Implementing Standard Antenatal Care Interventions: Health System Cost at Primary Health Facilities in Tanzania.

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Abstract

Background

Since 2002, Tanzania has been implementing the focused Antenatal Care (ANC) model that recommended four antenatal care visits. In 2016, the World Health Organization (WHO) reintroduced the standard ANC model with more interventions including a minimum of eight contacts. However, cost-implications of these changes to the health system is unknown, particulary in countries like Tanzania, that failed to optimally implement the simpler focused ANC model. We compared the health system cost of providing ANC under the focused and the standard models at primary health facilities in Tanzania.

Methods

We used a micro-costing approach to identify and quantify resources used to implement the focused ANC model at six primary health facilities in Tanzania from July 2018 to June 2019. We also used the standard ANC implementation manual to identify and quantify additional resources required. We used basic salary and allowances to value personnel time while the Medical Store Department price catalogue and local market prices were used for other resources. Cost were collected in Tanzanian shillings and converted to 2018 US$.

Results

The health system cost of providing ANC services was US$185,282 under the focused model and the cost increased by about 90% at health centres and 97% at dispensaries to US$358,290 for the standard model. Personnel cost accounted for more than one third of the total cost for both models. With the standard model, costs per pregnancy increased from about US$33 to US$63 at health centres and from about US$37 to US$72 at dispensaries

Conclusion

Introduction of a standard ANC model at primary healthcare facilities in Tanzania will double resources use compared to current practice. While resources availability has been one of the challenge to effective implementation of the focused ANC model, more research is required, to consider whether these costs are reasonable compared to the additional value for maternal and child health.

Introduction

In 2016, the World Health Organization (WHO) changed its Antenatal Care (ANC) guideline from a focused ANC model (1) to a standard ANC model, to reduce perinatal mortality and improve womens experience of care. The standard model contains 49 recommendations which are grouped into five types

of interventions.The new recommendations include calcium supplementation throughout pregnancy to reduce the risk of pre eclampsia (nutritional intervention), systematic screening for active tuberculosis and early ultrasounding (maternal and fetal assessment intervention), up to six month dosing with sulfadoxine-pyrimethamine (SP) for preventing malaria, seven day antibiotic regimen for asymptomatic bacteriuria (preventive measures intervention) and a minimum of eight contacts with a skilled health personnel, to reduce perinatal mortality and improve womens experience of care (health systems intervention) (2, 3). Despite the expected benefits, there are financial concerns in developing countries, particularly in countries that failed to effectively implement the more simple focused model (4–6). Implementation of the standard model with anticipated increased resource requirements need to be considered in the light of resource scarcity and other competing priorities.

The basic version of a focused model recommends four visits for a normal pregnant woman, i.e. one visit in each first and second trimesters and two visits in the third trimester. In this model, recommendations fall within screening, providing therapeutic interventions and educating pregnant women. The implementation manual suggests that, all services should be provided at the ANC unit, where rapid and easy to perform test should be available. It also suggests that, the activity-time should be between 30 minutes and 40 minutes during the first visit, and 20 minutes for each of the subsequent three visits (1). Women requiring special care follows a different version but are eligible to the basic one afterwards.

Tanzania adapted the focused ANC model in 2002, and is still using it to screen, provide therapeutic interventions and educate pregnant women(7). Screening for malaria at the first ANC visit is an add on recommendation The majority of pregnant women receive care from nurses and midwives at primary health facilities (dispensaries and health centers), but are referred to higher levels when special care is needed (7, 8). On daily basis, a group health education session is followed up by indivualized assessment, screening, provision of medicine interventions and education. During screening, tests missing at ANC clinic are requested from a facility laboratory, which means activity-time may exceed that recommended by WHO.

Although Tanzania has documented improvement in focused ANC implementation such that 98% of pregnant women visit ANC at least once and 51% manage to complete four visits (9), there are remaining challenges. For example, only 24% of all pregnant women go for their first visit before the 4th month of pregnancy, and there are reports of underutilization, inadequate service provision, poor quality of care and scares resources (4, 7, 9–15).

