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Low Carbon Studies

Powering the Health Sector

Approach and Methodology for an Impact Assessment of the provision of energy to health facilities in low income countries

Annex B

March 2013

Contents

IMPACT ASSESSMENT OF THE PROVISION OF ENERGY TO HEALTH FACILITIES IN LOW INCOME COUNTRIES

1 Objectives of the consultancy

As part of the GVEP International commissioned assessment, this consultancy aims to provide evidence to underpin the design and evaluation of reliable (and renewable) energy to the health sector; Liverpool School of Tropical Medicine (LSTM) expertise has been requested to design a field study to assess impact of energy provision to health facilities in the health of the communities. This document highlights the approach and methodologies recommended, as well as outlining the potential challenges in demonstrating and attributing health status impact to the provision of energy to health care facilities.

The consultants understand that the context adaptation of this methodology is the object of another assignment. The challenges to select the case and control areas and to show impact in the study population should not be underestimated. As showed by the number of studies published and referred to in the literature search the provision of energy is an enabler to better health. It has the potential to improve or facilitate new services provision and increase the number of people being attended by the clinics. However health services provision depends on other "critical" factors particularly the presence of trained staff and access to appropriate infrastructure, equipment, medication and supplies. Financial access to health services and transportation costs may hinder access to services by the rural poor. All of these factors will influence the utilization rate of health services and whether there will be a measurable improvement on health outcomes.

2 Background Information

GVEP has reviewed secondary data from academic and development reports, and project and programme evaluations to identify evidence of health impact of providing health facilities with reliable sources of electricity.

The search which has included medical and health databases as well as grey literature, focused initially on the identification of outputs of service provision in health facilities where electric energy was provided. The assumption behind this choice was that the provision of power to health care centres should increase uptake for, and availability of services with extension of its hours of operation. The indicators of service uptake (before and after provision of energy) that the team looked for in the literature included among others:

- Utilization rate (for all patients)
- Utilization rate (children under five years of age)
- Coverage of Antenatal Care 1st and 4th visits
- Percentage of deliveries in the health facility
- Number or proportion of births by C-sections in the health facility
- Availability and number of blood transfusions or the existence of a blood bank in the health facility.
- Proportion of children fully immunized or vaccinations conducted in the health facility
- Availability and number of surgical procedures in the health facility.

Despite the general consensus and assumption that energy improves health, it became apparent early on the search that there was no reliable information relating energy access in health centres either to measures of services provided or to improvements in the health status of users or to both. To widen the scope of the search, researchers added additional indicators of service availability and quality, including:

- Descriptions of extra services or service time expansion provided after installation of power in the health facility.

- Recruitment of new staff or reduction of attrition rate of staff as a result of infrastructure (energy) improvement.

Results of the literature search already provided to DFID were that beyond anecdotal evidence, there are few available studies that provide some evidence of links between electricity access at health facilities and changes in health outputs or outcomes. Considering the number of projects providing energy to health facilities which have been funded by Government Health ministries, international and bilateral agencies and NGOs it is surprising that many of these projects report **positive health outcomes, but the evidence behind this statement is not provided.**

The general consensus is that electricity can improve health services provision, and it is assumed that a lack of power is likely to have an impact on health service provision. However, in contexts where energy is not reliable because there is absence of power or the supply is inadequate, health staff often find workaround solutions in the form of torches; lanterns or even mobile phones. This means that services are provided to the community despite difficulties. This fact complicates attributing improved health outcomes to the provision of a more stable source of energy alone: while lack of energy may hinder health services or reduce health staff satisfaction, the provision of health services and the quality of these services is dependent on many other factors, some of them are critical, such as the presence of trained staff, the availability of working equipment and the regular supply of medicines. Moreover, health care use depends from multiple factors including ability to pay for transportation and care, confidence on and the presence of trained staff, the regular and reliable provision of medications and supplies and other culturally mediated factors. A number of reports found in the review confirm our finding that there is little, if any, evidence that demonstrate a direct link between electricity provision (renewable or non renewable sources) and improvement of health outcomes in the community served by the health facility.

Difficulties in attribution were analyzed by John Hopkins School of Public Health in Haiti as part of a large USAID programme to provide energy to health centres and the study (retrospective or prospective) was abandoned due to workaround solutions mentioned above. A more general study reviewing the impact of electricity supply on gender also refers to the problem of attribution since it mentions that there is much literature that describes the potential impacts of electricity assuming no other behavioural responses to the intervention. However, the authors found that claims are largely based on qualitative analysis, and thus "do not rule out rival explanations such as systematic differences in the communities or households that receive the electricity or motive power[i]".Details about these studies have been highlighted in the literature review document recently submitted. However, the search for health impact of energy provision has continued and there is currently a study underway by the Liberian Institute of Biomedical Research, which is aiming to provide proof-of-concept that low cost renewable energy offers a significant opportunity for reducing mortality and morbidity in developing countries and which aims to define requirements for a larger-scale study to provide definitive data on the impact of renewable energy on mortality and morbidity[ii]. No results are available yet.

Even taking into consideration all these challenges, the current investment in energy provision makes it imperative to try demonstrating the actual impact of the energy in health. The health services strengthening project in the Democratic Republic of the Congo implemented by Inter church Medical Assistance (IMA) World Health and Tulane School of Public Health offers an opportunity to measure the impact of energy in health, as it is addressed to rural remote districts where the provision of energy is likely to be unreliable if not absent. The current document provides the approach and methodology for conducting such a study in two comparable areas, one provided with energy and one without and for completing surveys to measure health outcomes and impact as well as quality of care before and after the provision of reliable energy. The study presented can be applicable to other rural districts in less developed countries where the provision of energy is unreliable for lighting and power dependent equipment.

