Assessing the Costs of Multiple Program Approaches and Service Delivery Modes for Adult Male Circumcision in Nyanza Province, Kenya

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MALE CIRCUMCISION CONSORTIUM

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ACRONYMS & ABBREVIATIONS

AIDS	acquired immunodeficiency syndrome
APHIA	AIDS, Population, and Health Integrated Assistance
CDC	US. Centers for Disease Control and Prevention
GOK	Government of Kenya
HCT	HIV counseling and testing
HIA	HIV infection averted
HIV	human immunodeficiency virus
KEPH	Kenya Essential Package for Health
MC	male circumcision
MCC	Male Circumcision Consortium
MOH	Ministry of Health
NASCOP	National AIDS and STD Control Program
NGO	nongovernmental organization
NRHS	Nyanza Reproductive Health Society
PANCEA	Prevent AIDS Network for Cost-Effectiveness Analysis
RRI	Rapid Results Initiative
STI	sexually transmitted infection
T&M	time and motion
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNDP	United Nations Development Programme
VMMC	voluntary medical male circumcision
WHO	World Health Organization

EXECUTIVE SUMMARY

It is well established that adult male circumcision (MC) is an effective and cost-effective method of preventing female-to-male transmission of HIV. MC has been accepted by the global health community as an important new strategy for confronting the HIV epidemic. The World Health Organization (WHO) estimates that as many as 2 million new infections in Sub-Saharan Africa can be averted in the next 10 years with careful, intentional scale-up of safe, high-quality MC services.

Kenya has formally adopted MC as part of its response to the epidemic, and the Kenya Ministry of Health (MOH) released the *Kenya National Strategy for Voluntary Medical Male Circumcision* (GOK, 2009). The strategy emphasizes a decentralized approach to MC implementation, including availability of MC at community-level sites through to district hospitals. In Nyanza Province, MC services are currently being provided at fixed or base health facilities and via outreach and mobile services. The national strategy states that voluntary medical male circumcision (VMMC) services may be delivered through either community- or facility-based systems (GOK, 2009, p. 15). It recommends that at all times, community services should have functional linkages with the adjacent health facility to ensure commodity supply, reporting, and quality assurance. Community VMMC services (otherwise known as mobile outreach) may be delivered through health facilities, schools, churches, or tented camps (GOK, 2009, p. 15). Given the system constraints, facility-based MCs are not expected to meet the strategic targets for VMMC in the short term (GOK, 2009, p. 15).

A large variety of strategies support mobile outreach: hospitals or health institutions, professional boards, private companies, nongovernmental organizations (NGOs), or governmental bodies. The categories of health professional involved vary from one strategy to another, and ways of mobilizing health professionals to increase access to MC services can also differ (deploying existing MOH staff, hiring additional full-time or part-time staff, etc.). In this study, "outreach" refers to when a health center or dispensary receives supplemental inputs (e.g., trained MC surgeons/surgical assistants, equipment such as an autoclave, surgical instruments, etc.) from an adjacent district or subdistrict hospital to provide MCs that meet standard surgery requirements during prescheduled MC days. The receiving facility contributes minimal or no inputs (local technical support, supplies) other than providing a space for surgeries. "Mobile" refers to when a fully contained MC surgical unit (e.g., trained MC surgeons/surgical assistants, equipment, surgical instruments, supplies, tents, vehicle) is able to stage MC operations that meet standard MC surgery requirements at any location (e.g., a school, community center, field, etc.), with the receiving location providing the space only.

For all three service delivery modes (base, outreach, mobile), limited availability of physicians and other senior health worker cadres (clinical officers and nurses) and other potential sources of high costs (e.g., equipment, vehicles, etc.) are barriers to scale-up of MC services. The financial resources necessary to respond to emerging and projected demand cannot be absorbed by the national budget, nor can any single donor provide the support necessary to train all clinical staff, equip surgical theaters, and secure and regularize the required commodity flows. A number of

international and local NGOs, with financing from donors, have supported the roll-out of the national MC program in Nyanza through a combination of horizontal and vertical program approaches. These organizations include EngenderHealth, through the AIDS, Population, and Health Integrated Assistance Project II (APHIA II) (funded by the U.S. Agency for International Development [USAID])[1] and the Nyanza Reproductive Health Society (NRHS) (funded by the U.S. Centers for Disease Control and Prevention [CDC]). APHIA II supported the MOH from October 2008 to October 2010 to implement MC services based on a horizontal program approach. NRHS has supported the MOH since October 2008 to implement MC services following a combination of horizontal and vertical program approaches.

The opportunity to change the course of the epidemic in one of the world's most-affected countries requires that the response be as thoughtfully planned and evidence-based as possible. Until recently, the potential savings of various MC service delivery modes have not been systematically quantified in Kenya and other countries. While research is examining the expected impact of scaling up safe MC services, including costs, the number of infections that could be averted, and the cost savings, a better understanding is still needed of the unit costs of various adult MC service delivery modes, their determinants and trends, and the potential for enhanced efficiency.

The current study, which was conducted from May 2010 to April 2011, compares the costs of various approaches and modes for delivering MC services using the forceps-guided method in Nyanza Province, Kenya, and aims to assist the Government of Kenya (GOK) in scaling up a national MC program by addressing three questions that can inform the choice of MC program approaches and service delivery modes in Nyanza Province:

1. What are the current costs per MC by program approach and service delivery mode? Program approaches and modes assessed are:
   a. Horizontal versus diagonal (combination of horizontal and vertical) approaches
   b. Fully MC-capable health facilities (fixed/base facilities) versus outreach services, versus mobile services
2. How do unit costs vary over the study period (i.e., from start-up to full implementation)?
3. What is the composition of the unit costs for each program approach and service delivery mode?
4. What do the cost findings suggest for strategies to increase efficiency? What would be the potential impact of these strategies on program costs, HIV infections averted, and cost per infection averted?

The second study question regarding trends in unit costs over the study period was not possible to analyze, due to difficulty in obtaining reliable allocations of the portion of time that MOH staff allocated to MCs over time.

The key results related to each of these questions are summarized below, followed by our recommendations.

What are the current costs per MC, by service delivery approach and mode?

During the period November 2008 to April 2010, a total of 62,705 MCs were delivered, 90.1% through the NRHS "diagonal approach" and 9.9% through the APHIA-II horizontal approach.[2] Overall, community-based services dominated the caseload, with 68.6% of MCs delivered at either mobile or outreach sites; the balance were provided at base facilities. This number is dominated by the large

[1] APHIA II Nyanza worked with Kenya's Ministry of Health, and with faith- and community-based organizations and other agencies to reduce the risk of HIV transmission and the fertility rate in Nyanza Province. EngenderHealth led the consortium of partners that implemented the project, which included the Academy for Educational Development, the Christian Health Association of Kenya, the Inter Diocesan Christian Community Services, and PATH.

[2] A diagonal program approach is one that combines aspects of both horizontal and vertical program approaches.

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number of cases performed with NRHS support. APHIA II delivered 53.5% of its MCs at outreach or mobile sites, while NRHS provided 70.3% of its MCs at outreach or mobile sites.

Using microcosting methods that identify and value each of the resources required to deliver MC services, we analyzed unit costs distributed across service delivery modes, as shown in the figure below. Overall costs were $38.62 and $44.62 for APHIA II and NRHS, respectively. Outreach services were similar, and mobile services were 37% lower at the APHIA II sites than at the combined NRHS outreach/mobile sites.

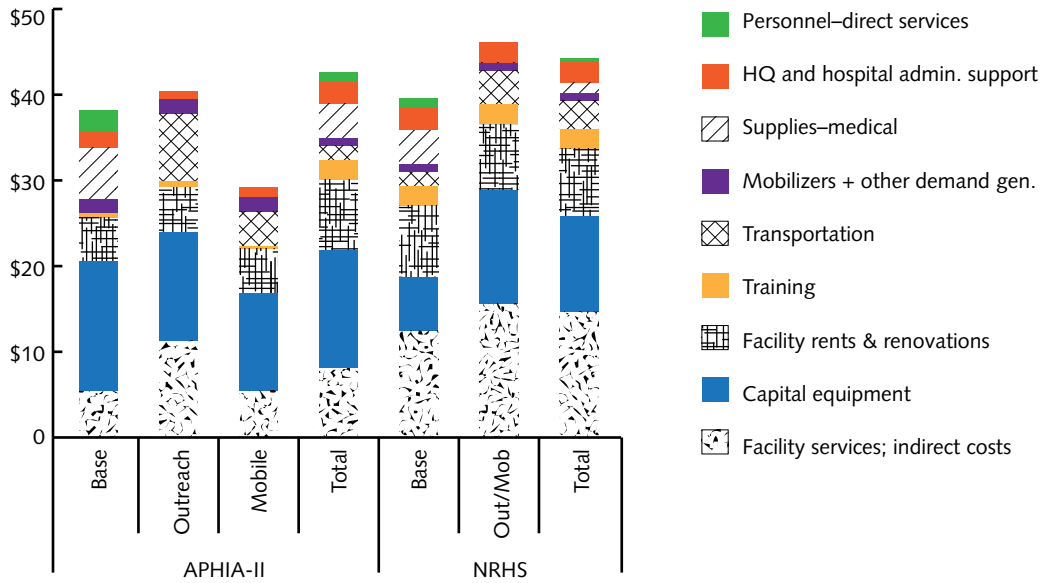
How to decrease cost while maintaining quality?

