POLICY OPTIONS TO RETAIN NURSES IN RURAL LIBERIA: EVIDENCE FROM A DISCRETE CHOICE EXPERIMENT

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I. INTRODUCTION

After years of conflict, Liberia is poised to make significant human development gains. Located on the west coast of Africa, Liberia is a small country with a population of about 3.5 million. Between 1989 and 2003, the country endured a devastating civil war, characterized by intermittent periods of peace and fighting, that left the country's basic infrastructure in tatters and brought social service provision to a halt. In addition, the civil war led to large movements of people, both within the country and abroad. Although peace and stability and the installation of a reform-minded government have brought about improved economic conditions, a majority of the population continues to live in poverty. According to the 2007 Poverty Reduction Strategy, 1.7 million Liberians are living in poverty with nearly half living in extreme poverty. Liberia ranks very low on the Human Development index – 169th out of 182 countries. However, the current leadership has been able to gradually institute reforms and develop policies that have led to noticeable improvements in many sectors of government.

The government of Liberia is aggressively rebuilding its health system. Since the restoration of peace and stability, the Ministry of Health and Social Welfare (MOHSW) of Liberia has made significant efforts to reform the health sector and improve access to quality health care. The Ministry is guided by a National Health Policy and Plan which outlines the government's plans for delivering quality health services to the people. A cornerstone of the health care delivery strategy is the Basic Package of Health Services (BPHS), which stipulates the preventative and curative services available at every level of care and includes specific requirements in terms of infrastructure, equipment and drug availability and human resources necessary to provide the basic package.

There is an overall shortage of nurses in Liberia. The civil war brought about the total destruction of many health facilities and caused many people, including health workers to flee the country. Liberia has made great strides in improving the human resources for health (HRH) situation. For example, according to the most recent health facility assessment, the average human resources for health score – which incorporates staffing levels and HRH management practices – increased from 74% in 2009 to 82% in 2010 (MOHSW, 2010). However, there are still overall shortages of staff. For example, within clinics the minimum staffing level according to the BPHS is two nurses[1] (assuming the in-charge is a nurse). According to the 2009 health worker census there is an average of only 1.3 nurses per clinic. For health centers the minimum staffing level is six (assuming the in-charge is a nurse) or five (assuming the in-charge is not a nurse) nurses while the current average is only 4.3 nurses per health center.

Nurses form the backbone of the health workforce. This study focuses on nurses, who make up the majority of the health workforce in Liberia. According to the 2009 health worker census,

[1] Throughout this report the term 'nurse' refers to registered nurses, graduated nurses, nurse anesthetists, licensed practical nurses, and certified midwives. This group of nursing cadres was the focus of the discrete choice study as they are the key providers of nursing care at clinics and health centers. They are also very similar as they have at least two years of post-secondary education.

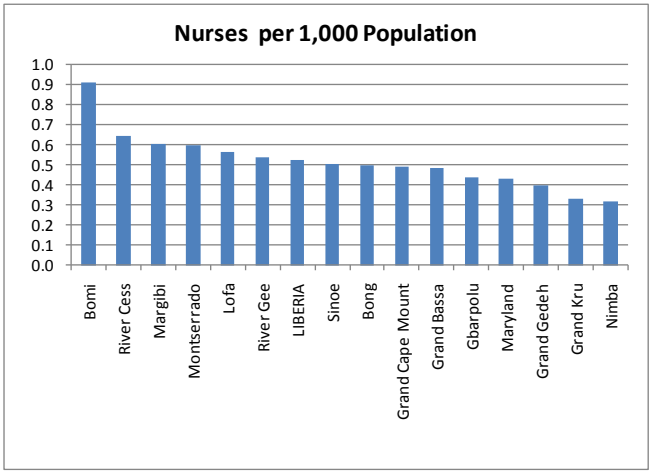
registered nurses (RNs), graduated nurses (GradNrs), nurse anesthetists, licensed practical nurses (LPNs), and certified midwives (CMs)– nursing professions that are the focus of the DCE study – together make up 35% of the clinical health workforce. Nurse aides and traditional midwives – cadres with less than two years of post-secondary education and which are not included in the DCE study – account for another 36% of the clinical health workforce. Physicians remain a very small part of the current health workforce at less than 2%.

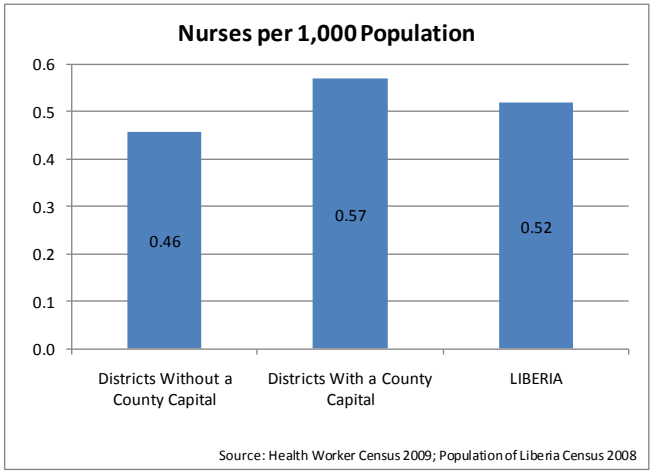
Cadre	Number	%
Physician	90	1.7%
Nurse (RN, GradNrs, LPN, CM, NA)	1805	34.9%
Nurse Aide	1589	30.7%
Physician Assistant	286	5.5%
Traditional Midwife	243	4.7%
Dentist	23	0.4%
Pharmacist	46	0.9%
Technicians	398	7.7%
Other	693	13.4%
TOTAL	5173	100%