FIELD STUDY TO MEASURE IMPACT OF ENERGY PROVISION ON HEALTH

1. Purpose of the Study

Measure the health impact of the provision of reliable energy to health facilities in less developed countries.

2. Objectives

1. To provide definitive data on the impact of reliable energy on health of the population served by health facilities in less developed countries.
2. To document the impact on health status from technology innovation.
3. To establish the value for money of the provision of low cost renewable energy to health facilities.

3 Expected Results

1. Measure impact of the intervention in terms of:
    a. Mortality of children 0-11 months of age defined as the probability of dying before one year of age, using as indicators infant mortality rate or age-specific mortality rate.
    b. Lives saved calculated using coverage of health interventions (outcomes) relevant to mortality and morbidity of mothers and children younger than one year of age in less developed countries[1].
2. Obtain an estimate of variation of indicators attributable to the provision of reliable energy.
3. Provide relevant data to assess the value for money of the provision of reliable (low cost and renewable) energy systems to rural health facilities in less developed countries.

4 Approach

The recommended approach to answer the question of whether reliable sources of energy improve health of the communities served is an **intervention versus control** or intervention versus non-intervention design study, widely known as a **case-control** study, integrated by:

1. The intervention group will be communities (users of services) in the catchment areas of health facilities provided with reliable energy by the project. The study population in the intervention areas will be infants less than one year of age for which mortality and health outcome indicators will be measured at baseline and time intervals along the project.
2. The counterfactual will be provided by infants under one year of age living in communities (users of services) living in the catchment area of health facilities providing similar services to the "intervention" group but which do not count and are not provided with reliable energy provision.

The study will measure as the main indicator of impact, mortality or calculate the lives saved of increased coverage of health outcome indicators. Health outcomes are either directly influenced by energy provision or by the increase in utilization rate as a result of new and better services. The counterfactual will provide the basis for attribution. The variation of health outcomes in the study population in the control area should be

[11] *NB: The health outcomes of younger children, those under one year, are likely to be more sensitive to energy provision in health facilities than health outcomes of older children. This is due to the potential life-saving health interventions used for this age group that are reliant on energy sources such as, incubators; compressed oxygen for respiratory support and new-born resuscitation devices.*

the consequence of other health interventions, namely the current project or other initiatives implemented by development partners.

Comparison between the two groups is contingent on the establishment of the "ceteris paribus" between the intervention and the control study populations. Both should live in communities similar or comparable in terms of population numbers, number and category of health facilities providing services; health facilities endorsement (infrastructure, equipment, staff and supplies or the lack of them) and services with the only difference being the allocation of **provision or lack of provision** of reliable energy in the intervention district. Ideally the utilization rate and indicators in both study populations should be similar and a routine report should be in place and submitted periodically – for monitoring purposes. Differences in health facilities infrastructure, equipment, staff, medication and supplies should be corrected before the source of energy is provided to the health services in the intervention area. Possible confounders and source of bias should be identified or corrected.

The study should take place in two well defined geographical areas, preferably health districts. Choosing of the district versus specific catchment areas has some practical advantages: districts are generally better defined than catchment areas of health facilities[2]; usually count with a similar health services endorsement (primary and secondary services) and have specific district management who can provide assistance and benefit from the capacity building required for this intervention. Assessment of outcomes and quality of care of districts and if LQAS is used, classification of catchment areas according to pre-determined indicators targets can be useful for the district managers to correct and improve quality of care in their areas of operation. Finally baseline indicators obtained by national surveys (UNICEF Multiple Indicators Cluster Survey) or Measure Demographic and Health Survey) can be used to initially identify districts and as comparator to the districts baseline and indicators over time to corroborate improvement. District progress can be assessed over time if successful lessons learned can be extrapolated to other areas of the country.

The energy provided to the health facilities is expected to come from **renewable** sources and should combine the provision of **lighting** which will mainly extend hours of service and make medical and surgical procedures easier and the provision of **power** to allow for the use of energy dependent equipment, particularly cold chain at the basic service level but also more sophisticated equipment such as ultrasounds, incubators, monitors, oxygen concentrators and ventilators in health care centres of higher category or providing extended primary health care or basic secondary health care services[3].

In constructing the study methodology, the main chain of assumptions with regards to energy provision is as follows:

1. The intervention is to benefit rural health care facilities providing primary or essential health care most of them with perhaps one facility of higher level providing basic secondary care.
2. Energy package will consist in the provision of low cost renewable energy systems which will provide ***lighting*** for 6-12 hours and power for cold chain (primary care) or more sophisticated reanimation and diagnostic equipment for expanded primary care or secondary care facilities.
3. Lighting will permit the centre to increase hours of operation and facilitate care provided including life–saving surgical procedures after darkness.
4. These expanded hours of service provision will result in increased acceptance by users which may be able to use the local health facility after dark in emergencies or after field work.

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[2] *Determining the limits of the catchment area of a health facility can be complex – some of them will be geographical (5 or 10 km radius); some based on population numbers (5-10,000); some will intersect or comprise a number of close villages defined based on tribal or ethnic links.*

[3] *While the use of renewable energy has added benefits over the use of other sources, the study is designed to assess energy impact, whichever its origin. It is assumed that energy will result in six hours (or in the case of hospitals for 12 hours) of lighting and be enough to allow for equipment relevant the level of the health care services provided.*

5. Lighting will make the facility and accommodation linked to it, safer and more acceptable by prospective or current staff.
6. Energy dependent equipment such as cold chain will be provided with a constant source of power which will facilitate the use of medication requiring low temperatures (for instance Oxytocin) and facilitate vaccination.
7. Quality of care will improve.
8. Service utilization particularly by main users of services (mothers and children) will increase.
9. Increased service utilization (preventive and curative) and better care will reduce morbidity and mortality of preventable and treatable causes of death and save lives of the study population.