We conducted a time and motion (T&M) study of 246 MC procedures performed using the forceps-guided method at base hospitals, at outreach sites, and at temporary sites served by mobile surgical teams; 130 procedures were supported by APHIA-II and 116 by NRHS. The resulting information, combined with cost data collected by a trained data collection team with support from EngenderHealth and the authors of this report, allowed us to describe variations in cost by:

- Variations in staffing patterns,
- Number of MCs performed per surgery-day
- The time required for specific steps of the MC procedure
- Waiting time prior to the first surgery of the day

We found extensive use of nonphysicians on the surgical teams for both approaches, with a team consisting of an average of 4.2 and 3.9 members for APHIA II– and NRHS-supported procedures, respectively.

PER-CLIENT COST OF MC PROVISION, BY SERVICE DELIVERY MODE

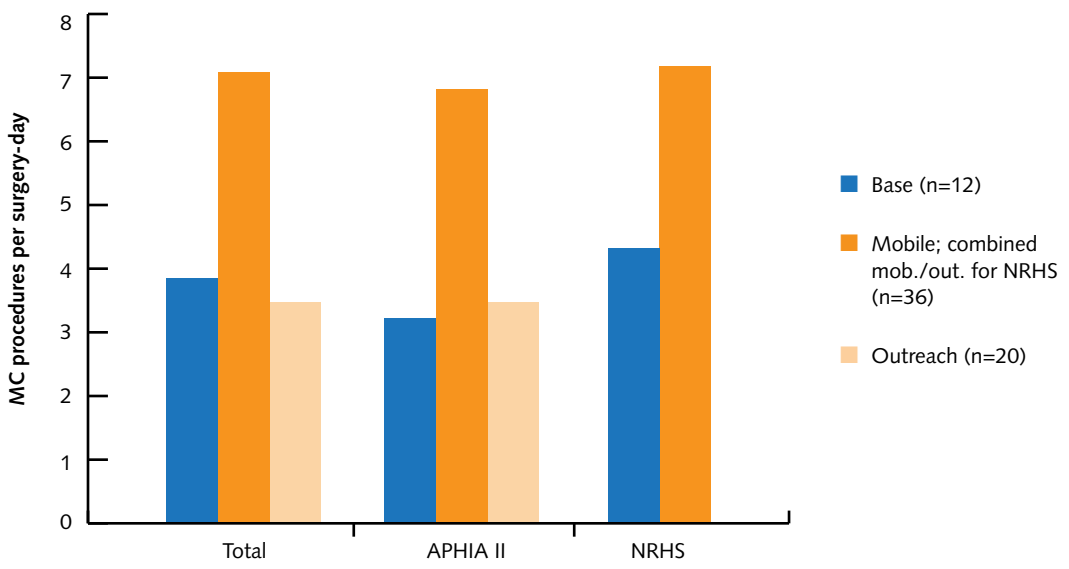


As the figure below illustrates, the number of procedures performed per surgery-day was lowest at the APHIA II–supported base facilities (3.2) and highest at the outreach/mobile sites (7.2).

Through the T&M data collection exercise, we were able to obtain detailed information on the amount of staff time required by the MC operation. The table below shows that the average procedure time per MC varied from 22 to 31 minutes, and the total time (including postoperative time) varied from 23 to 33 minutes.

The amount of down time prior to the beginning of surgical activity on each scheduled surgery day was significant and averaged 1.6, 2.7, and 1.7 hours, respectively, for base, outreach, and mobile sites.

NO. OF MC PROCEDURES PER SURGERY-DAY



TIME IN MINUTES PER MC

	Base (n=63)	Outreach (n=43)	Mobile (Combined Mobile/Outreach for NRHS) (n=139)	Total
Surgeon time	16.3	15.9	11.5	13.0
Procedure time	29.5	31.0	22.2	25.1
Total time per case	30.9	32.9	23.3	26.4
Surgeon time as % of total	**53%**	**48%**	**49%**	**49%**

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How might efficiency strategies affect cost and impact on the HIV epidemic?

The unit cost of MCs using the forceps-guided method ranged from $29 to $46 per procedure (see table below). The number of MCs that can be performed with a budget of $1 million (calculated by dividing $1 million by the unit cost of the procedure) ranges from 21,643 to 34,103.

We estimate that in a setting like Nyanza Province, with an HIV prevalence of around 20% (17% among men, 26% among women), 10 MCs avert about 2.5 HIV infections over 20 years; thus, 0.25 HIV infections are averted per MC. This estimate includes indirectly averted infections (e.g., in female sex partners) and is discounted to the present, per normal practice. The resulting estimate of HIV infections averted (HIAs) per $1 million ranges from 6,172 to 8,526, depending on the mode of MC provision.

The cost per HIV infection averted ranges from $117.29 to $184.82. All of these values are far below the lifetime medical cost of HIV disease, estimated at $6,000 in East Africa. Thus, each of the MC delivery models results in substantial net savings.

Using this model, and drawing on the findings from the cost analysis, we identified five possible strategies that could enhance program efficiency (defined as cost per HIA). We found that scheduling and administrative efficiencies, if feasible to implement, would yield up to a 20% drop in cost per MC, with operational efficiency (reducing start-up time on MC days) offering smaller savings. Two technical innovations (use of electrocautery and MC devices) appear to increase costs, given the cost structure of the MC programs we studied. Demand generation could efficiently increase demand for services and could potentially reduce unit costs, by distributing fixed costs over more MCs.

Conclusions and Recommendations

The most important overall finding of this study is that the cost differences between program approaches to MC scale-up using the forceps-guided method are not dramatic and are unlikely to be accounted for by the relative virtues and drawbacks of the more horizontal APHIA II approach and the more diagonal NRHS approach. In the Nyanza context, both approaches provide MC services well within the range of other published unit costs in other African settings. Differences in unit cost between APHIA II– and NRHS-supported MC services are modest (less than one-third), not consistently in the same direction, and to a large extent explained by differences in compensation levels. This compares with more than 10-fold variations in unit costs for other prevention strategies, previously reported by the Prevent AIDS Network for Cost-Effectiveness Analysis (PANCEA) project and other studies (Dandona et al., 2008; Marseille et al., 2007; Stover & Forsythe, 2010).

COST PER MC PROCEDURE AND COST-EFFECTIVENESS

	APHIA			NRHS	
	Base	Outreach	Mobile	Base	Outreach/ mobile
Cost per MC	$38.33	$40.51	$29.32	$39.58	$46.20
MCs per budget	26,092	24,687	34,103	25,266	21,643
HIA per $1 million	6,523	6,172	8,526	6,316	5,411
Cost-effectiveness: Cost per HIA	**$153.30**	**$162.03**	**$117.29**	**$158.32**	**$184.82**

However, 90% of the MCs performed during the study were conducted using the NRHS approach, versus about 10% by means of the APHIA II approach. This disparity may be attributable to the ability of the NRHS to deploy its own dedicated MC teams to provide MCs 100% of the time; in contrast, the APHIA II approach used existing MOH staff, which provide MCs only 12–38% of the time. The larger NRHS service volume to date may suggest that the diagonal NRHS approach can be scaled up more quickly in the short term, though with possibly larger future impediments to full integration with the MOH's services.

Both MC program approaches that we assessed rely largely on external financial support. It is therefore plausible that either, with additional funding, could attain higher service volumes, either through intensified efforts in existing service areas or through expansion of activities to new, underserved areas. Overall, community-based services dominated the caseload in either approach, with 68.6% of MCs delivered at either mobile or outreach sites. This indicates that access to MCs for rural and remote populations can be improved through either approach, utilizing outreach and mobile modes of service delivery.

The observed MC costs in both programmatic approaches and various service delivery modes correspond to an estimated programmatic cost per HIV infection averted of $117 to $185. The extent to which a program approach and service delivery mode allows MC resources to be deployed quickly would lead to further improvements in cost-effectiveness.

Another important finding is that further refinements in the staffing and logistical organization of the MC procedure itself using the dorsal slit method may yield only modest gains in efficiency. This is because the marginal cost of supplies and personnel for each procedure is a small portion of the total unit cost. Our analysis of the relationship between effective demand (number of cases per surgery-day) and efficiency (as measured by the time required per MC and the waiting time before the first surgery of the day) suggests that increased demand will not increase efficiency in itself. Proactive efforts will be required to do so.

The study findings lend support to the following recommendations:

- As additional resources are mobilized, expand access to MC services through a combination of both horizontal and diagonal MC program approaches—both are cost-effective, and neither has a marked advantage over the other.
- Continue the use of multiple MC service delivery modes: base, outreach, and mobile. The presence of all three modes increases access to MC services, and the three have similar unit costs.
- Develop, implement, and evaluate strategies to achieve efficiencies in scheduling, operations, and administration.
- Develop, implement, and evaluate strategies for intensified demand generation.
- Seek lower purchase prices for technology, especially MC devices, to see if the break-even cost can be achieved.

BACKGROUND

Male circumcision (MC) is one of the oldest and most common surgical procedures worldwide and is undertaken for religious, cultural, social, and medical reasons (NASCOP, 2009).