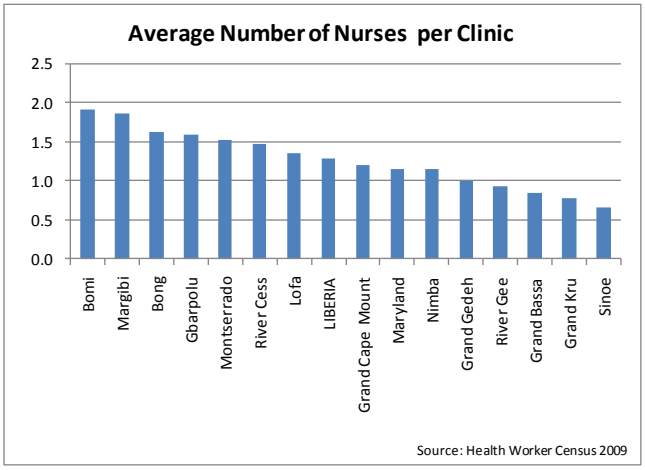
Source: Health worker census 2009

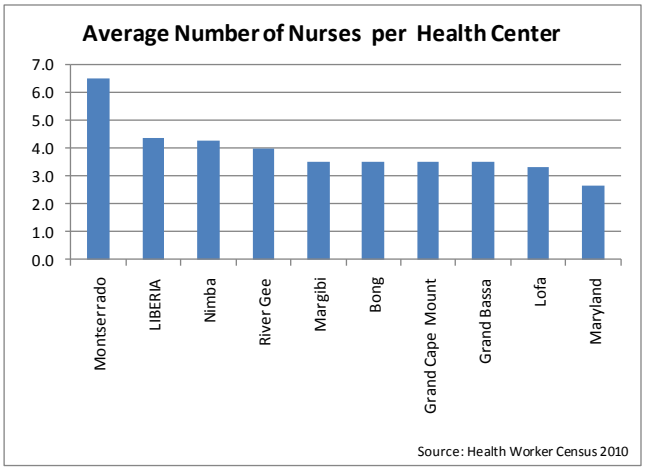
There is major geographic variation in nurse staffing levels, with the largest shortages in rural areas. Nurses per 1,000 population varies from 0.9 nurses in Bomi to 0.3 in Nimba. There is a 25% difference in staffing levels between districts that have a county capital – one rough proxy for urban areas in Liberia – and districts that do not have a county capital. Yet another measure of staffing levels – nurses per clinic or health center – also demonstrates significant variation in staffing levels across counties. Moreover, these data confirm an important general pattern of higher staffing levels in urbanized areas and low staffing levels in more rural, less developed counties. The counties in the south east tend to have the lowest staffing levels (Grand Kru, Grand Gedeh, Maryland, River Gee, Sinoe).

Furthermore, key informants within the Ministry of Health have clearly indicated that nurse retention rates are much lower in rural areas compared to urban areas.









II. THE DISCRETE CHOICE EXPERIMENT METHODOLOGY

A discrete choice experiment (DCE) is a quantitative technique for eliciting individual preferences. It allows policy makers to uncover how individuals value selected attributes of a program, product or job by asking them to state their preferred choice over hypothetical alternatives. DCEs have been applied to a range of health policy, planning and resource allocation decisions in high-income settings.

Only recently has the technique been applied to labor supply decisions of health workers and more specifically, the rural retention issue in developing countries. In this application, health workers or students in health training programs are asked about their preferences between different sets of hypothetical jobs. Each job is described by several job attributes (e.g. pay, location, working conditions). Responses are used to quantify the value health workers place on each job attribute. In this way, DCEs provide information on how individuals are willing to trade off one job attribute for another. This information is incredibly useful for policy makers. It allows them to quantify how much of a particular incentive (e.g. wage bonus, housing allowance) is needed in order to get health workers to accept a job in a rural area. Combined with cost data this provides an estimate of the cost-effectiveness of alternative policy options to retain health workers in rural areas. DCEs have been applied in several settings for the rural retention problem.

Country	Cadre(s)	Sample	Reference
Tanzania	Clinical Officers	Final year students	Riise Kolstad (2010)
Indonesia	Physicians	Final year students	Chomitz et al (1998)
Ethiopia	Physicians	Those working	Hanson and Jack (2008)
	Nurses	Those working	
Malawi	Nurses	Those working	Mangham (2007)
Ghana	Physicians	Final year students	Kruk et al (2010)
Kenya, South Africa, Thailand	Nurses	Final year students	Blaauw et al (2010)

There are several advantages of using a DCE over other survey techniques. First, a DCE provides a quantitative estimate of how health workers value different job attributes. For example, it allows an estimate of the monetary value (i.e. the wage equivalent) of improved working conditions, housing allowances, fast-tracked promotion, improved supervision etc. Second, it allows for several job attributes to be compared against each other simultaneously. Third, the survey is fairly straightforward to health workers as the choices closely resemble real-

world decisions. Fourth, combined with cost a DCE provides policy makers with estimates of the cost effectiveness of alternative policy options. Fifth, where there are insufficient data to estimate health worker preferences based on actual choices (e.g. evaluation of a past policy reform), a DCE is likely to be the only way to gauge preferences. Finally, there is often limited variation in key job attributes in practice, making it difficult to estimate the effects of policy options the government is considering. For example, unless housing allowances are implemented and allowed to vary in size, there is no way of estimating their impact from observed data. With the DCE technique it is possible to test policy options that have never been tried before.

There are also important challenges to consider. First, a DCE relies on hypothetical and not actual choices. While experiences from other fields shows DCEs to be a reliable predictor of actual behavior (Ryan et al, 2008; Hensher et al, 2005) there has not yet been a comparison of stated versus revealed preference for labor supply decisions as far as we can tell. As a result, a DCE is best used to inform the design of pilot retention schemes that can then be implemented and evaluated before being scaled up. Second, the number of job attributes and levels within each attribute is limited. This forces the researcher to carefully narrow down job and calibrate job attribute levels - through focus group discussions, in-depth interviews, pre-pilot testing and pilot-testing. Third, the analysis of DCE data requires a good understanding of econometric techniques. The estimates of the monetary value of different job attributes and predictions of take up rates for different jobs that are offered are based on regression coefficients from different types of discrete choice models.

Lagarde and Blaauw (2009) and Mangham et al (2009) provide a more detailed discussion of the benefits and shortcomings of using the DCE technique to elicit health worker preferences in developing countries.

The DCE methodology is based on utility maximization among health workers. As Riise Kolstad (2010) summarizes, the theoretical underpinning for the empirical analysis of health worker location decision is the random utility model. In the random utility framework health worker *n* is assumed to choose among *J* alternative jobs. He or she will choose the job which has the highest satisfaction or utility level (*U*). Thus, individual *n* will choose job *i* if and only if

$$U_{ni} > U_{nj} \qquad \forall i \neq j \in J$$

The random utility model assumes that the utility associated with a particular job is made up of two components. The deterministic component V_{ni} is a function of *m* job attributes ($x_1 \ldots x_m$) that are observed – e.g. pay, working conditions, location – each valued at a certain 'weight' or 'preferences' ($\beta_1 \ldots \beta_m$). The random component ε_{ni} is a function of unobserved job attributes as well as individual-level variation in tastes.

$$V_{ni} = \alpha_1 + \beta_1 x_{1ni} + \beta_2 x_{2ni} + \ldots + \beta_m x_{mni}$$

$$U_{ni} = V_{ni} + \varepsilon_{ni}$$

$$U_{ni} = \alpha_1 + \beta_1 x_{1ni} + \beta_2 x_{2ni} + \ldots + \beta_m x_{mni} + \varepsilon_{ni} \qquad (1)$$

The utility of a job is not directly observable. This means that the coefficients in equation (1) can not be estimated directly. The DCE methodology takes advantage of the fact that the jobs individuals choose are observed along with all other jobs they do not choose. Thus, when

individual *n* is presented with a pair of jobs, the probability he or she chooses job *i* over job *j* can be written as

$$
\begin{aligned}
P_{ni} &= \Pr[U_{ni} > U_{nj}] && \forall i \neq j \in J \\
P_{ni} &= \Pr[V_{ni} + \varepsilon_{ni} > V_{nj} + \varepsilon_{nj}] && \forall i \neq j \in J \\
P_{ni} &= \Pr[\varepsilon_{ni} - \varepsilon_{nj} > V_{nj} - V_{ij}] && \forall i \neq j \in J
\end{aligned} \tag{2}
$$

By making various assumptions on ε_{ni} (most commonly that is independent and identically distributed) equation (2) can be estimated using standard econometric techniques, giving estimates of α_1, $\beta_1 \ldots \beta_m$. It should be noted that an underlying assumption of these models is that individuals have a complete ranking of employment opportunities that is determined by their preferences for the varying job attributes.