Specifically, with regards to infants under one year of age, higher levels of energy provision and the possibility of attracting more qualified staff[4], will allow for use of other equipment (particularly in higher level primary health care centres or rural hospitals) which need energy to operate. Those are monitors, ultrasounds, incubators and ventilators whose effect will be at primary level the identification and referral (or treatment) of pregnancy related complications; the diagnosis of foetal distress during labour and delivery (and treatment or referral); the treatment of hypothermia of the newborn and better reanimation procedures; the facilitation of blood transfusions (for ABO and Rhesus tests) and the treatment of kernicterus. The use of equipment such as ventilators in the theatre will facilitate complex surgery though this may only happen in facilities with the required mix of medical specialists. Because the incidence of these conditions and the staff resources are not known, the effect of the use of power dependent equipment cannot be predicted, but is likely to be smaller when compared to the potential increase in the use of services as a result of lighting and reliable cold chain.

5 Definition of the study population

The study population for the measurement of mortality (and coverage indicators) should be infants under one year of age, due to the following considerations:

1. Infants under one year of age have the highest age-specific mortality rates. The average risk of dying before the first birthday for an infant in DRC is 10% (UNICEF, 2009) but in the rural areas the mortality is likely to be higher. Specific mortality studies in DRC (IRC 2002) measured a mortality which was three times the official estimate.
2. Infants under one year of age are extraordinary sensitive to the provision of better care. Infants are much more likely to survive when there are improvements in the attention to pregnancy, labour and delivery (reduction of neonatal mortality) and when there is access to good basic provision of preventive and curative health services. WHO and UNICEF have published reduction of the risk of dying from 1-11 months of age of up to 60% by a combination of simple measures such as immunization, provision of bed nets and prompt treatment of main causes of death. Two of these factors (immunization and prompt treatment of main causes of death – malaria, diarrhoea and pneumonia, can be influenced by the provision of energy to the health facilities.
3. Infants under one year of age are a frequent user of services at primary health care level.
4. Infants under one year are an easy to identify study population even in absence of birth certificates as it happens in the DRC.
5. Infant mortality rate is obtained by large national surveys, calculated using time series[5] and made public Although the rate will not be useful to show modest changes in mortality taking place in small populations (districts) it will provide the implementation agency with an estimate to which the district

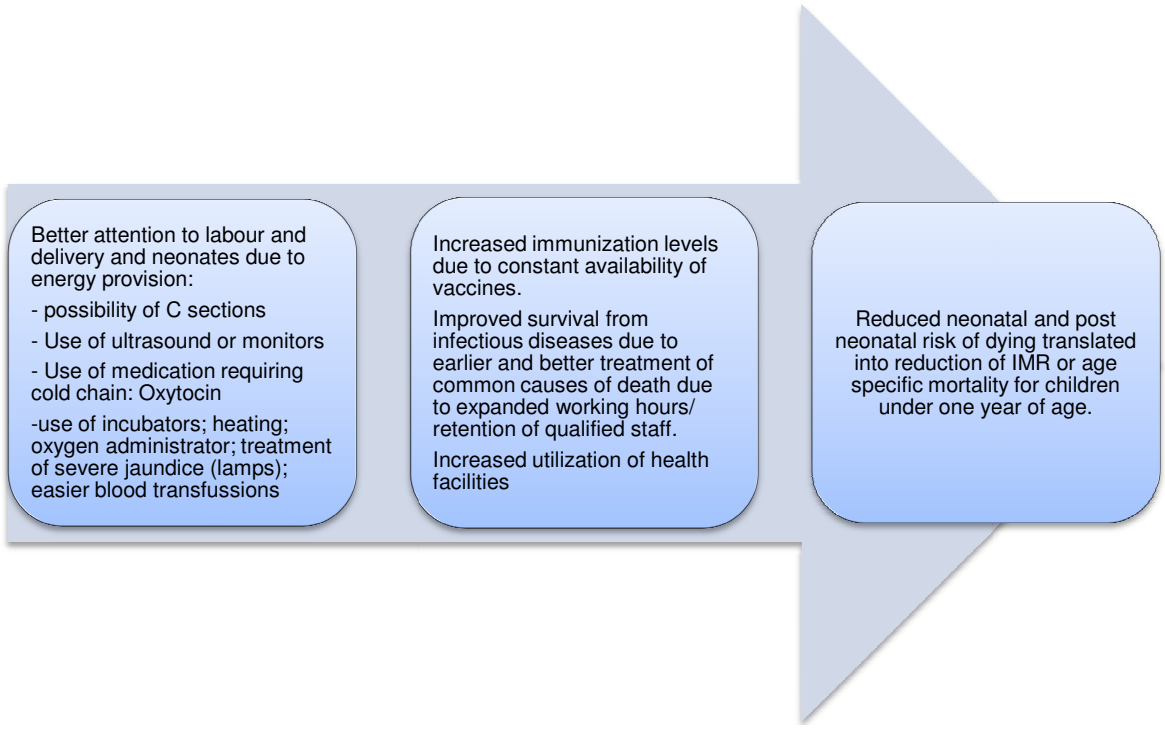
[4] *The provision of equipment and the recruitment or retaining of new higher qualified staff may result in higher costs. The study assumes that these extra costs will not be transferred to the population in terms of higher user fees, which will decrease utilization rate.*

[5] *http://www.childinfo.org/files/Methods_for_Estimating_Child_Mortality_2010.pdf*

rate may be compared and allow for the identification of the province or area where the project is to take place.

