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Adverting maternal death and disability

The cost of emergency obstetric care: concepts and issues

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Abstract

Emergency obstetric care (EmOC), like any health intervention, requires resources, and resources are almost always limited. This forces decision makers to take into account the costs (and effectiveness) of EmOC provision and compare them with the costs (and effectiveness) of other health interventions. This is not inordinately complicated, but it does require paying attention to the fact that EmOC services require different types of inputs and are produced in facilities that also provide other health care services. This paper discusses the basic concepts underlying the costing of EmOC services, and the essential issues one must take into account while assessing the cost-effectiveness of EmOC interventions. A definition of EmOC provision cost is offered and then explained by progressively refining a simple measure of expenditures on all that is used to provide EmOC services. Thereupon the process of collecting cost data and calculating costs is outlined using a simple spreadsheet format, and issues related to the analysis of costs and cost-effectiveness are discussed.

1. Introduction

Half a million women die of pregnancy-related complications every year. A large majority of these deaths occur in developing countries where fertility rates, even though falling, continue to be high, and access to health care services is very low. Great strides have been made in increasing access to primary health care services, and a large emphasis has been placed on preventive services—such as prenatal care. While this has had a large impact on reducing the burden of disease in general, its impact on maternal mortality remains constrained by the fact that screening (during prenatal care) is not very effective in predicting obstetric complications. For all practical purposes 'all pregnant women are at risk of serious obstetric complications' [1], and so emergency obstetric care is critical to lowering maternal mortality.

Like any health intervention, emergency obstetric care (EmOC), requires resources—of personnel time, equipment, drugs, and supplies—and resources are always limited. Limited resources, with competing demands on them imply trade-offs, and so the natural question is whether allocating more resources to EmOC is worthwhile in

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relation to the other health interventions. This, in essence, is cost-effectiveness (of EmOC) and to even begin to determine whether EmOC is cost-effective it is necessary to calculate the cost of delivering EmOC services.

This paper discusses concepts and issues related to the estimation of EmOC costs, and the cost-effectiveness of EmOC services. The objective is to provide a sufficiently detailed, but relatively non-technical, exposition that is useful in conceptualizing the costs of EmOC service provision, and answering some obvious questions such as: what does it cost to treat a pregnancy-related complication? Is this cost the same at all facilities, and if not, what determines variation in EmOC costs? What is the cost of setting up a facility to deliver EmOC? At such a facility, what are the recurrent costs of providing EmOC services? What does it cost to upgrade an existing facility so it can provide EmOC services? Is it cost-effective to construct a new facility—in relation to other interventions that improve a population's access to existing, but distant, facilities? What is the cost-effectiveness of different interventions that improve the delivery of EmOC services? All of these, and other related questions, are aimed at one larger question: what is the best way to provide EmOC services to all women in a country?

The paper is organized as follows. Section 2 provides a definition of the cost of service delivery and discusses why simple calculations are inadequate. Section 3 then goes on to outline what is needed to calculate the cost of EmOC services, and relates this to the costs of the improvement, upgrading, and construction of EmOC-capable facilities. Calculating costs in itself is a hollow effort unless the figures can then be interpreted and analyzed in a meaningful way, so Section 4 discusses cost measures and the information they can yield on various service delivery issues. One of these is the comparison of different interventions, in terms of impact and costs and cost-effectiveness analysis is one way to do this. Section 5 discusses cost-effectiveness. Finally, Section 6 concludes by offering some thoughts on how a costing exercise relates to other economic issues in the delivery of EmOC services.

2. What does it cost to provide EmOC services?

A simple definition of the cost of providing EmOC is that it is the cost of using all items, people, and facilities that are required to provide treatment for a pregnancy-related complication. We adopt the provider's perspective—not a private provider motivated by profits but a public provider examining the social cost of using resources.