Based on three clinical trials (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007) and other accumulated evidence demonstrating that MC reduces the risk of HIV acquisition among men, the World Health Organization (WHO) and the Joint United Nations Programme on HIV/AIDS (UNAIDS) recommend safe, voluntary MC for adult men in the short term as one important component of a comprehensive strategy to prevent HIV infection and maximize public health benefits (WHO & UNAIDS, 2007). The public health impact of MC on HIV transmission is difficult to quantify outside of a clinical trial. However, WHO's HIV/AIDS Programme estimates that as many as 2 million new infections in Sub-Saharan Africa can be averted in the next 10 years with careful, intentional scale-up of safe, high-quality MC services (WHO & UNAIDS, 2007). Model-based projections suggest that expanding MC programs to cover 80% of adult and newborn males by 2015 could reduce new adult infections by about 40% by the end of that year (USAID Health Policy Initiative, 2009). The greatest impact from MC will be realized through reaching as many uncircumcised men with the intervention within the shortest time possible. This means reaching the majority of men who are eligible for the intervention over the next 3–5 years.

The Kenya Demographic and Health Survey (DHS) reports a strong relationship between HIV prevalence and circumcision status, with HIV prevalence more than four times higher among uncircumcised men than among circumcised men ages 15–49 (13% vs. 3%) (KNBS & ICF Macro, 2010, p. 224). Results indicate that 6.3% of Kenyan adults aged 15–49 are infected with HIV (KNBS & ICF Macro, 2010, p. 214). In Nyanza Province, HIV prevalence rates vary widely by ethnic community and by whether a community practices circumcision, ranging from a high of 20.2% among the Luo to a low of 4.7% among the Kisii (KNBS & ICF Macro, 2010, p. 217). HIV prevalence is significantly higher among uncircumcised men (17.3%) than among circumcised men (5.5%) (Kenya AIDS Indicator Survey, 2009, p. 49). MC could offer tremendous benefits in HIV prevention efforts in Nyanza, as well as in other provinces where there is a strong relationship between HIV prevalence and circumcision status, including Nairobi, Rift Valley, and Western provinces.

Experts agree that MC should always be considered as part of a comprehensive HIV prevention package (WHO & UNAIDS, 2007) that also includes promoting delay in the onset of sexual relations, abstinence from penetrative sex, and reduction in the number of sexual partners; providing and promoting correct and consistent use of male and female condoms; providing HIV counseling and testing (HCT) services; and providing services for the treatment of sexually transmitted infections (STIs). MC should be performed by well-trained practitioners in hygienic settings with free and informed consent, confidentiality, and risk reduction counseling. National health systems need to provide high-quality MC services, including ensuring adequate infrastructure, training, equipment, and supplies. In Kenya, medical officers, clinical officers,[3] and nurses are currently permitted to perform MC.

To endorse the introduction of MC services for HIV prevention, the Kenya Ministry of Health (MOH) developed a *National Guidance on Voluntary Male Circumcision* (GOK, 2008). The document provides a framework for

[3] Clinical officers are medical practitioners who provide health care services, including advanced advisory, diagnostic, curative, and preventive medical services, either independently or with limited supervision from a physician.

ensuring the provision of safe, accessible, and sustainable MC services in Kenya. In 2009, the Kenya MOH released the *Kenya National Strategy for Voluntary Medical Male Circumcision* (GOK, 2009). This document outlines the strategic directions for voluntary medical male circumcision (VMMC) for men ages 15–49 and the national plan of operations for the years 2009–2010 through 2011–2012. To build human resource capacity to support MC rollout in the country, the WHO's *Manual for Male Circumcision under Local Anaesthesia* was adapted for the Kenyan context. The *Guide for Trainers on Male Circumcision Under Local Anaesthesia in Kenya* and the *Training Course Handbook on Male Circumcision Under Local Anaesthesia in Kenya for Participants* emphasize the forceps-guided method of MC (NASCOP, 2010).

The MOH's key strategy for overall health service delivery is the decentralization of services to the districts, with implementation of the Kenya Essential Package for Health (KEPH) (GOK, 2006). Service delivery is supposed to be provided at the following six levels:

- Level I—Community level
- Level II—Dispensaries
- Level III—Health centers, maternity homes, nursing homes
- Level IV—Primary hospitals
- Level V—Secondary hospitals
- Level VI—Tertiary hospitals

Inadequate health infrastructure, equipment, supplies, and trained health workers are critical logistical aspects of MC service delivery that need to be addressed in any national program, at all levels of the health system. Successful MC scale-up therefore requires comprehensive planning to address these operational challenges. Debates about the design and financing of MC programs currently stress both *vertical*, MC-specific programs as well as the development of *horizontal* health systems and infrastructure capable of addressing a broader spectrum of health issues, including MC. A vertical emphasis in other health services, however, has been more effective at reaching larger numbers of people in need of the service.

To rapidly scale up MC and achieve the desired impact and ensure sustainability of the service, the Government of Kenya plans to adopt a high-quality, high-volume approach delivered through a combination of modalities, including fixed health care facilities and mobile outreach teams in the short term (3–5 years) (GOK, 2009a). Given that public health facilities do not have the infrastructure to provide quality MC services and that implementing partners have resources but not the infrastructure, the GOK has supported a *diagonal* program approach (combination of horizontal and vertical program approaches) to meet its MC targets:

> *It is therefore envisaged that a middle ground will be found that takes into account the inevitable vertical introduction of these services along with the desire of the public health leadership to strengthen the capacity of the public health system to eventually take over the provision of the services.* (GOK, 2009)

While fixed health care facilities will play a critical role in scaling up MC in the long term, it is not clear whether they can meet MC targets in the short term, especially given current human resource shortages and other service delivery constraints. Based on the Government of Kenya's MC strategy, the initial rollout of MC stresses a diagonal approach, with a focus on sites that have the requisite staff to start providing routine MC services, while other lower-level sites (health facilities, schools, etc.) will be developed as bases for outreach and mobile services, to increase access to services for greater numbers of men (GOK, 2009a).

In Nyanza Province, MC services are currently being provided in fixed health care facilities and via outreach and mobile services. The national strategy states that VMMC services may be delivered through either community- or facility-based systems (GOK, 2009a, p. 15). It recommends that at all times, community MC services should have functional linkages with the adjacent health care facility

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for ensuring commodity supply, reporting, and quality assurance. Community services (otherwise known as mobile outreach) may be delivered through health care facilities, schools, churches, or tented camps (GOK, 2009a, p. 15). Given the system constraints, facility-based circumcisions are not expected to meet the strategic targets for VMMC in the short term (GOK, 2009a, p. 15).

The Kenya National MC Strategy also acknowledges the need to explore a variety of service delivery strategies based on the combination of horizontal and vertical approaches being implemented. Task shifting[4] to well-trained nonphysician clinicians (e.g., clinical officers and nurses) and lay counselors, task sharing[5], hiring contract staff, investing in new technologies (e.g., hemostasis by diathermy or electrocautery, MC devices), conducting integrated health facility–based MC outreach, making efficient use of client scheduling (e.g., evenings, weekends), and offering mobile surgical services are among the strategies that are being employed to address current service delivery challenges, including human resource shortages.

A wide variety of approaches support mobile outreach: hospital or health institutions, professional boards, private companies, nongovernmental organizations (NGOs), or governmental bodies. The categories of health professional involved vary from one strategy to another, and modes of mobilizing health professionals (volunteering, salary, etc.) to increase access to MC services can also differ. In this study, "outreach" refers to a health center or dispensary that receives supplemental inputs (e.g., trained MC surgeons/ surgical assistants, equipment such as an autoclave, surgical instruments, or vehicle) from an adjacent district or subdistrict hospital to provide MCs that meet standard surgery requirements in a rural setting during prescheduled MC days. The receiving facility contributes minimal or no inputs (local technical support, supplies), other than providing a space for surgeries. "Mobile" refers to a fully contained MC surgical unit (e.g., trained MC surgeons/ surgical assistants, equipment, surgical instruments, supplies, tents, vehicle) able to stage MC operations that meet standard MC surgery requirements at any location (e.g., a school, community center, field, etc.), including remote settings. The receiving location provides the space for surgeries only.

In all three service delivery modes, limited availability of physicians and other senior health worker cadres (clinical officers and nurses) and other potential sources of high costs (e.g., equipment, vehicles, etc.) are barriers to the scale-up of MC services (Perchal, Odingo, & Pavin, 2011). The financial resources necessary to respond to emerging and projected demand cannot be absorbed by the existing national budgets, nor can any single donor provide the support necessary to train all medical staff, equip surgical theaters, and secure and regularize the required commodity flows. Therefore, a number of international and local NGOs, with financing from donors, have supported the scale-up of the national MC program in Nyanza Province. Among others, these organizations include EngenderHealth, through the AIDS, Population Health, and Integrated Assistance Project II (APHIA II), which was funded by the U.S. Agency for International Development (USAID) and the Nyanza Reproductive Health Society (NRHS), which was funded by the U.S. Centers for Disease Control and Prevention (CDC). APHIA II supported the MOH from October 2008 to October 2010 to implement MC services based on a horizontal program approach. NRHS has supported the MOH since October 2008 to implement MC services, following a combination of horizontal and vertical program approaches.

[4] Task shifting is the name given to a process of delegation whereby all MC surgical tasks are moved, where appropriate, to less-specialized health workers. By reorganizing the workforce in this way, task shifting presents a viable solution for improving health care coverage by making more efficient use of the human resources already available and by quickly increasing capacity while training and retention programs are expanded (WHO, 2010).