Coverage of key indicators or changes in the coverage of indicators related to immunization; prompt and effective treatment of infant illnesses and attention to delivery by skilled birth attendants can be used to calculate lives saved by the project. The lives saved tool, as explained later in this document can provide an estimate of lives saved based on coverage indicators which can be completed at a fraction of the cost of undertaking mortality surveys. However one setback of this strategy is that measuring these indicators requires different target population for the surveys, therefore increasing complexity and costs.

In a graphic format, the theory of change underpinning this choice of study population is as follows:



6 Indicators

Impact on health is measured by changes in mortality or morbidity. For this study, if measure of mortality changes is deemed necessary, the recommendation is to measure variations in mortality in children under one year of age using internationally recognized indicators from UNICEF (Childinfo) or from the WHO (Countdown to MDGs). As quoted in the theory of change, this is the population with higher age specific mortality and more sensitive to better care during pregnancy, labour and delivery and the immediate postpartum.

Reductions in neonatal mortality may come as a result of detection of pregnancy complications or obstructed labour by ultrasounds (which in addition will reduce maternal deaths); management of foetal distress during delivery by the use of monitors; possibility of programmed or emergency C-sections by better surgical theatres (lighting; sterilization); use of energy dependent reanimation equipment such as heating lamps; incubators or Oxygen providers during reanimation or by the administration of tetanus toxoid during antenatal care, vitamin A or booster immunization (Pertussis) to mothers during immediate postpartum; BCG and Polio 0 to newborn babies. Therefore the indicators proposed include the skilled birth attendance ratio; percentage of C-sections completed in the centres and indicators of post-partum care. All of them are able to measure progress towards reduction of neonatal mortality using LiST or other modelling methods.

Similarly, infants 1-11 months are more likely to survive if quality preventive and curative interventions are provided early including vaccination; provision of antimalarials or antibiotics for treatment of fever; immediate treatment of dehydration. From this reason indicators recommended to be measured include vaccination coverage; morbidity prevalence; the behaviour of the family vis-a-vis sick children and their prompt diagnosis and treatment by health officers.

Acceptance by the community is essential for these changes to happen: In simple terms, in areas where health services are not viewed as useful, attendance is low and the opportunity to save lives through facility based interventions is non-existent. Provision of energy may increase utilization of services. To give an example, an increase in hours of service provision could be created by offering lighting at health facilities at night time; this may also allow for staff to perform their work better or work more flexible schedules to allow mothers to come to the centre once they have completed their chores or during emergencies. This increase in use of services has the potential to provide essential preventive and curative care and reduce mortality and morbidity. The follow up of utilization rate and outputs of care using routine health management information system will be useful to corroborate results of survey and to track progress over time.

The study indicators are included as part of this document. Questionnaires already tested and used world-wide and specifically in DRC in French can be downloaded from websites such as Childinfo.org.

When it comes to surveys, the detection of changes in indicators in this study population requires the administration of questionnaires as part of a community or household survey, to different target groups, as follows:

1. Mortality questions should be included as part of the questionnaire addressed to the head of households.
2. Coverage indicators to assess immunization should be included in the questionnaire administered to caretakers or mothers of children 12-23 months, to ensure that the vaccination calendar has been completed before the first birthday.
3. Coverage indicators for labour and delivery should be included in questionnaires addressed to mothers of children 0-11 months of age.
4. Coverage indicators for vitamin A coverage should be included in questionnaires administered to mothers of children 6-11 months of age.
5. Morbidity and health behaviour indicators should be included in questionnaires addressed to mothers of children 0-11 months of age with malaria, diarrhoea or presumed pneumonia in the two weeks preceding the survey.

The following list of indicators is indicative and includes indicators used by household surveys world-wide with the source of indicator - either Childinfo which constitutes the basis for the MICS national surveys conducted with support of UNICEF or WHO defined key indicators quoted in “Countdown to Millennium Development Goals”.

MORTALITY INDICATORS Target population: Households / Head of household.			
1.1	Infant mortality rate	Probability of dying by exact age 1 year (number of deaths of children before exact age 1 per 1000 live births.	MDG 4.2
1.2	Neonatal mortality rate	Probability of dying within the first month of life (number of infants death during the first month of age per 100 live births),	
OPTIONAL	Age specific mortality rate	Total number of deaths of children before age 1 per 1000 children 0-11 months of age.	

7 Coverage (Outcome) Indicators

Impact in health can be measured using modelling methods which estimates lives saved as a result of changes in coverage indicators. These indicators are known to influence survival of infants and are the basis for the assumptions embedded in the lives saved tool developed by John Hopkins School of Public Health (http://www.jhsph.edu/departments/international-health/centers-and-institutes/institute-for-international-programs/list/). This tool **does not** measure mortality but estimates how many lives have been saved as a result of the indicator improvement. The increase of these coverage indicators has resulted in increased survival in large populations and is the basis for this estimate. Coverage indicators known to influence survival of infants include immunization (whether they have received vaccinations against infectious diseases which are causes of death), provision of vitamin A after 6 months of age, sleeping under insecticide treated bed nets, and being prompted and effectively diagnosed and treated of diseases that are main causes of death in the area – malaria, diarrhoea-dehydration and presumed pneumonia.

