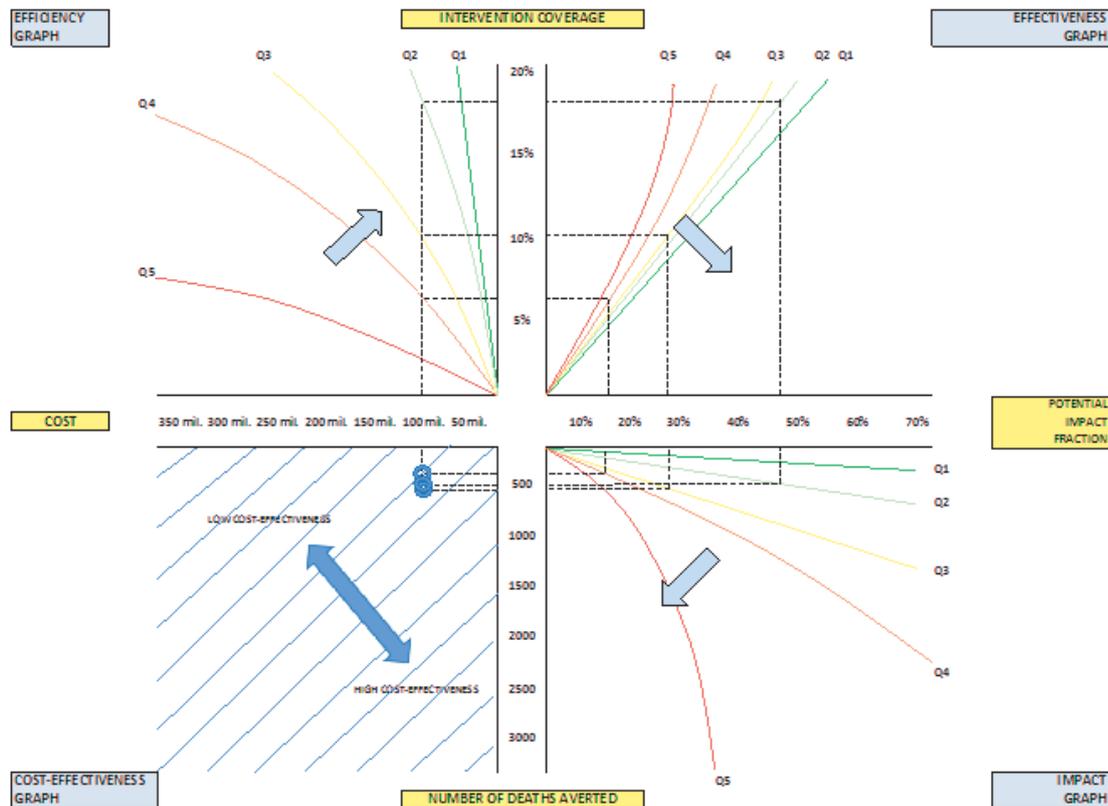
UNICEF's Equity in Child Survival, Health and Nutrition Analysis Team considered the progress on child mortality and undernutrition. It concluded that widening inequities and a concentration of child deaths and undernutrition in the most deprived communities were observed as a counter-intuitive and unexpected consequence of the progress in many countries, threatening the achievement of the Millennium Development Goals. This was happening within a context where a series of recent process and technological innovations have provided effective and efficient options to reach the most deprived populations. These trends raised the possibility that the perceived trade-off between equity and efficiency no longer applies for child health, and that prioritizing services for the poorest and most marginalised is now more effective and cost effective than mainstream approaches. **Carrera et al. (2012)**, on behalf of the UNICEF's Equity in Child Survival, Health and Nutrition Analysis Team, tested this hypothesis with a mathematical-modelling approach by comparing the cost-effectiveness in terms of child deaths and stunting events averted between two approaches (from 2011-15 in 14 countries and one province): an "equity-focused" approach, that prioritised the most deprived communities, and a "mainstream" approach that is representative of current strategies.

The authors combined some existing models, notably the Marginal Budgeting for Bottlenecks Toolkit and the Lives Saved Tool, to perform their analysis. They showed that, with the same level of investment, disproportionately higher effects are possible by prioritising the poorest and most marginalised populations, for averting both child mortality and stunting. Their results suggest that an equity-focused approach could result in sharper decreases in child mortality and stunting and higher cost-effectiveness than mainstream approaches, while reducing inequities in effective intervention coverage, health outcomes, and out-of-pocket spending between the most and least deprived groups and geographic areas within countries. However, the authors admitted that their findings should be interpreted with caution, due to uncertainties around some of the model parameters and baseline data. They suggested that further research would be needed to address some of these gaps in the evidence base. However, their over-arching suggestion was that strategies for improving child nutrition and survival should account for an increasing prioritisation of the most deprived communities and the increased use of community-based interventions **Carrera et al. (2012)**.

1.3.2. Approaches to modeling: Centre for Global Health Research, Edinburgh

We demonstrate opportunities for understanding the answer to these complex questions through an additional modeling-based analysis, where a recently described tool, which we developed in collaboration with UNICEF, was used to optimize community case management strategies to achieve equitable reduction of childhood pneumonia mortality in 5 low and middle-income countries.

FIGURE 1: Chopra, Campbell and Rudan's conceptual framework for EQUIST⁶
 Demonstrating a hypothetical planning exercise assessing the cost-effectiveness of delivery of a new intervention to different equity strata in the population (Q2 vs. Q3 vs. Q4) with a fixed budget



A recent Inter-agency Group for Child Mortality Estimation (IGME) meeting reported a child mortality decrease of over one third from 1990-2010 (IGME, 2011). However, one unforeseen issue is that in many low and middle-income countries (LMICs) a decrease in under-five mortality rate (U5MR) has been accompanied by increased inequity in health outcomes between the poor and those better off (You et al., 2010). This important consideration has been discussed extensively in a recent United Nations Children’s Fund (UNICEF) report which argues for abandoning the ‘mainstream approach’ where scaling-up of child health interventions is firstly provided to more readily accessible (and typically wealthier) groups in society. Instead, an ‘equity-focused’ approach is suggested, contending that it is more cost-effective to target interventions at the poorest in society, resulting in a greater U5MR decrease while also positively impacting upon equity.

To test this hypothesis, a tool is required that can address the many determinants in the multifaceted relationship between cost-effectiveness and equitable impact in child mortality reduction. Although a number of tools have been developed to assist intervention prioritization at local and national levels – such as Marginal Budgeting for Bottlenecks (MBB), supported by UNICEF (UNICEF, 2010), Choice of Interventions that are Cost-Effective (CHOICE), promoted by the World Health Organization (Evans, 2005), and

Lives Saved Tool (LiST), developed by Johns Hopkins University and Futures Institute (Fox et al., 2011), none of these tools can fully address equitable impact considerations as they make no allowance for income-related inequalities in countries.

Recently, Chopra, Campbell and Rudan (2012) described a conceptual framework that helps understanding the complex interplay between determinants of cost-effectiveness and equitable impact in child mortality reduction (see Figure 1 for visual representation of the framework), also exposing the importance of several critical determinants for which information is typically lacking. This study presents the first implementation of this tool to test the hypothesis that, against conventional wisdom and prevailing practices, significantly higher gains in child mortality reduction can be achieved through an equity-focused approach to scaling-up of child health interventions without compromising cost-effectiveness.

Figure 2: Studied exemplar countries



adapted from Wikimedia Commons (Wikimedia commons, 2010)

To test their tool, five exemplar countries representative of larger WHO regions were used: Nigeria (Sub-Saharan Africa), Egypt (Eastern Mediterranean), Bangladesh (South-East Asia), Cambodia (Western Pacific) and Peru (Americas) (illustrated in Figure 2). These were selected because of their large size and relatively adequate information reported by equity strata. It was also decided to focus on a single disease – pneumonia, which is still the leading cause of child deaths globally (UNICEF, 2006). To allow appropriate close scrutiny on intervention was studied, namely community case management with antibiotics (CCM), which has proven efficacy in reducing child pneumonia mortality (Theodoratou et al., 2010a, 2010b). The Child Health Epidemiology Reference Group (CHERG) estimates of worldwide child mortality for 2008 (Black et al., 2010) were used, as these data are complete, high-quality, and coincide closely with the most recent Demographic and Health Survey (DHS) data in the five chosen countries (El-Zanaty F, 2009; National

Institute for Population Research and Training Bangladesh, 2009; National Population Commission Nigeria, 2009; Instituto Nacional de Estadística e Informática, 2009; National Institute of Statistics Cambodia, 2009).

(i) Estimates of U5MR: The first step in populating this model was to establish U5MR distribution by wealth quintiles in the five countries, along with the quintile ratio (QR), a commonly used measure of equity (the closer QR is to 1, the closer the country is to health outcomes equity (**Reidpath et al., 2009**). For all of the countries, data were available from DHS reports 2008, 2010 or 2007, therefore correlating strongly with the most recent CHERG data.

(ii) Cost Estimates: The second step was to estimate the cost of scaling-up CCM in each quintile from its existing level of coverage. For more accurate estimation, cost was split for CCM into antibiotic costs and non-antibiotic costs. It was assumed that the direct costs of antibiotics (i.e. the medicines themselves) would be constant across countries and quintiles, while the non-antibiotic costs were likely to be different due to factors including geography, infrastructure and human resources (**Johns et al., 2005**). Direct antibiotic costs for CCM were taken as US\$0.27 for all quintiles in all areas (**UNICEF, 2006**). Non-antibiotic costs were modelled based on an unpublished report from Pakistan (**Shehzad, personal communication**), which was the only available source, highlighting the general scarcity of information on this important variable. The direct CCM cost was added to non-CCM costs calculated from the quintile's U5MR to obtain an estimate of the cost for each intervention per child treated in any individual quintile. Following this to gain a more accurate measure of the cost of treatment per quintile, the cost per child treated was multiplied by the total number of under-5 episodes of pneumonia in each quintile. The number of episodes was estimated by combining a modelled case fatality rate (CFR) for each quintile with the estimated number of under-5 pneumonia deaths.

(iii) Estimates of current intervention coverage: The third step was to determine coverage levels of the chosen intervention in the five countries in 2008. Coverage with CCM was assumed to be the same as the indicator “% under-fives with suspected pneumonia receiving antibiotics” used in UNICEF “The State of the World’s Children” (SOWC) reports.

(iv) Effectiveness Estimates: The fourth step was to estimate how CCM’s effectiveness varied according to the quintile in which it was implemented and therefore calculate the quintile-specific potential impact fraction (PIF). Effectiveness was modeled by graphing effectiveness reported in each study used in a review of CCM (**Theodoratou et al., 2010a**), against the U5MR for the specific country at the year of study publication (taken from Child Mortality Estimates database (**UNICEF et al., 2012**)). The estimate for each quintile given using the equation of this graph was then adjusted upwards by 50% of the remaining effectiveness gap as suggested in the methods used by **Theodoratou et al. (2010a)** and the LiST tool (**Fox et al., 2011**).

(v) Cause of Death Proportion Estimates. Finally, it was necessary to populate the model with disease burden estimates for each disease in each quintile. This was initially attempted through systematic literature review; however an attempt (using Medline, Embase and Global Health databases) yielded insufficient data therefore it was decided to model them instead. Data on distributions of under-5 mortality deaths by cause for all countries from the CHERG report (**Black et al., 2010**) were combined with U5MR data for each country

(UNICEF, 2009) in a model, resulting in estimates of cause-specific mortality in each quintile for each global region, and subsequently for the exemplar countries.

(vi) Final Model. Once the model was fully populated with data necessary to evaluate cost-effectiveness and impact on mortality and equity of community case management for under-5 pneumonia mortality, it was decided to compare the cost per number of lives saved for scaling-up the intervention in the next wealthiest 10% the uncovered population ('inequity promoting' approach), in the middle 10% of the uncovered population ('equity neutral'), in the poorest 10% of the population ('equity-promoting'), and finally a 10% scale-up in the 'mainstream approach' (coverage scale-up continuing to follow current quintile-specific relative distribution) (Chopra et al, 2012; UNICEF, 2010). Further detailed information on the methods described above in each section is available upon request.

Table 1: Quintile U5MR estimates

Country	U5MR					Quintile Ratio
	Q1 (wealthiest)	Q2	Q3	Q4	Q5 (poorest)	
Nigeria (2008)	87.00	129.00	165.00	212.00	219.00	2.52
Egypt (2008)	18.90	27.20	32.20	36.10	49.00	2.59
Bangladesh (2007)	43.00	62.00	83.00	85.00	86.00	2.00
Cambodia (2010)	30.00	49.00	68.00	83.00	90.00	3.00
Peru (2007/2008)	9.00	24.00	24.00	33.00	59.00	6.56

Table 1 and **Figure 3a** show the estimates of U5MR (as deaths per 1,000 live births) by quintile for the exemplar countries. Quintile ratios for each country are shown in **Figure 3b**. Data for each country exhibit expected trends of U5MR decreasing with wealth; however, not all to similar degrees. Nigeria is shown to have a noticeably higher U5MR than the other five countries and this is supported by the 2008 CHERG report, which found the significant majority of under 5 mortality to occur in Africa. Peru has the greatest QR ratio, suggesting it has the highest inequity. Bangladesh exhibits a higher U5MR in each quintile than Peru but a much less significant U5MR variation between quintiles (especially Q3-5), and the lowest QR of the five countries, suggesting it is the most equitable studied.

Table 2 shows estimates of coverage by quintile for community case management and this is illustrated in **Figure 4**. Although the estimates of coverage by quintile for community case management generally follow expected trends of decreasing coverage with increasing poverty (the greatest differences by quintile being found in Nigeria and Cambodia), Egypt

exhibits a slightly unexpected pattern with increased CCM of suspected pneumonia in Q2 and Q3 as compared with Q1. This is thought to be due to the fact that in rich urban communities (i.e. Q1), medical professionals are trying to avoid over-treating (and therefore promoting antibiotic resistance), but in poorer quintiles this is not the case and more cases are treated aggressively with antibiotics, explaining the higher coverage levels. There is then a dip again in coverage observed in Q4 and Q5 in Egypt, likely to be explained by poor access to health care in the poorest part of the population.

Figure 3a,b: U5MR and inequity by Wealth Quintiles

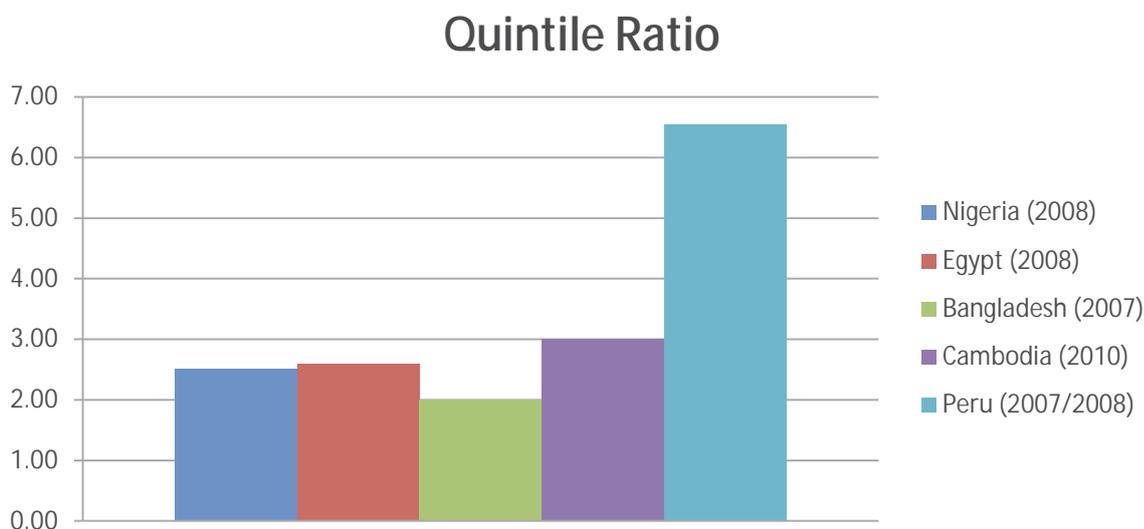
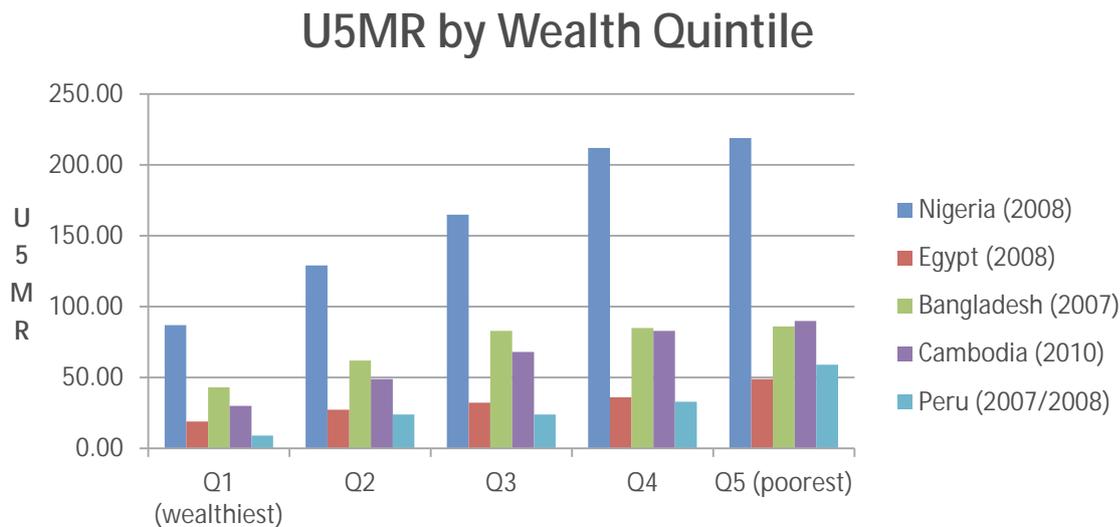


Figure 5 illustrates the model for non-antibiotic cost for CCM while **Table 3** shows the final “cost per child treated” calculated for CCM in each quintile of the exemplar countries. A consistent trend is observed of increasing intervention cost from Q1-Q5 with Cambodia showing the biggest cost differences between Q1-Q2 and Q2-Q3 and Nigeria between Q3 and Q4. These countries also show the highest overall cost difference.