Cost can be calculated by: (a) defining an observation period for measuring cost components and number of EmOC services produced; (b) identifying all the things (inputs) that are used for treatment; (c) determining quantities used of each item; (d) valuing the quantities with appropriate prices; and (e) summing these values. In principle this is straightforward, but in practice it requires paying attention to a few key features of EmOC service delivery. These are best illustrated by starting with a simple approach (Estimate A), and progressively building in complexity until the definition given above has been correctly operationalized (Estimate D).

2.1. Estimate A

A simple starting point to costing EmOC is to calculate the total expenditure undertaken by a facility on all drugs, equipment, supplies, and personnel salaries used to deliver EmOC services during a certain time period, say a year. This is estimate A—the simplest—and it is the 'total expenditure on EmOC inputs' during the observation period.

The most obvious limitation of A is that it does not take into account the fact that expenditures on inputs (equipment, supplies, drugs, and personnel) during a certain time period do not perfectly match the use of inputs during that period. Some of the inputs used during that period were purchased earlier, some of the purchased inputs are left over, and some others are not purchased but received as donations.

2.2. Estimate B

The appropriate modifications to A are: (a) subtract expenditures on inputs purchased during

the year but not used up; (b) add the cost of using inputs from previous years (using the purchase price if the purchase was made not too far back in the past); and (c) add the cost of using inputs received as donations by valuing them at existing market prices (as if they were purchased or rented). If the results of the costing exercise are to have a larger relevance all inputs (including donated inputs) must be valued as if they were purchased or rented. This corresponds to the economist's concept of opportunity cost, which is the value of the next best alternative. This new estimate (B) is the 'total cost of EmOC inputs' during the observation period.

2.3. Estimate C

Estimate B is adequate for inputs that are completely used up during an observation period, but what about the equipment and facility that is used over a longer period of time? Expenditures on these inputs during the year do not reflect the cost of using them during this year; in some years there are no expenditures, but in others these expenditures are large. To get at the cost of using these durable inputs during a reference period we need to amortize the cost of the input over its usable life span; this can be done fairly easily with information on life span, depreciation, interest rate, and inflation rate. This modification yields estimate C, and may be termed the 'total cost of using EmOC inputs' during the observation period, getting us closer to the definition.

2.4. Estimate D

Provision of EmOC also requires inputs that are shared with other health care services at the facility—for example, the building itself is used for all other types of health care services, and some types of equipment might also be used in this manner. Then there are overhead costs related to administration, accounting, sanitation, security, etc. Including the cost of these inputs overstates their contribution, while excluding them understates costs. To calculate the EmOC-specific cost of these shared inputs, we need to determine how much of these inputs is used in the provision of EmOC services during the reference period and then use that share to allocate the cost of these inputs to EmOC. This estimate represents the total cost of using all inputs in the provision of EmOC services during the observation period and corresponds to the definition outlined at the start of this section.

The progression of cost from 'sum of EmOC-specific expenditures' to 'sum of costs of all inputs used in the production of EmOC services' highlights three features: (a) EmOC services are produced in 'multi-output' facilities and as a result share some inputs with the other health care services they provide; (b) production of EmOC services requires multiple inputs (drugs, supplies, equipment, a facility, and trained personnel); and (c) some of these inputs are used over and over again. Calculation of costs of providing EmOC services then boils down to determining the cost of using all relevant inputs, either for a specific number of EmOC services, or what is easier to measure, over a specific period of time. The following section provides a brief step-by-step outline of the types of data required for this calculation, and the calculation process.

3. Data collection and cost calculations

The entire process consists of designing data collection forms, recording the data, and then using either a calculator or computer to do the calculations. Here I describe the types of data needed, and how they can be organized and used in a spreadsheet computer program; the design of data collection forms follows naturally from this, and is relatively straightforward. Note that this is not intended to be comprehensive, and the interested reader should refer to a WHO manual that describes this in detail [2] or other such cost manuals for a more comprehensive treatment of costing. The column numbers (in italics) refer to columns in a spreadsheet (Fig. 1).