It should be noted that immunization is the only likely coverage indicator likely to be **directly** influenced by the provision of energy because the diagnosis and treatment of main causes of disease which may affect one third of children at a given time, do not actually require the provision of energy. In the context of HIV infection, coverage indicators should include the coverage of PMTCT programme and treatment coverage of mothers and children for opportunistic infections or ARV, as these measures have shown a reduction in mortality of infants born of HIV positive mothers. Similarly, none of these indicators would be directly modified by the use of energy.

Vaccinations

Target population: Children 12-23 months

	Indicator definition	Source	Numerator	Denominator
1	Tuberculosis immunisation coverage	Childinfo	Number of children aged 12-23 months who received BCG vaccine before their first birthday	Total number of children aged 12-23 months surveyed
2	Polio immunisation coverage	Childinfo	Number of children aged 12-23 months who received OPV3 vaccine before their first birthday	Total number of children aged 12-23 months surveyed
3	Measles immunisation coverage	Childinfo	Number of children 12-23 months who received measles vaccine before their first birthday	Total number of children aged 12-23 months surveyed
4	DTP3/PENTA coverage	Childinfo	Number of children aged 12-23 months receiving the third does of DTP/PENTA vaccine before their first birthday	Total number of children aged 12-23 months surveyed
5	Hepatitis B immunisation coverage	Childinfo	Number of children age 12-23 months who received the third dose of Hep B vaccine before their first birthday	Total number of children aged 12-23 months surveyed

Vitamin A

Target population: children 6-11 months of age

	Indicator definition	Source	Numerator	Denominator
6	Vitamin A supplementation	Childinfo/Countdown	Number of children aged 6-59 months who received two doses	Total number of children aged 6-59

			of vitamin A during the calendar year *Alternate:* Number of children aged 6-59 months who received one dose of vitamin A in the last 6-months	months surveyed

Morbidity

Target population: Children 0-11 months with malaria, diarrhoea and /or presumed pneumonia

	Indicator definition	**Source**	**Numerator**	**Denominator**
7	Percentage of children aged 0-11 months with suspected malaria	N.A. Required as denominator	Number of children aged 0-11 months who had a fever in the past two weeks	Total number of children 0-11 months surveyed
8	Malaria diagnostics usage	Childinfo[6]	Number of children 0-11 months reported to have had fever in the past 2 weeks who had a finger or a heel stick for malaria testing.	Total number of children 0-11 months with fever in the past two weeks
9	Anti malarial treatment of children under age 1 the same or next day	Childinfo	Number of children 0-11 months reported to have fever in the previous two weeks who were treated with any anti-malarial drug within the same or next day of onset of symptoms	Total number of children 0-11 months with fever in the past two weeks
10	Percentage of children receiving first line anti malarial treatment	Countdown	Number of children aged 0-11 months who had fever in the past two weeks who received appropriate malaria treatment according to national policy	Total number of children 0-11 months with fever in the previous two weeks who received any anti-malarial drugs
11	Children 0-11 months sleeping under any type of mosquito net	Childinfo	Number of children 0-11 months who slept under any type of mosquito net the night preceding the survey	Total number of children aged 0-11 months surveyed
12	Percentage of children aged 0-11 months sleeping under an ITN/LLIN	Childinfo/ Countdown	Number of children aged 0-11 months sleeping under an ITN/LLIN the night preceding the survey	Total number of children aged 0-11 months surveyed
13	Diarrhoea reported prevalence	Required as denominator	Number of children aged 0-11 months who had diarrhoea in the past two weeks	Total number of children 0-11 months surveyed
14	ORT and continued feeding	Childinfo/ Countdown	Number of children aged 0-11 months with diarrhoea in the two weeks prior to the survey receiving ORT and	Total number of children 0-11 months surveyed with diarrhoea in the past two

[6] *Indicators modified to adapt to the 0-11 rather than the 0-59 months population used by MICS.*

			continued feeding	weeks
15	OPTIONAL: Use of improved water source	Childinfo/ Countdown	Number of children 0-11 months living in households using improved drinking water source (including piped on premises, public standpipe, borehole, protected dug well, protected spring and rainwater collection)	Total number of households surveyed
16	OPTIONAL: Use of improved sanitation	Childinfo/ Countdown	Number of children 0-11 months using improved sanitation facilities (including connection to a public sewer or septic system, pour-flush latrine, simple pit latrine or a ventilated improved pit latrine)	Total number of households surveyed
17	Reported prevalence of suspected pneumonia	Required as denominato r	Number of children aged 0-11 months who had suspected pneumonia[7] in the past two weeks	Total number of children 0-11 months
18	Care-seeking for suspected pneumonia	Child info	Number of children aged 0-11 months who had suspected pneumonia in the past two weeks and were seen by a health worker within 24 hours of the onset of symptoms	Total number of children 0-11 months with suspected pneumonia in the past two weeks
19	Antibiotic treatment of suspected pneumonia	Child info	Number of children aged 1-11 months who had suspected pneumonia in the past two weeks who received antibiotics within 24 hours of the onset of symptoms[8]	Total number of children 1-11 months with suspected pneumonia in the past two weeks

Labour, delivery and post-partum

Target population: Mothers of infants 0-11 months of age[9]