Table 2: CCM coverage estimates

	Q1 (Wealthiest)	Q2	Q3	Q4	Q5 (Poorest)
Nigeria	36.20	32.90	27.90	21.30	12.20
Egypt	20.00	20.00	18.00	0.00	0.00
Bangladesh	7.17	4.76	3.43	3.34	3.30
Cambodia	39.1	56.70	37.60	35.40	45.10
Peru	77.4	87.80	79.40	81.90	71.10

Figure 4: CCM coverage estimates by quintile

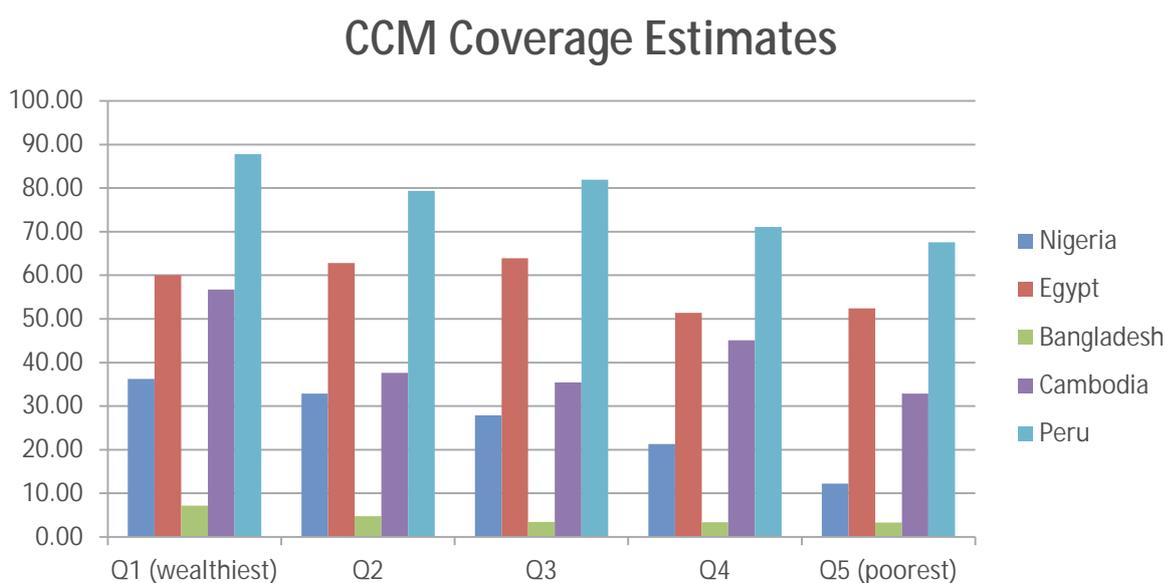


Figure 5: Non-antibiotic cost estimate model

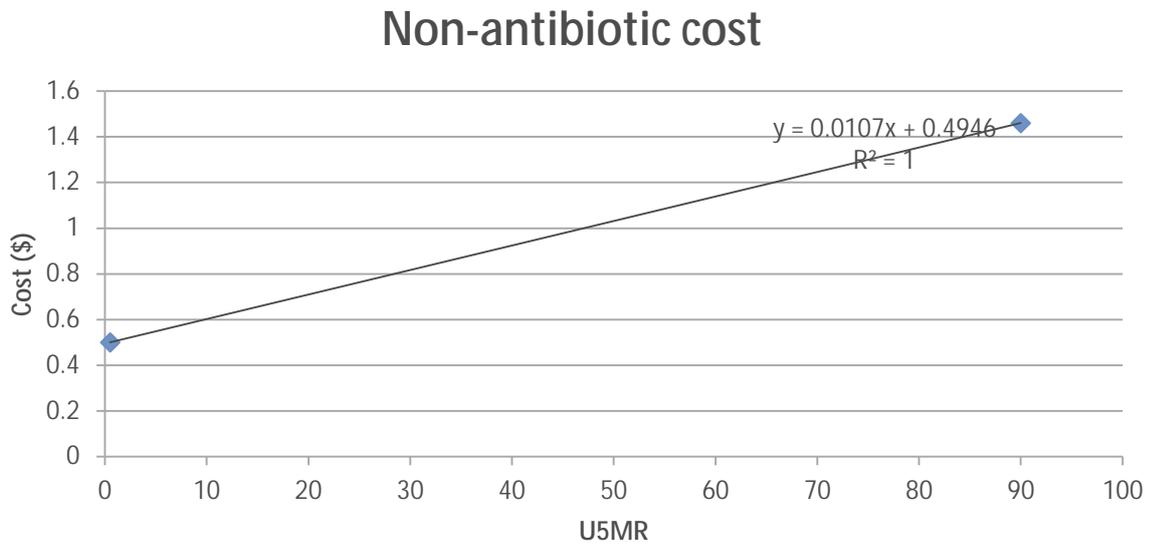


Figure 6: Case Fatality Rates by Quintile

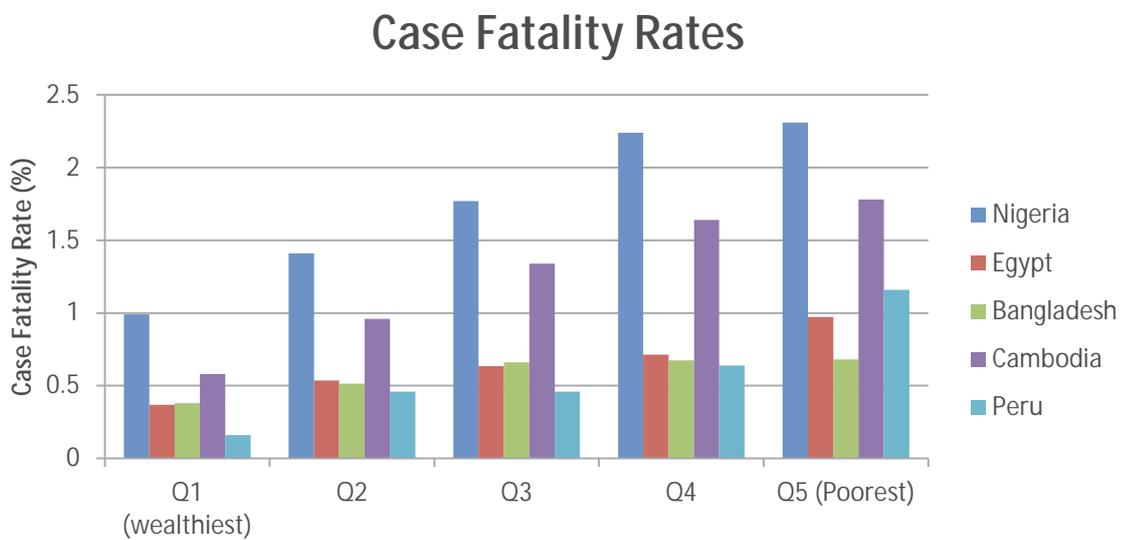


Figure 6 illustrates the case fatality rates modelled for each quintile (region-specific graphic models are available upon request) and **Figure 7** shows the resulting adjusted cost per quintile treated. Again the trend almost entirely shows an increasing cost from Q1-Q5 with one noticeable difference being an interesting finding of Q5 in Nigeria being marginally less costly than Q4, suggesting that the case fatality in Q5 is so high that scaling-up in this quintile will save more money than in Q4 for the same investment.

Table 3: Cost of CCM per child treated in each country by quintile

		Overall	Q1 (wealthiest)	Q2	Q3	Q4	Q5 (Poorest)
Nigeria	U5MR	189.00	87.00	129.00	165.00	212.00	219.00
	Cost of Antibiotic (\$)	0.27	0.27	0.27	0.27	0.27	0.27
	Non-Antibiotic cost (\$)	2.52	1.43	1.87	2.26	2.76	2.84
	Total Cost of CCM per child treated	2.79	1.70	2.14	2.53	3.03	3.11
Egypt	U5MR	36.00	18.90	27.20	32.20	36.10	49.00
	Cost of Antibiotic (\$)	0.27	0.27	0.27	0.27	0.27	0.27
	Non-Antibiotic cost (\$)	0.88	0.70	0.79	0.84	0.88	1.02
	Total Cost of CCM per child treated	1.15	0.97	1.06	1.11	1.15	1.29
Bangladesh	U5MR	61.00	43.00	62.00	83.00	85.00	86.00
	Cost of Antibiotic (\$)	0.27	0.27	0.27	0.27	0.27	0.27
	Non-Antibiotic cost (\$)	1.15	0.95	1.16	1.38	1.40	1.41
	Total Cost of CCM per child treated	1.42	1.22	1.43	1.65	1.67	1.68

Cambodia	U5MR	54.00	30.00	49.00	68.00	83.00	90.00
	Cost of Antibiotic (\$)	0.27	0.27	0.27	0.27	0.27	0.27
	Non-Antibiotic cost (\$)	1.07	0.82	1.02	1.22	1.38	1.46
	Total Cost of CCM per child treated	1.34	1.09	1.29	1.49	1.65	1.73
Peru	U5MR	27.00	9.00	24.00	24.00	33.00	59.00
	Cost of Antibiotic (\$)	0.27	0.27	0.27	0.27	0.27	0.27
	Non-Antibiotic cost (\$)	0.78	0.59	0.75	0.75	0.85	1.13
	Total Cost of CCM per child treated	1.05	0.86	1.02	1.02	1.12	1.40

Figure 7: Cost of CCM treatment per quintile

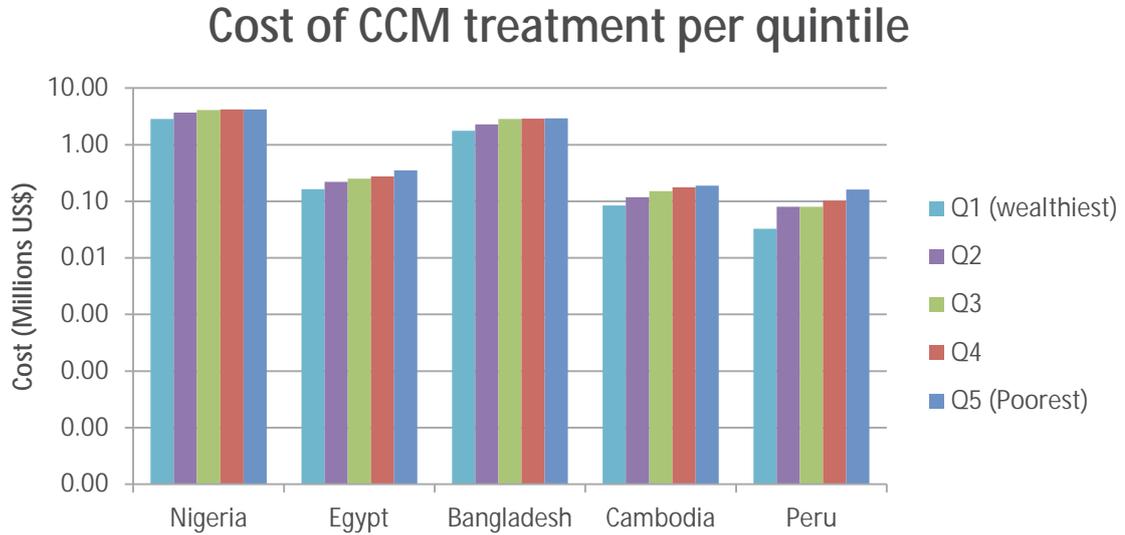


Table 4 shows data used to model CCM effectiveness/PIF, **Figure 8** illustrates the model. Importantly, **Table 4** highlights scarcity in CCM effectiveness data, as although these papers were carefully screened in a recent review and found to be high-quality⁹, none of them were published after 1998. **Figure 9** illustrates the upwards-adjusted effectiveness data for each quintile in each country, showing a continual trend of decreasing effectiveness from Q1-Q5 but with the biggest decrease being seen in Nigeria, where the poorer quintiles have a significantly higher U5MR.

Table 4: Data for CCM effectiveness/PIF modelling

Study	Location	Year	U5MR	Effectiveness
Mtango et al ²⁴	Tanzania	1986	161.40	30.10
Pandey et al ²⁵	Nepal	1989	126.30	84.00
Bang et al ²⁶	India	1990	114.80	49.10
Khan et al	Pakistan	1990	123.60	55.00
Reddaiah et al ²⁷	India	1991	111.90	26.00
Pandey et al ²⁸	Nepal	1991	122.00	30.00
Fauveau et al ²⁹	Bangladesh	1992	132.10	50.00

Agarwal et al ³⁰	India	1993	105.60	27.80
WHO ³¹	Phillipines	1998	43.10	35.00
Expert Opinion ³²	Global	2012	0.00	100.00

Figure 8: Effectiveness/PIF model for Community Case Management

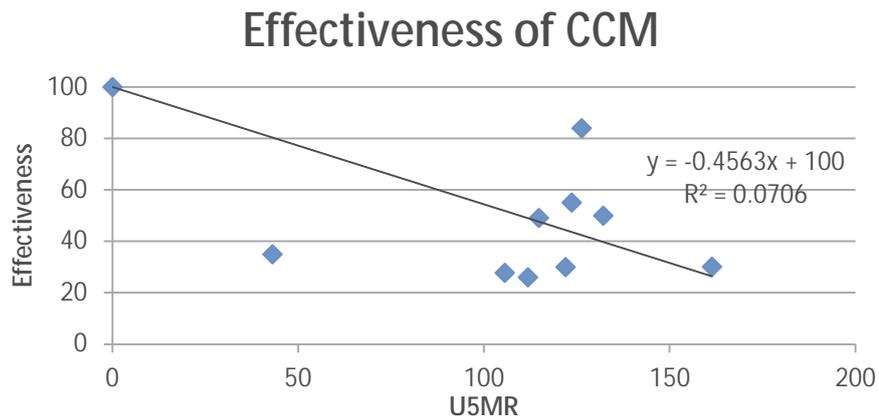
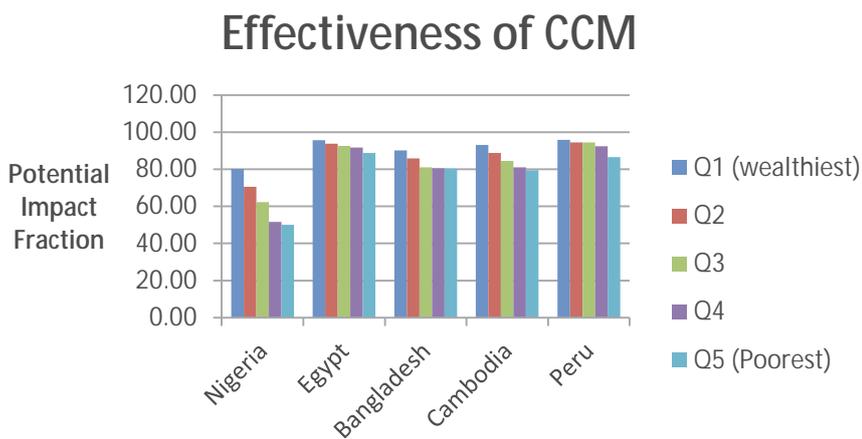


Figure 9: Effectiveness/PIF for CCM in each country by quintile



Figures 10-14 and Tables 5-9 show quintile-specific disease proportion estimates for each of the exemplar countries, expressed as a % of the total under 5 mortality burden. Significant differences across wealth quintiles in causes of death in those aged under 5 can

be seen in each of the five exemplar countries with all studied countries showing increasing proportions of deaths due to malaria, pneumonia and diarrhoea in poorer quintiles while proportions of deaths due to congenital abnormalities, preterm birth complications and injury decrease as poverty increases. This is thought to be due to the fact that infectious diseases such as malaria and pneumonia are treated more effectively in richer populations resulting in a diminished proportion of deaths due to these causes but an increased proportion of deaths due to causes that even well-funded health systems struggle to deal with such as congenital abnormalities or injury. Bangladesh shows an interesting pattern of birth asphyxia with it taking up highest proportion of mortality in Q2 and Q3, potentially suggesting that in these quintiles although the infectious diseases which are prevalent in poorer quintiles are still well treated, the healthcare facilities in these quintiles are not as good as in Q1 and so more babies die of birth asphyxia. Supplementary tables and figures that show WHO region-specific disease proportion estimates and models for disease proportion against U5MR are available upon request. Supplementary tables that highlight quintile-specific numbers of deaths in 2008 from each of these causes of death in each of the five exemplar countries are also available upon request.

Figure 15 and **Table 10** illustrate the final results: cost per life saved (in US\$) for each quintile in each country by scaling-up CCM in the different studied strategies. Strikingly, the “mainstream” approach for CCM in all countries is not the most cost-effective, instead an equity-promoting approach always delivers the greatest cost-effectiveness in terms of \$ per life saved. The absolute cost differences between this and the next most costly approach differ with context, varying from \$59.92 per life saved in Peru to \$1.10 in Bangladesh, where an equity-promoting approach is of almost the same cost-effectiveness as an equity-neutral approach of scaling up in middle uncovered 10%. It is thought this is due to the differences in U5MR from Q3-Q5 being relatively small in Bangladesh, resulting in the differences in disease burden, coverage, effectiveness and cost also not being large. This can be contrasted with Peru where the greatest difference in cost-effectiveness is between equity-promoting and equity-neutral and the greatest difference in U5MR is between Q5-Q3. This potentially suggests that in more inequitable contexts such as Peru (which has the highest QR of the countries studied), an equity-promoting approach will have a greater impact when compared with more equitable contexts. Egypt is the only modelled country where the next most cost-effective scale-up option is the “mainstream approach”, possibly due to an already relatively equitable coverage of CCM across quintiles (a difference of only 7.6% coverage from Q1-Q5).

Nigeria is an interesting context to study as due to its exceedingly high U5MR in poorer quintiles, the effectiveness modelled for Q5 is 50.4%. It was thought that this might result in an equity-promoting scale-up delivering poor results however what is observed in actuality is that scale-up in Q5 is still the most cost-effective. This highlights that the childhood pneumonia burden in this stratum is so great that even treating 50% will result in a huge improvement, but also that any intervention which could improve effectiveness of CCM could further enhance this and result in extremely significant reductions in Nigeria’s overall childhood pneumonia burden.