The coefficient estimates can then be used to estimate health workers' willingness to pay for various job attributes e.g. how much salary are health workers willing to give up for better working conditions. Even more importantly, the coefficients can also be used to predict the proportion of health workers choosing one job over another. These types of simulations are very useful to policy makers as they show the predicted impact on health worker decisions of alternative levels of job attributes i.e. alternative jobs offered. Furthermore, when cost data are available these data can be used to estimate the cost-benefit ratios of alternative jobs.

The willingness to pay for a particular attribute x_m is calculated as the amount of pay a health worker is willing to sacrifice in order to achieve a higher level of this attribute. Based on equation (1), and setting x_1 as the pay attribute, this is given by

$$
WTP(x_m) = -\frac{\partial U / \partial x_m}{\partial U / \partial x_1} = -\frac{\beta_m}{\beta_1} \tag{3}
$$

The coefficient estimates of $\beta_1 \ldots \beta_m$ can simply be entered into equation (3) to calculate the WTP for the various job attributes.

Using the logit model, the proportion of health workers that would choose job *i* over all other jobs that are available to them is given by

$$
P_i = \frac{e^{\alpha_1 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_m x_{mi}}}{\sum_J e^{\alpha_1 + \beta_1 x_{1j} + \beta_2 x_{2j} + \ldots + \beta_m x_{mj}}} \quad \forall i, j \in J \tag{4}
$$

Equation (4) can then be used to carry out various policy simulations. For example, the proportion of health workers willing to accept a job in a rural area can be estimated for alternative incentive packages offered in rural areas. Moreover, equation (2) can be estimated and the resulting policy simulations can be carried out separately for different subgroups of interest (e.g. men versus women, older versus younger health worker).

Preparatory qualitative work identified the most important job attributes that affect nurses' decisions on where to locate. In November 2009 a qualitative study was completed on a sample of both nurses and physician assistants to identify key job attributes for the DCE (World Bank and MOHSW, 2010). In-depth interviews were carried out with 15 nurses. This was a

sufficient sample to provide a range of views and to allow for enough repetition so that attributes and their levels could be assigned. The participants were drawn from four counties - Montserrado, Grand Bassa, Margibi, and Grand Cape Mount. The locations were chosen to include both rural and urban areas.

In light of the qualitative work, the choice of attributes for inclusion into the DCE was guided by three principles. First, the frequency with which respondents mentioned an attribute was considered. The rationale for this is that the most valued and important attributes to health workers would naturally crop up more often and therefore warrant inclusion into the DCE. Second, attributes were chosen to ensure that they were independent of each other to avoid inter-attribute correlation. This helps to accurately estimate the main effect of a single attribute. For example it would be inappropriate to include both 'lack of gloves' and 'on-the-job-risk' since they partially express the same concern. Third, attributes chosen had to be amenable to policy interventions and within the present government capacity to implement.

The levels chosen for each attribute were informed by the qualitative work, current levels in Liberia, and policy makers views on feasible alternatives. The qualitative work provided insight into the range of job attribute levels that health workers face and the changes they would like to see. A base level was usually assigned to represent the existing situation of the attribute in question. A desired level was then set to balance the views of respondents in terms of what they consider to be an acceptable improvement on that attribute and what policy makers deemed was feasible in the short term given budget and political economy constraints. As noted in a subsequent section, the piloting stage was crucial in refining both the way attributes and levels were defined. The final list of attributes and levels is given below.

Attribute	Levels	Definition
Location	Urban	County capital
	Rural	At least 2 hr drive from County capital
Equipment	Adequate	Medical equipment, drugs, and facility standards allow you to provide about 75% of the government's full basic package of health services.
	Inadequate	Medical equipment, drugs, and facility standards allow you to provide about 25% of the government's full basic package of health services
Total Pay	US$ 120	This is total monthly income from working in the facility. If you currently get incentive, it is the incentive amount plus any allowances. If you are on government payroll, it is the salary amount plus any allowances.
	US$ 160	
	US$ 200	
	US$ 240	
Transportation	Yes	A motorbike is available to you during working hours. It is shared with other health workers and is not for personal use.
	No	No motorbike provided.
Housing	Yes	Housing is provided to you free of charge. It is self-contained, concrete, apartment-style housing on-site at the facility.
	No	No housing provided.
Workload	Heavy	You barely have enough time to care for patients, you are always on call, you work 1-2 extra hours every day.
	Normal	You have enough time to see patients and you leave work on time.

Location was defined to reflect the core rural retention problem in Liberia. Based on data analysis and consultations with Ministry of Health staff, it was clear that facilities that are in sparsely populated areas with few amenities (e.g. schools, transportation networks, banks) have the lowest staffing levels and the hardest time retaining nurses. It was also clear that even counties with the highest nurse staffing levels overall had pockets of geographic areas that were rural and where it was difficult to retain nurses. The within-county distribution of nurses was a very relevant issue to policy makers. The definition of 'rural' for the location attribute was designed to reflect this. Of course, the main drawback is that even with specific quantitative travel times, there are still some areas more than a two hour drive from a county capital that are well developed towns, and areas that are less than a two hours drive that are sparsely populated with few amenities. To minimize the implicit ambiguity, the enumerators were instructed to carefully explain to respondents the objective of the survey and to emphasize that the rural definition is meant to describe areas that are less developed and generally difficult to live in. We also considered describing living conditions typical to these rural areas with retention problems (e.g. lack of school, housing, transportation) but decided this would confound with other attributes. Our characterization is consistent with previous DCE studies.

Country	Levels for Location Attribute in DCE		Reference
Tanzania	▪ National Capital ▪ Regional headquarters ▪ District headquarters ▪ A 3-hour or more bus ride from district headquarters		Riise Kolstad (2010)
Indonesia	▪ Non-remote ▪ Remote ▪ Very Remote		Chomitz et al (1998)
Ethiopia	Physician	▪ National Capital ▪ Regional Capital	Hanson and Jack (2008)
	Nurse	▪ City ▪ Rural	
Malawi	▪ City ▪ District Town		Mangham (2007)
Ghana	Area that lacks socioeconomic development and has few amenities such as good schools, roads, piped water etc.		Kruk et al (2010)

Equipment was defined based on government standards and in relation to the basic package of health services. The key consideration for this attribute was to define levels in a way that is easily understood for the average nurse. The pilot testing revealed that nurses were familiar with the basket of services outlined in the BPHS. The levels were chosen to reflect the wide range of medical equipment, drugs, and facility standards in Liberia. For example, according to the most recent facility accreditation report, the drugs, supplies, equipment (including laboratory) scores for facilities in Liberia vary considerably and are as low as 24%. (MOHSW, 2010)

Total pay was more challenging to define than anticipated. In Liberia the pay system for public sector health workers is very fragmented. Staff on the government of Liberia (GOL) payroll are paid a base salary that depends only on cadre (i.e. it does not depend on location, education, years of experience). In addition, GOL staff receive a salary top-up that varies by location, with Liberia divided into three zones. Staff that are not on the GOL payroll but who are working in the public sector on contracts are paid a contract fee (or 'incentive') that is equivalent to the salary plus top up of a GOL staff. The contract fees vary according to geographic area. There are also volunteers who are either not paid, or paid irregularly.