3.1. Define the time period

The first step in the collection of cost data consists of defining an observation period over which input use and EmOC service is to be measured. There is a balance to be struck between

Identify Inputs	**Classify**		**Apportion usage by EmOC**		**Quantity used**							**Current market price**	**Acquisition**				**Cost of use**
			Share of EmOC	Fraction of cost/quantity of input used during this period	EmOC-specific & consumable	Shared & consumable		EmOC-specific & durable		Shared & durable			When	How	Cost	Qty	
	EmOC-specific (Yes/No)	Consumable (Yes/No)	(1.0 if EmOC-specific, calculated fraction if shared)	(1.0 if consumable, calculated fraction if durable)	Qty used	Total qty used	Qty used by EmOC = Col 4 x Col 7	No. used	Qty used during period = Col 5 x Col 9	No. used	Qty used by EmOC = Col 4 x Col 5 x Col 11		Date	Purchased/ donated	Price/ unit		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Referral																	
Input 1																	
Input 2																	
Input 3																	

Fig. 1. Spreadsheet-based cost data collection and calculation.

a short observation period, like a month, wherein measurement is likely to be more accurate, and a longer period, like a year, which is likely to be more comprehensive and less influenced by short-term variations. To the extent possible, it is best if data are collected for several time periods (months). This allows cross-checking information and averaging out short-term fluctuations.

3.2. Identify all inputs

The second step consists of identifying all inputs used to provide EmOC. The best way to do this is to mentally walk through the entire process starting with referral to facility, and moving on through the different stages—arrival at the facility, diagnosis, treatment, recovery, discharge. At each point any involvement of facility personnel, equipment, drugs, and supplies is noted. In a spreadsheet these are entered in column 1, with identified inputs making up the rows; Fig. 1 displays a skeleton spreadsheet with only three inputs (identified during the referral stage of the walk-through). If a walk-through is used to identify inputs, then the inputs can be categorized in terms of the stages of the process.

3.3. Specify whether input is durable or consumable, specific or shared

Once the inputs have been identified, they must be classified in terms of their specificity for EmOC service delivery, and their durability (use over time). The way in which 'use cost' is calculated is different for shared inputs, and inputs that are used over several observation periods. This early classification alerts the analyst to what lies ahead. In a spreadsheet each of these criteria can be used to define separate columns (columns 2 and 3) and the two-way classification of EmOC-specific vs. shared, and consumable vs. durable can be used to obtain a four-way classification: EmOC-specific and consumable (i.e. used up during the measurement period); EmOC-specific and durable; shared and consumable; and shared and durable.

In the case of inputs that are shared with other health care services a method is needed for determining how much of the cost of the input is to be allocated to EmOC. This requires identifying all other health care services that use the shared input, and determining the share of EmOC in total usage and cost. This information may be recorded in the same spreadsheet, but it is easier if this is done in a separate spreadsheet (along with any calculations) with only the share of EmOC appearing in column 4 of the spreadsheet. This can be done in various ways. One simple algorithm is to allocate total cost (of these inputs) equally between all health care services produced by the facility. This is simplistic and assumes that the shares of all health care services—in the total output mix—are the same, and so are their requirements. Another is to allocate based on the case load of each health care service during the observation period. This takes care of differences in output mix, but still assumes that input requirements are the same. The most careful approach is to measure detailed use patterns for each health care service and allocate costs based on number of times used, and intensity of use.

With durable inputs we need to specify their life span in terms of the measurement period. Often the analyst must assume a life span as it is not readily apparent how long a piece of equipment (or a training session) is usable. Therefore if the measurement period is months, life span should be recorded in months. This information is used to amortize the cost of the input over its entire life span. It is best if this, too, is done in a separate spreadsheet, and only the relevant variable (for determining the portion of the durable input used in the observation period) appears in column 5 of the spreadsheet. Details on amortizing can be found in most cost manuals, and provision should be made to collect these data separately [2].

3.4. Determine how much of the input is used

Once the inputs have been identified and classified, the amount of each input used (in the observation period) for EmOC services must be determined.