Figure 10: Modelled cause-specific child mortality by wealth quintile in Nigeria

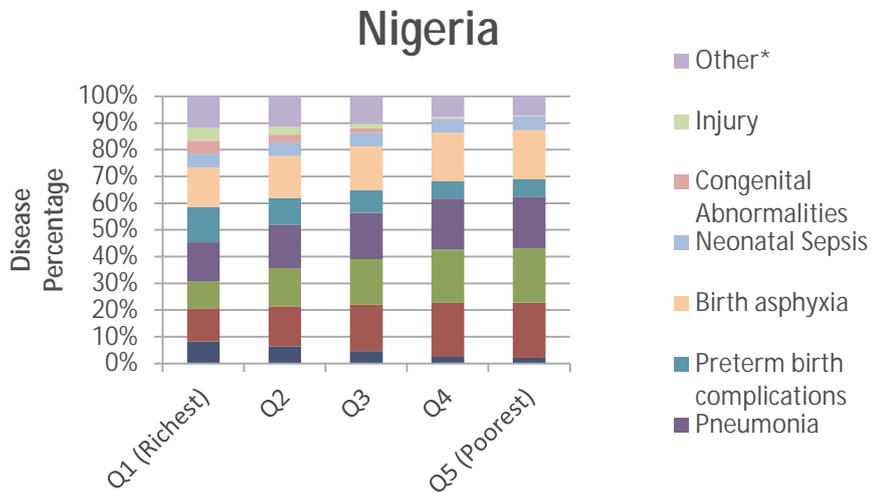


Figure 11: Modelled cause-specific child mortality by wealth quintile in Egypt

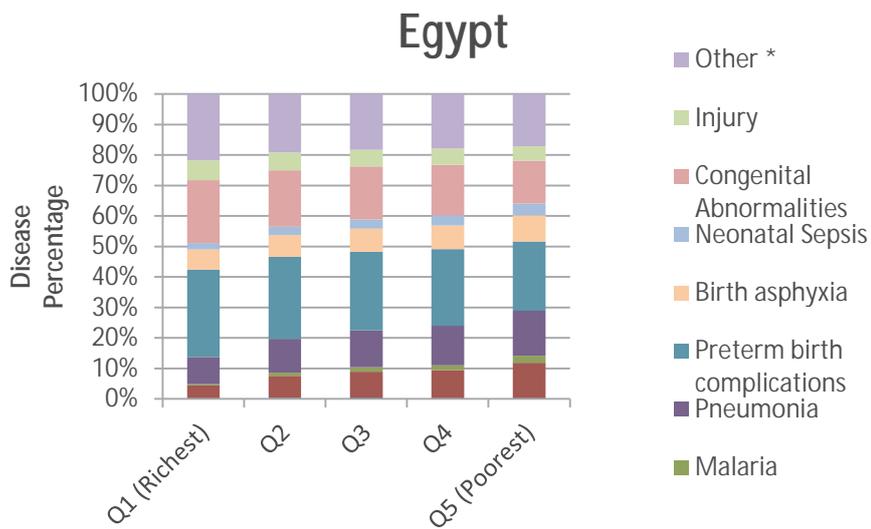


Figure 12: Modelled cause-specific child mortality by wealth quintile in Bangladesh

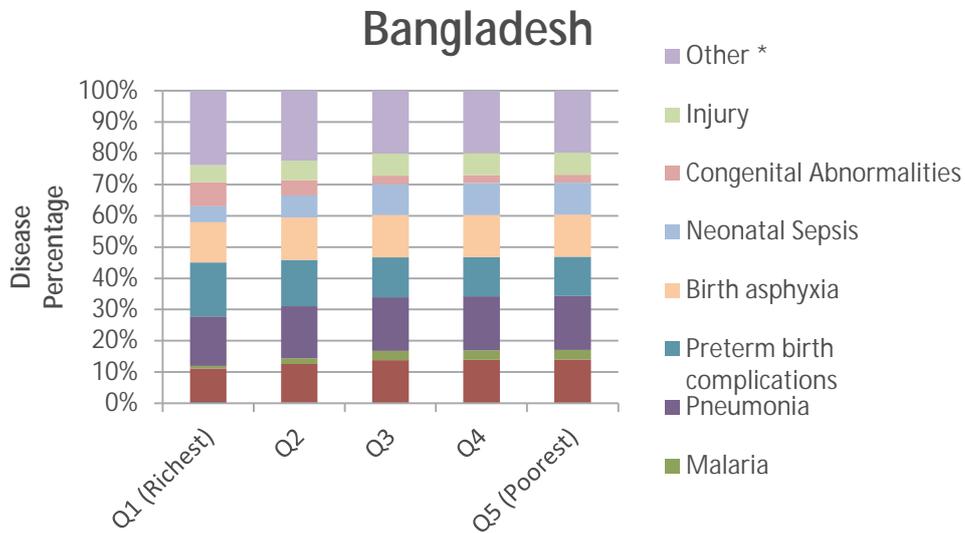


Figure 13: Modelled cause-specific child mortality by wealth quintile in Cambodia

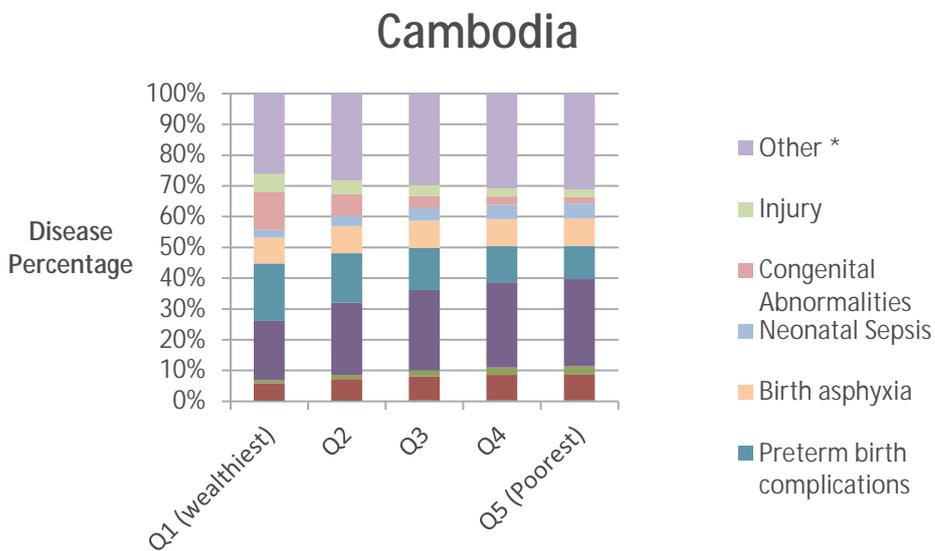


Figure 14: Modelled cause-specific child mortality by wealth quintile in Peru

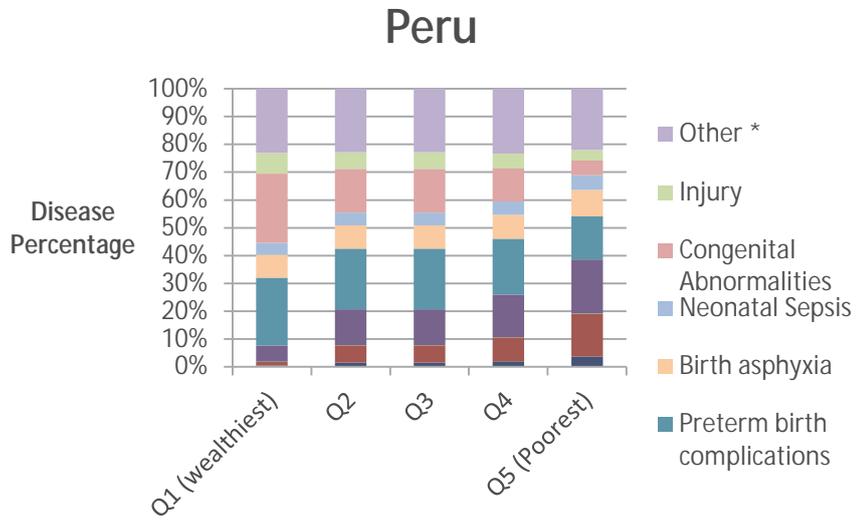


Table 5: Modelled cause-specific child mortality by wealth quintile in Nigeria

Quintile	U5MR	Disease proportion (as % of total mortality burden)									
		AIDS	Diarrhoea	Malaria	Pneumonia	Preterm birth complications	Birth asphyxia	Neonatal Sepsis	Congenital Abnormalities	Injury	Other*
Q1 (Wealthiest)	87.00	8.22	12.46	9.95	14.74	13.12	8.86	5.20	4.88	4.88	17.70
Q2	129.00	6.27	15.07	14.38	16.10	10.24	7.85	5.18	2.89	2.89	19.14
Q3	165.00	4.60	17.30	17.15	17.36	8.44	7.22	5.17	1.64	1.64	19.47
Q4	212.00	2.42	20.22	19.97	19.16	6.61	6.58	5.16	0.37	0.37	19.14
Q5 (Poorest)	219.00	2.09	20.65	20.33	19.45	6.37	6.50	5.16	0.20	0.20	19.03

Table 6: Modelled cause-specific child mortality by wealth quintile in Egypt

Quintile	U5MR	Disease proportion (as % of total mortality burden)										Other *
		AIDS	Diarrhoea	Malaria	Pneumonia	Preterm birth complications	Birth asphyxia	Neonatal Sepsis	Congenital Abnormalities	Injury		
Q1 (Wealthiest)	18.90	0.15	4.33	0.33	8.97	28.66	6.55	2.08	20.63	6.56	21.73	
Q2	27.20	0.37	7.16	1.07	11.15	26.82	7.17	2.76	18.52	5.82	19.14	
Q3	32.20	0.47	8.48	1.42	12.16	25.77	7.52	3.07	17.36	5.48	18.27	
Q4	36.10	0.54	9.37	1.66	12.84	24.98	7.78	3.29	16.50	5.25	17.81	
Q5 (Poorest)	49.00	0.72	11.75	2.28	14.67	22.53	8.54	3.85	13.95	4.63	17.07	

Table 7: Modelled cause-specific child mortality by wealth quintile in Bangladesh

Quintile	U5MR	Disease proportion (as % of total mortality burden)										Other *
		AIDS	Diarrhoea	Malaria	Pneumonia	Preterm birth complications	Birth asphyxia	Neonatal Sepsis	Congenital Abnormalities	Injury		
Q1 (Wealthiest)	43.00	0.41	10.70	0.83	15.88	17.26	12.86	5.14	7.60	5.49	23.83	
Q2	62.00	0.24	12.39	1.83	16.62	14.76	13.67	6.99	4.91	6.19	22.40	
Q3	83.00	0.10	13.73	2.94	17.20	12.77	13.56	9.82	2.76	6.97	20.15	
Q4	85.00	0.09	13.84	3.05	17.25	12.60	13.49	10.15	2.59	7.04	19.90	
Q5 (Poorest)	86.00	0.09	13.90	3.10	17.27	12.52	13.45	10.31	2.50	7.08	19.78	

Table 8: Modelled cause-specific child mortality by wealth quintile in Cambodia

Quintile	U5MR	Disease proportion (as % of total mortality burden)									
		AIDS	Diarrhoea	Malaria	Pneumonia	Preterm birth complications	Birth asphyxia	Neonatal Sepsis	Congenital Abnormalities	Injury	Other *
Q1 (Wealthiest)	30.00	0.51	5.40	0.86	19.59	18.44	8.37	2.54	12.20	5.89	26.19
Q2	49.00	0.46	6.74	1.41	23.53	16.01	8.82	3.30	7.03	4.43	28.27
Q3	68.00	0.41	7.63	1.96	26.16	13.58	8.98	4.06	4.05	3.33	29.84
Q4	83.00	0.37	8.17	2.39	27.75	11.67	8.90	4.66	2.62	2.66	30.81
Q5 (Poorest)	90.00	0.36	8.39	2.59	28.40	10.77	8.80	4.94	2.14	2.39	31.22

Table 9: Modelled cause-specific child mortality by wealth quintile in Peru

Quintile	U5MR	Disease proportion (as % of total mortality burden)										Other *
		AIDS	Diarrhoea	Malaria	Pneumonia	Preterm birth complication	Birth asphyxia	Neonatal Sepsis	Congenital Abnormalities	Injury		
Q1 (Wealthiest)	9.00	0.52	1.26	0.05	5.78	24.47	8.17	4.29	24.98	7.42	23.05	
Q2	24.00	1.46	6.22	0.13	12.86	21.78	8.43	4.59	15.69	6.02	22.83	
Q3	24.00	1.46	6.22	0.13	12.86	21.78	8.43	4.59	15.69	6.02	22.83	
Q4	33.00	2.02	8.55	0.18	15.16	20.16	8.65	4.77	11.87	5.30	23.34	
Q5 (Poorest)	59.00	3.64	15.29	0.32	19.36	15.48	9.55	5.29	5.30	3.69	22.09	

* Includes Measles, Meningitis, Pertussis, Tetanus, Other infections and Other non-communicable diseases

Figure 15: *Estimated cost per life saved*

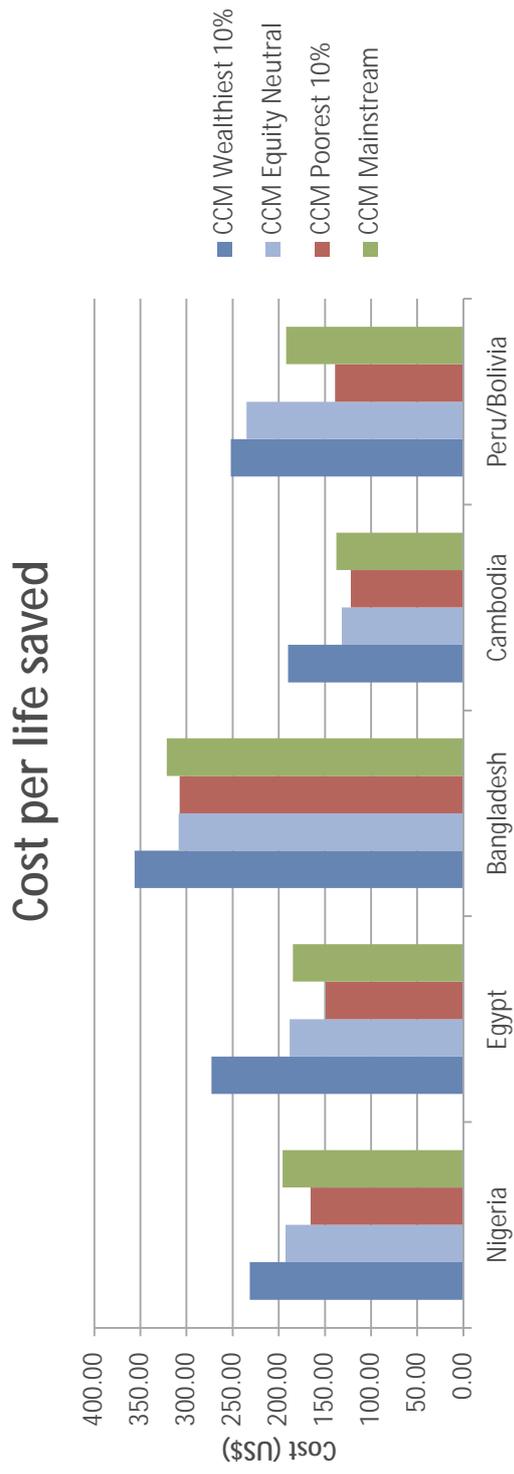


Table 10: Estimated cost per life saved

Who Covered	CCM 10% Wealthiest	CCM Neutral Equity	CCM 10% Poorest	CCM Mainstream
Nigeria	108.48	208.08	318.54	212.02
Egypt	51.82	61.39	74.42	64.60
Bangladesh	69.64	104.55	107.49	94.01
Cambodia	63.03	90.58	111.49	94.21
Peru	54.92	55.41	82.72	68.64

Table 11: Mainstream vs Equity-promoting investment

	1\$ Million Mainstream	1\$ Million Poorest 10%	Increase in number of lives saved
Nigeria	5108	6037	929
Egypt	5411	6698	1287
Bangladesh	3110	3254	144
Cambodia	7262	8188	925
Peru	5209	7191	1982

Figure 16: Mainstream vs Equity-Promoting for same investment

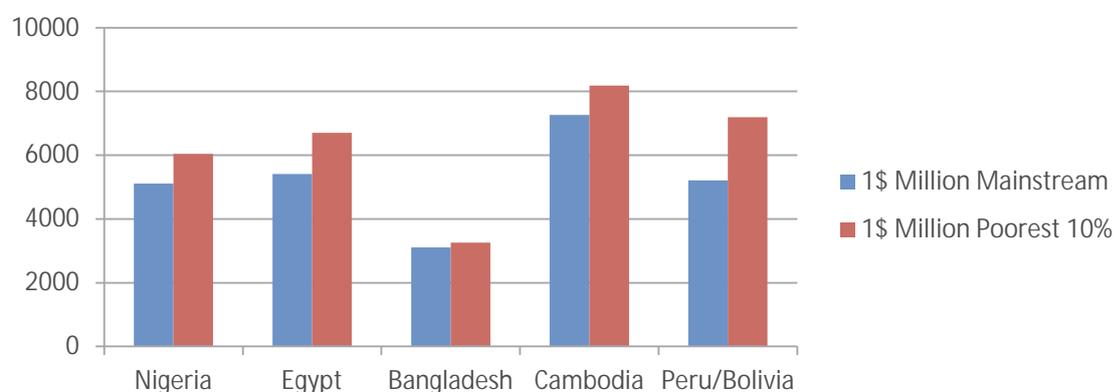


Table 11 shows the exact numbers of lives saved from the same investment of \$1,000,000 either in the “mainstream” approach or an equity-promoting approach with targeted CCM scaling up in Q5. This is illustrated in **Figure 16**. Although it can be seen that an equity-promoting approach to investment in CCM always results in a greater saving of life than the “mainstream” approach, the gradient of the difference varies significantly between countries with the greatest contrast found in Peru, the country with the highest QR and therefore greatest inequity, again suggesting that an equity-promoting approach is potentially most valuable in countries with the highest inequity.

This study aimed to populate the recently developed assessment framework on intervention coverage, equity and cost-effectiveness with real data from five exemplar LMICs and thereby investigate cost-effectiveness of different strategies to scaling-up childhood pneumonia interventions. Apart from noting the scarcity of high-quality information in this area, this work has delivered three major outcomes. Firstly, the information generated through modeling to populate the framework/tool represents a novel contribution to understanding equity and child health in LMICs. Secondly, this work has shown that the new framework is potentially a valuable tool for evaluating cost-effectiveness of different approaches to scaling-up health interventions. Finally, this implementation of the framework/tool has highlighted the complexity of relations between the multiple determinants of cost-effectiveness and equitable impact in LMIC child mortality reduction. Unexpected patterns are seen both in each variable’s distributions and in the final outcome results, further compounded by the difficulty in determining which of the multiple contributory variables is influencing the results most. This emphasizes that data on equity and cost-effectiveness for intervention planning in LMICs can be far from intuitive.

An extensive review of the literature found only one paper that attempted to model any child health data split by wealth quintile. Amouzou et al used the LiST tool to model child mortality data for richest and poorest quintiles in Bangladesh and found this to be within a 95% confidence interval of current DHS data (**Amouzou et al., 2010**). This is an impressive result, suggesting that LiST could play a role in expanding knowledge on wealth-related child health outcomes. The paper however does not go further to investigate policy implications and extensive literature searching found no published attempt to adjust any of the major tools (i.e. LiST, MBB or CHOICE) for calculating scaling-up costs by wealth quintiles and thereby explore equity considerations. EQUIST appears to be the only published framework which adequately addresses these considerations, making it an important development for future public health policy.

There are many limitations in this model that need to be acknowledged transparently. In absence of available information, it was necessary to model much of the data needed to populate the framework, including data for non-antibiotic costs, as although there are several studies estimating overall cost of global scale-up of health systems and some discussing the cost of more specific scale-up of individual countries and/or interventions, no studies were found which reported data on the differential cost of scale-up across wealth quintiles - although the importance of this difference was highlighted by **Johns and Torres (2005)**.

Estimates of relative disease proportions split by wealth quintile were the most extensive modelling exercise undertaken and are therefore central to consider when assessing this EQUIST implementation’s robustness. The modelling was based on data from the highly-cited CHERG report on child mortality and the UNICEF SOWC 2009 report and is therefore

thought to robustly estimate differential disease proportions. That the model used U5MR instead of GDP to split disease distribution is justifiable as the U5MR for Q1-Q5 in each country was known, so this could be used as a common denominator to determine quintile-specific disease distribution.

The results of this implementation of the new framework provide important conclusions. Firstly, one of the main findings of this study was the lack of good data in this important area. The need for extensive future research to fill gaps should be emphasized, especially into variables such as effectiveness and cost of interventions across population wealth strata. One potential way of doing this would be to further expand the DHS or MICS to collect information on more diverse health indicators, including those related to the tools' framework variables. This work also adds to the calls from others for future intervention scale-ups to be monitored with relation to their differential costs, effectiveness and impacts across equity strata so as to widen the knowledge base, a process which is starting to happen through the UNICEF initiative “Monitoring Results for Equity System” (MoRES) (**Mulholland et al., 2008; Zerzan et al., 2012**). The trends observed here for CCM for pneumonia may be similar or completely different for other pneumonia interventions or other major causes of childhood mortality and so if further research was conducted to populate this framework with data for other interventions/diseases, these could be investigated and greater understanding could be developed regarding equitable impact of childhood mortality interventions more broadly. For example vaccines have been shown previously to have a positive impact on equity while also reducing childhood mortality significantly, such as in the case of measles vaccination in Bangladesh (**Bishai et al., 2003**). Therefore as vaccines such as Pneumococcal Conjugate (PC) and Haemophilus Influenzae (Hib) against pneumonia are rolled out across an increasing number of countries through the GAVI Alliance (**GAVO Alliance 2012a, 2012b**) using the new framework it could be possible to target scale-up in a more informed manner, directing vaccines in with increased cost-effectiveness while also promoting equity. Further research/modelling however will be necessary to determine the necessary components of the model for analysing these interventions before any policy recommendations can be made.