No	Indicator definition	Source	Numerator	Denominator	MDG
20	Skilled attendant at delivery	Childinfo	Number of mothers with a live birth in the year preceding the survey who were attended during childbirth by skilled health personnel	Total number of mothers with a live birth in the year preceding the survey	MDG 5.2
21	Institutional deliveries	Childinfo	Number of mothers with a live birth in the year preceding the survey who delivered in a health facility	Total number of mothers with a live birth in the year preceding the survey	
22	Caesarean section	Childinfo	Number of live births in the year preceding the survey who were delivered by caesarean section	Total number of live births in the year preceding the survey	

[7] *In the MICS surveys this indicator involves a filter question querying for difficult breathing or cough, and followed by a question as if the child has difficult or rapid breathing.*

[8] *This indicator will change according to the timing for treatment of presumed pneumonia with antibiotics at the primary health care level.*

[9] *MICS uses as target group women 15-49 years with a life birth in the two years preceding the survey. LSTM experience is that this increases the recall bias and recommend to interview women who have given birth in the year prior to the survey.*

23	Post-partum stay in health facility	Childinfo	Number of women who stayed in the health facility for 12 hours or more after the delivery of their live birth in the year preceding the survey	Total number mothers with live births in the year preceding the survey	
24	Post-natal health check for the newborn	Childinfo	Number of live births in the last year who received a health check while in facility or at home following delivery, or a post-natal care visit within 2 days after birth	Total number of live births in the year preceding the survey	

- Child Info and MICS reference: http://www.childinfo.org
- Countdown to MDGs reference: Countdown to health- maternal, newborn and child survival. World Health Organization and UNICEF 2012.

8 Selection of intervention and control districts

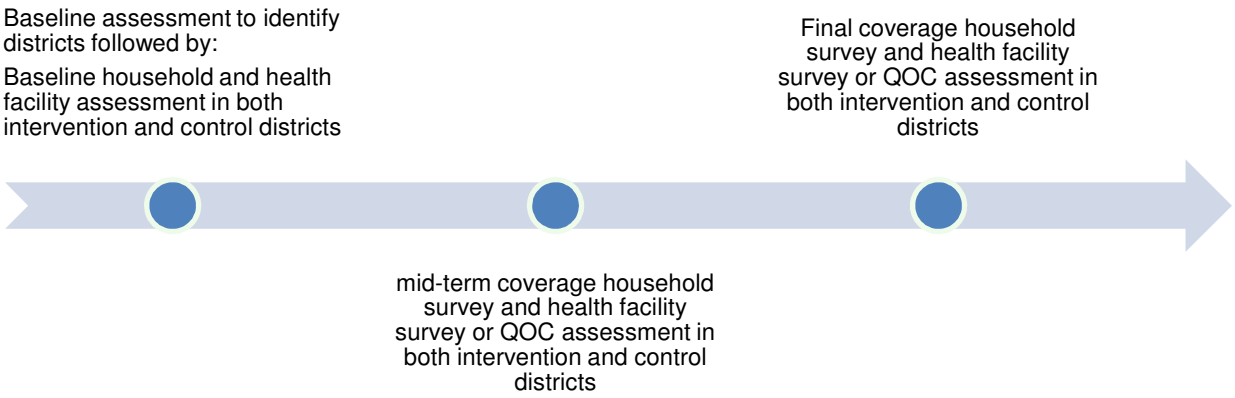
The selection of districts or areas where the study population lives is of paramount importance and it will require a series of preliminary assessments. This is to ensure that both (intervention and control group) are comparable. Changes of indicators between baseline and mid-term or final surveys will allow for estimations of effects in the intervention population; differences in indicators between the intervention and control groups (difference in difference) will provide an estimate of attribution of changes to provision of energy – provided ceteris paribus has been maintained or effects of other interventions controlled for, as explained in the analysis section.

1. In principle, districts or areas should be similar in terms of population, service provision, and quality of care and use of services by the population particularly of mothers and children less than one year of age.
2. LSTM recommends measuring the quality of care of services provided in both the control and the intervention areas using a quality of care tool such as the *Measure* rapid Health Facility Survey (HFS) in all or a representative sample of the health facilities of the district previously classified in category groups – for instance: health centres; health posts or dispensaries; hospitals etc. Ideally all health facilities of the study area should be included, but in practice a sample (random sample or LQAS stratified by health facility level) could be selected and a QOC assessment completed. Variations in the QOC can be assessed over time in both the control and intervention areas and differences in the care provided corrected before the starting of the study; over time or controlled for during the analysis.
3. It is understood that there will not be two similar study populations. However districts selected should be as similar as possible. Once selected the implementing agency has two possibilities:
    a. Establish the “ceteris paribus” by focusing on improving care or infrastructure of the less resourced district and improvements of the quality of care of the lower quality of care district to match the intervention and control areas health services provision. As an added bonus, these improvements may facilitate use of services and increase utilization rate by pregnant women and mothers of children less than one year of age.
    b. Use statistical methods to control for the lower resourced and quality of care health facilities to make the intervention and control districts comparable in terms of service provided to pregnant women and children less than one year of age.
4. Measure indicators using lot quality assurance sampling (LQAS) or random cluster surveys to set the baseline and over time along the life of the project to measure changes in the indicators. Because

these surveys are complex and costly, the M&E and implementing agencies should consider the periodicity of the surveys: yearly or every other year along the life of the project. A final survey should take place at the end of the project life..

5. HFS or similar QOC assessments should be conducted at baseline and regular intervals to assess changes in the intervention versus non intervention area and correct them along the life of the project or control for its effects during the statistical analysis.

Suggested timeline for completion of community and quality of care surveys



Considerations

A. Because the effect is likely to be small and require large samples to be measured (see next section), the best option to measure it is to provide the "energy" in the shortest period of time to all health facilities in the intervention district while other activities of the project continue as planned.