Pay Rates for MOH Contract Employees, Selected Cadres, $USD per month			
Cadre	**Monrovia**	**Outside Monrovia**	**South East**
Nurse (RN, GradNrs)	125	163	200
Nurse Anesthetist	175	213	225
Nurse Midwife	150	175	200
Nurse Aide	80	80	80
License Practical Nurse (LPN)	100	125	150
Certified Midwife (CM)	110	143	175

Source: Ministry of Health

The key point in defining the pay attribute was to emphasize that it represents total pay from the nursing job, irrespective of what form of payment the nurse is currently receiving (e.g. salary or incentive). This was emphasized in the questionnaire and re-emphasized by the enumerators.

There were four main factors that influenced pay levels selected. First, the qualitative work provided insight into the pay levels nurses felt would be sufficient for improved retention in rural areas.

Second, data from the health worker census provided information on the distribution of current pay levels for nurses in Liberia. This was made available only midway through the piloting stage. Pay is very compressed in Liberia. For nurses (RN, GradNrs, CM, LPN) combined the mean monthly pay is $US187 with a 99^{th} confidence interval of ($175, $200).

Third, policy makers provided insight into a feasible upper bound for pay in rural areas based on the fiscal and political environment. A government-wide pay reform is planned in Liberia that will limit the scale of pay increases feasible in rural areas in the short and medium term in the health sector. Fourth, the piloting stage was crucial to revising the pay levels. Respondents were asked why they made their indicated choices and the high pay levels was often the reason.

Transportation only partially captures the true transportation problems in rural areas. From the in-depth interviews it was clear that transportation during working hours was an issue in rural areas. But it was also very clear that transportation to and from work as well as outside of working hours was also a major issue in rural areas. Nevertheless, the Ministry of Health does not have authority over road infrastructure and public transportation and this is the reason for selecting motorbikes as the transportation intervention in this context.

Housing was defined based on MOHSW norms. The MOHSW already has housing units at some facilities and is interested in expanding this policy. The housing levels, therefore, were defined according to the type of housing that the MOHSW currently is considering building as a policy response to the rural retention problem.

Workload was defined based on the views expressed by nurses on what the current situation is and what a reasonable level of work would be. The challenge with the workload attribute is that is it is not directly influenced by policy interventions. Rather, it is a consequence of staffing levels (which are amenable), patient demand, working hours.

The choice sets for the DCE questionnaire were generated using well established statistical methods. With six attributes in total, five of which have two levels and one of which has four levels, there are a total of 128 possible nursing 'jobs' that can be generated and 16,256 possible pairs of nursing jobs for respondents to choose between. Within the DCE questionnaire, we chose

to limit the number of choice sets to 16 which is within the acceptable range for DCE studies. We used DCE macros in SAS to generate a D-optimal design that maximized D-efficiency, taking account of orthogonality (i.e. attributes levels are independent of each other), level balance (i.e. attribute levels appear with the same frequency), and minimal overlap (i.e. attribute do not take the same level within a choice set). Two questions were inserted as tests of rationality where one job dominates the other in every attribute (and these were dropped for the econometric analysis). This led to a total of 18 choice sets.

We also asked respondents whether they would be willing to accept the indicated preferred job over their current job. This was to check whether the jobs presented in the choice sets were actually desirable within the current context in Liberia. It also provided additional modeling flexibility if the current job is treated as a third possible choice.

An example of instructions and a choice set is given below.

In this section of the questionnaire we want to try and understand what types of nursing jobs you most prefer.

We will be doing this by presenting you with two different nursing jobs and then asking you tell us which you prefer. You will see that each job has advantages and disadvantages and you will need to carefully trade-off the advantages and disadvantages in telling us which job you prefer.

For each pair of jobs, we would also like to know whether you would accept this job over your current job if the Ministry of Health offered it to you.

You can assume that the length of service in all jobs is 3 years.

Job 1	
Location	Urban
Equipment	Inadequate
Total Pay	160
Transportation	Yes
Housing	No
Workload	Heavy

Job 2	
Location	Rural
Equipment	Adequate
Total Pay	240
Transportation	Yes
Housing	Yes
Workload	Normal

Which of these two jobs do you prefer? ☐ **Job 1** ☐ **Job 2**
Would you accept this job over your current job? ☐ **Yes** ☐ **No**

The questionnaire was pilot tested and revised twice. The first pilot stage consisted of a convenience sample of 12 nurses in two large facilities within Monrovia. This first pilot phase led to significant changes in wording and sequencing of questions. It also provided an estimate of time requirements to complete the questionnaire which was needed for planning the full roll out. It also led to changes in wording of some of the attributes and their levels as well as major revisions to the levels of the pay attribute. It was clear from the response patterns and feedback from respondents that the pay attribute levels were being set too high (e.g. almost 100% of respondents indicated they would be willing to leave their current job).

The second round of pilot testing was done on a convenience sample of 30 nurses both inside and outside Monrovia. This led to only minimal revisions in the questionnaire. The only significant

revision was again a further reduction in the levels of the pay attribute. This was again a result of feedback from respondents, but was also motivated by discussions with key policy makers on what type of pay levels would be feasible in the near future in Liberia. Thus, a balance was struck between defining levels for the pay attribute that would vary enough to trigger changes in responses, but were still largely within the range that is fiscally and politically feasible for policy makers to implement.

Random sampling was used to generate a target sample of 220 nurses. In the DCE literature a minimum sample of 50 respondents is suggested for each particular subgroup of interest (Ryan et al,2008; Mangham, 2007; Hensher et al, 2005; Scott 2001). We applied this rule of thumb, with the main subgroups of interest being men compared to women, those under 35 compared to those over 35, and those working in Monrovia compared to those working outside Monrovia. Since information on the age and gender breakdown of the nursing workforce was available for all nurses in Liberia (from the recent health worker census) we could estimate the overall sample size needed to ensure at least 50 nurses fall within each subgroup (assuming a random sample). Taking account the expected difficulties in Liberia of field data collection – unexpected nurse absenteeism, travel difficulties due to roads being washed out, delays due to poor road conditions – we increased the target sample size by 20%. This led to a total target sample size of 220 nurses.

Based on the experience from the qualitative study and the DCE pilot phase, it was clear that it was not possible to randomly sample individual nurses. This would be far too costly and time consuming. Instead, we chose a facility based approach. The sampling strategy had three phases. In the first stage we stratified facilities into groups. The first group was excluded facilities. All facilities in Maryland, River Cess, and River Gee counties (accounting for 7.8% of nurses in Liberia) were excluded due to travel logistics. The second group was 'small' facilities, where only one or two nurses were expected to be available for the survey. The third group was 'large' facilities where up to ten nurses were expected to be available for the survey.

In the second stage we randomly selected facilities. Given travel times and resources available (enumerators and vehicles) for data collection, the total number of facilities to visit was limited to fifty. We then set the breakdown between small and large facilities to ensure sufficient sample size. The final breakdown selected was 25 large and 28 small facilities. This represents 10% of small facilities in Liberia and 52% of large facilities. We, therefore, oversampled large facilities.