Another potential facet for future research is the inclusion within this tool of other indicators of inequity apart from wealth. Policy makers are likely to find targeting interventions strictly by wealth quintiles difficult, therefore decomposing the components of the new tool for other sub-population group measures may be of more use. One potential way to do this is to consider using geographical areas to split populations as significant variances in U5MR are typically seen and geographical areas are easier for policy makers to target. Further research/modelling however would have to be undertaken to define these groups and their values for each component variable of the EQUIST. Another potential discriminatory variable which could be explored is gender, as U5MR is known to be higher in boys than girls in most LMICs, however there is little known with relation to the other variables of the new tool such as gender differences in disease distribution within specific wealth quintiles. If these data were to be attained either through survey or modelling, it would be possible to apply the framework to gender as well as wealth/geography and further address equity considerations.

One of the most important findings in this first implementation of the new framework is that the current, “mainstream”, approach never showed the highest cost-effectiveness in studied examples. Therefore for CCM scale-up, the current approach is unjustifiable. If countries are already not delivering interventions maximally cost-effectively, and many are increasing inequity, could an equity-focus lead to improvement in both areas? The CCM cost-

effectiveness data generated in this work suggest that indeed the most cost-effective approach is in actuality scale-up in the poorest, as although poorer quintiles display a decrease in effectiveness and an increase in cost of scale-up, the higher burden of disease and case fatality observed in these strata is great enough to offset this. This potentially lends increased weight to policy makers and academics increasingly calling for exactly this kind of equity-focus in scale-up of interventions and can be seen as a major development in the evidence supporting this call. Although this implementation is only the first of the new framework and therefore needs refinement and improvement of data, it is hoped that eventually this tool could be used at a national and sub-national level to aid policy makers to more efficiently target intervention scale-up so as to both save a maximal number of lives and also impact positively on equity.

This implementation of the new framework and the conceptual process involved behind thinking about intervention scale-up in this manner also suggests possible means of further enhancing cost-effectiveness, resulting in more lives saved for a given investment. The limiting factor in CCM in poorer quintiles such as Nigeria seems to be the very low effectiveness of the intervention and so it is implied that enhancement of the efficiency or quality of provision will also significantly decrease cost and therefore increase cost-effectiveness. This development should therefore be a focus for future research so that cost concerns do not force resource-limited policy makers to further perpetuate the observed trends of increasing inequity in many countries worldwide. A recent review highlights a number of current limiting factors in the effectiveness of community case management including incomplete compliance with guidelines, inappropriate choice of antibiotics and poor management of treatment failure and co-morbidities (**Graham et al., 2008**). These must be overcome if an equitable approach to scaling-up CCM is to become practicable in some of the world's poorest countries.

Child health information split by wealth strata in LMICs is severely lacking. This first implementation of the new framework has expanded knowledge and delivered important analyses on cost-effectiveness of different strategies in scaling up of community case management to tackle pneumonia in five LMICs, demonstrating this model's potential future value. It has highlighted the complexity of interactions between equity, cost-effectiveness and their determinants, also reinforcing important suggestions for future policy such as the significant effect on cost-effectiveness of increasing efficiency and quality of interventions in poorer quintiles.

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PART 2. Integration into Health Systems

2.1. How have countries or states overcome the financial and health systems constraints in implementing and sustaining IMCI at scale?

IMCI is an integrated approach to child health that focuses on the well-being of the whole child. IMCI aims to reduce death, illness and disability, and to promote improved growth and development among children under five years of age. IMCI includes both preventive and curative elements that are implemented by families and communities as well as by health facilities.

The strategy, which was ultimately adopted by more than 100 countries, remains a central element of many child health programmes. However it did not spread evenly with many countries experiencing challenges related to the financing and systems constraints of introducing such a comprehensive new way of treating sick children. A multi-country evaluation of IMCI (**Bryce et al., 2004**) conducted in Bangladesh, Brazil, Peru, Tanzania, and Uganda in 2003 as well as other reviews identified seven main challenges in implementing and sustaining IMCI. These are detailed further below with examples of how some countries have strived to overcome these constraints.

2.1.1. Political commitment and management capacity

Across all successful countries a common feature has been the initial and ongoing strong political commitment with a systematic approach that includes national planning, district management involvement and monitoring bodies, all as being central to being able to implement and sustain IMCI at scale.

Egypt, for example, was an early adopter of the IMCI strategy in 1997 with the main aim of it accelerating the reduction in under-five mortality. The government addressed the need to improve essential health system elements prior to the initiation of the IMCI strategy in 1999. The Egyptian national IMCI programme, composed of a central IMCI unit and governorate and district coordinators, led the implementation under a director general. The IMCI strategy was included in the Basic Benefit Package of the Health Sector Reform in 1999. The programme developed a systematic approach for scaling-up activities, with well-defined sequential steps and quality criteria for each step.

Tanzania is another example of how political drive and support alongside systematic planning and implementation has resulted in a successful IMCI programme. Steps taken between 1995-1996, included the appointment of an IMCI lead in the Ministry of Health, establishment of IMCI national plan, field testing of IMCI materials, training of front line health workers in early use districts and translation and printing of training materials and training of master trainers. In 1998 a 2-year roll out plan was established with a full time national IMCI coordinator and introduction of community IMCI in selected districts. Between 2000-2001 IMCI was introduced into medical school curriculums, separate funding for IMCI at district level became mandatory and pre-referral drugs were introduced into PHC facilities (**Prosper et al., 2009**).

In addition to central political support, another important factor related to success in Kenya and Tanzania was the presence of stable district management teams. There was very little turnover of these district leadership teams that displayed strong personal commitment to the IMCI programme (**Prosper et al., 2009**).

Countries where such political leadership was missing had challenges with donor and stakeholder coordination – often resulting in poor coverage, as reported in both the MCE-IMCI (**Bryce et al., 2004**) and DFID-led evaluation (**DFID et al., 2003**). In these settings there was often a lack of investment of government funds, which resulted in some places in IMCI being donor driven and often led by Ministry of health staff, without the necessary rank or authority.

2.1.2. Ongoing reliable funding

Successful programmes require sufficient and reliable funding. Funding for IMCI implementation initially was heavily reliant on developmental partners and in many countries this remains the status quo. This type of funding is not sustainable in the long term and countries that have been successful in scaling up IMCI have addressed this early on, both at the national and district level by designated specific funding to IMCI.

As early as 1999, Egypt recognized the need to be independent from donors and allocated a separate government budget line to IMCI. Tanzania went further and made it mandatory to have separate funding for IMCI within all the district budgets.

Even though national financing for IMCI is central to sustaining the programme it is worth noting that **Mushie et al. (2010)** found that the presence of strong district leaders in both Kenya and Tanzania was an important positive influence on IMCI implementation as this facilitated district access to external funding.

2.1.3. Early linkages and involvement with academia and international partners

In order for national programmes to operate at optimal levels there needs to be continuous evaluation and research to ascertain and document the effectiveness of the programme. The role of both academia and international partners is paramount in this regard. Knowledge sharing – capturing and using to one’s advantage knowledge that has been gained from other countries experiences in implementing IMCI – is both prudent and insightful. There is certainly no point in ‘reinventing the wheel’ – countries should learn from each other but always take into consideration the specific context and make adaptations where needed. Research institutions and international partners are key players in the generation of new information and knowledge for diagnosing and providing solutions to programme implementation as well as monitoring of health system performance. Countries that have been successful have identified this need and developed these early linkages, for example Sudan and Egypt.

2.1.4. Effective training and supervision of health care staff

Improving case management skills of health care staff is only one of the 3 components of the IMCI strategy. However, in many countries it has been the first and only component to be implemented and rolled out. The WHO standard training course for health workers is 11 days and combines classroom work with hands on clinical experience. The rigor and quality of this clinical training is very high but it is costly. The length and cost of the course has been a barrier, with logistical difficulties being reported in both financing the course and in freeing up health staff to attend the course. Commentators have noted that this resulted in inability to train a sufficient number of providers. It has been noted that in some countries there is an initial burst of training activity during which a large number of health care workers are trained, but then the budget and time constraints lead to a decrease in the number of training courses. The overall outcome is reflected in low coverage levels of IMCI trained health staff.

Successful countries have used innovative ways to reduce the time and cost burden of the training. A recent survey of 24 countries found that all offered shortened courses, typically lasting 5-8 days (**Goga et al., 2009**). The effectiveness of these shortened courses are still unclear. A trial in Zambia compared the performance of primary health workers trained in the standard 11 day course with those trained in a 6 day shortened course and it found no significant difference in many key indicators which assessed health worker performance (**Mwinga et al., 2007**). Another study in Kosova found that primary care physicians trained through 8-day course performed assessments as well as (or even better than) those trained in the 11 day course (**Skender 2007**). In contrast, in 2011 a systematic review based on limited evidence, published in the Lancet, concluded that standard training seemed more effective than shortened training, although the difference might be small (**Rowe et al., 2011**).

Another approach has been the introduction of the IMCI Computerized Adaptation and Training Tool (ICATT) – an innovative software technology to support the adaptation of generic IMCI guidelines at national and sub-national levels. This has been tested in several settings - in a classroom setting in Peru and Tanzania and then as distance-learning material in East Java, Indonesia and Tanzania (**WHO, 2009**). ICATT is still undergoing further refinement but could be an innovative way to reduce the burden of training both financially and from a human resource perspective (**Goga et al., 2012**).

Tanzania has been investigating another alternative. D-Tree International has been working to improve the use of the IMCI protocols through the development of an electronic version of IMCI (eIMCI) for use on cell phones and other mobile devices (**D-Tree International, n.d.**). The e-learning guides health workers step-by-step through the full IMCI assessment, classification and treatment plan. The software has been designed for ease of use and the training of clinicians took less than one hour in all cases. D-Tree has piloted e-IMCI in rural Tanzania where initial results indicate that clinicians were enthusiastic about this and more closely adhere to the IMCI protocol when using it than without it. A large-scale study is currently underway to validate these initial findings and to examine e-IMCI's cost-effectiveness (**Goga et al., 2012**).

Perhaps a more sustainable solution is pre-service training. For example, in 2001 six Sudanese universities introduced IMCI into their medical school curriculum, thereby training whole cohorts of physicians in a standardized setting (**Abdelrahman et al., 2008**). For trained health staff to continue effectively implementing the IMCI guidelines there needs to be regular ongoing supervision and support of IMCI health workers. A study in Benin showed that relatively inexpensive post-training supports could lead to additional improvements (**Rowe, 2009**).

2.1.5. Robust monitoring systems

A fifth success factor has been the ability of planners and managers to effectively monitor implementation and tweak the strategy if necessary. In Egypt, the establishment of a central database for continuous monitoring of programme implementation and service provision facilitated regular and timely feedback at all levels (**Rakha et al., 2013**).

Moreover, **Mbuya et al. (2003)** argue that success in Tanzania was mainly because, in the multi-country evaluation districts, IMCI was linked to a lot of “intelligent thinking” behind the IMCI strategy; for example, the use of burden of disease information for planning, training of non-clinicians, rapid achievement of good IMCI coverage, and solving supervision problems through cascade supervision. The programme set up an IMCI monitoring system with a central database to which health facilities with trained staff provided monthly reports, through the governorate and district management teams. The central unit gave feedback on the data at least quarterly and developed a detailed annual IMCI report.

2.1.6. Reliable availability of necessary treatments, supplies and equipment.

Equipment and vaccines are needed for IMCI delivery. **Victora et al. (2006)** reported shortages in Cambodia and Zambia. Other countries, such as Peru and Tanzania, reported that essential IMCI drugs were mostly available. On the other hand, Egypt used the introduction of IMCI to undertake a systematic strengthening of the health system. The steps included: orientation of key government officials; a situation assessment in districts and health facilities; orientation of district staff; district planning (training, supervision, provision of supplies and medicines, referral system, recording and reporting, community based activities); capacity building (training of IMCI facilitators, IMCI supervisors, IMCI health staff) and monitoring and feedback.

2.1.7. Retention and motivation of skilled staff

Successful countries have prioritized the need to retain and motivate skilled staff. In Peru, between 1996 and 2001, 43% of IMCI-trained health workers had already been rotated since their training (**Huicho et al, 2005**). In Tanzania, where staffing patterns appear to be quite stable in comparison with the situation in other countries, 23% of trained staff had moved within three years of initial training (**Mbuyia, personal communication**). Problems with turnover were also observed in Bolivia, Brazil, and Niger. These health workers did not necessarily leave government employment, but high rotation could result in loss of skills and delivery of inconsistent messages to the target audience.

Another relevant issue mentioned in several countries was low staff motivation, which was often associated with low salary levels. In Uganda, the performance of health workers fell dramatically in 2001 after the government discontinued cost-sharing schemes that were used to supplement drug supplies and health worker salaries at the facility level (**Burnham et al., 2004**). In Cambodia and Tanzania, salary levels are so low that health workers need other sources of income to maintain their families.

2.2. What is the relationship with the community component of IMCI including iCCM?

Success in reducing childhood mortality requires more than the availability of adequate health services with well-trained personnel. As families have the major responsibility for caring for their children, success requires a partnership between health providers and families, with support from their communities. Using community members to render certain basic health services to the communities they come from is a concept that has been around for at least 50 years. There have been innumerable experiences throughout the world with programmes, ranging from large-scale national programmes to small-scale community-based initiatives. Community IMCI (cIMCI), by utilizing CHWs, engages families and communities in discussions about child health and assists them to assess, analyse and take action on the problems affecting them and their children. Four key elements have been identified as being necessary to maximize the impact of community IMCI and hence IMCI as a whole. These are: (i) the need for political commitment to cIMCI and CHW programmes; (ii) robustly designed CHW programmes; (iii) community involvement and acceptance of IMCI; and (iv) rational prescribing by CHWs.

2.2.1. Political commitment and institutionalization

In order for large-scale programmes to deliver, there needs to be strong leadership supported in national policy. A key challenge lies in institutionalizing and mainstreaming community participation. To date, the largest and most successful programme in this regard is the Brazilian Family Health Programme, which has integrated CHWs into its health services and institutionalized community health committees as part of municipal health services to sustain social participation. This means that community participation does not become an alternative, but an integral part of the state's responsibility for health care delivery. Many factors can affect the timely and appropriate development of policies related to community programmes. For example, Kenya demonstrates hurdles that can arise and hinder the development of an iCCM policy. **Juma et al. (2015)** identified that one of the key issues causing concern was the question about whether CHWs had the ability to offer quality care, and what the potential consequences of inappropriate use of antibiotics by this cadre may result in. Alongside these concerns were considerations of how the development of community health worker cadres may affect the livelihood of clinicians, as well as initial concerns about how an integrated approach might affect vertically oriented programs. Furthermore, Kenyan policy makers identified differences in their context that led them to question the applicability of evidence on iCCM effectiveness from elsewhere. To address the above concerns, there needs to be clear mechanisms to assess quality of care being delivered by CHWs – this includes aspects of training and supervision. Local evidence needs to be available to show the effectiveness of iCCM and cIMCI.

In her qualitative study, **Strachan et al. (2014)** also identified drug resistance due to potential incorrect prescription of medications and poor adherence at community level as concerns from stakeholders during the central level planning stages in South Sudan and Zambia.

2.2.2. Optimal design of CHW programmes

In light of the shortage of health workers in sub-Saharan Africa, there has been recognition for the need of Community Health Workers to provide a variety of community-level services, including cIMCI and iCCM. International agencies and donors have prioritized iCCM and CHWs as critical to success of child survival strategies (**WHO/UNICEF 2012**). Numerous studies, including that by **Christopher et al. (2011)**, have demonstrated without doubt that CHWs, a heterogeneous cadre of frontline health workers operating in a diverse set of countries and contexts, can improve people's health and wellbeing. An extensive review by **Lehman and Saunders (2007)** identified a number of key issues related to the design of CHW programmes. Firstly, for CHWs to be able to make an effective contribution, they must be carefully selected, appropriately trained and – importantly – adequately and continuously supported. Hence, large-scale CHW systems require substantial increases in support for training, management, supervision and logistics. Secondly, numerous CHW programmes have failed in the past because of unrealistic expectations, poor planning and an underestimation of the effort and input required to make them work. This has unnecessarily undermined and damaged the credibility of the CHW concept. Thirdly, CHW programmes are vulnerable unless they are driven, owned by and firmly embedded in communities themselves. Evidence suggests that CHW programmes thrive in mobilized communities but struggle where they are given the responsibility of galvanizing and mobilizing communities.

Naimoli et al. (2015) identified a minimum package of four strategies that could provide opportunities for increased cooperation (between communities and health systems) and address traditional weaknesses in large-scale CHW programmes. He postulated that these strategies could be implemented at the sub-national levels over large geographic areas and among vulnerable populations in the greatest need of care. The strategies are: (i) joint ownership and design of CHW programmes; (ii) collaborative supervision and constructive feedback; (iii) a balanced package of incentives; and (iv) a practical monitoring system incorporating data from communities and the health system. These four strategies are supported by other literature.

With regard to joint ownership and design of CHW programmes, **Strachan et al. (2014)** noted many benefits in areas where communities were strongly involved in the selection of CHWs. In South Sudan, Uganda and Zambia, respondents anecdotally reported higher utilization of iCCM services, more community support for CHWs, deeper trust in CHWs' capacity to treat children and a stronger overall sense of community ownership. This effect was also seen in a review by **Sharkey et al. (2014)**, where a participatory process for community selection of local individuals to work as CHWs facilitated community acceptability of CHW services and for the CHWs themselves. In a recent review of peer-reviewed literature on supervision of peripheral health workers, including CHWs, **Hill and Benton (2010)** identified several promising approaches for strengthening supervision, all of which could benefit from collaborative engagement by actors from both the community and the health system. Examples of these approaches are: (i) supervisor meeting groups of CHWs for problem solving; (ii) engaging stronger peers in support of weaker one through peer assessment; (iii) on-the-job training and mentoring; (iv) monitoring and assessing CHW performance by communities through consumer reporting on provider performance; (v) sharing the results of periodic self-assessments with a supervisor, possibly using cell phones; and (vi) using supervisory checklists. **Strachan et al. (2014)** identified alternative supervision models, such as peer support groups, being of help in her qualitative study of three African countries.

The question of whether CHWs should be volunteers or remunerated in some form remains controversial. There is a promising body of evidence suggesting that performance can be improved when CHWs receive both financial and non-financial incentives linked to performance (**Glenton, 2013**). For example, Afghanistan, Indonesia, Nepal, Rwanda and India all have national programmes that use volunteer CHWs who generally receive some combination of both kinds of incentives (**Perry, 2014**). Both the health system and the community typically play complementary roles in providing these incentives. Another crucial factor identified in the Ugandan setting by **Bagonza et al. (2014)** is the importance of community support as a motivator for CHW performance. This includes how the community accepts, cooperates and appreciates the services offered by the CHWs. Studies in India and Bangladesh also showed the intangible benefits to CHWs of community support and respect. **Strachan et al. (2014)** highlighted how community data should be incorporated fully into the Health Information System with analysis, use and feedback to all levels.

2.2.3. Community involvement and acceptance

Community programmes can only have positive impact if they are truly utilized by the community. Research by **Sharkey et al. (2015)** has identified lessons learnt from successful programmes in Niger and Mozambique with regard to demand generation and social mobilization for iCCM and child health. Strategies used in these two countries included community dialogues to stimulate debate and media messages (cinema forum, community radio, theatre) to disseminate information on promotion and prevention. An example of the positive effect of community dialogue in Mozambique was that the community agreed with traditional medicine practitioners that all sick children presenting with a cough should be evaluated by a CHW. Demand for iCCM activities and other child health priorities followed the implementation of comprehensive social mobilization efforts.