Few studies have documented resources used for ANC in Tanzania and none have considered the costs of implementing a standard ANC model. Von Both (2008) estimated consultation costs from the health system perspective to be US$2.5 per visit (16), while Kowalewski (2002) estimated indirect user cost of US$9.9 per visit at primary health facilities (17). Another study in rural areas of southern Tanzania (2009) reported a cost of US$16.4 per visit from a health system perspective (18). In 2015, a study in the neighbouring country Rwanda estimated a cost of US$10.65 per visit (19) under the focused model and

US$9.9 per visit after addition of some recommendations from the standard model (20), both from a health system perspective.

WHO's recommendations influences guideline updates in developing countries, yet country level economic evidence to support such decisions are scarce while resources for implementation are limited. Therefore, our objective was to estimate the cost of providing ANC services at primary health facilities in Tanzania under two scenarios: (1) the current practice, which reflects a suboptimal implementation of the focused ANC model, and (2) a hypothetical but full implementation of new recommendations from the standard ANC model on the same population.

Methodology

Study settings

We conducted this study in Kigamboni and Korogwe districts. Kigamboni is situated along the Indian Ocean, south-east of Dar es Salaam and is devided into nine wards with a population of 206,000 (21). Kigamboni has a total of 21 public health facilities, including one designated hospital, two health centres and 18 dispensaries. Korogwe district is within Tanga region, 283 kilometers north of Dar es Salaam and has a population of about 260,000. Korogwe district provide health services from one district hospital, three public health centers and 44 dispensaries. From each district we purposively chose three primary health facilities, i.e. one health centre and two dispensaries, with highest number of ANC visits to document maximum cost per facility used under the focused ANC model, and maximum cost expected under the standard ANC model. Dispensaries and health centres are primary health facilities providing basic ANC in Tanzania. A dispensary is the lowest post and offers mainly outpatient services, while a health center provides more services to a larger population.

Data Collection

We collected data from August to October 2019 using the micro-costing or bottom-up approach, and from a health system perspective. Data collection involved documentation review, physical inventory and interviews with healthcare workers. We identified actual resources used to provide focused ANC from July 2018 to June 2019 (one financial year) for the chosen facilities. For standard ANC we used an implementation manual to model additional resources required, since the intervention is not yet implemented and observational data consequently are unavailable. We classified resources consumed within one year as recurrent cost items; these included personnel, non-medical and medical supplies, medicines, laboratory supplies, utility, maintenance and repair of capital items. We categorized resources that last more than a year as capital cost items, which included buildings, equipment, furniture and national level programme cost (22).

Quantification and Valuation of resources

Personnel

We interviewed each health personnel that was identified as being involved with ANC about his/her qualifications, salary scale, allowances, and how much of their working time they spent on ANC compared to other duties. We assumed that pregnancies are evenly distributed over the year and that time allocated to ANC did not vary over the study period. We included the gross salary, overtime and uniform allowances when calculating personnel costs. We excluded annual leave cost because data were unreliable. We used the gross salary for a medical attendant to represent forgone benefits among voluntary workers. For each personnel, we multiplied the proportion of time allocated to ANC and annual cost to calculate personnel cost attributed to ANC. We used the proportational floor space for ANC activities as allocation factor to calculate non medical personnel cost (guard and cleaners).