1. With EmOC-specific and consumable inputs this is straightforward because the quantity used is clearly identifiable (column 6). Complica-

tions arise with cost-sharing and durability, and this will require fairly detailed work which is beyond the scope of this paper. Here I present the broad outlines of what is needed to collect the relevant data and undertake the necessary calculations.

2. In the case of shared and consumable inputs, identifying quantity used should, in principle, also be straightforward but it may be more difficult to obtain. Total quantity used—by all services—can be recorded in column 7 of the spreadsheet and then the quantity used for EmOC services can be calculated as fraction of this total (in column 8 by multiplying columns 4 and 7). When it is not possible to quantify input usage, the only recourse is to allocate total costs of the relevant inputs using the same procedure (column 18).
3. With EmOC-specific and durable inputs (like vacuum extractors) the amount used during the observation period has to be calculated. This can be done by noting the number used during the observation period (column 9), and calculating the portion (of these inputs) used during that period (in column 10) by multiplying columns 5 and 9.
4. In the case of shared and durable inputs the complications of cost-sharing and durability appear together and need to be taken care of by recording the number used during the observation period (column 11), and then determining the fraction used by EmOC services (column 12)—by amortizing usage and calculating the share attributable to EmOC. In this simple outline this is done by multiplying columns 11, 4 and 5. In all cases, if quantity is not identifiable, then costs, instead of quantity, can be appropriately apportioned (column 18).

3.5. Assign a value to inputs

The penultimate step consists of assigning a value to all the input quantities used in the production of EmOC services during the observation period. The objective is to value all inputs at current market prices because these, with some qualifications, reflect the underlying valuation of resources in the economy. The first step then is to obtain information on current market prices for all inputs used in the provision of EmOC (column 13). Before the quantities can be valued at these prices two factors must be taken into account: (a) the input might not have been acquired during the same observation period; (b) the input might not have been purchased by the facility and received as a gift. The information needed for this purpose consists of determining when each input was acquired (column 14), how it was acquired (column 15), and its acquisition cost (column 16). Because information on acquisition cost is likely to be available in terms of total expenditures on the input it is necessary to also record the quantity acquired (column 17) to determine the unit cost.

In the case of inputs purchased during the same measurement period, if the quantity used equals the quantity purchased during the period, value of the input (column 18) is the same as acquisition cost. If, however, the quantity used is different from the quantity purchased, then valuation should be restricted to the quantity that is used during the measurement period. If the input was purchased before the observation period, then it is necessary to determine whether its acquisition price is reflective of current market prices. If it is, either because it was purchased recently, or because inflation is low, then acquisition cost reflects current value. If not, then it is best to value the quantity used with current market price. Finally, if the input was received as a gift, then current market price should be used to value the quantity used.

3.6. Sum the values

The final step of the exercise consists of summing the values obtained in column 18 to arrive at the ‘total cost of producing EmOC services during the observation period’; in a spreadsheet this is the sum of all rows in column 18. It reflects the number of services provided, the mix of EmOC cases treated, the prices of various inputs used to produce EmOC services, and the management and operational objectives of the facility in question. It is the core measure of service delivery costs, but in itself it is of limited value. More meaningful measures can be derived from this estimate and these are discussed in the next section.

4. Cost measures and analysis

Starting with the total cost of producing EmOC services during a period of time, the most obvious and usable cost measure to calculate is the average cost of treating an obstetric emergency. This is calculated by dividing the total cost estimate by the number of EmOC cases treated during the observation period. This represents the typical cost of treating a pregnancy-related complication at the selected facility. It is a very useful measure because it can be compared with the average cost of other health interventions, and used to assess the overall cost configuration of services in the selected facility. There are, however, three points to bear in mind when using this measure of costs.

4.1. Impact of case mix

The average cost of treatment is influenced by the mix (both type and severity) of EmOC cases treated during the period. Only if the observed mix is a typical pattern of cases can the estimate be used to generalize to other facilities. It may be preferable to calculate costs separately for each type of complication, but at the very least one should calculate costs over several time periods to reduce the impact of month-to-month variation in case mix.