B. During the project life, changes in one of the study arms should be matched with changes in the other one. Principally, this refers to changes in the staff or medication procurement; these are two critical factors affecting the provision of healthcare to mothers and children with an established link to health outcomes.

C. While the provision of energy may not be essential to save lives there is a general consensus of energy being an enabler to better services and therefore better health: ethical considerations of non provision of energy to the control group need to be carefully considered.

Health Facility Assessments

Health facilities assessments (HFA) should be conducted in all or in a representative sample of all health facilities in the intervention and control districts at regular intervals. The HFA should be based on tools already developed and tested world-wide such as the measure tool (http://www.mchip.net/node/791). This tool uses four modules which measure:

1. The presence and quality of infrastructure, including the availability of drugs
2. The technical quality of treatment of patients (focusing primarily on sick children and antenatal care)
3. Management and supervision systems present in the HF
4. Exit interviews of patients to determine their knowledge of their diagnosis, whether they have the required appropriate medication or a script, and their knowledge of how to use it.

Each HFA module exam critical subsystems which can pass or fail according to a standard as prescribed both internationally and according to the medical guidelines of the Democratic Republic of the Congo. These data will form the basis of judging the quality of services.

Household Surveys

Baseline and mid-term or final household surveys need to take place to measure mortality or coverage indicators or both. The surveys can be conducting using cluster random sampling or LQAS as the sampling methodology.

LQAS, a classification technique in its elementary form, works by classifying supervision areas as having either reached or not reached a pre-determined target for each survey indicator. Whilst point estimates cannot be calculated for in supervision areas, data may be aggregated for the entire survey area to calculate point estimates of prevalence with 95% confidence intervals for all survey indicators. In addition, classification of supervision areas can be of interest to assess progress of these areas towards health outcome targets and inform the planning and implementation of relevant actions tailored to supervision areas needs.

Using Lot Quality Assurance Sampling (LQAS), assuming the survey is to detect a 10% change in coverage at time 1 and time with 95% confidence and 80% power of the sample, the survey will need 407 households with members of the target populations included in each of the target groups at each time point in both the control and the intervention areas. The sample size increases to 1604 if the survey is to detect a 5% change.

According to LQAS principles, in order to reach this sample size, the area should be broken down into 21 supervision areas. Following standard LQAS principles, supervision areas are normally chosen based on existing logical geographical and health administration boundaries. Within each supervision area, 19 villages will be selected from an up-to-date list of villages (sampling frame) using probability proportional to size. A starting household will then be randomly selected from each of these villages using segmentation sampling. Using the next nearest door principle, data collectors will approach households on foot until respondents from the appropriate age group are located [iii].

Using cluster sampling to detect changes in mortality will require large samples. For a community where the probability of dying before exact age 1 is 12% to detect a change to a 10% mortality the size of the sample for each survey will be of 3,940 households in the intervention and control areas.

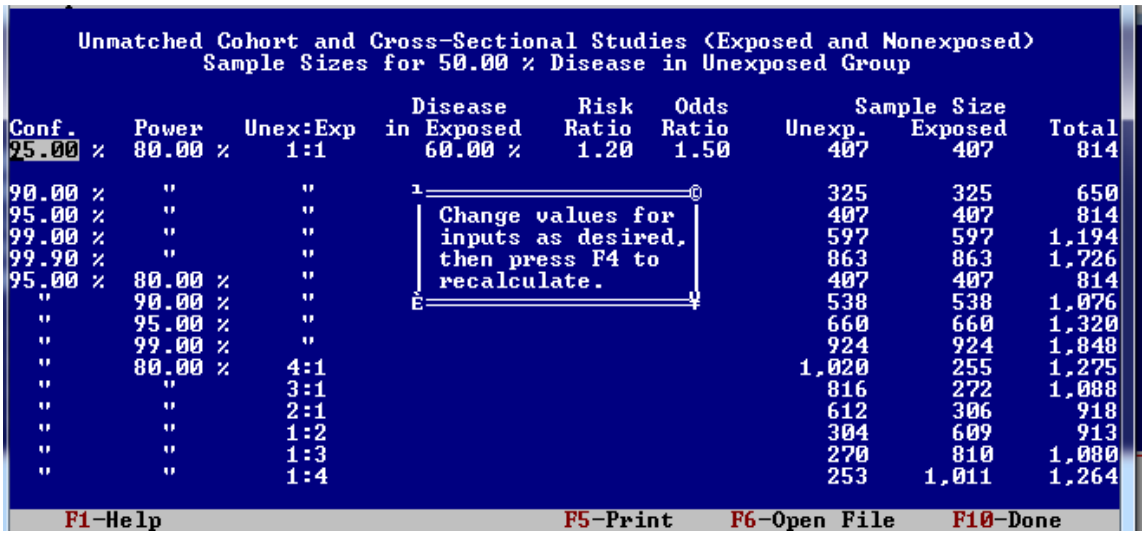
Sample size to measure 5% prevalence changes in time 1 and time 2

Unmatched Cohort and Cross-Sectional Studies (Exposed and Nonexposed)
Sample Sizes for 50.00 % Disease in Unexposed Group