To calculate personnel cost for the standard ANC model we valued additional time needed in a five step process: First we calculated the total time allocated to focused ANC by nurses (who performs most ANC activities) and laboratory staffs (who conduct testing missing at ANC). We named these “reported-time”. Second, we calculated the time that ideally is required to attend all pregnant women, based on the WHO suggestion of spending 30 minutes to 40 minutes during the first visit and 20 minutes for subsequent visits, which we named “activity-time”. We calculated activity-times for both ANC modes, visits recorded during the study period and eight visits expected under standard ANC. Third, we calculated a ratio between reported-time and activity-time for the study period. Fourth, we calculated “expected time” to implement standard ANC by multiplying activity time for standard ANC and the ratio calculated above. The ratio was used to account for the time spent on other responsibilities related ANC, but not direct patient encounter, e.g. documenting, training and organizing test and results from the main laboratory. Lastly “additional time” required to implement standard ANC was the difference between expected time and reported time. We devided additional time among nurses equally at each facility, and used their annual cost for valuation. For other personnel we assumed that, their reported-time would not change with a new model. We included the annual cost of a sonographer at each facility and assumed 50% allocation to ANC.

Supplies

We used ANC monthly reports to quantify medicine and laboratory supplies consumed. Monthly reports record types and numbers of tests performed, vaccines provided and medicines administered. For example, with a report of 260 Tetanus Toxoid vaccines, we estimated 13 vials of the vaccine (one vial contain10 mls and the standard dose is 0.5mls) and 260 syringes of 1ml each. We used the standard ANC recommendations shown in Table 1 to quantify additional supplies, including six monthly doses of calcium suppliments and antibiotic for seven days to 13% of pregnant women predicted to have asymptomatic bacteriuria (23). We quantified other medical supplies (gloves, cotton wool, spirit, bedsheet, and safety boxes) issued to ANC and the laboratory from pharmacy registers, and additional supplies for a standard model based on the recommendations. The allocation of shared medical supplies

reflected nurses and laboratory staff time allocation to ANC. We also included thermal and tissue papers and ultrasound jelly for a routine scan.

We interviewed either a facility accountant or facility in-charge of expenses on cleaning detergents and equipment and allocated them using the same factor as for cleaners (see above). We quantified stationaries used at the laboratory and ANC, and we assumed that consumption will double under the standard ANC model. We increased the total quantity for each supply by 5% to account for spoilage (24). We used the Medical Store Department (MSD) price catalogue (2018/2019) and local market prices to attach values, and increased the unit cost by 10% for transportation expenses (24). The annual cost was estimated as the product of adjusted quantities, adjusted unit cost and allocation to ANC for each item.

Table 1
Recommended visits, medicine and laboratory investigations during ANC

Output per pregnancy	Focused ANC (Tanzania)	Standard ANC (WHO)
Number of visits	4	8
Anemia test by hemoglobinometer	4	3
Urine dipstick test	4	3
Blood grouping test	1	1
Malaria by MRDT	1	1
Syphilis test	2	2
HIV test	2	2
Tetanus Toxoid vaccine	Depend on the previous vaccination status	
Seven day antibiotic for asymptomatic bacteriuria	0	13% of the population
Sulfadoxine Pyrimethamine for malaria prophylaxis	≥ 3	6
Long-Lasting Insecticide Treated Net (LLITN)	1	1
Ferrous and Folic acid supplements	≥ 3	6
Antihelminthes (Albendazole 400mg)	1	1
Calcium supplementation	0	6
Routine Ultrasound scan	0	1

Water, gas and electricity

We interviewed the facility accountant or facility-in charge about water, gas and electricity bills. We allocated 50% of the gas cost (used to store vaccines during electricity cuts of) to ANC because the

freezer also stores vaccine for children and others. We allocated electricity and water bills based on the proportion of equipment and rooms for ANC unit. For the standard model, we assumed that the cost of electricity would increase to cater for air conditioning the ultrasound room, which is not a requirement with focused ANC. We adopted the electricity bill from a facility which had ANC clinic installed with an air condition.