In the third stage the individual nurses within facilities were selected. In small facilities all of the nurses were selected. In large facilities with 10 or fewer nurses all of them were selected. In large facilities with more than 10 nurses, 10 nurses were chosen randomly.

In practice, due to a variety of logistical reasons, the actual sample of nurses surveyed was smaller, and was based on both random and convenience sampling. Enumerator teams faced numerous constraints, including fuel shortages, insufficient estimated for travel time, and difficulties reaching certain facilities. In order to ensure the final sample was a close to the target sample within each county, the enumerator teams visited alternate site facilities if the target facilities were inaccessible. In addition, the true absence rate of nurses at facilities was much higher than what was estimated to construct the target sample. This led to a consistent underachieving of the target sample in facilities.

The final sample was 197 nurses, representing 10.9% of the Liberia nurse workforce.

The final sample is quite representative of the Liberian nurse workforce on several key characteristics. Several comparison variables were available from the health worker census. In

general, the means are quite similar to those in the DCE sample. It appears, however, that volunteers in the present sample are slightly overrepresented whereas the opposite is true for GOLs. The DCE sample has fewer men as well – likely due to the fact that male nurses are more likely to work in evenings and our data collection took place mostly during the day. One other concern with regard to sampling was that some of the hardest to reach, most remote counties were excluded from the sample. Individuals in these counties might have different (unobservable) attitudes toward rural service than nurses in the rest of Liberia since they have decided to locate there, potentially biasing results. The excluded counties, however, account for only 7.8% of the nurse workforce in Liberia. Therefore, their exclusion is not likely to bias results significantly.

Variable Means for DCE Sample and Health Worker Census (For RNs, GradNrs, Nurse anesthetists, LPNs and CMs)			
Variable		**DCE Sample**	**Health Worker Census**
n		197	1805
Age		40	43
Gender	Male	0.22	0.33
	Female	0.78	0.67
Education	Diploma	0.87	0.82
	Bachelor's	0.10	0.17
	Master's	0.03	0.01
Type of Employment	GOL	0.27	0.39
	Contract	0.26	0.23
	Volunteer	0.37	0.23
	FBO	0.08	0.12
	Self-employed	-	0.01
	Other	0.02	0.02

Enumerators administered the questionnaire face to face at facilities. In some cases enumerators visited nurses at their homes (for nurses that live on-site or very close to the facility). A team of enumerators travelled throughout Liberia over a period of four weeks to collect data.

Data were double entered into Excel, checked for consistency and then transferred to Stata for analysis.

III. MAIN FINDINGS

We estimated equation (2) using mixed logit framework. This specification has been used increasingly in the health economics literature and in two recent applications of DCE to health worker decisions (Kruk et al, 2010; Blaauw et al, 2010). The mixed logit model can accommodate two particularities of the data at hand: the violation of the assumption of the independence of irrelevant alternatives and the fact that the in our survey individuals indicated their preferences over three jobs (Hensher and Greene, 2001). The latter point is an innovative feature of our design and we have not seen an example of this type of DCE design with health workers. First individuals were asked to choose between two fictional jobs; Job A or Job B. Second, the individual was then asked whether he or she would accept the preferred choice over their current job. They were asked about the levels of all job attributes in their current job too.

All attributes were significant and coefficients were of the expected sign. The means and standard deviations of the coefficients estimated by the mixed logit regression for the whole sample of 197 nurses are reported below. At the 5% confidence level respondents positively value

being located in an urban area, having adequate equipment, having higher pay, having access to transportation and housing, and having a normal workload.

Mixed Logit Model Results for Discrete Choice Experiment Estimating Nurse Preferences for Different Job Attributes in Liberia		
Variable	**Coefficient**	**Standard Deviation**
Total Pay	0.012***	-
	[0.001]	
Location	0.640**	3.625***
	[0.316]	[0.268]
Equipment	0.489***	0.732***
	[0.109]	[0.145]
Transport	0.750***	0.282
	[0.095]	[0.215]
Housing	0.701***	0.317
	[0.080]	[0.196]
Workload	0.346***	0.428***
	[0.076]	[0.124]
Job A Constant	1.719***	2.294***
	[0.265]	[0.221]
Job B Constant	1.113***	2.346***
	[0.213]	[0.288]
Number of Individuals	197	197
Observations	7118	7118
Log likelihood	-1509.78	-1509.78

Notes: (i) Estimations of Mixed Logit regression. (ii) Dependent variable takes value one if individual chooses that particular alternative. (iii) Estimations based on sample of 197 nurses. (iv) "Total Pay" coefficient fixed, remaining coefficients assumed to be normally distributed. (v) Every individual contributes a total of 54 observations (18 choice sets with three alternatives each). (vi) Standard Errors reported in brackets. (vii) ** p<0.05, *** p<0.001

Overall, nurses valued free transportation most and a normal workload least. The willingness to pay estimates are reported below. Willingness to pay is the amount of total pay nurses are willing to forego or trade-off each month in order to attain a higher level of a particular job attribute. In other words, it is the monetary value nurses place on different job attributes. For the whole sample, nurses were willing to pay USD$63 a month for a motorbike and USD$29 for not having a heavy workload. Housing is valued the second highest at USD$58 followed by working in an urban location (USD$53). Finally, nurses in our sample put a value of USD$41 on having adequate equipment.

It is important to note that these results are only valid assuming the length of service in all jobs is 3 years. This was explicitly noted to respondents in the questionnaire. It is likely e that with shorter or longer length of service the relative value nurse place on different attributes would not be the same.

We then divided our sample according to factors we believe may influence nurses' preferences. According to previous work, age, gender, whether the individual was born in a rural area, whether she spent part of her training in a rural area, whether she has ever worked in a rural area and whether the current facility is located in a rural area have all been shown to affect willingness to

work in a rural area (Lagarde and Blaauw, 2009; Riise Kolstad, 2010; Dolea et al, 2010; Serneels et al, 2010). Furthermore we asked several questions related to 'intrinsic motivation' and 'attitude to rural life' and used this to construct indexes (see Annex 2, questions 29-37 in the DCE questionnaire). We then analyze whether preferences vary according to these measures. We found that the joint equality of coefficients within the different subgroups is rejected throughout, indicating that there is significant variations in preferences by worker characteristics.

How Nurses Value Different Job Attributes, USD$ Per Month Per Nurse						
Sub-Group		**How much are you willing to pay to have…**				
		Job in urban area	**Adequate Equipment**	**Free Transportation**	**Free Housing**	**Normal Workload**
Combined Sample		**$53**	**$41**	**$63**	**$58**	**$29**
Age	Above 35	$141	$57	$71	$67	$42
	Below 35	$27	$35	$51	$51	$21
Gender	Men	$12	$61	$52	$25	$16
	Women	$79	$39	$62	$69	$34
Born in County Capital	Yes	$150	$56	$78	$96	$30
	No	$1	$39	$50	$36	$32
Work Experience in Rural Area	Yes	$14	$78	$82	$73	$42
	No	$133	$20	$48	$39	$18
Received Training in Rural Area	Yes	$99	$50	$58	$30	$30
	No	$7	$29	$56	$43	$31
Currently Working in Rural Area	Yes	-$89	$74	$82	$72	$5
	No	$160	$26	$38	$48	$22
Has High Intrinsic Motivation	Yes	$21				
	No	$59				

Note: Minimum and maximum values for each attribute are highlighted.