Local leaders within the communities in the above study were identified as the key actors in community behaviour change. These leaders included Imams, traditional chiefs. The involvement and support of these leaders in CHW activities legitimized their role and gave more weight to the messages of health promotion and prevention conveyed by the CHWs. In addition to the expert local knowledge from local leaders, a better understanding of social norms can support efforts to reduce bottlenecks related to behaviour.

Community members were explicitly made aware of the skills of the CHWs. This becomes a factor when caregivers have a variety of provider options. Caregivers are more likely to seek care from people they trust and respect. In addition, community members were also made aware of danger signs and appropriate treatments for illnesses, key factors in improving prompt and appropriate care-seeking (**Sharkey et al., 2015**). CHWs are seen to be of even more value if they are able to treat more than one problem (**Kallander et al., 2004**). For CHWs to provide optimum care within their scope, they need to have the necessary supplies and treatments available consistently. It has been noted in one Ugandan study that even after medicines were back in stock with CHWs (following a stock shortage), caregivers continued to bypass CHWs. This indicated that regaining trust becomes a long and difficult undertaking.

2.2.4. Rational prescribing by CHWs

Community health workers' roles are expanding and there has been some concern and criticism over the ability of CHWs to rationally prescribe pneumonia and malaria treatment. This issue has even been an impediment to the implementation of iCCM. However, many studies have shown that CHWs are able to prescribe correctly. In Malawi, **Gilroy et al. (2012)** found that the majority of CHWs trained in iCCM used antibiotics appropriately and suggested that there was no widespread misuse of antibiotics. Similarly, a study in Uganda (**Kalyango et al., 2013**) demonstrated that integrated community management of malaria and pneumonia increased the prompt and appropriate treatment for pneumonia symptoms and improved treatment outcomes. In the same setting (**Kalyango et al., 2013**), there was high adherence to artemisinin-based combination therapies (ACTs). High adherence to ACTs provided by CHWs gave reassurance that community based interventions did not increase the risk of drug resistance.

2.3. How have community and facility based approaches been reconciled? What are some best practices? How will a new approach contribute, and not undermine health systems?

The community and facility based components of IMCI are both essential and designed to complement and support one another. The uniqueness of IMCI is the focus on the integration of the above elements and use of a multi-sectoral platform to promote appropriate child care, illness prevention, illness recognition, home management, care seeking and treatment compliance practices. Linking these aspects involves intentional design to ensure that efforts carried out at the facility, community and household level are not isolated.

2.3.1. Synergistic implementation of facility and community IMCI

In many countries, the initial and main focus has been on implementing and scaling up the facility component of IMCI. In some countries both the facility and community component were introduced, but not in an optimal way. In Peru, for example, there was no coordination between the location and timing of where and when the facility and community aspects of IMCI were introduced. The facility component was introduced in different districts from where the community component was initiated. This resulted in a loss of the expected synergy when both components are functioning within the same communities (**Huicho et al., 2005**).

2.3.2. Institutionalization of community IMCI

There is agreement on the importance of community actions for child health. The analytic review of the IMCI strategy conducted by DFID and others (**DFID et al., 2003**) found that in some countries community programming for child health was included in national program strategies, e.g. in Nepal, Pakistan, Honduras and Nicaragua. In other countries, such as Bolivia and Madagascar, networks of NGOs were developing and coordination was improving. This review found that countries wanted to utilize IMCI to improve the quality of health care in the facility, as well as a means of linking the health facility to care and prevention activities in the community. In Zambia, for example, facility-based IMCI was

seen as a good entry point because it improved care and counselling skills, increased access and promoted outreach activities. Mali and Peru already had a tradition of working with communities and they planned to deploy even more community based health agents.

The literature, though somewhat limited, reveals some discrepancies in outcomes associated with the implementation of community IMCI. For example, a small study on CHWs from South Africa (**Stellenberg et al., 2015**) showed that the knowledge of CHWs was inadequate to provide safe, quality cIMCI. It recommended that refresher courses should be offered annually to build competencies. In contrast, a study from Armenia (**Thompson and Harutyunyan, 2009**) demonstrated a significant impact of the community IMCI programme with increases in rates of exclusive breast feeding and maternal knowledge of childhood illness signs. **Thac and colleagues (2016)** studied a group of 600 mothers in rural South Vietnam. The majority (more than 90%) were literate, married and the main caretakers of their children. Despite being educated, approximately 25% did not manage cough correctly and 38% did not manage diarrhoea correctly. The study concluded that continuing education and messages related to home management and health seeking needed to be reinforced. In Peru, **Harkins and colleagues (2008)** noted a dramatic improvement in exclusive breastfeeding rates and rates of immunization, as well as recognition of danger signs for both pneumonia and diarrhoea by mothers. Nepal has also demonstrated that districts where community IMCI was implemented had significantly fewer cases of pneumonia and of diarrhoea accompanied with dehydration (**Ghimire et al., 2010**).

2.3.3. Supportive supervision of CHWs

Langston et al. (2014) reported on a project to support the Rwanda Ministry of Health in scaling up iCCM of childhood illness in certain districts. The project trained and equipped CHWs according to national guidelines. It also trained them to conduct household-level health promotion. Supervision and reporting mechanisms were established through CHW peer support groups and quality improvement systems. Findings from this study suggested that the peer support group model helped improve CHW performance, motivation, supervision and collaboration with the health facilities. Health facility staff acknowledged that the CHWs acted as their representatives to the community and provided information that could be used by facility staff to make decisions and send health messages to the community.

2.3.4. Monitoring systems

Strong monitoring systems, in which community treatment data are integrated within national health information systems and used to identify issues and take timely action, are essential to improve the ability of integrated community case management programs to achieve high levels of appropriate utilization and thereby impact child health. The data generated by CHWs can be huge. As an example, Rwanda has more than 50,000 CHWs involved in IMCI programmes (**Guenther et al., 2014**). In addition, literacy and numeracy skills of CHWs vary widely in between and within countries. Monitoring systems need to be able to accommodate this scale and variability. **Robinson and colleagues (2016)** examined the feasibility of collecting 18 routine monitoring indicators in 10 countries in sub-Saharan Africa with the iCCM monitoring systems they had in place. They found that much of the data was already being collected through existing monitoring systems, although these data are only available at

health facility level and are not aggregated to district or national levels. The results highlight the challenge and also the need for countries to maintain accurate deployment data on CHWs and their supervisors. They suggest that routine monitoring will be more feasible, effective and efficient if iCCM programmes focus on a smaller set of high-value indicators that are easy to measure and interpret reliably. Such indicators would be useful to global and national stakeholders alike and to frontline health workers themselves.

Guenther et al. (2014) noted that there is no single approach or strategy on how to strengthen routine monitoring for iCCM that would serve all contexts. Still, valuable lessons have been learnt from many African countries and are in line with those identified for broader Health Information Systems. Monitoring systems need to have simplified data collection and reporting requirements in order for them to be utilized and provide meaningful results. Otherwise, they may result in an unintended consequence of increasing service provider resistance towards the whole IMCI strategy due to the added significant documentation burden, as has been seen in Moldova (**Center for Health Policies and Analysis in Health, 2011**).

2.3.5. Availability of treatments and supplies

CHWs should have the necessary treatments and supplies needed for them to function in a consistent and reliable manner. The availability of these commodities both at the CHW and facility level will improve referral compliance.

2.4. What lessons have been learnt in the implementation of IMCI/IMNCI especially with regard to strengthening health systems?

Numerous lessons on the implementation of IMCI can be identified from the literature and these have been summarized below. In addition, vital health system strengthening lessons can be learnt from other programmes and disease entities. **Denney and colleagues' (2015)** report on Ebola and Sierra Leone's health system identifies four very pertinent "blind spots" that can be easily applied to the case of health system strengthening and IMCI.

The first "blind spot" is taking the complexity of (seemingly) basic interventions for granted. In the case of IMCI, behaviour change for health workers and caregivers relies on many interconnected dynamics and social relationships. This means that CHWs' behaviour does not necessarily change simply because CHWs know what to do. Second "blind spot" is taking "what ought to be" as the starting point, rather than "what actually is". Many caregivers seek health care from private providers of one form or the other – this is how things actually work and should be used as a base to achieve behaviour change. Therefore, for IMCI, these private providers need to be fully incorporated into the strategy. The third "blind spot" is focusing on the units, not the connections. Each level and unit of the health system is important, but there needs to be communication and strong connections between them. For IMCI in particular, this translates to the need for strong referral systems and robust supply systems. The fourth "blind spot" is failing to see that systems are made up of people who relate to each other. Technical training of health workers may increase their knowledge, but there is a myriad of other factors that will result in good care of the child and family. Caregivers and children

need to be treated with respect and a "good bedside manner" – these soft skills help to build lasting and trusting relationships.

2.4.1. National health plans and budgets

Case studies carried out in 5 African countries by **Bennett et al. (2014)** demonstrated that country iCCM policies evolved in an "ad hoc" fashion and were driven by the Ministry of Health, with support from international donors. There was little or no mobilization of communities or political leadership. They noted that availability of external financing played a critical role in facilitating policy change. They concluded that global initiatives should be tailored to meet country needs. This policy change could be positively facilitated by high-level political ownership, including strategies for long-term sustainability. The positive effect of high-level political champions that have ensured iCCM being positioned as a core part of the national health strategy have been seen in countries such as Ethiopia, Rwanda and Niger (**Rasanathan et al., 2014**). Rasanathan and colleagues highlight the critical role of financing for delivering iCCM services. Most of the funding for iCCM in Africa continues to be dependent on development partner.

Looking at Malawi, factors that influence the implementation of a health policy include the perceived need and the compatibility with the health system. In addition, institutional factors are needed to set the groundwork for the negotiations and decision-making. These two sets of characteristics are needed to ensure there is no mismatch between the policy and the local context. They are both needed to ensure success (**Rodriguez et al., 2015**).

2.4.2. Integration into national plans and budgets

Integrating iCCM into national health systems allows for a means to overcome some of the core problems such as sustained financing, supply of commodities, provision of supervision, scaling up implementation and monitoring outcomes. Due to the support of development partners, only 9 countries in sub-Saharan Africa have separate budget lines for iCCM (**Rasanathan et al., 2014**).

2.4.3. Role of development partners

In Malawi, the leadership of the MoH across the public sector and with development partners was crucial, despite having to overcome internal struggles for agreement. Furthermore, support from development partners was evidenced through practical technical assistance, such as developing iCCM-specific algorithms, as well as through their role as knowledge brokers where they bring research evidence and experiences from other countries to the attention of local policymakers (**Rodriguez et al., 2015**).

2.4.4. District involvement

With regard to the implementation of IMCI, WHO had recommended certain characteristics for these early implementation districts. These included proximity to the capital and suitable training sites, presence of motivated health managers and a functioning health system. **Victoria et al. (2006)** noted that in the expansion phase, IMCI tended to be adopted by other districts with similar characteristics. In Brazil, uptake by poor and small municipalities and those further away from the state capital was significantly lower. In Peru, there was no association with distance from Lima, and a non-significant trend for IMCI adoption by small and poor departments. In Tanzania, the only statistically significant finding was a lower uptake by remote districts. Significant implementation of IMCI was not associated with baseline mortality levels in Peru, Brazil or Tanzania. Criteria to promote IMCI expansion were not provided to countries and as a consequence areas of greatest need were not prioritized.

Another review in Tanzania, by **Proper et al. (2009)**, supports the need for the involvement of district stakeholders from the early stages of the policy roll out process for effective policy implementation. This early open communication has the potential to enhance legitimacy, ownership and support for the policy at district level. This in turn may reduce possible grievances over inconsideration of practicalities of daily life in rural/ peripheral areas of the country.

2.4.5. Supply chain

In order for health providers to fully implement IMCI both at the facility and the community levels, they need to have uninterrupted access to commodities and supplies. Several studies have highlighted shortcomings in the availability of necessary supplies. For example, in the CCM programme in Malawi (**Callaghan-Koru et al., 2013**) it was found that the health system support with the most direct impact on effectiveness and coverage of the programme was the supply chain. The authors found that one third of the CHWs did not have all the essential CCM drugs in stock on the day of the visit. Moreover, an analysis of clinical errors revealed that more than half of the mismanaged fever and diarrhoea cases were due to the CHW not having stock of the required treatment. In Malawi, health centre drug supply is a large health system problem. Solving this will take coordinated efforts and systems strengthening by many stakeholders. In the meantime, CCM programme managers can make targeted improvements under their control, such as providing supply chain training to CHWs and managers and addressing transportation issues. An example of circumnavigating supply chain issues is Zambia, where there was a major issue related to the stock shortage of zinc and ORS in rural health facilities. However, in the same area it was also noted that private retailers were fully stocked with supplies, including Coca Cola. A new Diarrhoea Kit was designed and partnership was made with Coca Cola. The Diarrhoea Kits were designed to fit into the empty spaces in the Coca Cola delivery truck. Following the implementation of this initiative, the use of zinc and ORS among children with diarrhoea increased from <1% at baseline to 45% at end-line (**Ramchandani, 2014**).

Innovations are required to manage the various challenges that may need to be overcome to ensure adequate supplies. Documented strategies that have demonstrated success include: (i) deliberate and consistent coordination at all levels with timely problem solving; (ii) maximizing reporting rates by linking reporting to resupply as this shows that the reporting data is being used for decision making and has a direct impact on the ability to provide services; (iii) well-designed mHealth applications have improved efficiency and accuracy of

CHW resupply and helped to reduce stock outs; (iv) simple tools with minimum data elements in local languages enables execution of supply chain tasks; (v) supply chain issues need to be discussed and solved in a structured, regular manner (**Centre for Population Health Sciences, 2014**).

2.4.6. User fees

User fees for iCCM still occur – mostly in West Africa. This requires attention to identify sustainable solutions, as there is sound evidence of the negative impact of user fees (**Meessen et al., 2011**).

2.4.7. Monitoring

Some areas still need external technical assistance and support, such as revising the national IMCI monitoring and evaluation system, or else they may result in unintended consequences. The added significant documentation burden can increase service provider resistance towards the whole IMCI strategy, as has been seen in Moldova (**Center for Health Policies and Analysis in Health, 2011**).

2.4.8. Training

Perhaps the greatest missed opportunity in IMCI is related to pre-service training (**Duke, 2009**). The IMCI strategy has been implemented in many countries for several years and one would expect to see it institutionalized as a core part of the pre-service curriculum by now. In reality, coverage is patchy and training is inadequate. To achieve a workforce competent in the IMCI approach it is essential that training should be integrated into the curriculum for all cadres of health workers at all medical training colleges, and that the curriculum is revised to include a practical component when students can practice case management skills. In addition, all medical training institutions need to have appropriate training aides and access to a health facility with a sufficient number of outpatient cases. Finally, there is a need to establish a system to track those who are trained in IMCI during their pre-service training to avoid the unnecessary cost of retraining. However, challenges include a shortage of financial resources for training colleges, the complexity and diversity of the curriculum, the large numbers of students, resistance to the IMCI approach from teachers, and a lack of commitment at the national level (**WHO, 2007**).

The alternative training modes (pre-service and on-the-job) that had the potential to reduce overall training costs have not worked well in Tanzania. The pre-service training is facing challenges due to lack of training harmonization, and the absence of the counselling component that appears integral to in-service training. In terms of "on the job" training, the main challenges are lack of job aids, lack of incentives for peer knowledge sharing within facilities, and lack of transparency in selection of in-service training candidates. Each of these forms of IMCI training seems to bring their own challenges (**Prosper, 2009**).

2.4.9. Supervision and staff turnover

Supervision is a key component part of IMCI training and implementation. This supervision needs to be conducted by skilled personnel in a timely and frequent manner. Results of a follow-up study from Ethiopia have shown that there is a loss of skills following the training over time. This is exaggerated when follow-up was conducted after 6 months of training (**Simoes et al., 1997**).

Findings from the review by **Huicho and colleagues (2005)** of the Peru IMCI programme identified the major constraints of supervision and staff turnover. These findings were not unique to Peru and were also reported for other countries included in the IMCI evaluation (**Bryce et al., 2003**). Supervision activities were clearly insufficient; the average reported 0.19 visits per facility per year was well below the two annual visits recommended by IMCI guidelines (**WHO/UNICEF, 1999**). The two main reasons for this were identified as insufficient numbers of IMCI facilitators available for supervision, and supervision activities not being routinely planned and budgeted for. In Rwanda, a programme was introduced to provide mentoring and enhanced supervision at the health centers focusing on clinical and systems improvement. In this study, health care workers reported high acceptance and positive perceptions of the MESH model as an effective strategy to build their capacity, bridge the gap between knowledge and practice in pediatric care and address facility and systems issues. This approach also improved relationships between the district supervisory team and health center-based care providers (**Manzi et al., 2014**).

A study in Northern Ghana (**Daniels et al., 2015**) identified the problem of high turnover of supervisors. The loss of trained supervisors caused a major problem for consistent and coherent supervision and even resulted in supervision by untrained new incumbents.

A study by **Goga and Muhe (2012)** on the global implementation of IMCI found that while some facilitators and course directors accepted that follow-up is an integral part of IMCI training, others seemed unable to plan for integration of IMCI follow-up activities into their daily work. Similarly, although IMCI trained health workers recognized the importance of follow-up, a group of trained health workers also expressed despondency about follow-up, likening it to policing. They also highlighted the lack of skill or possible lack of human resources to undertake follow-up. The lessons learned on follow up and supervision were that follow-up need to be accepted as an important part of IMCI training; an emphasis needs to be made that follow-up strengthens practical skills and establishes technical support; that planning of follow-up activities should take place before a course is planned; and that follow-up should be linked with routine supervision of services.

The lack of monitoring and supervisory mechanism for trained workforce possibly indicates lack of strategic planning and more emphasis on training rather than strengthening all aspects of health system.

2.4.10. Referral system

Not all sick children can be managed at the first level they are assessed. Once that danger signs have been identified and initial treatment provided, the next step is referral. In Pakistan (**Pradhan et al., 2013**), in the context of referring sick children according to IMCI protocol, the referral system was perceived ‘weak’ and ‘inefficient’ with lack of transport facilities in

the district cited as the foremost concern. The need to have transport facilities for urgent referrals was emphasized. In addition, financial constraints by the families of sick children also surfaced as an impediment to optimal referrals because families, rather than going to tertiary care hospital or any referred care facility, go home and arrange money for transport and anticipated expenses for the treatment of their child. Furthermore, feedback from the referred care facility was also cited as ‘being non-existent at the district.’

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PART 3. Innovations

In recent years, there's been growing interest in supporting and expanding IMCI through innovations. A number of publications proposed new solutions to improving various aspects of IMCI implementation. Also, several presentations at a recent evidence review symposium on IMCI held in Accra, Ghana, in March 2014 were focused on reviewing innovations.

Given the range of ways in which integrated community case management (iCCM) is implemented across countries and even within some countries, the landscape of innovations and innovative approaches as part of iCCM is quite diverse. Innovations range from ways in which community health workers (CHWs) are supervised to mobile-phone based solutions to track, report and manage cases at the community level. Innovations could also be helpful in improving supply, training, motivations, monitoring and evaluation. Innovative solutions need to be user centered, simple, designed with end users in mind. The review meeting on iCCM in Ghana (CPHS, 2014) concluded that there are four cross-cutting subject areas of innovation in iCCM: (i) Putting CHWs at the center - user centered design; (ii) using real-time information to drive programming; (iii) mHealth: state of the evidence and country strategies; and (iv) new models for service delivery.

Innovations are clearly needed in monitoring, evaluation and health information systems (CPHS, 2014). Innovations in monitoring and integration with health management information systems should enable the use of results to drive programmatic decision-making and improvements, evaluation design and methods. Innovations such as rapid SMS for CHW reporting should be coordinated through the Ministry of Health and linked to plans for integrating iCCM treatment data into HMIS or other platforms. Many small, resource-intensive projects can be a distraction rather than a contribution.