Capital items

All identified equipment and furniture were costed using the proportion of time used for ANC of involved health care workers as the allocation key. We used the Tanzanian Medical Stores Department price catalogue or local market prices to assign values. For the standard ANC model, we in addition included annual costs for the Ultrasound machine, examination bed, movable chair, washbasin stand, double step, and air-condition, which were allocated to ANC by 50%, which is an assumption made in the WHO implementation manual for standard ANC (2). Assumptions about useful life years for capital items were adopted from the WHOs “Choosing Interventions that are Cost-Effective project” (25), and in addition we assumed 10 years for the ultrasound machine. Annuitized capital costs were calculated using a 5% interest rate (22).

We used a tape measure to quantify floor space used for ANC, and allocated building space based on personnel. We adapted the costs used to construct a Reproductive and Child Health (RCH) building in Korogwe in 2008, assuming 20 years of useful life and 5% interest rate. Observations made during data collection support the idea that the standard model can be facilitated within buildings already available at each facility, with minor renovations for the ultrasound machine security and functionality. Finally we assumed annual maintenance and repair costs of 5% of total capital cost and then 10% of the total annual cost at facility level represented national level programme cost (26).

Data analysis

We adapted the data collection tools from the Costing Guidelines for HIV Prevention Strategies (27), and used Microsoft Excel® for compilation and analysis. We calculated the total cost by aggregating annual cost of all items and personnel. We calculated the unit cost per visit as the ratio of total costs to the number of ANC visits, and the cost per pregnancy as the ratio of total cost to the number of first visits. Items were valued in TSh and converted to the US$ using the Bank of Tanzania exchange rate for early July 2018 (US$1 = TSh2,278) (28).

Results

ANC characteristics of study facilities

We recorded a total of 19,342 visits across six primary health facilities, which accounted for 90% of visits (21,080) expected for a focused model (Table 2). Pregnant women at a health centre in Kigamboni (health centre$_1$) attended more than the recommended four visits. This could have been caused by some visits being referrals from dispensaries for specialized care including ultrasound. The number of visits

will double or triple across primary health facilities under the standard model, which signals an additional workload.

Table 2
Number of ANC visits at each study facility

	Recorded for the focused ANC			**Standard ANC**
Health facility	First visits	Annual visits	Visit/ pregnancy	Annual visits
Health Centres				
Health centre$_1$	1,676	7,714	4.6	13,408
Health centre$_2$	742	2,149	2.9	5,936
Dispensaries				
Dispensary.$_1$	795	2,735	3.4	6,360
Dispensary.$_2$	1,019	3,886	3.8	8,152
Dispensary.$_3$	397	1,140	3	3,176
Dispensary.$_4$	641	1,718	2.7	5,128
All facilities	**5,270**	**19,342**	**42,160**	
¤ Assuming 8 visits per pregnancy				

Personnel time

Table 3 presents the time (in hours), used by nurses and laboratory staff under the focused model (reported time) and additional time required for the standard model. The ratio between reported-time and activity-time for the focused model suggests that, personnel used from 1.6 to 3.8 times higher the time suggested by the WHO. But within current levels of personnel productivity, facilities need more personnel time from one to three additional nurses allocated 100% to ANC for the standard ANC model implementation. While each pregnant woman in addition will use two to six hours of personnel time throughout pregnancy.

Table 3
Time (hours) used for the focused model and time required for the standard model

	Health center (2)		Dispensaries (4)			
	Health $centre_1$	Health $centre_2$	$Dispensary_1$	$Dispensary_2$	$Dispensary_3$	$Dispensary_4$
A. Reported time	5,184	2,112	4,416	3,744	864	1,248
B. Activity-$time_1$ _ focused ANC	3,130	964	1,177	1,635	512	786
C. Ratio (A/B)	1.66	2.19	3.75	2.29	1.69	1.59
D. Activity time $_2$ - standard-ANC	5,028	2,226	2,385	3,057	1,191	1,923
E. Calculated time (C*D)	8,328	4,879	8,951	7,000	2,009	3,052
F. Additional time (E-A)	3,144	2,767	4,535	3,256	1,145	1,804
G. Additional time per pregnancy	1.88	3.73	5.70	3.20	2.88	2.81

Annual cost and unit cost.