The value nurses place on location varies considerably by age, gender, and intrinsic motivation. Nurses aged 35 or above appear to value an urban location very highly with a willingness to pay of USD$147 (to be in an urban area) compared to individuals under 35 who are willing to pay USD$27 to be in an urban area. Women place a higher value on an urban location compared to men (USD$79 versus USD$12). Interestingly, for individuals with high intrinsic motivation location appears to be less important. These individuals express a willingness to pay of USD$21 to be located in an urban area compared to USD$59 among nurses with low intrinsic motivation.

Individuals with exposure to rural areas – either by birth or through nurse training or on-the-job experience – value being located in an urban area the least. Nurses born in a county capital are willing to pay USD$150 to be located in an urban area versus a rural area. For individuals born outside of a county capital, the willingness to pay is only USD$1. Nurses who have worked in a rural area are willing to pay only USD$14 to be located in an urban area compared USD$130 for nurses who have not worked in a rural area. Nurses who did part of their training in a rural area are willing to pay only USD$7 to be located in an urban area compared to USD$99 for nurses who did not have any exposure to rural areas during their training. Nurses who are currently employed in a rural area are willing to pay USD$89 to be located in an urban area compared to USD$160 for those that are currently working in an urban area.

Men, older nurses, and nurses who have worked or trained in a rural area value adequate equipment the most. Older health workers (aged 35 or above) place a higher value on having adequate equipment; USD$57 against USD$35 for nurses younger than 35. The willingness to pay for men is also higher than for women (USD$61 versus USD$39). Expose to rural areas, conversely, seems to be important for the valuation of this attribute. For nurses, who worked or trained in rural areas, the figures are USD$78 and USD$50. The respective figures for individuals without these experiences are USD$20 and USD$29. The results for nurses currently working in a rural area confirm this trend. For nurses employed in a rural facility the willingness to pay is USD$74 whereas for the urban counterpart it only is USD$26.

Men, older nurses, and those with exposure to rural areas value transportation the most. The figures for the willingness to pay for men and women are USD$52 and USD 62, respectively. Older nurses value transportation more than nurses aged below 35 (USD$71 versus USD$51). For individuals who work in a rural area the willingness to pay is USD$82 compared to USD$38 for those that work in an urban area – more than double. Interestingly, exposure to rural life (in a variety of forms) is also positively correlated with willingness to pay for transportation. Nurses born in a county capital value transportation at USD$62 compared to USD$50 for those born in a county capital.

The fact that nurses with rural exposure value transportation the most likely reflects that fact that the transportation infrastructure in rural areas is practically non-existent in Liberia. According to the health worker census, the majority of health workers outside of Montserrado county stated that their main mode of transport to work was by foot or bicycle. In fact, 18% of health workers outside of Monrovia stated they take public transport and 77% stated that they walk or use a bicycle. Meanwhile, in Monrovia, 81% of health workers stated that they use public transport to go to work and only 9.1% walk or use a bicycle.

Women, older nurses, and those with exposure to rural areas value free housing the most. Free housing is valued more by nurses aged above 35 (at USD$67) compared to younger individuals (USD$51). Women appear to place a higher value on this attribute (USD$69) compared to men (USD$25). For nurses born in a county capital the willingness to pay for housing is USD$96 compared to USD$37 for those born outside the county capital. Nurses who have previous experience working in rural areas are willing to pay USD$73 for housing compared to USD$39 for those nurses with no such experience. For nurses currently working in a rural area the willingness to pay for housing is USD$72 compared to USD$48 for urban-based individuals. For individuals who had part of their training in a rural area the difference is not that large – USD$30 compared to USD$43 for nurses who had none.

The fact that nurses with rural exposure value housing the most likely reflects that fact that housing conditions in rural areas in Liberia are much worse than in urban areas and those nurses with exposure to rural areas have faced this challenge in their day to day work. The table below from the health worker census shows housing conditions in different counties.

	Cement, wood or tile floor		Cement Block or Clay Brick wall		Zinc, asbestos, cement or tile roof		
County	No.	%	No.	%	No.	%	Total
Montserrado	2776	95.5%	1929	66.3%	2850	98.0%	2908
Bong	503	80.1%	368	58.6%	595	94.7%	628
Margibi	470	87.4%	254	47.2%	506	94.1%	538
Grand Bassa	351	77.0%	151	33.1%	409	89.7%	456
Grand Cape Mount	242	78.8%	105	34.2%	264	86.0%	307

Bomi	233	74.7%	106	34.0%	263	84.3%	312
Maryland	270	73.8%	104	28.4%	291	79.5%	366
Nimba	591	69.0%	120	14.0%	816	95.2%	857
Gbarpolu	104	62.3%	31	18.6%	106	63.5%	167
Lofa	366	42.2%	67	7.7%	700	80.6%	868
Grand Gedeh	141	46.4%	48	15.8%	149	49.0%	304
Sinoe	155	38.7%	60	15.0%	211	52.6%	401
River Cess	89	43.0%	17	8.2%	111	53.6%	207
River Gee	80	38.8%	6	2.9%	88	42.7%	206
Grand Kru	84	35.9%	15	6.4%	93	39.7%	234
Total	6455	73.7%	3381	38.6%	7452	85.1%	8759
The counties are in order of the highest percentage of HWs with optimal floor, walls and roofs combined. Other types of floor included: mud or other Other types of walls included: mud and Bricks; mud and sticks; reed, bamboo, grass or mat; wood or board; zinc or iron. Other types of roof included: bamboo, leaves or thatch; tarpaulin; others.							