[5] Task sharing refers to the use of nonphysicians or lower cadres of health care workers to complete specific steps of MC surgery. The sharing of surgical tasks among health care cadres allows more highly trained health professionals additional time to dedicate themselves to the most complex clinical tasks, thus helping to address staffing shortages and reducing the cost of the service provided (WHO, 2010).

To date, a few studies in Kenya and other countries have compared the cost and efficiency of different program approaches and service delivery modes for MC. Auvert and colleagues (Auvert et al., 2008) conducted one of the first studies to provide estimates of the cost of scaling up MC services in Sub-Saharan Africa, the number of circumcision providers needed, and the likely savings due to averted HIV-related medical care costs. That study, which developed a model that included costing, demography, and HIV epidemiology, investigated 14 countries in Sub-Saharan Africa where MC prevalence was lower than 80% and HIV prevalence among adults was higher than 5% (in addition to Uganda and the Nyanza Province in Kenya). The authors assumed that the rollout would take five years and would lead to an MC prevalence among adult males of 85%. They also assumed that surgery would be done as it was in the trials. The number of personnel required was based on the experience of the authors and on expert opinion.

The authors estimated that to have an impact on the epidemic, 82 full-time circumcisers would be needed in Nyanza Province, Kenya, over the next five years. The authors conclude that while a rapid roll-out of adult MC in Sub-Saharan Africa requires substantial funding and a high number of circumcisers for the first five years, these investments are justified by the substantial health benefits and the savings accrued by averting future HIV infections. Additionally, they conclude, lower ongoing costs and continued care savings suggest long-term sustainability.

In support of efforts to scale up MC in Kenya, the USAID Health Policy Initiative (Stover et al., 2009) undertook a cost-effectiveness analysis study to estimate the potential cost and impact of medical MC services in Nyanza, Kenya, to reach 60% of adult males (ages 15–49) by 2014. Their results are illustrative and for only one possible scenario; however, the scenarios can be modified to reflect a variety of possible policies at the country level. Key conclusions from this initial scenario are that scaling up the program would avert more than 47,000 adult HIV infections over the period 2009–2025, would result in cumulative net savings of US$247 million over the same time period and would require almost 85,000 MCs to be performed in the peak year (2012).

Following this initial study to assess the impact of MC in Kenya, the USAID Health Policy Initiative (Kioko et al., 2010) conducted a study on the unit cost per MC by different service delivery models, with a view to determine the impact of scaling-up MC in Kenya. The study used the Decision Makers Program Planning Tool (Bollinger et al., 2009) to estimate the impact of scaling up MC in averting new infections. Two different MC delivery modes (fixed and outreach) were considered, allowing for comparison of the unit costs across these service delivery modes.

The preliminary results from this analysis suggested that increasing MC can substantially reduce HIV prevalence. Scaling up adult MC to reach 80% coverage by 2015 would avert more than 30,000 new HIV infections and almost 180,000 through 2025, at a total cost of $125 million through 2015 and $100 million during the following 10 years. This would result in an average cost per HIV infection averted of $2,975 during the period 2009–2015 and $719 over the period 2016–2025. The results also reveal that increasing the prevalence of MC from current levels to 80% of adult males would increase the discounted net savings per infection averted, from $4,425 to $6,681.

The results also indicate that between 2008 and 2015, one HIV infection would be averted for every 68 circumcisions performed. However, because MC continues to lower the chances of HIV infection for many years, considering longer time periods shows even better results. For example, during the period 2016 to 2025, only five MC procedures are needed to avert one HIV infection.

Until recently, the potential savings of various MC service delivery modes have not been systematically quantified in Kenya and other countries. Research is proceeding in Kenya and in other heavily affected countries on the

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Research Questions Addressed

To help support the introduction of adult MC for HIV prevention in Kenya, this study was conducted from May 2010 to April 2011 to compare the costs of various approaches and modes for the delivery of MC services in Nyanza Province, Kenya. While it is recommended that MC be offered as part of a comprehensive package of HIV prevention services—e.g., promoting delay in the onset of sexual relations, abstinence from penetrative sex, and reduction in the number of sexual partners; providing and promoting correct and consistent use of male and female condoms; providing HIV counseling and testing (HCT) services; and providing services for the treatment of sexually transmitted infections (STIs)—the intent of this research is to provide evidence on the structure of costs in MC services, especially those subject to manipulation, separate from these other HIV prevention interventions. Large differences in efficiency may suggest an opportunity for shifting a portion of support toward service delivery modes that ultimately generate more health benefits for a given budgetary commitment. The specific research questions addressed are as follows:

1. What are the current costs per MC by program approach and service delivery mode? Program approaches and modes assessed are:
   - Horizontal versus diagonal (combination of horizontal and vertical) approaches
   - Fully MC-capable health facilities (fixed/base facilities) versus outreach services, versus mobile services
2. How do unit costs vary over the study period (i.e., from start-up to full implementation)?
3. What is the composition of the unit costs for each program approach and service delivery mode?
4. What do the cost findings suggest for strategies to increase efficiency? What would be the potential impact of these strategies on program costs, HIV infections averted, and cost per infection averted?

The second study question regarding trends in unit costs over the study period was not possible to analyze, due to difficulty in obtaining reliable information on the portion of time that MOH staff allocated to MCs over time.

Description of MC Program Approaches and Service Delivery Modes

The study analyzed costs of MC services implemented by the MOH, with technical assistance from the APHIA II Nyanza Project and NRHS, in accordance with the National Strategy for Voluntary Male Circumcision through a combination of horizontal and vertical approaches. Table 1 describes the key elements in each program approach.

At the time of this study, the Kenya Ministry of Public Health and Sanitation had no standard definitions for the MC service delivery modes outlined in the National Strategy for Voluntary Male Circumcision. In addition to MC services provided at fixed or base health facilities, two main strategies—outreach and mobile—are being implemented by the APHIA II Nyanza Project and NRHS to facilitate the involvement of MC health workers from better-served areas in community settings with limited or no MC services. In both strategies, MC health workers have to go in the field to provide services.

The main differences between the APHIA II and NRHS approaches is that in the former, 2–3 nondedicated MC teams per district (e.g., a surgeon/surgical assistant, counselor, and infection prevention specialist) who are employed by the MOH are assigned to provide MC services during 12–38% of their time. The same teams, based at district or subdistrict hospitals, provide services at base facilities and travel to health clinics, dispensaries, and other community locations to provide outreach and mobile services. In the latter approach, 2–9 dedicated MC teams per district (e.g., a surgeon/surgical assistant, counselor, and infection prevention specialist) who are employed by NRHS are assigned to devote 100% of their

TABLE 1: KEY ELEMENTS, BY PROGRAM APPROACH

Program Approach	Key Elements
Horizontal	❍ MC is provided as part of a comprehensive HIV prevention package that includes correct and consistent use of condoms, reduction in the number of sexual partners, delay in the onset of sexual relations, treatment of STIs, and provision of HCT. ❍ Nondedicated MOH MC teams, working an average of 10–20% of a 220-day work-year, provide MC services integrated with routine health services at base facilities, outreach sites, and mobile locations. ❍ Additional strategies used for meeting demand during high-volume periods, such as the Rapid Results Initiative (RRI),[6] include task shifting to nurses, task sharing, scheduling more MC services during evenings and weekends, and ensuring that sufficient numbers of nondedicated MOH MC teams are scheduled to provide coverage to meet demand. ❍ APHIA II provided the MOH with the following types of technical assistance: • Minor renovations to surgical theaters • MC supplies/equipment • Training and supportive supervision • Quality assurance • Optimization of facility space (e.g., improved design and layout of surgical theaters, staff ratios, patient flow, and patient scheduling) • Vehicles for transporting outreach and mobile teams • Demand generation, through collaboration with public health officers to carry out one-on-one and group mobilization strategies • Community engagement activities
Diagonal (Combination of Horizontal and Vertical)	❍ MC is provided as part of a comprehensive HIV prevention package that includes correct and consistent use of condoms, reduction in the number of sexual partners, delay in the onset of sexual relations, treatment of STIs, and provision of HCT. ❍ Dedicated MC teams employed by NRHS, working 100% of a 220-day work-year, provide MC services at base health facilities, outreach sites, and mobile locations, to supplement MC services offered by the MOH. ❍ Additional strategies used for meeting demand during high-volume periods, such as the RRI, include task shifting to nurses, task sharing, hiring short-term contract staff, and scheduling more MC services during evenings and weekends. ❍ NRHS provided the MOH with the following types of technical assistance: • Minor renovations to surgical theaters • MC supplies/equipment • An MC training center for certifying MC providers • Quality assurance • Supportive supervision • Optimization of facility space (e.g., improved design and layout of surgical theaters, staff ratios, patient flow, and patient scheduling) • Vehicles for transporting outreach and mobile teams • Demand generation through one-on-one and group mobilization strategies • Community engagement activities

[6] The RRI is a strategy used by government ministries and departments to tackle large-scale change efforts through a series of small-scale, result-producing, and momentum-building initiatives. The Government of Kenya applied the RRI approach to MC from November to December 2009, which coincided with the school holidays.

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time to providing MC services. The NRHS dedicated teams supplement MC services provided by other nondedicated MOH MC teams. The dedicated MC teams are based at the NRHS office in Kisumu and travel to base facilities as well as health dispensaries, clinics, and other community locations to provide outreach and mobile services.