4.2. Impact of case load

The average cost of EmOC services varies with case load, typically displaying a U-shaped relationship. Average costs are usually high when a facility is treating relatively few obstetric cases (because fixed costs are spread over fewer patients), then fall with increasing case load, and rise again when the number of cases exceeds the installed capacity. In calculating EmOC costs, and assessing cost effectiveness of alternative interventions it is important to keep this in mind because it might take a while for service utilization to increase. High average costs in the initial stages are not indicative of the average cost of EmOC services during an extended period of time, and should not be used in an unqualified way. At the very least one should compare the existing case load with estimates of unmet need to project how average costs are likely to vary as service utilization increases. This amounts to looking at the marginal, or additional cost of delivering more EmOC services. Economists emphasize the distinction between average and marginal because decision-making is typically based on considerations at the margin.

4.3. Economies of scale

Average cost calculations, following the procedure outlined in the previous section, are specific to a certain level of installed capacity, i.e. facility size, number of staff, sets of equipment, etc. In economic jargon these are short run costs. A different level of installed capacity might have a different cost configuration. If there are no economies or diseconomies of scale, i.e. if there are no benefits from operating a larger facility with greater installed capacity for treating EmOC cases, then average costs will be the same, and the average cost figure can be used to estimate how much a ‘scaled up’ version of a facility might cost. However, to the extent that a larger facility, say a regional hospital (compared with a district hospital) is able to be more efficient, and, potentially, negotiate better prices for inputs, there will be economies of scale and average costs will be lower. All of this depends on the specific context, but caution is clearly needed in extrapolating beyond the existing scale of operation.

Going beyond the average, or marginal cost of EmOC services, one needs to also pay attention to an essential distinction in the types of costs that make up total service delivery costs.

4.3.1. Fixed costs

There are the costs of inputs that reflect capacity, and do not vary with the number of cases treated during the observation period. These include facility costs, equipment costs, overheads, etc., and are termed fixed costs because they are incurred regardless of the number of patients treated during the observation period. These are the costs of setting up new facilities, upgrading existing non-EmOC facilities to become EmOC-capable, and renovation of functioning EmOC facilities. With

minor modifications to the procedure, all of these can be calculated relatively easily. Fixed costs represent infrequent outlays, and are likely to be large, in some cases too large for a facility, community, or government to undertake. There is, therefore, ample justification for external, i.e. donor, financing of these costs.

4.3.2. Variable costs

Besides fixed costs, there are costs that are directly related to the case load and these obviously vary with the number of complications that are treated. These are the costs of drugs, and supplies and are termed variable costs because they vary with the number of cases treated. These are recurrent costs and often viewed as the responsibility of facilities, communities, and governments. They can be financed with budgetary allocations, community funds, or even user fees, that can be set in relation to average variable costs.

Calculating cost of EmOC—whichever cost is determined to be the most appropriate one—gets us to one point. Now the question to consider is whether the cost of the intervention is affordable and sustainable. This requires going beyond costs and examining the facility's financing and revenue sources, keeping in mind the distinction between start-up costs, and recurrent costs. This needs to be done for all types of interventions to get a comprehensive picture of what all a facility spends its resources on, what is accomplished with that level of expenditure, what its priorities are, and how these expenditures are financed. If it is then determined that the existing pattern of expenditure does not match the revenue flow, then either services must be restructured or additional funding sought. The latter might require a combination of actions including instituting and/or raising service fees and soliciting additional funds from government, or donors.

5. Cost-effectiveness

After calculating the costs of EmOC it is natural to question whether it is cost-effective. This section, without going into the details of cost-effectiveness analysis, will clarify what cost-effectiveness means, and how to go about determining whether EmOC is cost-effective.