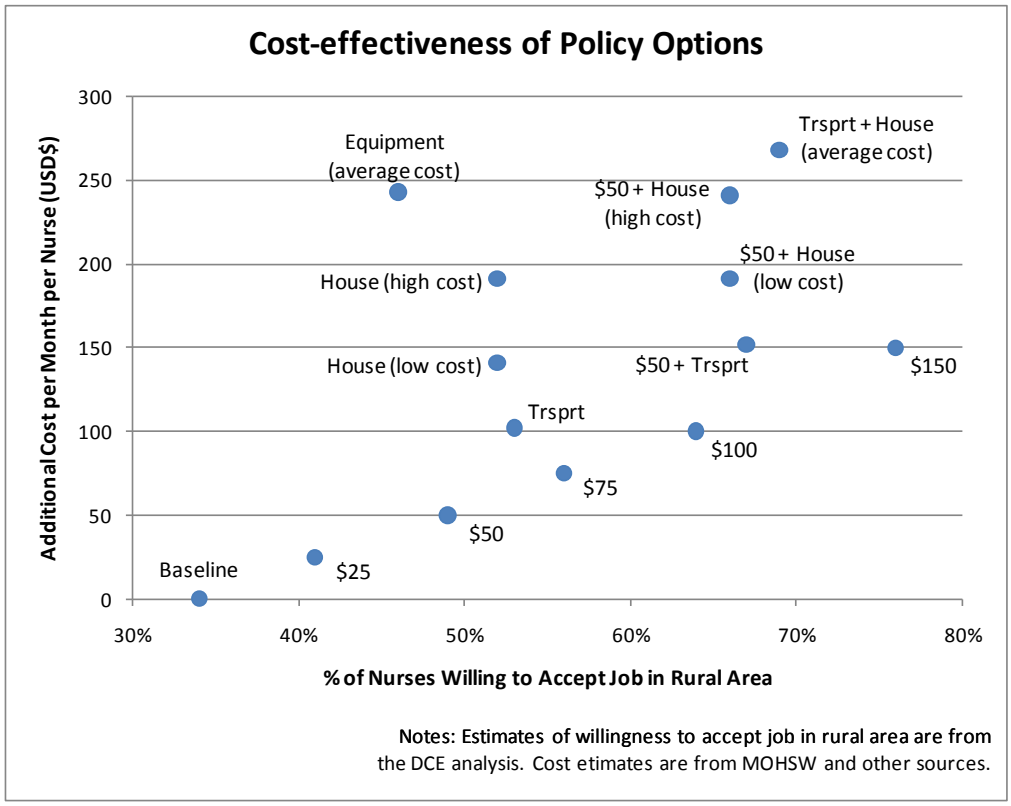
Women, older nurses, and those who have worked in a rural area value a normal workload the most. Older individuals (aged 35 or above) value normal workload at USD$42 whereas the figure for younger nurses is half this at USD$21. Similarly, women appear to value a normal workload twice as much as men, USD$34 versus USD$16. Whether the nurse worked in a rural area is strongly positively correlated with the value placed on normal workload. Individuals with this experience value it at USD$42 whereas the figure for the remaining sample is USD$18.

Policy simulations show that improving equipment, or providing either housing, transportation or a $USD50 per month bonus all have a similar impact on willingness to work in rural areas. Equation (4) can be used to predict the share of nurses who would accept a rural job over an urban job for different levels of equipment, transportation, housing, workload and pay. In the baseline scenario both urban and rural area jobs are assumed to have the same equipment levels (inadequate), no transportation, no housing, and have the same workload level (normal) and pay (USD$150). This is an accurate depiction of the current situation in Liberia based both on the DCE questionnaire and health worker census. Under this baseline scenario, the model predicts that 34% of nurses would be willing to work in a rural area.

Impact and Cost Estimates for Alternative Policy Options to Attract Nurses to Rural Areas		
Policy option to be implemented in rural areas	**% of nurses willing to accept rural area job**	**Additional cost in $USD per month per nurse (Min-Average-Max)**
Baseline	34%	0
Improve equipment	46%	168 – 243 - 318
Provide transportation	53%	102
Provide housing	52%	141 – 166 - 191
Provide housing and transportation	69%	268
Increase pay by $25	41%	20
Increase pay by $50	49%	50
Increase pay by $100	64%	100
Increase pay by $150	76%	150
Increase pay by $50 and provide housing	66%	216
Increase pay by $50 and provide transportation	67%	152

Note: In the baseline situation both the urban and rural area jobs have inadequate equipment levels, no transportation, no housing, and have the same workload level and pay. This is an accurate depiction of the current situation in Liberia.

By changing different job attribute levels in rural areas, we can get a sense of the relative impact this has on willingness to work in rural areas. For example, if equipment levels in rural areas were to improve (from inadequate to adequate) the model predicts that the proportion of nurses willing to work in a rural area would increase to 46%. If nurses in rural areas were provided with a motorbike then 53% of nurses would be willing to work in a rural area. If housing was provided in rural areas, then 52% of nurses would be willing to work in a rural area. If a USD$50 bonus was paid for service in a rural area (i.e. an extra allowance) then 49% of nurses would be willing to work in rural areas. It is interesting to note that a USD$25 bonus would have a very small effect. If a USD$100 bonus was paid for service in a rural area then 64% of nurses would be willing to work in rural areas. If both housing and motorbikes were provided in rural areas then 69% of nurses would be willing to work in a rural area. If housing and a USD$50 bonus were provided in rural areas then 66% of nurses would be willing to work in a rural area.



However, once costs are taken into account, pay increases are by far the most cost-effective policy option, followed by free transportation. Improving equipment is the least cost effective. To compare the cost-effectiveness of alternative policy options, the predicted probability analysis can be combined with costing data. But only one previous DCE study that we know of has done this very important step, and even then only for a very narrow set of attributes (Chomitz et al, 1998). This is the first case we know of where such a detailed costing of attributes has been carried out within a DCE study on health workers. Data were collected from various agencies within the MOHSW. Annex 1 describes in detail the methodology used for calculating attribute costs in Liberia. A range of costs is estimated in cases where assumptions needed to be

made and some values were uncertain. The midpoint estimate is used for the analysis presented in this section.

By far the most cost-effective policy option is to increase pay in rural areas. Paying a USD$50 bonus for locating in a rural area is estimated to have roughly the same impact as providing housing and improving equipment, but is costs about one-third the amount ($50 per nurse per month compared to USD$141 or USD$191 for housing and USD$243 for improving equipment). A USD$100 bonus has a slightly smaller impact than providing both housing and transportation but is much cheaper ($100 compared to USD$268). Similarly, if the MOHSW has USD$150 to spend per nurse, providing a USD$150 rural allowance is expected to have a much larger impact than providing housing (low cost estimate) or a USD$50 bonus and transportation.

However, if there are limitations on how much pay is allowed to vary by geographic areas in Liberia – either because of the civil service pay structure or political economy reasons – then large rural area bonuses may not be feasible. In this case, the next best policy option is to provide nurses with transportation in rural areas or a combination of a small bonus (e.g. USD$50) and transportation. Providing housing is the next best cost-effective option after this.

IV. POLICY RECOMMENDATIONS

Based on the DCE analysis there are three main actionable recommendations that emerge for improving nurse recruitment and retention in rural areas of Liberia.

The MOHSW should consider actively recruiting students from rural areas and exposing them to rural work conditions during their nurse training. The DCE analysis has shown that exposure to rural areas is associated with a much higher willingness to work in a rural area. This includes being born in a rural area, having served in a rural area during training, or having spent some part of their career in a rural area.

The MOHSW should consider increasing pay levels in rural areas relative to urban areas as this is likely to be very cost-effective. For example, introducing a USD$50 bonus in rural areas is predicted to increase the share of nurses willing to work in a rural area from 34% to 49%. This is quite similar to the impact of providing housing or improving equipment but providing the rural area bonus will cost much less. There are several other factors that make financial bonuses attractive. First, they are recurrent and do not involve investing in long-term infrastructure or durable goods. Second, financial bonuses can be set at many levels. Housing and transportation are discrete – nurses either receive them or they do not (or at best there are a few categories of these goods). Pay levels can be fine tuned, but housing and transportation can not.