The cost for recurrent and capital items under the focused and the standard models are shown in the additional file 1. The annual cost was US$185,282 across six facilities under the focused model and increased to US$358,290 for the standard model. Health facilities in Kigamboni (Health $centre_1$,$dispensary_{1 and 2}$) recorded more visits and therefore higher cost compared to health facilities in Korogwe (Health $centre_2$ $Dispensaries_{3 and 4}$). Personnel cost accounted for 38% of the total cost under the focused model at health centres, and 36% at dispensaries. Additional personnel time and the cost of a sonographer increased annual cost, but the contribution decreased to 33% and 35% under the standard ANC model as shown in Table 4. Calcium supplementation throughout pregnancy (US$22,445 across facilities), three doses of SP, seven day antibiotics to 13% of the polulation and other medical supplies, doubled medicine and medical supplies cost, and increased the contributon by 5% at both health centres and dispensaries. Laboratory supplies cost also doubled, but the contribution to the total cost did not change substantially. Capital cost items accounted for 18% of the total cost at health centres under the focused model and 21% at dispensaries, and the contribution decresed under the standard ANC model.

The results suggest that, at primary health care facilities recording more than 1000 ANC visit per year, the cost will increase from US$30,880 to US$59,715 with implementation of a standard model. More

specifically, the cost will increase from US$40,172 to US$75,898 at health centres and from US$26,234 to US$51,263 at dispensaries. Therefore, the unit cost per pregnancy will increase from about US$33 to about US$63 at health centres, and from about US$37 to US$72 at dispensaries. The unit cost per visit will not change substantially with guideline update, meaning that the increased costs are largely attributable to increased number of visits.

Table 4
Cost comparison between levels of PHC under two antenatal care models Tanzania.

Cost in US$	Health centres (2)		Dispensaries (4)		All facilities (6)	
	Focused ANC	Standard ANC	Focused ANC	Standard ANC	Focused ANC	Standard ANC
Personnel	30,483 (38%)	50,591 (33%)	38,116 (36%)	73,186 (35%)	68,599(37%)	123,777(35%)
Medicine/medical supplies	21,846 (27%)	49,206 (32%)	25,441 (24%)	59,746 (29%)	47,287(26%)	108,952(30%)
Laboratory supplies	11,076 (14%)	24,649 (16%)	15,744 (15%)	30,028 (15%)	26,821(14%)	54,676(15%)
Other recurrent items	2,146 (3%)	4,449 (3%)	3,978 (4%)	9,172 (4%)	6,124(3%)	13,621(4%)
Capital items	14,793 (18%)	22,901 (15%)	21,658 (21%)	34,363 (17%)	36,451(20%)	57,264(16%)
Total cost	80,344	151,797	104,938	206,493	185,282	358,290
Cost per facility	40,172	75,898	26,234	51,623	30,880	59,715
Cost per ANC visit	8.1	7.8	11.1	9.1	9.6	8.5
Cost per pregnancy	33.2	62.8	36.8	72.4	35.2	68

Discussion

Our findings shows that, more resources are required to implement the standard ANC model at primary healthcare facilities in Tanzania. At each health centre recording more than 2,000 ANC visits annually, one will require two additional nurses, and one to three additional nurses at dispensaries with more than 1,000 annual visits. Also two times more resources should be allocated to medical and laboratory supplies at both health centres and dispensaries. It is important to emphasize that results for the standard ANC model were extrapolations built on facility data.

The cost per visit at US$9.6 was less than US$16.4 calculated in Mtwara (18), time differences and many visits in our research may explain the difference. They recorded 5,962 visits across eleven facilities while we recorded 19,342 visits across six facilities. However, the estimation by Hatimana et al for the focused

model (US$10.65) and the standard model (US$10) (19, 20), is at about the same level as US$9.6 and US$8.5 per visit that we found.