According to Gold [3] 'cost-effectiveness analysis is a method designed to assess the comparative impacts of expenditures on different health interventions.' Cost-effectiveness analysis compares two or more health interventions in terms of their costs and some measure of their health impact. It is done by calculating the costs of the interventions in question, and the outcomes resulting from the interventions. The ratio of the difference in costs to the difference in the outcome measure is the cost-effectiveness ratio, and this measures the 'incremental price of obtaining a unit health effect (such as dollars per year, or per quality-adjusted year, of life expectancy) from a given health intervention when compared with an alternative' [3].

There are at least three different approaches to assessing the cost-effectiveness of EmOC. One is to compare (costs and effectiveness of) provision of emergency obstetric care with some other intervention that addresses maternal mortality. Another is to compare cost-effectiveness of EmOC with that of other health interventions. In this case effectiveness is measured in terms of a unit such as life expectancy, disability-adjusted life years (DALY) or deaths averted. A third does not compare EmOC with other interventions. In this case effectiveness is measured by comparing before and after measures of obstetric services such as maternal mortality or the UN indicators [5].

Clear objectives are critical to defining the scope of cost-effectiveness analysis: should the comparison be with maternal mortality interventions or other (more general) health interventions? Should effectiveness of EmOC be measured in terms of the number of (maternal and/or perinatal) lives saved, or the number of patients treated? Should we calculate the cost of treating each emergency, the cost of each obstetric patient, the cost of each obstetric bed day, or the cost per capita of the population served? There are no easy answers to these questions, but if cost-effectiveness analysis is to be attempted some justification has to be provided for whichever measure is used to assess effectiveness.

Once cost-effectiveness ratios have been calculated they require interpretation so they can be used appropriately in decision-making. The interpretation is clear when the cost of an intervention is lower and the intervention is more effective than the one with which it is being compared. If an intervention has no effect on the outcome, it makes no difference whether its costs are lower or higher, it is not cost-effective. Real questions arise when an intervention is both more costly and more effective, or less costly and also less effective. In these two cases, there are trade-offs and decision-makers have to think more carefully about whether additional costs are affordable, even when they are clearly more effective.

6. Conclusion

In developing countries especially, limited resources along with many competing demands on them force choices among different health interventions. How should a policy maker, program manager, or donor go about making these choices? Several factors enter this decision-making process but two that clearly should be at the top of the list are cost and effectiveness. It is only sensible that interventions with a larger impact on death and disability and ones that are not costly should receive most attention. This requires developing comparable estimates of effectiveness and costs.

Because interventions target a wide variety of people and illnesses, their effectiveness is not easy to compare. A beginning has been made with DALY [4], and while the measure is problematic and sometimes controversial, it is a start. The problems of cost estimation are more tractable and much work has been done in the context of developed countries. Surprisingly there appears to be little effort to measure costs in developing countries. This is necessary if a more rational resource allocation is to be achieved.

This paper has presented the basic concepts of costing emergency obstetric care. Given the persistent questions about the perceived high cost of EmOC, and its cost-effectiveness relative to other health interventions, calculation of EmOC costs is needed in diverse settings to determine whether these concerns are justified. In conducting these analyses it is of paramount importance that sufficient attention be paid to (a) the perspective that is adopted; (b) the alternatives under consideration; and (c) the current-level of service utilization. The last determines the average cost of service delivery, and thereby influences cost-effectiveness calculations. It would be beneficial in conducting these analyses to simulate the impact of different service utilization rates on cost calculations. This is critical because in developing countries a large percentage of deliveries take place at home, and the transition to facility-based deliveries, and use of EmOC services can take a long time.

Finally, it needs to be recognized that service delivery costs form one component in the overall economic evaluation of emergency obstetric care and maternal mortality. There are demand-side issues involving utilization, user fees, access costs, quality, and insurance. On the supply-side there are questions of service quality, public-private roles, regulation, sustainability, and financing. The point of linkage between the demand and supply side is the price of EmOC services, and costs can have a large bearing on this, especially when sustainability and rational allocation of limited health resources are integral elements in the decision-making processes of policy makers.

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