Both approaches utilize outreach or mobile services to increase access to MC for rural and remote populations, while supporting the availability of MC services at base facilities. Table 2 summarizes the key features of the three service delivery modes we assessed. Although NRHS delivers MCs using both outreach and mobile deployment, it was not possible to disaggregate NRHS cost information on this basis. For this reason, we combined the costs and surgical output data for MCs performed outside of base facilities and classified them as "outreach." About 90% of the field-based MCs provided by NRHS are in fact performed in an "outreach" setting, and only 10% are conducted at mobile locations. For this reason, the term "outreach" is roughly equivalent for APHIA II and NRHS, and results for "outreach" in NRHS and APHIA II can be compared.

TABLE 2: KEY FEATURES OF MC SERVICE DELIVERY MODES

Service Delivery Mode	Key Elements
Base	❍ A district or subdistrict hospital in an urban or semiurban setting provides ongoing MC services. ❍ The facility meets standard MC surgery requirements (e.g., has trained staff, supplies, surgical instruments, an appropriate space). ❍ In the case of base sites supported by NRHS, MC procedures are supplemented by NRHS dedicated MC teams; APHIA II base sites rely on existing MOH staff to provide MC services.
Outreach	❍ A health center or dispensary in a rural setting that receives supplemental inputs (e.g., trained MC surgeons/surgical assistants, equipment, surgical instruments, supplies, transport) from a "base" facility provides MCs that meet standard MC surgery requirements during prescheduled MC days. ❍ The receiving facility contributes minimal or no inputs (e.g., local technical support, supplies) other than providing a space for surgeries.
Mobile	❍ A fully contained MC surgical unit (consisting of a trained MC surgeon/surgical assistants, equipment, surgical instruments, supplies, and transport) is able to stage MC procedures that meet standard MC surgery requirements at any location (e.g., a school, community center, tent, etc.), including remote settings. ❍ The receiving facility provides the space for surgeries only.

TABLE 3: NUMBER OF STUDY LOCATIONS, BY MC APPROACH AND SERVICE DELIVERY MODE

	Base	Outreach	Mobile	Total
APHIA II (horizontal)	3	28	13	**44**
NRHS (diagonal)	20	158		**178**
Total	23	199		**222**

Site Selection and Sample Size

As shown in Table 3, a total of 222 service delivery sites and locations were purposively selected for the study, based on the above program approaches and modes. For APHIA II, the sites and locations included combinations of base facilities at district and subdistrict hospitals, as well as outreach to health centers and mobile services. For NRHS, sites and locations included facilities at district and subdistrict hospitals, outreach to health centers and dispensaries, and mobile services.

For these locations, we collected comprehensive expenditure and services data. Most data were retrospective, obtained from the MOH, from the EngenderHealth APHIA II Nyanza office, from NRHS Nyanza office financial documents, and from discussions with program officials. In addition, we observed 246 MC procedures using the forceps-guided method at 35 service delivery locations in six districts, to collect information for a time and motion (T&M) analysis (see Table 4).

TABLE 4: DISTRIBUTION OF T&M OBSERVATIONS

	Modality	Districts	T&M Observations	No. of Facilities Visited
APHIA II	Base	Homa Bay	12	1
		Rachuonyo	9	1
		Rongo	4	1
	Total		**25**	**3**
	Mobile	Homa Bay	11	2
		Rachuonyo	31	5
		Rongo	19	2
	Total		**61**	**9**
	Outreach	Homa Bay	27	3
		Rachuonyo	6	3
		Rongo	11	1
	Total		**44**	**7**
Total			**130**	**19**
NRHS	Base	Bondo	2	1
		Kisumu	19	2
		Rarieda	28	1
	Total		**49**	**4**
	Mobile/ Outreach	Bondo	25	6
		Kisumu	21	5
		Rarieda	21	1
	Total		**67**	**12**
Total			**116**	**16**
		Grand total	**246**	**35**

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Ethical Approval

EngenderHealth obtained ethical approval for this research from the FHI and Kenya Medical Research Institute institutional review boards. Concurrence from the Nyanza Ministry of Public Health and Sanitation through a memorandum of understanding ensured a collaborative partnership between this ministry and EngenderHealth as part of the Male Circumcision Consortium. Written informed consent was obtained from clients, providers, and program officials prior to their participation in the study. The confidentiality of clients, providers, and program officials was protected through secure data storage, including stripping the data of identifiers.

Training and Piloting

We used local data collectors for this study. We conducted a seven-day training in Nyanza for the data collection teams. Training consisted of brief didactic sessions regarding the purpose of the costing activity and basic principles of cost analysis, combined with detailed instruction and practical exercises in the use of the cost instrument. The training integrated pretesting of the cost instrument in three sites, representing one of each of the three MC delivery modalities. The completed pilot instruments were carefully assessed by the team, to make needed refinements. All data collectors also received training in research ethics. Ethical considerations were taken into account during this study, and protection of the rights of the clients was enforced.

Analysis of Current Cost per MC Delivered, by Service Delivery Mode

Both the unit (average) and marginal costs were calculated through an Excel-based costing instrument that integrates data entry with tabular and graphical presentation of final outputs. These costs were collected and summarized by cost category, over monthly or longer time intervals, and by service modality—"base", "outreach", and "mobile" (see Table 2). Short-term marginal costs (reflecting short-term recurrent cost inputs only) were tabulated by cost component (e.g., personnel, supplies) and by service delivery modality. All MCs were performed using the forceps-guided method; none were done via the dorsal slit or sleeve resection methods.

Services output data

The numbers of MC procedures performed each month for each service modality were obtained from routine monitoring records at each study site and constitute the denominator of the unit cost figures.

Unit costs

The costs per adult MC delivered were calculated at each of the study sites from November 2008 through April 2010. November 2008 is defined as the time when significant MC services began, and April 2010 is the most recent time for which expenditure data were available at the time of data collection. The full range of cost elements were included and appropriately distributed across clients served in the three different delivery modalities. The cost categories were:

- Personnel (direct services)
- Headquarters and hospital administrative support, including procurement and inventory control
- Supplies (medical)
- Compensation for mobilizers and for other demand generation activities
- Transportation (fuel, maintenance, insurance, etc.)
- Training
- Facility rents and renovations
- Capital equipment
- Facility services (indirect costs)

Capital costs were amortized over five years of expected life, and it was assumed that materials had no salvage value. Training was assumed to have a lifetime of three years—that is, that staff must be trained or retrained every three years, on average.

Marginal costs

The cost of the next MC procedure is the cost of staff members' time for the procedure and for set-up and waiting time and the quantity and market unit cost of each expendable supply item used. Departing slightly from a strict definition of marginal cost, we also include marginal transportation costs (fuel and an allowance for maintenance), because it is important for the purposes of this study to capture any additional costs detailed in more transport-intensive outreach and mobile activities. We excluded capital, training, and overhead expenses from the marginal cost calculation.

Inputs for marginal costs were assessed using the T&M modules in the cost instrument. These modules list the sequential activities needed to complete each of three possible types of MC procedures (forceps guided, dorsal slit, or sleeve resection) as adapted from WHO's *Male Circumcision Models for Optimizing the Volume and Efficiency of Services* (WHO, 2010).

Routine MC procedures provided to males were observed, the duration of each activity was measured, and the staff involved were noted by category (e.g., nurse, counselor, clinical officer). The quantity and type of expendable supplies consumed were recorded in the same T&M modules. The market unit cost paid by APHIA II and NRHS was obtained from the respective projects' procurement records and sent to the study team in an Excel template.

Cost Allocation

The proper allocation of costs to MC (versus other services) is critical. We developed methods specific to the three types of allocation required for this analysis: personnel involved in direct services provision, personnel involved in support activities, and other indirect costs. In addition, the instrument is able to allocate personnel time for MC to base, outreach, or mobile MC activities, in the case of sites that engage in more than one of these service delivery modes.

Allocation of direct services personnel costs

The cost instrument records the number of hours per week that members of each personnel category (e.g., surgical nurse, clinical officer, counselor, hygiene officer) spent on MC and non-MC activities. The allocation of staff time to MC versus non-MC clinical activities was accomplished through interviews with the program managers closest to program operations, who reviewed budgets, payroll records, personnel schedules, and other management documents that clarified how personnel divided their time among activities. The total MC-related full-time equivalents (FTEs) were further allocated to fixed facility, outreach, or mobile activities based on the managers' best estimates of staff members' designated duties and the schedule and time required by mobile and outreach activities, including transport time. The respective portion of each FTE was multiplied by the average compensation rate of the associated staff category to derive the cost of direct service provision for fixed facility, outreach, or mobile activities. Due to the absence of comparable data by modality or approach on the incidence, severity, and costs of treating adverse events, we excluded these costs from our analysis.