A substantial share of innovations in IMCI and iCCM today are trying to exploit mobile phone technology. In 2014, there were more mobile phones than people: 25% were basic phones, 65% feature phones and 5% smart phones. mHealth is a technology that helps people to access healthcare with the use of mobile phones. mHealth itself does not guarantee quality healthcare, but it assists. There is now a framework for developing mHealth, which can help with patient registration, assessment, patient monitoring and work planning. For technologies like mHealth to be helpful, they must be kept simple, designed with end users in mind and invest in evaluation and capacity building.

At the recent meeting in Ghana (CPHS, 2014), Peter Benjamin from mHealth Alliance reported on several mHealth-based initiatives, including MAMA (in Bangladesh, India, South Africa and other African Countries), mPedigree and "SMS FOR LIFE" – the latter being used to report on the amount of stock in the country, which is especially used in Tanzania. mCare initiative is used in the delivery of ante-natal and post natal care. "mHealth evidence.org" is the website that serves as a registry for mHealth initiatives. mHelp Expert Program supports NGO's, with more than 50 experts in mHealth available to support countries and NGO's. The success of mHealth is expected to be readily demonstrated through the implementation of "Saving million lives" programme in Nigeria (World Bank, 2015). It is also reported that there had been a significant improvement of antenatal care in South Africa (CPHS, 2014).

mHealth is still in a relatively early phase, but it is already beginning to transform health systems, with concrete benefits. For maximum impact, mHealth solutions should be holistic,

integrating multiple health system functions. Their success will depend on a harmonized mHealth agenda and close partnership between multiple national stakeholders. With regards to use of mobile phones and laptops to provide health care, the question of power (or electricity) supply is often raised. The more recent devices can be designed to run on solar energy and can operate while offline until connectivity with telecommunication provider is initiated. It is noted that all these technologies should be designed in a way that makes them compatible with others, so we don't end up having too many platforms and to also enable them to expand outward. As innovative mHealth-based programmes mature, more attention must be paid to country's ability to plan for programming at scale, including adapting and managing mHealth systems independently. Of particular importance are non-traditional skill sets, such as system administrators, computer programmers and programme managers, and ensuring that Ministry of Health can retain skilled staff with these qualifications.

New and innovative methods for reporting and supervision are currently being tested, including the use of cost-effective interactive and innovative channels for online engagement. At the Ghana meeting, Nick Oliphant from UNICEF, New York, presented on the ways to improve CHW motivation and retention through innovative and entrepreneurial models. Several challenges remain, where innovations could make a difference. There is a need to identify best practices and innovative solutions to CHW motivation, supportive supervision of CHWs and CHW performance. Theoretical framework for inSCALE mHealth innovation, which is being implemented in Uganda and Mozambique (**CPHS, 2014; Kallander, 2015** - see later), identifies the following drivers of performance: (i) standing, status, identity and value (in the community); (ii) support and supervision: from supervisor and community itself; (iii) connectedness to community and health system. Through provision of affordable mobile phones and solar chargers, four main packages are provided: (i) data submission and instant feedback based on personalized submission; (ii) alerts to supervisor triggered by data; (iii) closed user group for supervision and peer support: options to call, talk for free, to supervisors on various issues; and (iv) monthly motivational SMS, which is automated and personalized.

Innovations that facilitate community-based programming should also consider including Rapid Diagnostic Test (RDTs) and mobile technologies. Innovations could help CHW to diagnose pneumonia, and the tools are close to becoming available through mobile phone apps.

In terms of new models of service delivery, multi-sectoral partnerships and integrated innovation improves chances of sale and reach of iCCM. The concept of developing value chains instead of just supply chains alone should be tested. To address issues of affordability in remote rural areas, some level of government subsidy is likely to be required.

Follow up and change management is critical during initial implementation and scale up of new supply chain practices. Best practices from other areas of health care management, such as quality improvement approaches, can be successfully implemented at the community level. However, these innovations will require support, monitoring and possibly adaptation so that they are tailored to suit the community level and its unique supply chain challenges. Designing tools and processes for the community level is often an iterative process – especially when implementing a proven best practice from higher levels; it can work but may require adaptability and flexibility to make appropriate for the community level (**CPHS, 2014**).

In the remaining part of this section, we will review the proposed ideas related to innovations in five different aspects of IMCI: (i) provision of training; (ii) sustaining quality improvements; (iii) reducing cost of implementation; (iv) market-related improvements; and (v) planning, monitoring and evaluating IMCI programmes.

3.1. Innovations in provision of training

Källander et al. (2015) stated that properly trained, equipped and utilised, community health workers (CHWs) delivering iCCM can potentially reduce child deaths by 60%. Their study focused on maintenance of CHW's motivation and performance. They reported on cluster randomised controlled trial - the inSCALE project - which evaluated the interventions to increase CHW supervision and performance. The outcome of interest was the achieved coverage of appropriate treatment for children with diarrhoea, pneumonia and malaria, with participatory methods used to identify best practices and innovative solutions. Following formative research and stakeholder consultations, two intervention packages were developed in Uganda and one in Mozambique. In Uganda, approximately 3,500 CHWs in 39 clusters were randomised into: (i) a mobile health (mHealth) arm; (ii) a participatory community engagement arm; and (iii) a control arm. In Mozambique, 275 CHWs in 12 clusters were randomised into: (i) a mHealth arm and (ii) a control arm.

Innovative interventions based on mHealth had three components: (i) free phone communication between users; (ii) data submission using phones with automated feedback, messages to supervisors for targeted supervision, and online data access for district statisticians; and (iii) motivational messages. The community engagement arm in Uganda established village health clubs seeking to (i) improve the status and standing of CHWs, (ii) increase demand for health services and (iii) communicate that CHWs' work is important. Process evaluation was conducted after 10 months (with end-line surveys planned at month 12 in Uganda and month 18 months in Mozambique). Main outcomes included the proportion of sick children appropriately treated, CHW performance and motivation, and cost effectiveness of interventions. The results are still being awaited. The strength of the proposed design and protocol includes a user-centred approach to the innovations. Weaknesses include the lack of a robust measurement of coverage of appropriate treatment. Evidence of cost-effective innovations that increase motivation and performance of CHWs can potentially increase sustainable coverage of iCCM at scale.

Awoonor-Williams et al. (2013) reported on the highly successful community health program developed during the 1990s by researchers at the Navrongo Health Research Centre in northern Ghana. The keystone of their approach was the deployment of nurses - termed "community health officers" - to village locations. Their trial showed that the approach reduced child mortality by half, maternal mortality by 40%, and fertility by nearly a birth - from a total fertility rate of 5.5 in only five years. These results are based on comparisons to areas that relied on existing services alone. As a result, the government of Ghana launched a national program in 2000, called "Community-based Health Planning and Services (CHPS)", aiming to scale up the Navrongo model. The new Ghana Essential Health Intervention Project (GEHIP) now aims to improve the CHPS model through further innovations, which include: (i) extending the range and quality of services for newborns; (ii) training community volunteers to conduct the World Health Organization service regimen known as integrated management of childhood illness (IMCI); (iii) simplifying the collection of health

management information and ensuring its use for decision making; (iv) enabling community health nurses to manage emergencies, particularly obstetric complications and refer cases without delay; (v) adding \$0.85 per capita annually to district budgets and marshalling grassroots political commitment to financing CHPS implementation; and (vi) strengthening CHPS leadership at all levels of the system.

3.2. Innovations in sustaining quality improvements

Daniels et al. (2015) noted that, within the integrated community case management of childhood illnesses (iCCM) programme, the traditional health promotion and prevention role of community health workers (CHWs) has been expanded to treatment. Their qualitative case study explored the implementation experience in Ghana. They used focus groups and individual interviews in Accra and the Northern Region of Ghana, and included locally based UNICEF staff, their partners, researchers, Ghana health services management staff, CHWs and their supervisors, nurses in health facilities and mothers receiving the service. They noted an appreciation both by mothers and by facility level staff for the contribution of CHWs, which saves mothers from the effort and expense of seeking treatment outside of the village. Concerns included CHWs being unpaid, poorly supervised, regularly out of stock, lacking in essential equipment and remaining outside the formal health system. They concluded that there is a need to develop innovative and sustainable mechanisms to sustain the programme.

Similarly, **Magge et al. (2015)** suggested that impact of IMCI is threatened by gaps in quality of care (QOC). They report on an innovative nurse mentorship intervention - "Mentoring and Enhanced Supervision at Health Centres" (MESH) - in two rural districts of Rwanda, which was started in 2010 by Partners In Health and the Rwanda Ministry of Health. The authors measured change in QOC following the addition of MESH to didactic training after 12 months in 21 rural health centres in Rwanda. Primary outcome of their analysis was a validated index of key IMCI assessments. They found that the index significantly improved in two districts and that children seen by IMCI-trained nurses increased from 83.2% to 100%, while the use of IMCI case recording forms improved from 65.9% to 97.1%. Correct classification improved from 56.0% to 91.5%, and correct treatment from 78.3% to 98.2%. They concluded that MESH was associated with significant improvements in all domains of IMCI quality and that it could be an innovative strategy to improve IMCI implementation in resource-limited settings.

3.3. Innovations to reduce cost of implementation of protocols

Rodriguez et al. (2015) explored critical issues in implementation of IMCI that arose during policy formulation through the lens of the innovation (i.e. iCCM) and of the institutions involved in the policy process in Malawi. They conducted a documentary review and 21 in-depth stakeholder interviews across institutions in Malawi. Their findings suggested several strategies that helped reduce the cost of implementation of protocols. Firstly, iCCM was compatible with the Malawian health system due to the ability to build on an existing community health worker cadre of health surveillance assistants (HSAs) and previous experiences with treatment provision at the community level. The Ministry of Health (MoH)

demonstrated leadership, while the WHO, United Nations Children's Fund (UNICEF) and implementing organizations played a supportive role as knowledge brokers. Regulatory issues around HSA training as well as concerns around supervision and overburdening of HSAs were discussed during policy development. The analysis concluded that the financial sustainability of iCCM, including the mechanisms for channelling funding flows to allow implementation, is a major challenge that remains unresolved and that it deserves focus as an area where innovative approaches would be welcome.

Another important evidence with implications for reduction of the costs of implementation of protocols was presented by **Oliphant et al. (2014)**, who conducted multi-country analysis of routine data from integrated community case management (iCCM) programs in sub-Saharan Africa (SSA). They examined 15 evaluations or studies of iCCM programs in SSA conducted between 2008 and 2013. They found that the median percent of annual expected cases treated was 27% (1-74%) for total iCCM, 37% (1-80%) for malaria, 155% (7-552%) for pneumonia, and 27% (1-74%) for diarrhoea. Importantly, they found that treatment rates and percent of annual expected cases treated were equivalent between programs with volunteer CHWs and programs with salaried CHWs. They concluded that programs with volunteer CHWs and those with salaried CHWs can achieve similar treatment rates and percent of annual expected cases treated, but to reach this equality in outcomes volunteer programs must manage more CHWs per population, while salaried CHWs must provide more treatments per CHW per month.

3.4. Which innovations both in the market and close to market could make a difference to integrated treatment of children and neonates?

Chandani et al. (2014) reviewed the evidence for improving community health supply chains from Ethiopia, Malawi, and Rwanda. Drug shortages are a common bottleneck to scaling up integrated community case management (iCCM), but little thought has gone into the design of supply chains. The Supply Chain for Community Case Management (SC4CCM) project conducts intervention research to identify proven, simple and affordable solutions to address the unique supply chain challenges faced by CHWs. Interventions based on Theory of Change (TOC) framework were developed in each country and tested over 12-24 months, with an assessment in 2012-2013. The project then simplified the TOC into a Community Health Supply Chain (CHSC) framework to enable cross-country analysis. The authors concluded that the greatest supply chain benefits are realized when all three CHSC framework elements (data flow, product flow, and effective people) are in place and working together. The synergistic effect of these three elements results in lower mean stock out rates and higher in stock rates on day of visit, when compared to other interventions. Although these three elements may be designed differently in different settings, streamlining and synchronizing them while ensuring inclusion of all components for each element improves supply chain performance and promotes product availability at the community level.

In relation to innovative use of mHealth applications for supply chain management, two further widely used initiatives need to be mentioned: mTrac (applied in Uganda and Zambia) and c-Stock (applied in Malawi). At the meeting on iCCM in Ghana (**CPHS, 2014**), Dr. Davis Musinguzi presented mTrac, a tool funded by DFID, which serves to use mobile phones and real time information for iCCM programming. He noticed that, in Uganda, people have to jump on motorbikes moving from one place to the other in search of drugs. There was

also huge pile of unusable data in the form of papers and files in health centres. The use of mTrac helped with data collection and usage. CHWs could use their own phones to access information about drugs. This tool was also made available on laptops, which were distributed to district health teams. mTrac is based on information about drugs which is available from health centres. This information is sent to CHW phone and it can be viewed on a dashboard. District dashboard is easy to use and allows for data analysis. It helps to immediately stock supply for community health workers. The mTrac begun with 10 CHW on phase one and increase later. It receives data from 3 sources - CHWs, community members, and health facilities. Some challenges are that storage and caring solutions for tools and commodities aren't flexible enough, and that data currently generated by CHWs and other actors in the system is not consistent, and it seldom turns into useful information. Up to 10,000 CHWs have now been trained in mHealth, with 70% reporting rates.

c-Stock is a RapidSMS, open-source, web-based logistics management information system for community-level health products in Malawi (CCM, FP and HIV testing). CHWs or Health Surveillance Assistants as they're called in Malawi (HSA), use their personal basic GSM phones to report stock on hand and receipts data via SMS on a toll free phone line. cStock calculates resupply quantities for health centers and HSAs receive a message notifying them either "order ready" or "out of stock" so they know when to pick their products at the health center. A web-accessible dashboard with simple, easy-to-use reports, shows stock levels, reporting rates, and alerts for central and district level managers. Data is hosted on the cloud, an inexpensive, reliable, and easy to manage option for a small scale system. cStock is currently being scaled up nationwide in Malawi (CPHS, 2014).

At the recent meeting on iCCM in Ghana (CPHS, 2014), Dr Humphreys Nsona presented an overview of c-Stock implementation experience in Malawi. CCM in Malawi is run and managed by CHWs called "Health Surveillance Assistants" (HSAs). c-Stock was introduced to address the frequent problems of unavailability of medicines, irrational drug management process and lack of coordination in drug management. A 2010 baseline assessment showed that product availability was hampered by poor use of community level data. The Enhanced Management approach (EM) was introduced to improve the community level supply chain, and it contained the mHealth system called c-Stock, which addressed data visibility challenges. Within this system, HSAs reported logistics data monthly via SMS with their personal phones. The system calculated resupply quantities and notified the HSA when to pick up products. The second part of EM approach are District Product Availability Teams (DPATs). These teams are made up of HSAs and district staff who set combined performance goals, use a structure approach for problem solving, and recognize improvements in performance. Evaluation results of the EM programme showed that HSAs using cStock and DPATs had 14% fewer stock outs or low stocks than other districts on day of visit, and that more than 80% of HSAs reported logistics data to c-Stock every month. The data provided by HSAs is being used by drug stores to inform resupply quantities and by HSA supervisors to monitor performance. cStock and DPATs are now being scaled up country-wide, with committed funding for all 29 districts. The example of c-Stock and DPATs implementation showed that a clear Ministry of Health leadership and engagement of partners from the beginning was the key to building of broad ownership, and that mHealth systems need to be kept simple and suitable for the context. It also emerged that "cloud hosting" is cheap, reliable and easy to manage for small-scale systems. EM is now seen as a promising and acceptable intervention for improving medicines availability at the community level.

Ginsburg et al. (2015) presented "mPneumonia" - an innovative mHealth application for diagnosing and treating childhood pneumonia (and other childhood illnesses) in low-resource

settings. They started from the premise that the current approach for pneumonia diagnosis in low-resource settings - using the World Health Organization Integrated Management of Childhood Illness (IMCI) paper-based protocols (and relying on a health care provider's ability to manually count respiratory rate) has proven inadequate. Furthermore, hypoxemia - a diagnostic indicator of the presence and severity of pneumonia often associated with an increased risk of death - is not assessed because pulse oxymetry is frequently not available in low-resource settings. PATH collaborated with the University of Washington to develop "mPneumonia" - an innovative mobile health application using an Android tablet. "mPneumonia" integrates a digital version of the IMCI algorithm with a software-based breath counter and a pediatric pulse oximeter. A design-stage usability field test has already been carried out in Ghana, aiming to improve diagnostic accuracy and facilitate adherence to established guidelines.

At the iCCM meeting in Ghana (CPHS, 2014), P. Anderson presented the initiative called "Living goods", which is a private sector model for making healthcare accessible. Living goods initiative is committed to increasing coverage (but not to improving equity). It operates by relying on service charges and sometimes even incorporates CHWs into their system by using them to supply medications. Private sector initiatives like "Living Goods" helps to free up the burden on public sector to focus on vital cases. It adopts the public sector delivery model by lowering cost through technology. Living Goods model is user centred; it designs systems based on the end users, to put community health workers at the centre, and it is meant to support CHW. In terms of challenges, transportation is important (how to carry medicine around if roads are bad), and there is no specific structure of CHWs workforce - just conventional growth. Issues of conflict of interest were often raised, especially in the case of public and private sector health care delivery systems operating side by side. There was concern with private models like Living Goods that CHWs could feel tempted to sell free public drugs as that of private organizations, but "Living Goods" claim that they ensure this does not happen by making their drugs different from that of public health systems. Most of the profit for "Living Goods" is expected to come from durables sold, and not from the drugs, since the initiative prioritizes provision of affordable drugs. The current model could also work if the treatments were given free and the other goods were sold, or if they provided vouchers to poorer people to obtain the goods. Some of "Living Goods" products include the following, which they sell to CHWs or end users: ORS, ACT's, Amoxicillin, Deworming, etc. (for treatment); fortified foods, micronutrients, safe delivery kits, contraceptives, etc. (for prevention); and e.g., solar lamps, clean cook stoves, consumer goods, etc. (as pro-poor durables).

There are two other private sector models of iCCM that are being used or tested that deserve mention here: Accredited Drug Dispensing Outlets (ADDO) in Tanzania and Drug Shop Attendants in Uganda. ADDO is a donor-supported initiative led by the Tanzanian Food and Drug Authority to train and license small, privately operated retail outlets in rural and poor areas to sell a set list of essential medicines, including selected prescription drugs (**Health Market Innovations, 2016**). Since pharmacies are located almost exclusively in major urban areas (60% in Dar es Salaam alone), small drug shops mandated to sell non-prescription medication are often the most convenient retail outlet from which to buy medicines for the approximately 75% of the population that lives in rural and peri-urban communities. Thus, the goal of the ADDO Program is to better equip such shops to provide affordable, quality medicines and pharmaceutical services in rural and periurban areas of the country. The initiative employs a holistic approach to change the behavior and expectations of individuals who buy from, own, regulate, or work in retail drug shops. For shop owners and dispensing staff, this approach was achieved by combining training, incentives, consumer pressure, and

regulatory pressure with efforts to affect client demand for and expectations of quality products and services. Key program components include: (i) broad-based stakeholder support; (ii) provider accreditation program; (iii) provider training and consumer awareness; and (iv) monitoring and evaluation. The ADDO program is being expanded throughout Tanzania and its rollout is co-funded by USAID, DANIDA and the Government of Tanzania.