If for some reason implementing rural area bonuses is not feasible, the MOHSW should consider providing transportation to nurses in rural areas. if there are limitations on how much pay is allowed to vary by geographic areas in Liberia – either because of the civil service pay structure or political economy reasons – then large rural area bonuses may not be feasible. This is the next best cost-effective policy option. In terms of housing, this is predicted to have roughly the same impact on willingness to work in a rural area as transportation but, according to our cost estimates, providing housing is much more expensive. Improving equipment in rural areas is not likely to be a cost-effective way of attracting nurses. If a USD$50 rural areas bonus is feasible, then combining this with provision of transportation is a very cost-effective way of attaining a substantial improvement in willingness to locate in rural areas.

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ANNEX 1

METHODOLOGY FOR ESTIMATING COSTS FOR DIFFERENT ATTRIBUTES

Summary of Attribute Costs

Cost Estimates for Providing Alternative Incentives in Rural Areas			
Incentive	**Description**	**$USD per month per nurse**	
		High	**Low**
Equipment	Cost of improving drugs, medical supplies, and medical equipment to a point where nurses can provide 75% of the BPHS instead of 25%	318	168
Transportation	Cost of providing a motorbike that can be used during normal working hours	102	
Housing	Cost of providing self-contained, concrete, apartment-style housing on-site at the facility.	191	141

Source: Annex 1

Equipment Attribute

We needed as estimate of the incremental cost of improving medical equipment, drugs, and facility standards to a point where nurses can provide 75% of the basic package of health services (BPHS) instead of 25%. To estimate this cost we relied on the recent BPHS costing report[2], the most recent facility accreditation results[3], and expert opinion.

The BPHS costing report summarizes the operating cost (including salaries, drugs, medical supplies but not infrastructure and medical equipment) in clinics, health centers and hospital for delivering the full basic package of health services. First, the volume of services within facilities was estimated base on catchment population and service delivery coverage scenarios. The low service delivery scenario represents levels that should be achievable in the short-term. It is based on current utilization levels for a sample of facilities and can be regarded as a reasonable goal for the average facility. The number of services per capita under this low coverage scenario is 0.72, which represents a coverage rate of 27% (i.e. 27% of 'needed' services are delivered). The 27% coverage rate was used for all services except immunizations, for which the individual coverage rates for each country were used based on the 2007 DHS report. As a comparison, the medium service delivery scenario assumes a 77% coverage rate for immunization and 50% for other services.

Second, the staffing, drugs and medical supplies (but not infrastructure and medical equipment) required to meet the target service delivery levels were determined by a team of local experts comprised primarily of physicians, nurses and midwives from the MOHSW and four NGOs. The standards were based, where possible, on MOHSW official guidelines and standards of treatment. The team of experts provided detailed information on the staff time and activities, drugs and supplies, and laboratory tests required for each service. These inputs were then costed.

[2] *Costing the Basic Package of Health Services at Clinics and Health Centers in Liberia*, Rebuilding Basic Health Services Project, October 2009.
[3] January 2010 BPHS Accreditation Final Results Report, MOHSW, Republic of Liberia. April 2010.

We used the drugs and medical supplies cost estimates for clinics and health centers under the low service delivery scenario as this most accurately reflects the current situation. We then assumed that *x*% of this total cost would be a good proxy for the cost of drugs and medical supplies needed to deliver *x*% of the full BPHS. To convert per facility costs to per nurse costs we simply divided by the average number of nurses per facility. We focused only on the nursing cadres that were the focus of the DCE study (RN, GN, CM, LPN) and relied on health worker census data (i.e. actual average staffing levels).

Thus, the monthly cost per nurse for improving drugs and medical supplies to a point where nurses can provide 75% of the basic package of health services (BPHS) instead of 25% is calculated as

Annual recurrent cost of drugs and supplies needed to deliver BPHS in clinics
×
(Share of cost needed to deliver 75% of BPHS – Share of cost needed to deliver 25% of BPHS)
÷
Months in year
÷
Average number of nurses per facility

= \$9,899 × (75% - 25% = 50%) ÷ 12 ÷ 1.39 = \$297 for clinics
= \$15,439 × (75% - 25% = 50%) ÷ 12 ÷ 4.38 = \$147 for health centers

For equipment costs, we could not use this same methodology because data on total equipment costs were not available in the same way. However, the most recent facility accreditation report provides a list of the most common equipment items that were missing from clinics and health centers. These equipment items are:

- Work surface near bed for newborn resuscitation
- Self-inflating bag and mask - adult & neonatal size
- Baby scales
- Examination table
- Stool, adjustable height
- Instrument / dressing trolley
- Instrument tray
- I.V. stand
- Resuscitation set with adult and child masks
- Instrument sterilizer
- Jar for forceps
- Opthalmoscope
- Otoscope
- Height measure

We then assumed that if these missing pieces of equipment were provided, this would be a good proxy for raising equipment standards from where nurses can provide 25% of the basic package of health services to where they can provide 75%.

Unit costs and expected useful life for the equipment items were provided by the Liberia National Drug Service. It was assumed that 1 of each item is required per clinic. The clinic cost was scaled up in proportion to average staffing levels to derive the health center cost. In other words

Equip. cost for HC
=
Equip. cost for Clinic
×
(avg. # of nurses in health center ÷ avg. # of nurses in clinic)

Thus, the monthly cost per nurse for improving medical equipment to a point where nurses can provide 75% of the basic package of health services (BPHS) instead of 25% is calculated as

Cost of purchasing equipment needed in clinics and health centers
÷
Estimated useful life (in months)
÷
Average number of nurses per facility

= $1,429 ÷ 48 ÷ 1.39 = $21 for clinics
= $4,504 ÷ 48 ÷ 4.38 = $21 for health centers

Taken together, the total monthly cost per nurse for improving drugs, medical supplies, and medical equipment to a point where nurses can provide 75% of the basic package of health services (BPHS) instead of 25% is

= $297 + 21 = **$318 for clinics**
= $147 + 21 = **$168 for health centers**

Transportation Attribute

The Expanded Program on Immunization unit of the MOHSW provided cost estimates for motorbikes. The most recent cost for a Yamaha AG100 97cc 2-stroke motorbike with headgear is $3,724. The average monthly maintenance and fuel cost is estimated to be $100. The expected useful life is 36 months with no salvage value. Assuming straight line depreciation this results in a monthly operating cost of $203 per motorbike. Consistent with the definition of the transportation attribute in the DCE survey, and based on consultations with decision makers, we decided on a rough allocation of one motorbike for every two nurses.

Thus, the monthly cost per nurse of providing motorbikes is

Monthly cost of providing a motorbike
÷
Nurses per motorbike

= $203 ÷ 2 = **$102**

Housing Attribute

The Infrastructure Unit of the Department of Planning and Research, MOHSW provided one set of cost estimates for housing. The Ministry of Education also provided estimates of housing cost for teaching quarters.

According to the MOHSW, the most recent estimates of the construction cost of a standard staff housing unit (two-bedroom duplex that could house two nurses) including materials, labor, transportation of goods is $95,000. According to the ministry of education the cost for a housing unit for teachers (that could house one nurse) is $35,000. In both cases the average annual maintenance cost is estimated at 1.5% and the expected useful life is 30 years with no salvage value. We assume straight line depreciation.

Thus, this results in a monthly operating cost per nurse of

$191 according to MOHSW estimates
$141 according to ministry of education estimates

ANNEX 2

THE DCE QUESTIONNAIRE