Allocation of support services personnel costs

The FTEs of support staff members (e.g., pharmacists, clerical assistants, and accounts clerks) were tabulated from administrative records and interviews. For the APHIA II and NRHS administrative activities, this estimate was obtained by interviews with program managers conversant with the responsibilities and routines of the staff. Administrative support functions at the APHIA II base hospitals were apportioned to MC on the basis of the percentage that MC constituted of total inpatient-equivalent days, using methods prescribed by *WHO-CHOICE* (WHO, 2009) for establishing the resource equivalence of outpatient visits versus inpatient days. The allocation of administrative staff time to service modality was made on the basis of mangers' estimates for staff members whose responsibilities were specific to or weighted toward a particular modality. For example, the cost of APHIA II's community mobilization facilitator was apportioned to outreach and mobile activity

costs, as the position was known to be primarily outreach-focused. The allocation of costs for core administrative staff (e.g., information technology and clerical staff) was arithmetically apportioned to modality according to the relative share of total caseload in each modality. Administrative support for the NRHS MC activities are captured by the central office costs reported to us by the NRHS manager in Kisumu. Some residual costs incurred at the facilities served by NRHS were unable to be captured.

Allocation of other indirect costs

Building maintenance, utilities, vehicle storage and maintenance, and other miscellaneous nonpersonnel support costs at the APHIA II base hospitals were allocated to MC modality according to the WHO-CHOICE method described above. The incremental MC-related indirect costs at outreach sites and at the NRHS base sites were unavailable but are believed to be minimal. In the case of outreach facilities, MC services are episodic; in the case of the NRHS sites, most of the indirect support costs are centralized in NRHS. However, there may be some incremental MC-related facility-related costs, such as utilities or waste disposal, that we did not estimate.

Qualitative information

Data from the foregoing quantitative analyses are needed to assess program costs and efficiency and to help identify the proximate causes of high or low efficacy among sites and MC delivery modalities (e.g., fewer patients seen in a day). However, cost and outcome data alone do not identify the underlying reasons for variations in the efficiency of programs providing similar services.

To supplement quantitative data, we used a semistructured qualitative interview on the determinants of efficiency and sustainability at the study sites. Respondents were clinicians or other knowledgeable high-level staff members. The interview-derived information contributed to framing our findings. Particularly since the study scope inhibited our ability to make statistical inferences, the insights and experience of senior program managers helped us to determine whether an observed association was likely to be causally linked, random, or determined by an unmeasured intervening variable.

Analysis of Trends in Unit Cost for Scaling Up MC Services

We were not able to complete a second planned objective of this research—namely to document the changes in unit cost over time. For the MOH, the obstacle was reliably allocating the portion of time hospital staff spent on MC over time. Since the staff have a wide range of duties and the facility maintained no log of time spent on activities, it was not possible to reconstruct this information. We therefore evaluated personnel costs for direct services based on the information derived from the T&M study. However, by definition, this important portion of total costs would be constant over changes in service volume. Furthermore, it imposes the level of productivity found during the T&M study period on the entire time we wished to examine, thus obscuring the potential effects of increased productivity that often accompanies experience. We investigated the cost of the supplies purchased by APHIA II over four consignments between August 2008 and February 2010. The unit costs were essentially invariant, eliminating another source of possible variation.

Our obstacles were different with NRHS. Information on critical items, such as transport and mobilization costs, were unavailable in a form that allowed for them to be disaggregated over time and allocated to base, outreach, and mobile sites with sufficient precision to be useful.

Areas for Enhanced Efficiency: Cost-Effectiveness and Cost Savings

In Nyanza, in other settings in Kenya, and elsewhere in Africa, there is a large unmet demand for MC. To the extent that they are administratively manipulable, understanding the determinants of efficiency in MC

delivery can help program managers to identify ways to deliver more MCs for the money and personnel resources available. This in turn would mean lower HIV incidence and a reduction in its attendant medical care costs. Based on the results of our cost analysis, we identified five potential strategies to improve the efficiency of MC service delivery. We explored the potential effects of these strategies on cost, HIV infections averted, and cost-effectiveness, using specified assumptions.

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Current Cost per MC Delivered, by Program Approach and Service Delivery Mode

Table 5 summarizes the number of MCs delivered, by approach and service delivery mode using the forceps-guided method. During the study period November 2008 to April 2010, a total of 62,705 MCs were delivered, 90.1% through the NRHS diagonal approach and 9.9% through the APHIA II horizontal approach. Overall, community-based services dominated the caseload, with 68.6% of MCs delivered at either mobile or outreach sites and the balance provided at base facilities. This number is dominated by the large number of cases performed with NRHS support. APHIA II delivered 53.5% of its MCs at outreach or mobile sites, while NRHS delivered 70.3% of its MCs at outreach or mobile sites.

Figure 1 presents the marginal costs of delivering an MC using the forceps-guided method. The marginal cost includes the value of expendable supplies, the value of personnel time prior to and during the procedure, and transportation costs including the staff time in transit. The total marginal cost was lowest for APHIA II base ($11.62), which has no transportation costs. Outreach services for the APHIA II approach were highest ($23.52), due primarily to the cost of transportation and to the long average waiting time for the MC team prior to the first surgery of the day. The NRHS approach delivered MCs with a marginal cost of $19.06 at the base facilities and slightly less ($17.04) at the combined outreach/mobile sites. This small net difference is the result of higher transportation costs at the outreach-mobile sites but lower opportunity cost of the MC team's time prior to the first surgery of the day at the outreach-mobile sites.

Figures 2 and 3 present estimates of *total cost* per MC patient—in absolute dollars, and as a percentage distribution across cost components. Total cost includes the fixed costs excluded from the marginal cost figures above (i.e., administrative costs, capital equipment, facility rents and renovations, facility services and indirect costs, and training). It also includes the cost of local community mobilization efforts and other demand generation strategies (e.g., cost of flyers and similar printed publicity material, and stipends for community mobilizers). These costs were calculated for the forceps-guided method and would be different for other surgical methods of MC based on differences in personnel time and supplies.

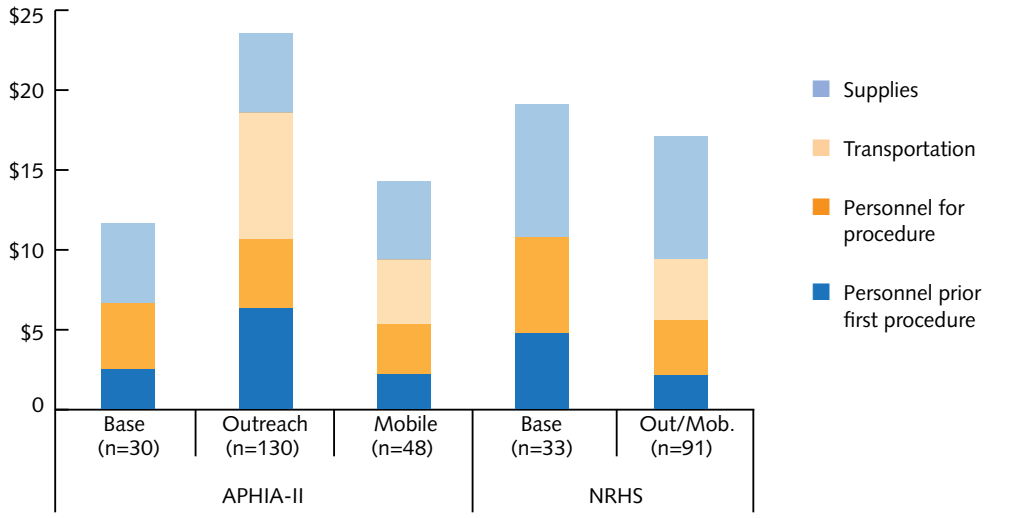
Due to the absence of comparable data by modality or approach on the incidence, severity, and costs of treating AEs, we excluded these costs. However, based on other research conducted by EngenderHealth in Nyanza on the safety and effectiveness of MC service delivery modes, the incidence of AEs was 3.6–3.8% at seven days follow-up and 0.5–1.0% at 60 days follow-up (Pavin et al., 2011). If each AE required an outpatient visit at a secondary care facility costing $7.88 (WHO, 2009), the cost of treating AEs would be $0.32 to $0.38, roughly 1% of the total unit cost.

TABLE 5: NUMBER OF MCS DELIVERED, NOVEMBER 2008–APRIL 2010, BY AGENCY AND SERVICE DELIVERY MODALITY

	Base	Outreach	Mobile	Total	% of Total
APHIA II	2,897	2,829	485	6,211	9.9%
NRHS	16,791	39,703	n/a	56,494	90.1%
Total	19,688	42,532	485	62,705	100.0%
% of total	**31.4%**	**67.8%**	**0.8%**	**100.0%**	

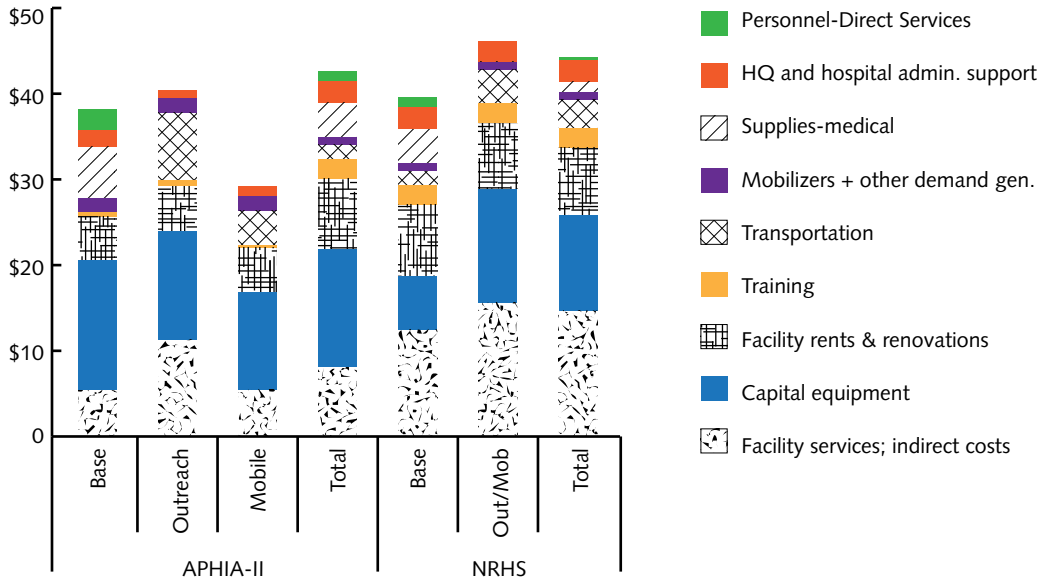
* For NRHS, "outreach" signifies combined outreach and mobile activities. Of these, about 90% took place at permanent facilities and 10% at mobile locations. is the procedures were therefore predominantly "outreach" in nature.