Awor et al. (2015) reported on the programme of "Drug Shop Attendants" in Uganda. They evaluated drug seller adherence to clinical protocols with integrated management of malaria, pneumonia and diarrhoea at drug shops in Uganda, because drug shops are usually the first source of care for febrile children - although the quality of care they provide is known to be poor. The authors used a quasi-experimental study introducing the WHO/UNICEF recommended integrated community case management (iCCM) of malaria, pneumonia and diarrhoea intervention for community health workers in registered drug shops. They were interested in the level of adherence to clinical protocols by drug sellers. The intervention area included 44 drug shops with more than 7,000 child visits. Drug shops maintained a standard iCCM register where they recorded the children seen, their symptoms, diagnosis and treatment. The analysis showed that more than 90% of the children with dual or triple diagnosis were treated appropriately. Meanwhile, 81.1% of children who were categorized as severely sick (with a danger sign) were referred for appropriate management. The authors concluded that, with the introduction of the iCCM intervention at drug shops in Eastern Uganda, it was possible to achieve high adherence to the treatment protocols, which is likely compatible with increased quality of care.

3.5. Innovations in planning, monitoring and evaluating IMCI programmes.

In the 21st century, science is increasingly based on combining massive amount of information ("big data" approach), powerful computation using IT, and sophisticated statistical prediction modelling. Given that powerful computers and sophisticated prediction models are available to most research groups interested in "big data"-based research, the success of any innovations in IMCI that will rely on large amount of collected information will depend on the amount and quality of information collected, its informativeness and standardized nature.

This generates an increasing need for transparent, fair, replicable and coordinated processes and tools that could be used to gather and analyse useful data on IMCI and advance implementation research. The key challenges are setting investment priorities to support and enhance IMCI in countries, monitoring the distribution of funding in real time, and evaluating the impact of these investments. Currently, policy-makers have access to two types of information to assist with these three tasks. The first type is rooted in epidemiology and focuses on understanding the present burden of disease and the reduction in that burden (i.e. morbidity and mortality) that a project or policy could achieve. Most recently, the "*lives saved*" terminology has been adopted by agencies such as the Global Fund and used to drive evidence-based health policy (**Low-Beer et al., 2013**). The second type of available information is economic and focuses largely on cost-effectiveness. Policy makers at the national and sub-national level have limited resources for scaling up cost-effective health interventions in their populations (**Chopra et al., 2012**). When planning the "*best buys*" for committing their resources in maternal and child health, they are faced with a complex task. They need to choose among at least several dozen interventions that target various diseases

and vulnerable populations and decide on the most rational way to invest in the scale up of selected health interventions. Health investors usually like to know how many deaths (or episodes of disease) could be averted for a fixed level of investment. This type of analysis has been promoted by the **World Bank (1993)**, the **Commission on Macroeconomics and Health (2001)** and the recent report "*Global Health 2035*" (**Jamison et al., 2013**).

We attempt to overcome these problems by proposing a novel approach to planning, monitoring and evaluation of IMCI implementation - the "PLANET tool" - which could assist in generating large amount of standardized information relevant to IMCI and iCCM implementation programs.

3.5.1. Proposing PLANET tool

We present a new methodology called PLANET (PLANning, monitoring and Evaluation Tool) that could be used to improve information on the delivery and implementation of IMCI. Fundamentally, PLANET is based on a combination of two useful procedures: (i) the reduction of the multi-dimensional space of a complex system to a smaller number of core variables that capture most of the variation (e.g. using a statistical procedure known as "*principal component analysis*"); and (ii) the use of collective knowledge for decision-making (**Surowiecki, 2004; Rudan, 2008**). Our approach brings transparency, inclusiveness, fairness and replicability to the process.

Principal component analysis is a statistical technique which reduces a very complex system of large number of variables to a small number of relatively independent "*principal components*" which still capture a sizeable proportion of variation in the system (**Rudan, 2008**); by defining a set of 15 "*criteria*". Through this the PLANET process effectively reduces a notoriously complex and multi-dimensional task, which could be approached through an almost infinite number of "*lenses*", into an exercise in which 15 of the most important (and reasonably independent) criteria for priority setting are clearly defined. If necessary these can later be weighted according to their relative importance to the users.

Collective knowledge has been increasingly recognized as a way to address these types of challenges (**Surowiecki, 2004; Rudan, 2008**). Collective knowledge and crowdsourcing refer to the process of taking into account the collective input of a group of individuals rather than of a single expert (or small number of experts) to answer a question. This is based on the observation that the average of collective judgments is closer to the truth than any single expert judgment in most circumstances. The pre-requisites for this process to work are: (i) *diversity of opinion* (each person should have private information even if it is just an eccentric interpretation of the known facts); (ii) *independence* (people's opinions are not determined by the opinions of those around them); (iii) *decentralization* (people are able to specialize and draw on local knowledge); and (iv) *aggregation* (some mechanism exists for turning private judgments into a collective decision – in this case, the PLANET method) (**Surowiecki, 2004**). Once each individual is given an opportunity to express their opinion in a way that is treated equally with respect to the opinion of any other individual, then the personal biases that those individuals bring into the process tend to cancel and dilute each other regardless of who the participants are. What is left is information based on the accumulated knowledge, lifetime experience and common sense of those who took part. This collective knowledge illustrates that disagreement and contest, rather than consensus and compromise, among independent minds can lead to the best decisions (**Surowiecki, 2004**).

3.5.2. Conceptual framework

We conceptualize IMCI as a programme in which multiple stakeholders - mainly national governments - invest a finite sum of money each year into improving survival of children in low and middle-income countries. In this process, the funding can be thought of the “energy” or “resource” required to fill the gaps in IMCI provision and deployment, while all steps through which these funds need to be taken during this process can be seen as potentially retarding forces which may cause deviations from the most effective approach. These forces do not disappear even if more money is injected into the system. A problem is that, in reality, we neither have the detailed evidence nor the information required for the optimization of the process of IMCI in most settings, nor can we monitor and centrally coordinate the flows of funding.

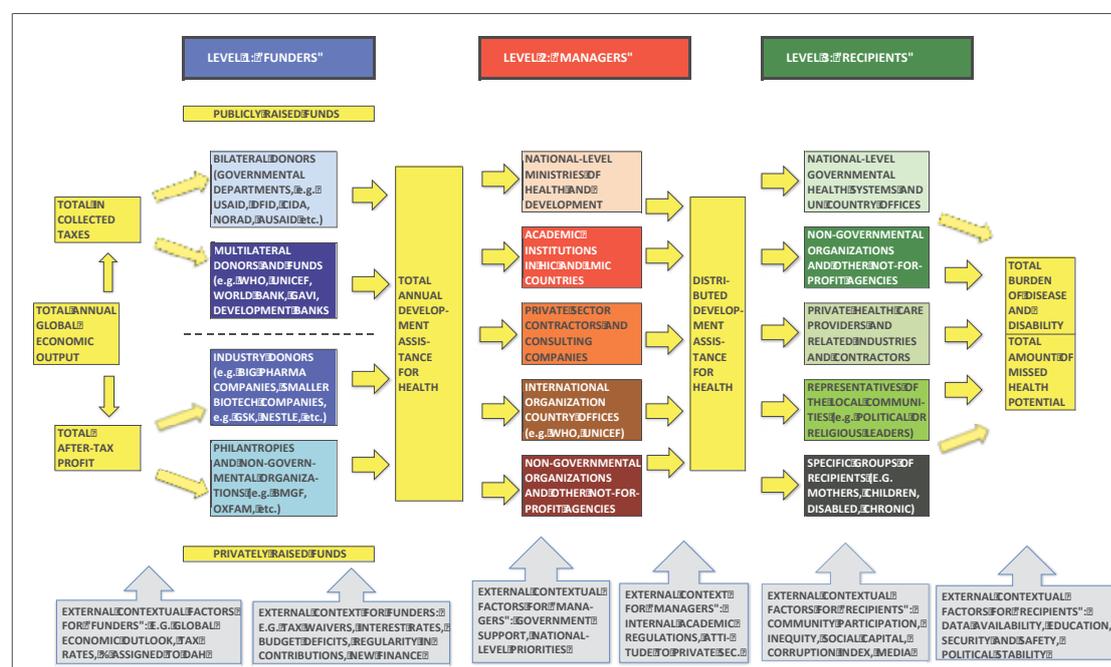
However, regardless of that, we can develop a conceptual framework that can systematically define all the fundamentally important retarding forces that are at work through this process, and try to assess, for each initiative (based on the collective knowledge of the persons most closely informed about each step in the process), how likely it is to complete its mission, and how vulnerable it is to retarding forces (see **Figure 3-1**).

Building on **McCoy et al. (2009)**, we identify three functions associated with IMCI and the associated stakeholders. The first function is labelled “*providing*” and is concerned with the need to raise or generate funds (the funders of IMCI). The second function is “*managing*” and is concerned with the management or pooling of those funds, as well as with mechanisms for channelling funds to recipients (the managers of IMCI). The third function is “*spending*” and is concerned with expenditure and consumption of those funds (the recipients of IMCI). It is worth noting that while this schematic establishes a clear time sequence of the key events in the IMCI process, several actors work across all three levels simultaneously. Nevertheless, similar to **McCoy et al. (2009)**, we believe that these categories provide a useful framework for studying the IMCI process from a financial perspective.

3.5.3. Funders of IMCI programs

The first level of stakeholders of interest are the funders of IMCI programs, referred to here as donors, which could include philanthropists, government or international organizations, and the investors from the private sector and industry. Donors have become increasingly aware of the importance of measuring success in terms of political sustainability but have not been in possession of a clear framework or technology to help them undertake this task effectively. Often their priority is on disbursing resources according to internal interests, or they find delivery data too difficult to collect accurately, or too politically sensitive (see **Figure 3-2**).

Figure 3-1: A summarized overview of the structure and some key determinants of function of an IMCI national programme.

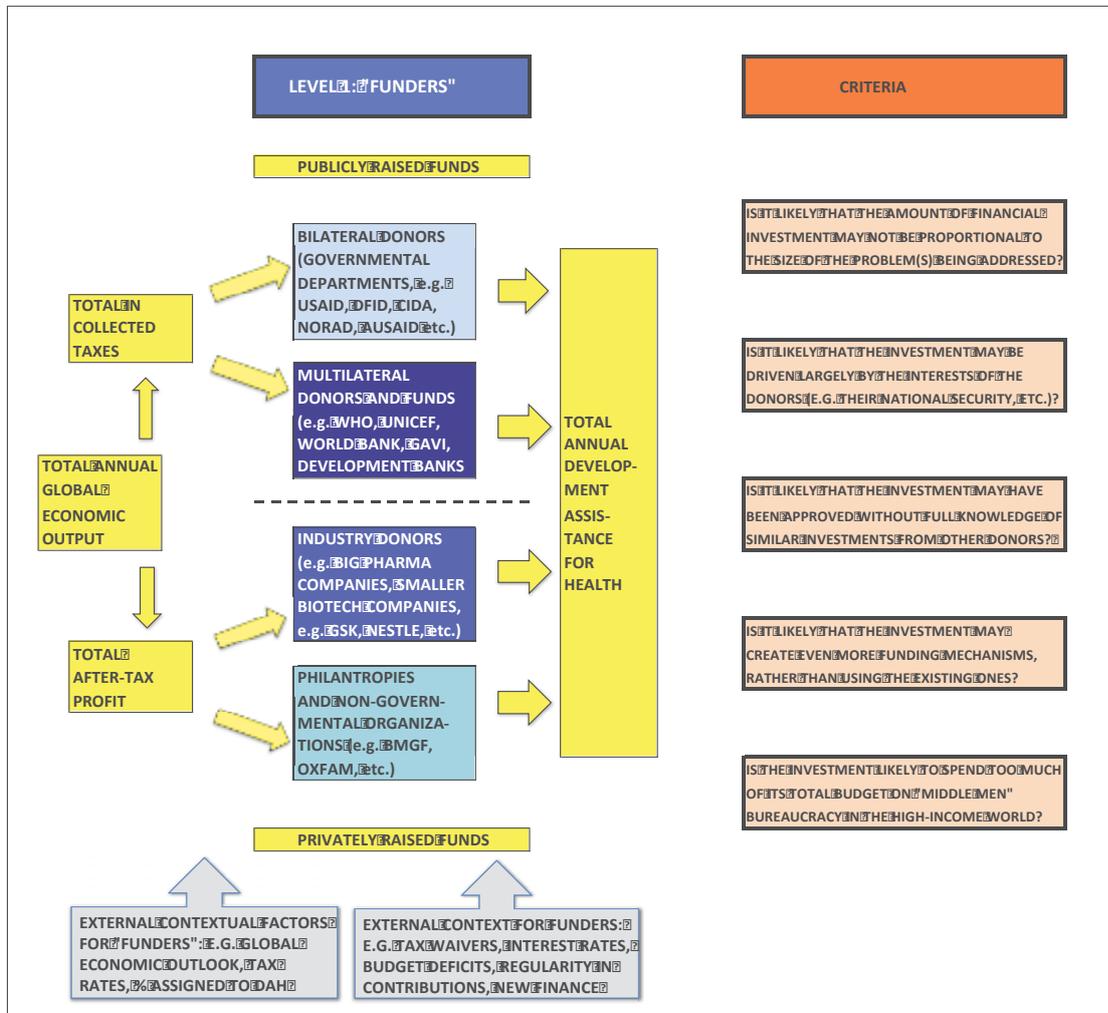


At the level of donors, several factors could hinder the effectiveness of investments. Firstly, donors could misalign the size of their support (financial commitment) with the size of the problem (burden of disease). An unprecedented amount of money is being pledged and used to fund health services throughout the world. However, several studies have shown that funding does not correspond closely to burden (IHME, 2012). For example, Shiffman (2006) demonstrates that within communicable diseases for the years 1996 to 2003, there were several neglected topics such as acute respiratory infections and malaria. Similarly, Sridhar & Batniji (2008) noted that in 2005, funding per death varied widely by disease area from US\$ 1029.10 for HIV/AIDS to US\$ 3.21 for non-communicable disease. The reasons for this misalignment could be due to the social construction of the problem, lobbying by vested interests or the personal interests of donors (Shiffman, 2009; Buse, 2014). Thus, the risk that the donors are misaligning their financial commitment to a disease area with the burden it causes needs to be assessed.

Second, donors could prioritize initiatives that focus on their national self-interest rather than those that support improved health in the recipient country. For example, since the Oslo Declaration in 2006, health and foreign policy have become increasingly linked. While translating health into national security language might attract attention from high levels of government, this focus has been limited to a few high-profile problems such as AIDS, pandemic influenza and humanitarian assistance and not expanded to less glamorous areas important to child survival such as health systems, malnutrition or water and sanitation. In fact a review of six countries' policies illustrates that most strategies tend to be catalyzed and supported by concern with surveillance and control of infectious disease (Sridhar and Smolina, 2012). Thus, the risk that an IMCI programme serves national self-interests, such

as economic, geopolitical or security, rather than improved health outcomes in the recipient country needs to be established.

Figure 3-2: The level of funders and key performance risks at this level



Third, donors could fail to coordinate their activities. The current architecture of funding of global health and development is characterized by fragmentation, lack of coordination and even confusion as a diverse array of well-funded and well-meaning initiatives which descend with good intentions on countries in the developing world (Gostin and Mok, 2009). However ambitious or well-intentioned these initiatives might be, it becomes difficult in this environment for recipient governments to develop and implement sound national plans for their country. While there is, in general, little incentive for various development partners to coordinate their activities, some programs work better through a joint strategy. Thus, the risk that partners will fail to coordinate their activities for a specific IMCI programme needs to be established.

Fourth, donors could invest in new players and models rather than strengthening and building on the existing institutional infrastructure. There has been a continuous expansion in the number as well as type of actors involved in national-level IMCI programmes. Instead of examining how the existing institutional infrastructure - specifically the WHO and World Bank - can be reformed to deliver on projects, new initiatives are launched that attempt to compensate for their shortcomings (**Garrett, 2007**). The WHO is unique in being governed by 193 member states and its role in setting evidence-based norms on technical and policy matters, highlighting best practices that improve health globally and monitoring and coordinating action. *Thus, the risk that an IMCI programme will result in a new institution rather than working through the existing institutional infrastructure needs to be established.*

Finally, donors could fund their initiatives in a way that results in too much funding going to more costly institutions. As **McCoy et al. (2009)** discuss, global health is a multi-billion dollar industry, and there are clearly competing interests amongst different actors to make use of this funding. For example, pharmaceutical companies appear to benefit considerably from global health programs that emphasize the delivery of medical commodities and treatments. NGOs, global health research institutions and UN bureaucracies also have an interest in increasing or maintaining their level of income and thus tend to prefer that funding from major donors flows through them (as managers of funding), rather than directly to developing countries. Further scrutiny is needed on aid flows in global health to assess whether they are being captured by vested interests and used to support inappropriate spending on the private commercial sector or on a large and costly global health bureaucracy and technocracy. *Thus, the risk that an IMCI programme will be designed in a way that results in too much funding going to costly organizations needs to be established.*

3.5.4. Managers of IMCI programmes

The second level of stakeholders in IMCI consists of the managers of the programmes. These could be national government ministries, NGOs, academic institutions in donor or recipient countries, private sector (with pharmaceutical companies and biotech industries), various private or not-for-profit independent consultants and country offices of international organizations. Managers are often torn between global priorities, specifically the priorities of donors, and being accountable to local communities and the ultimate recipients (see **Figure 3-3**).

At the middle level, several factors can hinder the effectiveness of investments. First, managers could deliberately steal resources from the investment for their own benefit, i.e. the risk of corruption. The need to identify and address corruption and weak governance is often lost in the commitment to raise funds and expand services. *Thus, the risk that funding from the programme will be stolen needs to be assessed.*

Second, managers could inadvertently channel resources to purposes other than IMCI programme objectives because of miscommunication, lack of competence, or lack of capacity. For example, those managing the project may not have the necessary technical or administrative skills to meet key objectives. *Thus, the risk that managers inadvertently channel resources to purposes other than IMCI programme objectives due to lack of competence needs to be assessed.*

Third, managers could lack credible information and evidence to maximize the cost-effectiveness of investments. The basis of cost-effectiveness is that interventions should not

only have established effectiveness in reducing child mortality but also represent an effective use of resources. For a certain budget, population health would then be maximized through choosing interventions that show the best value for money. Most information about cost-effectiveness, such as that generated through the WHO-CHOICE project, are available at the regional level (WHO, 2014). This creates challenges when applying these estimates to country and district level projects. *Thus, the risk that managers lack good information on the cost-effectiveness of investments needs to be assessed.*

Fourth, managers could route funding through non-governmental organizations or private sector bodies rather than working through governments. In the past two decades there has been a move towards funding non-state actors, especially by the newer funding institutions (Gostin and Mok, 2009). The US government, particularly through its HIV/AIDS funding, predominantly funds faith-based organizations and NGOs. Lack of involvement and leadership of developing country governments in IMCI programmes raises questions about their long-term sustainability (WHO, 2007). However, in some situations funding through NGOs or private sector bodies rather than through governments can work better but this should be carefully considered over a long term time horizon. *Therefore, the risk that an IMCI programme routes funding through nongovernmental organizations or private sector bodies rather than through government needs to be assessed.*

Fifth, managers could exclude the participation of local experts and the inclusion of local evidence in the processes of priority setting. Managers face strong incentives to orient 'upwards' towards the donors that are funding the IMCI programme (Sridhar, 2010). They have little incentive to include local experts and local knowledge. *Thus the risk that local experts and local evidence are excluded in the processes of priority setting needs to be assessed.*

The above are the first ten PLANET criteria to evaluate an IMCI programme. The informants for these aspects would include policy-makers in various global health institutions as well as health economic, governance and health systems experts (see **Box 1**).