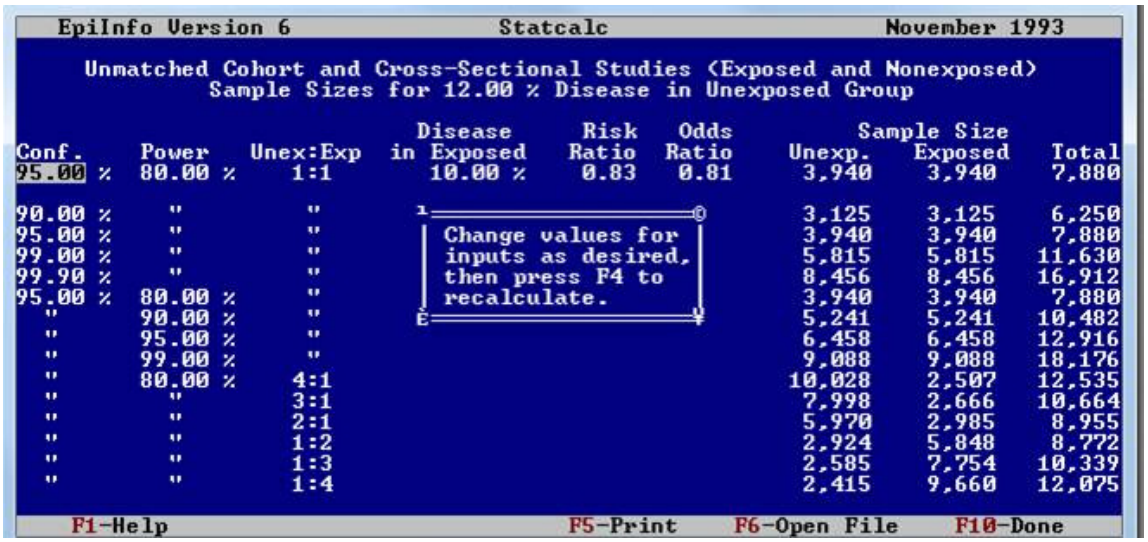
Conf.	Power	Unex:Exp	Disease in Exposed	Risk Ratio	Odds Ratio	Sample Size Unexp.	Exposed	Total
95.00 %	80.00 %	1:1	55.00 %	1.10	1.22	1,604	1,604	3,208
90.00 %	"	"				1,272	1,272	2,544
95.00 %	"	"				1,604	1,604	3,208
99.00 %	"	"				2,368	2,368	4,736
99.90 %	"	"				3,445	3,445	6,890
95.00 %	80.00 %	"				1,604	1,604	3,208
"	90.00 %	"				2,134	2,134	4,268
"	95.00 %	"				2,629	2,629	5,258
"	99.00 %	"				3,700	3,700	7,400
"	80.00 %	4:1				4,012	1,003	5,015
"	"	3:1				3,210	1,070	4,280
"	"	2:1				2,408	1,204	3,612
"	"	1:2				1,202	2,405	3,607
"	"	1:3				1,068	3,204	4,272
"	"	1:4				1,001	4,004	5,005

Change values for inputs as desired, then press F4 to recalculate.

Sample size to measure 10% prevalence changes in time 1 and time 2



Sample size to detect changes in mortality using cluster random sampling survey



Because of the large sample required for the completion of the surveys and the need for ensuring that (even considering the smaller sample size) 407 households for each of the target groups will need to be surveyed, the population from where the sample will be obtained has to be large. In fact using the morbidity indicator (one third of children will be affected by either of them) as a basis for calculation, the study population of children under one year of age has to be at least 1,200 infants in both the control and intervention communities, from which the sample is to be selected. If morbidity levels are lower the study population will need to be adjusted. Districts should have at a minimum 30,000 people if the pregnancy rate is 4%. Cluster sampling extends the sampling size to 3,940 infants. If this is the sampling methodology chosen the minimum population size from which the study population and the sample is to be selected will be of 100,000 people.

ANALYSIS

Using the above intervention-control plan and linked health survey data, two primary analyses should be conducted:

(1) Analysis of the health facilities survey data to assess performance and quality of care (health facilities data)
(2) Analysis of data collected using household surveys to assess impact of interventions on vulnerable groups, particularly mothers and children under one year of age to obtain coverage indicators which can be used to calculate the number of lives saved of children during the time period. Conducting a mortality survey is feasible but will be too costly and complex to detect changes in infant death rates with enough statistical power to be relevant and acceptable to the scientific community.

The M&E agency should monitor changes in indicators over time in the various health facilities, comparing these indicators across intervention groups in order to assess the efficacy of interventions in the health facilities. It is important to accurately monitor the number of individuals who visit a clinic, so that such factors can be accounted for when monitoring changes in stock out rates or within-clinic mortality rates. The health facility data will be the primary source of data used to assess changes in quality of care at the clinics.

For the second analysis, the agency should construct a hierarchical model or use the Lives Saved Tool to isolate the effect of the interventions on the primary indicators (specifically those pertaining to use of services and to health outcomes/burden of disease likely to be affected by the provision of energy), controlling for clustering within village. Outcomes of interest in mothers include the indicators related to the provision of skilled birth attendance at delivery and the number of life saving interventions taking care after the provision of energy starts particularly C-sections. For children, immunization is a key indicator while others will only be modified if the provision of energy allows for greater utilization of services as explained previously. All relevant spatial confounding factors and the timing of the interventions and control will be key for the analysis.

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[i] *Energy, gender and development : what are the linkages? Where is the evidence?, Working Paper 64410, World Bank, August 2011*

[iii] *Valadez J (1991). Assessing Child Survival Programs in Developing Countries. Testing Lot Quality Assurance Sampling. Harvard School of Public Health.*

[ii] *' Light up a Life' Research Factsheet." In: Factsheets Global Health Research. Zurich, UBS Optimus Foundation website. http://www.ubs.com/global/en/wealth_management/optimusfoundation/commitment/global_research/factsheets.html*