FIGURE 1. MARGINAL MC COSTS AND THEIR COMPONENTS, BY SERVICE DELIVERY MODALITY AND APPROACH



Note: These estimates are derived from 246 T&M observations. *NRHS outreach includes approximately 10% mobile. †Transportation assumes $0.37 per km, including fuel, maintenance, depreciation, insurance (NRHS records); and compensation of personnel time in transit.

FIGURE 2. PER-CLIENT COST OF MC PROVISION, BY AGENCY AND MODALITY



Note: Transportation includes fuel, maintenance, depreciation, insurance, and the value of staff time.

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The total cost per patient was lowest for APHIA II mobile services ($29.32) and was highest for NRHS outreach/mobile services ($46.20), a difference of 37%. APHIA II mobile activities were initiated in February 2010 and account for only 7.8% of the APHIA II cases included in this analysis. The cost per MC at base facilities was very similar for the two approaches, ($38.33 and $39.58, respectively, for APHIA II and NRHS).

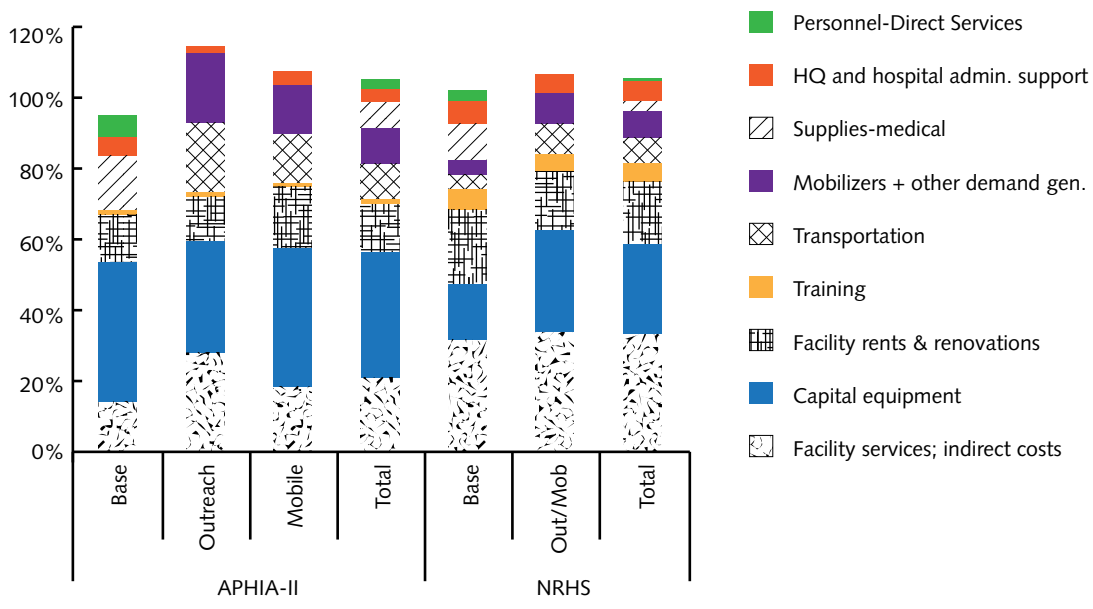
Components that Decrease the Unit Cost While Maintaining Quality

This section reports the findings of the time and motion observations that are relevant to understanding the staff resources required for MC using the forceps guided method, by approach and mode. We look in particular at:

- Variations in staffing patterns
- Number of MCs performed per surgery-day
- Breakdown of time required for specific steps of the MC procedure
- Waiting time prior to the first surgery of the day

Figure 4 displays, based on T&M data, the average number of various staff who were part of the MC team delivering services. The distribution of staff in the surgical teams is similar between the two approaches, as are the overall number of staff per case (4.2 for APHIA II and 3.9 for NRHS). This suggests that differences in unit costs between the two approaches cannot be explained by important differences in staffing patterns for direct service delivery. In Kenya, both clinical officers and nurses are permitted to perform MC surgery. The relative distribution of staff and unit costs would be quite different in countries in which medical officers are required to be part of the surgery.

FIGURE 3. PERCENTAGE DISTRIBUTION OF COST PER CLIENT ACROSS COST COMPONENTS, BY AGENCY AND MODALITY



Note: Transportation includes fuel, maintenance, depreciation, insurance, and the value of staff time.

FIGURE 4. AVERAGE NUMBER OF STAFF DELIVERING MC SERVICES, BY TYPE, ACCORDING TO SERVICE DELIVERY MODE

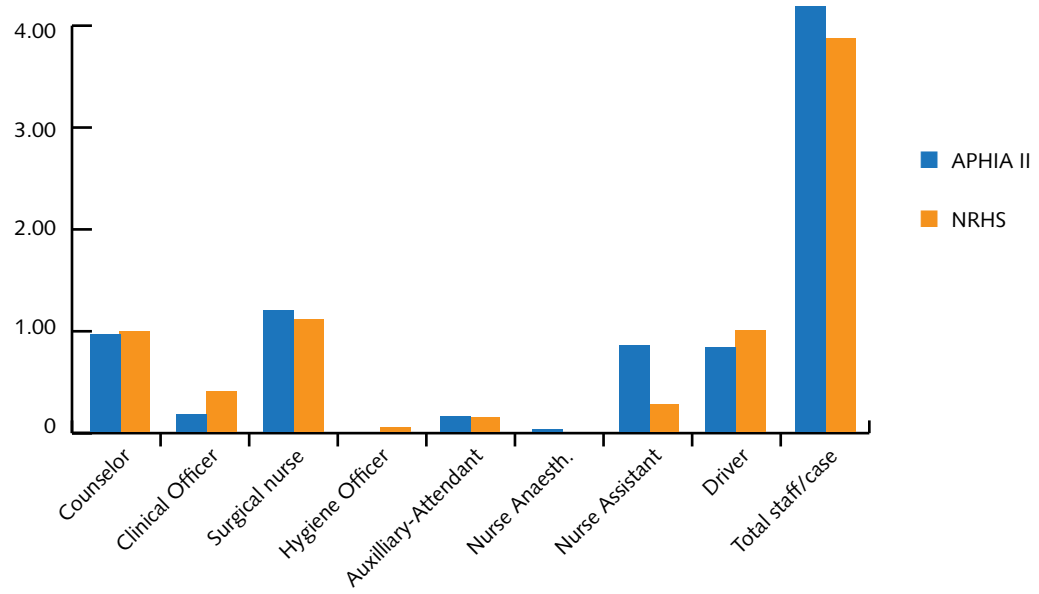
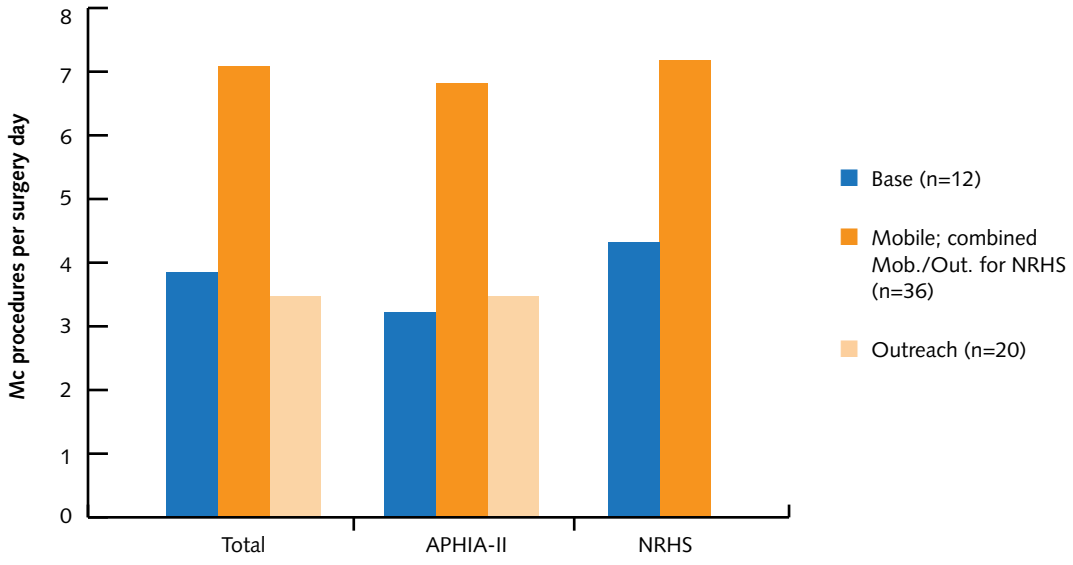


FIGURE 5. AVERAGE NUMBER OF MC PROCEDURES PERFORMED PER SURGERY-DAY, BY SERVICE DELIVERY MODE



Note: The n values represent surgery-days observed.