Personnel time was the main cost driver for both ANC models, and represented more than one-third of the total cost at the health centre and dispensary. Our result shows reported time exceeded activity time differently at each facility. Interviews of staff revealed that part of the reported time was spent on other responsibilities related to ANC. Our analysis was based on self reporting, it was not possible to differentiate the actual activity time and the time spent on other responsibilities. While a simulation study in Tanzania estimated time use for ANC at 46 minutes for the first visit and 36 minutes for subsequent visits (29), observational studies have reported less time for each contact (30). A time sequence study at the ANC unit would have been required to better differentiate activity time from time used for other responsibilities related to ANC, but this is very labor intensive and outside the scope of this project.

The cost for medicine, medical and laboratory supplies increased by more than twice for health centres and dispensaries. Calcium supplementation, antibiotics for seven days, urinalysis and hemoglobin concentration tests in the standard model were key driver of this observation, despite that calcium supplementation was not found to be cost effective in Ethiopia (31). Our data indicate that, coverage for medicines and laboratory tests recommended under the focused ANC model was higher for facilities in Kigamboni (health centre $_{1}$ Disensary $_{1 \text{ and } 2}$) than facilities in Korogwe, which explains cost differentials (additional file 1). But their stock status have been one of the challenges to effective implementation of the focused ANC model.

Our estimation of unit costs is based on the assumption that utilization of ANC in terms of number of pregnancies will not change with a standard model. We did however include in the costing resources required to provide ultrasound under the standard model. It is not clear if ultrasound use will improve fetal and maternal outcomes (32), but it is possible that standard ANC will improve adherence, which subsequently could improve health outcomes and reduce unit costs per visit. This study was undertaken in facilities characteristized by attending relative many pregnant women annually. For smaller health facilities, the unit cost of ANC per pregnancy could be expected to be somewhat higher than for facilities attending more women.

Study Limitations

This study has several limitations, first, we purposively sampled six relatively large primary health facilities attending many pregnant women. The plan was to estimate the highest possible annual cost, which can be used by policy makers when budgeting for the standard ANC model. However, the approach also limit the generalizability of our findings in Tanzania, especially to facilities attending few pregnant women. We also estimated resources for an ambition to fully implement the standard ANC model. Second, incomplete or inaccurate facility records compelled us to exclude some information, such as the cost of managing diseased pregnant women, which represents potential underreporting. Third, we used self reporting to allocate personnel time to antenatal care which is prone to information bias. This could

have resulted into overestimation or underestimation of personnel cost. Nevertheless, personnel were asked to allocate time to each of their responsibility, which might have reduced the bias. Finally, analysis from the provider's perspective, ignored additional cost of more facility visits among pregnant women, which understimate the overall cost implication of policy change from focused to standard antenatal care.

Conclusion

The introduction of standard ANC in primary health facilities in Tanzania will double the resources requirements compared to current practice. While resource availability has been a challenge for effective implementation of the focused ANC model, more research is required, to consider whether these costs are reasonable compared to the additional value for maternal and child health if the standardised ANC is scaled up in Tanzania.

Abbreviations

ANC:Antenatal care, WHO: World Health Organization,

Declarations

Ethical approval: We obtained approval from the Ethical Review Committee of the Tanzania National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/3139) and the exemption from Regional Ethics Committee, Western Norway (2019/758/REK Vest) as our study was deemed outside the scope of the Norwegian health research act. We also obtained written permissions from the Office of the President of the Regional Administration and Local Government; Kigamboni Municipal and Korogwe District Directors, and District Medical Officers. We sought verbal consent before the interview with health care providers.

Consent for publication: Not applicable.

Availability of data and materials:. All data generated or analysed during this study are included in this published article.

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Authors' contributions: ATC, ATM and BR contributed to the development of the concept and study design. ATC collected, analysed and interpreted the data, and wrote the first draft of the manuscript. ATM

and BR contributed to the analysis and interpretation of the results. All authors revised the manuscript critically and approved the final version.

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