3.5.5. Recipients of IMCI programmes

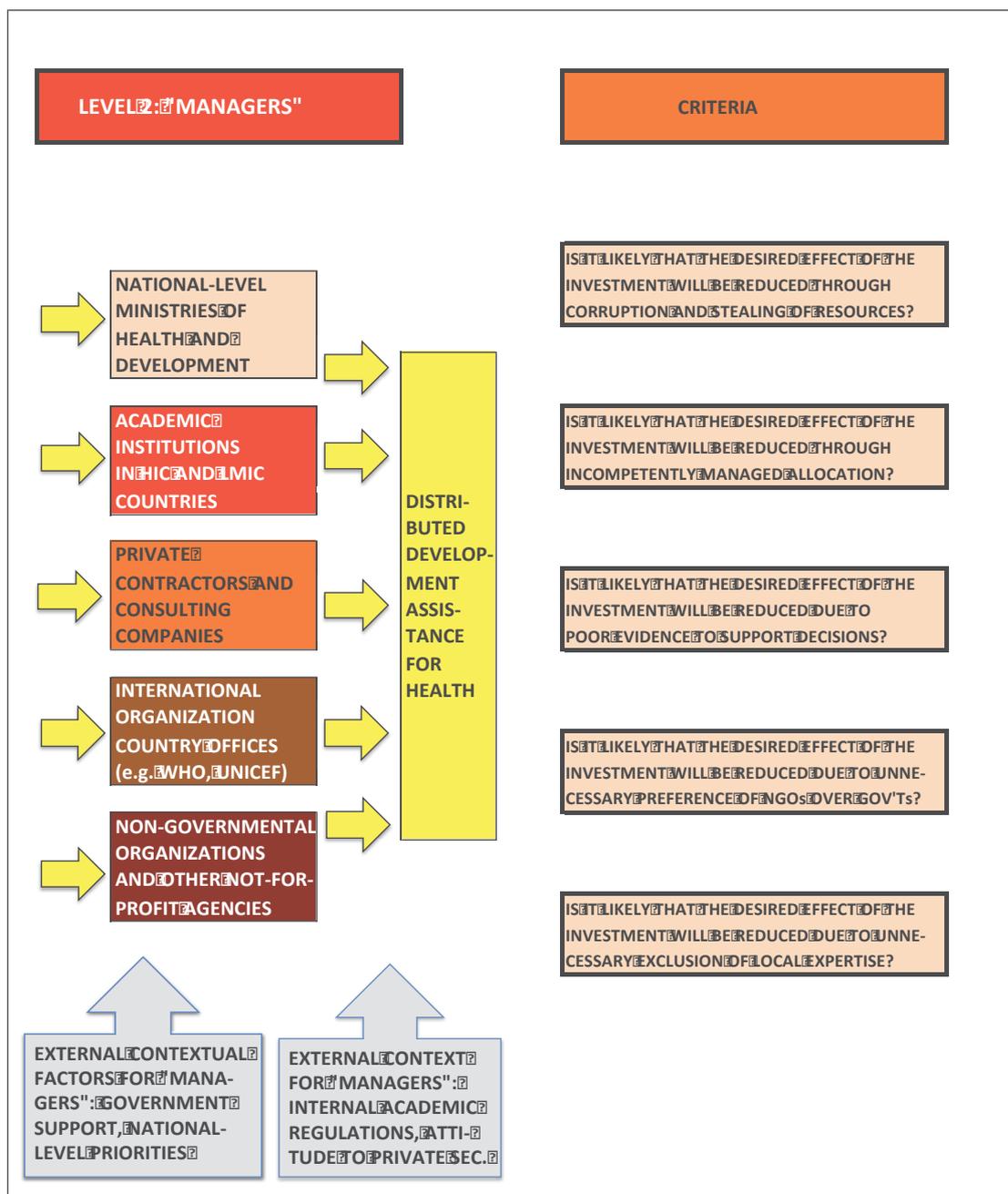
The third level of stakeholders includes all those involved in the final stage of IMCI, i.e. reaching the recipients. This may involve government health systems, NGOs, private healthcare providers, local community representatives, and recipient groups (e.g. mothers and children) themselves, including the operational workforce. At this level, several factors could hinder the effectiveness of investments (see **Figure 3-4**).

First, the primary recipient could deliberately steal funding or commodities from this process for his/her own benefit. Numerous studies have documented such problems, for example, in the procurement of health supplies, in under-the-table payments for services, and in nurses and doctors who fail to show up at their clinics but nonetheless collect their salaries (Lewis, 2006). *Thus, the risk that funding from the project will be stolen needs to be assessed.*

Second, the recipient could set up unnecessary parallel structures to deliver on the project rather than working through government or "horizontally". Horizontal interventions are defined as those that strengthen the health care system, improve health systems service and delivery, and address general non-disease specific problems such as health worker shortages and stock outs of medicines and supplies. Despite the consensus that IMCI should be funded

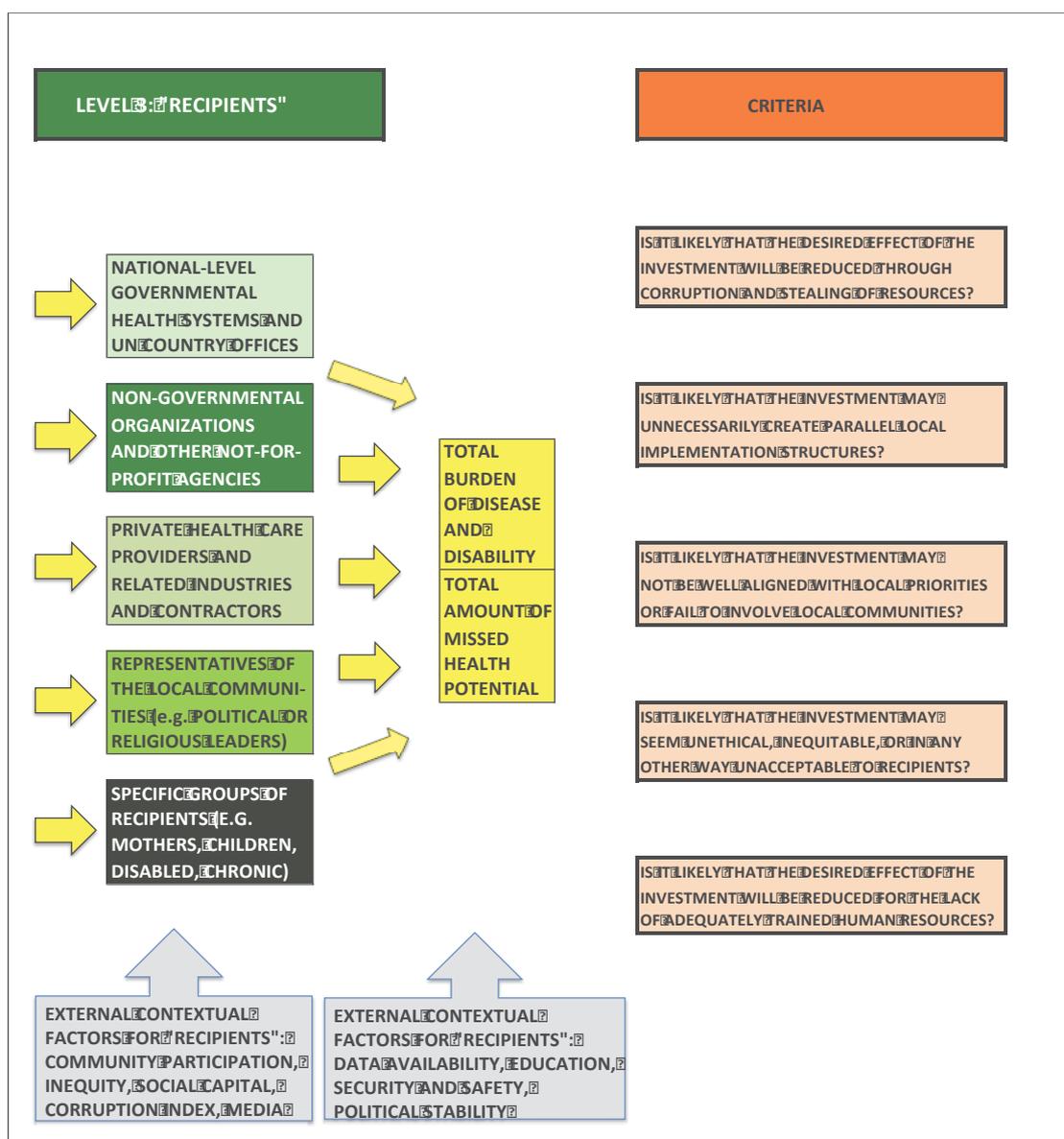
and organized horizontally, some financing may be channelled vertically (defined as setting up separate systems to deliver on the objectives often related to specific diseases). In recent years much of the funding has been directed to address HIV/AIDS, malaria and TB. The imperative to show measurable results in a short-time frame results in setting in place short-term fixes that deliver on the project with the problem that relatively little funding may go towards capacity-building or working through government. *Thus the risk that an IMCI programme will result in unjustified parallel local implementation structures rather than work through the existing health system needs to be assessed.*

Figure 3-3: The level of managers and key performance risks at this level



Third, the IMCI programme may not be aligned with local priorities or promote community involvement. The choice of an IMCI programme as a priority over other possible investments in population health directly affects recipients' health, meaning that these individuals should also have the right to participate in deciding on the priorities and implementation of the project. If this participation is to be meaningful nationally (or locally), then the results of the participation must have the possibility of having an impact, in this case, of affecting the nature of the project. *Thus the risk that the IMCI programme will not be aligned with local priorities or promote community involvement needs to be assessed.*

Figure 3-4: The level of recipients and key performance risks at this level



Fourth, some elements of the IMCI programme could be seen as unethical, inequitable or unacceptable to the final recipients. In recent years policy-makers have increasingly become aware of the disparities in health status between different groups in society and the distributional impact of interventions (**Commission on Social Determinants of Health, 2008**). In particular, concern focuses on the extent to which interventions reach and benefit disadvantaged groups, such as the poor, women or certain ethnicities or otherwise marginalized populations. *Thus, the risk that the IMCI programme is not ethical, equitable or acceptable to the final beneficiaries needs to be assessed.*

Finally, the IMCI programme may not be sustainable, defined in terms of ensuring required human resource capacity to deliver on targets and objectives. It is increasingly recognized that the success of local implementation is highly dependent on a strong health workforce (**Chen et al., 2004**). It is people who prevent disease and administer cures. *Thus the risk that the IMCI programme will lack the requisite human resources, such as trained health workers, needs to be assessed.*

The informants reporting of these final 5 criteria could be representatives of operations workforce and / or the ultimate recipients. The above factors can be used as the 15 criteria to plan an IMCI programme at the inception stage, to monitor its implementation in real-time, and/or to evaluate previously conducted efforts. The resulting questions that could be asked of key informants are provided in **Table 25-1**.

Table 3-1: Questionnaire for implementation of PLANET tool.

	Planning	Monitoring	Evaluating
Level 1: Donors	1. Is it likely that the amount of financial investment may not be proportional to the size of the problem(s) being addressed? 2. Is it likely that the investment may be driven largely by the interests of the donors? 3. Is it likely that the investment may have been approved without full recognition of similar investments from other donors? 4. Is it likely that investment may create even more funding	1. Is the amount of financial investment disproportional to the size of the problem(s) being addressed? 2. Is the investment driven largely by the interests of the donors? 3. Is the investment being implemented without full recognition of similar investments from other donors? 4. Is the investment creating even more funding mechanisms rather than using existing ones? 5. Is the investment	1. Was the amount of financial investment disproportional to the size of the problem(s) being addressed? 2. Was the investment driven largely by the interests of the donors? 3. Was the investment approved without full recognition of similar investments from other donors? 4. Did the investment create even more funding mechanisms rather than using existing ones?

	<p>mechanisms rather than using existing ones?</p> <p>5. Is the investment likely to spend too much of its total budget on costly "middle men" organizations?</p>	<p>spending too much of its total budget on costly "middle men" organizations?</p>	<p>5. Did the investment spend too much of its total budget on costly "middle men" organizations?</p>
Level 2: Managers	<p>1. Is it likely that the desired effect of the investment will be reduced through corruption and stealing of resources?</p> <p>2. Is it likely that the desired effect of the investment will be reduced through incompetently managed allocation?</p> <p>3. Is it likely that the desired effect of the investment will be reduced due to poor evidence to support decisions?</p> <p>4. Is it likely that the desired effect of the investment will be reduced due to unnecessary preference for NGOs over government?</p> <p>5. Is it likely that the desired effect of the investment will be reduced due to unnecessary exclusion of local expertise?</p>	<p>1. Is the desired effect of the investment being reduced through corruption and stealing of resources?</p> <p>2. Is the desired effect of the investment being reduced through incompetently managed allocation?</p> <p>3. Is the desired effect of the investment being reduced due to poor evidence to support decisions?</p> <p>4. Is the desired effect of the investment being reduced due to unnecessary preference for NGOs over government?</p> <p>5. Is the desired effect of the investment being reduced due to unnecessary exclusion of local expertise?</p>	<p>1. Was the desired effect of the investment reduced through corruption and stealing of resources?</p> <p>2. Was the desired effect of the investment reduced through incompetently managed allocation?</p> <p>3. Was the desired effect of the investment reduced due to poor evidence to support decisions?</p> <p>4. Was the desired effect of the investment reduced due to unnecessary preference for NGOs over government?</p> <p>5. Was the desired effect of the investment reduced due to unnecessary exclusion of local expertise?</p>
Level 3: Recipients	<p>1. Is it likely that the desired effect of the investment will be reduced through corruption and stealing of resources?</p>	<p>1. Is the desired effect of the investment being reduced through corruption and stealing of resources?</p> <p>2. Is the investment</p>	<p>1. Was the desired effect of the investment reduced through corruption and stealing of resources?</p>

	<p>2. Is it likely that the investment may unnecessarily create parallel local implementation structures?</p> <p>3. Is it likely that the investment may not be well aligned with local priorities or fail to involve local communities?</p> <p>4. Is it likely that the investment may seem unethical, inequitable, or in any other way unacceptable to recipients?</p> <p>5. Is it likely that the desired effect of the investment will be reduced due to lack of adequately trained human resources?</p>	<p>unnecessarily creating parallel local implementation structures?</p> <p>3. Is the investment not well aligned with local priorities or failing to involve local communities?</p> <p>4. Is the investment unethical, inequitable, or in any other way unacceptable to recipients?</p> <p>5. Is the desired effect of the investment being reduced due to lack of adequately trained human resources?</p>	<p>2. Did the investment unnecessarily create parallel local implementation structures?</p> <p>3. Was the investment misaligned with local priorities or did it fail to involve local communities?</p> <p>4. Was the investment unethical, inequitable, or in any other way unacceptable to recipients?</p> <p>5. Was the desired effect of the investment reduced due to lack of adequately trained human resources?</p>
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3.5.6. Three applications of PLANET tool

The PLANET tool's approach, as defined above, has three major applications. First is in *planning* of new IMCI programmes. Donors in particular might be considering different investment options and project possibilities to address child mortality. While the overarching concern is justifiably a reduction in the number of child deaths, running a PLANET exercise will look at other equally important dimensions that would impact on the success of the project in reducing child mortality as well as aligning with best practices, equity considerations, community involvement and acceptability.

How could the framework be used? Based on this conceptual framework we have developed a questionnaire (see **Table 25-1**) that can be used to engage three groups of respondents. These would include those with knowledge of health governance, economics and health systems as well as policy-makers intimately involved with the execution of the programme. It would also include those at the local level who are likely to be involved with the delivery of the programme as well as the actual beneficiaries. All relevant stakeholders would be given this questionnaire and asked to respond independently and anonymously based on their knowledge of the project. The process could be conducted by technical experts in a transparent way (e.g. each vote counts equally). The outcome would be a comprehensive list of the strengths and weaknesses of particular programmes against many criteria, based on the

collective input of technical experts. Additional criterion or questions can be added or substituted in to ensure covering all aspects relevant to that specific programme. Analysis of the respondent data would, taken together, provide a complete picture of the strengths and weaknesses of the programme that would be made available publicly.

Given that donors would be running this exercise using the expertise and accumulated knowledge of respondents, an additional step is necessary. Donors would need to define the context of the exercise based on their anticipated outcomes, the population they are targeting, the time-frame they are working under as well as stating how much risk they are willing to take to reach certain outcomes. For example, the Bill & Melinda Gates Foundation might be willing to take a major risk for a high-payoff while public donors such as the UK government might be looking to minimize risk and under those conditions to maximize health outcomes. The outcome would be a comprehensive list with competing priorities ranked according to the combined scores they received in the process. Such a list would be helpful because it provides an overview of the strengths and weaknesses of competing options in child mortality reduction against many criteria, based on the collective input of technical experts. The list can also be adjusted by taking the values of many stakeholders into account such as occurred during the extensive experience with the implementation of CHNRI in health research prioritization (**Rudan et al., 2008**).

Second, PLANET can be used to *monitor* ongoing IMCI programs and receive real-time feedback on their implementation. Third, PLANET could also be used to *evaluate* the success of previous IMCI programmes. Evaluation is often neglected and efforts such as by the Center for Global Development to fill this gap have focused on the creation of new institutions with the capacity to undertake this kind of work (**Centre for Global Development, 2013**). The implementation would be similar to that described above using a modified questionnaire (see **Table 25-1**).

3.5.7. Strategies for data collection

Exploitation of collective knowledge is now possible and moreover easier and cheaper than ever before. Information / communication technology becoming a digital utility enables us now to seek input from hundreds or thousands of independent individuals at little higher cost than asking one person. We can now, in real-time, in almost every country or setting collect feedback or opinions from billions of people who actively use mobile phones (with the proportion of smartphones rapidly growing) (**International Telecommunication Union, 2013**). This can be done through text-message, automated phone calls, dedicated apps, email or the internet in a device or platform agnostic manner. It is certain that this is redefining not just the norms of who provides a feedback or communication of their assessment of a programme and how and when this is done, but also how healthcare programmes are delivered or consumed. The PLANET questionnaire is currently being developed into an app that would be freely available to all governments, international institutions and individuals looking for a simple, tech-friendly tool to plan, monitor and evaluate healthcare programmes.

The PLANET tool has several major advantages over existing efforts in planning, monitoring and evaluation. First, it presents a standardized methodology that can be used for planning, monitoring and evaluation of any type of healthcare programme, but it also has sufficient flexibility to be tailored to the context of specific initiatives. PLANET would be an additional tool available to policy-makers, along with LiST (for health care/interventions) (**Steinglass et al., 2011**) and CHNRI (for health research) (**Rudan et al., 2008**) which will involve local

experts and incorporate issues of local context in the process of determining priorities in a transparent, user-friendly, replicable, quantifiable and specific, algorithm-like manner. Second, it is simple to implement and with the development of mobile-phone software, should be able to be run anywhere in the world at low-cost. The low-cost of input means it can be run multiple times resulting in real-time monitoring of IMCI programmes. Third, while respondents are protected through anonymity in feedback, the results are provided transparently. Finally, the exercise gives equal voice to all those involved in the process of development from the donor (e.g. in London, Seoul or Seattle) to a manager and to a recipient (in rural Uganda, Dhaka or Antigua). The voice of local stakeholders, including operations teams and beneficiaries, is included in every exercise.

The use of these types of novel methodologies can lead to more rational planning, higher quality evaluation as well as more knowledgeable future decision-making, especially given that IMCI initiatives have traditionally lacked formal tools to examine delivery and implementation. The use of such tools would promote attention to objective evidence on planning, monitoring and evaluation leading to more effective aid and ultimately better evidence on reduction in child mortality across the world and how this relates or could relate to specific development efforts.

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