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Figure 5 summarizes the number of MC procedures performed per surgery-day. Combining both APHIA II and NRHS, the range is from 3.2 (APHIA II base) to 7.1 (mobile only for APHIA II and outreach/mobile for NRHS). This index reflects the impact of several factors: procedure duration, waiting time (especially before procedures begin), and length of the surgery-day (mainly a function of demand for MC services).

Through the T&M data collection exercise, we were able to obtain detailed information on the amount of staff time required for the MC operation for the forceps-guided method. The next three tables provide data on the time required to conduct MCs. Table 6, which summarizes data on the time required per MC across the three modalities, shows that the average procedure time varied from 22.2 minutes (mobile) to 31.0 minutes (outreach), and that total time (including postoperative time) varied from 23.3 minutes (mobile) to 32.9 minutes (outreach).

While there were significant differences in the time required for MC services between mobile and both outreach and base modalities, the differences between base and outreach were small. Looking at the portion of total case-time required by the most trained member of the team, the surgeon, we see only small differences, ranging from 48% for outreach to 53% for base facilities.

Tables 7 and 8 provide data by specific step in the MC delivery and by the approach and setting. The highlighted cells indicate differences that are statistically significant at $p<.05$ (two-tailed t-test). The time for each specific step in the MC task follows in subsequent columns.

Tables 7 and 8 provide a convenient way to study differences between steps in the MC procedure. Although our study suggests that staffing patterns are similar between the two approaches, the time required per case and the time required for the various steps of the MC procedure vary between the two approaches and service delivery modes. These would also vary based on the surgical method used for MC. Overall, the APHIA II approach requires 6.1 minutes more per case, on average, than the NRHS approach, of which 2.7 more minutes are required for the steps requiring a surgeon's active participation. These differences were statistically significant. MCs performed at base facilities in either approach required more of the surgeon's time than these performed at mobile sites (7.5 minutes vs. 4.8 minutes), a difference that was also statistically significant. However, a comparison of performed MCs at base facilities and outreach sites in either approach revealed only small differences in the time required, and neither difference was statistically significant. Finally, in a comparison between mobile and outreach approaches, 9.5 minutes more were required per case at the outreach sites, of which 4.4 minutes were surgeons' time.

One unexpected finding from this analysis is the significant amount of time that elapses between the arrival of the surgical team at the service location and the time services

TABLE 6. AVERAGE TIME (IN MINUTES) FOR MC CASE, BY MODALITY

	Base (n=63)	Outreach (n=43)	Mobile (Combined Mobile/Outreach for NRHS) (n=139)	Total
Surgeon time (in mimutes)	16.3	15.9	11.5	13.0
Procedure time (in mimutes)	29.5	31.0	22.2	25.1
Total time per case (in mimutes)	30.9	32.9	23.3	26.4
Surgeon time as % of total	**53%**	**48%**	**49%**	**49%**

TABLE 7. SELECTED COMPARISONS OF TIME PER MC PROCEDURE (IN MINUTES) USING THE FORCEPS-GUIDED METHOD

	NRHS vs. APHIA II			Base vs. Mobile			Base vs. Outreach			Outreach vs. Mobile		
	Avg. mins.		p-value	Avg. mins.		p-value	Avg. mins.		p-value	Avg. mins.		p-value
	NRHS (n=124)	APHIA II (n=121)		Base (n=63)	Mobile (n=139)		Base (n=63)	Outreach (n=43)		Outreach (n=43)	Mobile (n=139)	
Summary Measures												
Surgeon time[1]	12.1	14.9	.0014	16.3	11.5	.0000	16.3	15.9	.7414	15.9	11.5	.0000
Procedure time[2]	23.0	28.4	.0000	29.5	22.2	.0000	29.5	31.0	.3882	31.0	22.2	.0000
Total time per case[3]	23.9	30.1	.0000	30.9	23.3	.0000	30.9	32.9	.2635	32.9	23.3	.0000
Transition times on table (tot.)[4]	1.0	1.9	.0001	0.8	1.4	.0299	0.8	2.6	.0001	2.6	1.4	.0010
Postoperative time[5]	1.0	1.6	.0000	1.4	1.1	.0158	1.4	1.7	.1649	1.7	1.1	.0005
Individual Surgical Steps and Related Tasks												
Presurgical counseling[6] — simultaneous	14.0	10.0	.0048	13.1	12.4	.6532	13.1	8.3	.0440	8.3	12.4	.0769
Placement on table, surgical preparation	4.6	5.3	.1163	6.6	4.0	.0000	6.6	5.6	.2095	5.6	4.0	.0005
Injection of anesthesia	1.2	1.5	.0002	1.4	1.2	.0185	1.4	1.9	.0004	1.9	1.2	.0000
Other surgical preparation[7]	0.8	0.9	.3859	0.6	1.0	.1246	0.6	0.8	.5100	0.8	1.0	.4201
Marking	0.2	0.4	.0006	0.3	0.3	.4565	0.3	0.3	.8167	0.3	0.3	.6896
Palpation of glans	0.1	0.3	.0000	0.2	0.2	.6957	0.2	0.4	.0189	0.4	0.2	.0003
Forceps placement	1.4	1.5	.9991	1.9	1.2	.0024	1.9	1.6	.2697	1.6	1.2	.1613
Incision	0.1	0.2	.0081	0.1	0.1	.5115	0.1	0.3	.1038	0.3	0.1	.0109
Hemostasis	4.2	4.7	.0282	4.8	4.2	.0382	4.8	4.8	.9273	4.8	4.2	.0819
Suturing	6.0	7.3	.0471	8.7	5.3	.0000	8.7	8.0	.4969	8.0	5.3	.0002
Sutures — other misc. tasks	1.8	2.8	.0042	1.8	2.1	.3330	1.8	3.5	.0102	3.5	2.1	.0055
Dressing	1.7	1.9	.1441	2.2	1.5	.0001	2.2	2.1	.7461	2.1	1.5	.0013
Postoperative monitoring and instruction — simultaneous	0.2	0.6	.0000	0.3	0.4	.0476	0.3	0.4	.1375	0.4	0.4	.7602
Instrument sterilization — simultaneous	0.7	1.0	.0060	1.1	0.6	.0000	1.1	1.3	.1680	1.3	0.6	.0000
Transition time before next client[8] — simultaneous	1.5	1.9	.3717	1.5	1.9	.5489	1.5	1.3	.8279	1.3	1.9	.4542

Note: MC steps continue from upper to lower block of rows. Highlighted cell signifies that p<.05, using 2-tailed t-test for unequal variance.
1. Surgeon time = "Marking" through "Sutures". 2. Procedure time = "Placement on table" through "Dressing". 3. Total time per case = "Procedure time" + transition time between dressing and postoperative monitoring + "Postoperative time". 4. Transition time on table = Sum of the transitions from "Injection of anesthesia" through "Dressing". For economy of presentation, the individual transition times are not displayed in this table. 5. Postoperative time = "Postoperative monitoring" + transition time + "Instrument sterilization". 6. Additional to any HIV counseling and testing. 7. For example, shaving. 8. Laying out instruments; other miscellaneous surgical preparation.

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TABLE 8. DIFFERENCES IN TIME PER MC PROCEDURE (IN MINUTES) USING THE FORCEPS-GUIDED METHOD, BY PROGRAM AND MODE

	NRHS vs. APHIA II[1]	Base vs. Mobile[2]	Base vs. Outreach[2]	Outreach vs. Mobile[3]
Summary Measures				
Surgeon time[1]	2.73	4.84	0.42	4.42
Procedure time[2]	5.43	7.22	-1.50	8.72
Total time per case[3]	6.12	7.50	-2.03	9.53
Transition times on table (tot.)[4]	0.90	-0.51	-1.79	1.28
Postoperative time[5]	0.61	0.29	-0.29	0.58
Individual Surgical Steps and Related Tasks				
Presurgical counseling[6]—simultaneous	-4.01	.73	4.75	-4.02
Placement on table, surgical preparation	0.67	2.65	1.06	1.59
Injection of anesthesia	0.30	0.19	-0.52	0.71
Other surgical preparation[7]	0.16	-0.36	-0.12	-0.24
Marking	0.18	-0.05	-0.02	-0.03
Palpation of glans	0.26	0.02	-0.22	0.25
Forceps placement	0.02	0.71	0.33	0.38
Incision	0.14	0.01	-0.20	0.21
Hemostasis	0.55	0.58	-0.03	0.61
Suturing	1.23	3.43	0.69	2.73
Sutures—other misc. tasks	1.06	-0.37	-1.73	1.36
Dressing	0.22	0.66	0.07	0.59
Postoperative monitoring and instruction—simultaneous	0.33	-0.16	-0.12	0.04
Instrument sterilization—simultaneous	0.28	0.47	-0.25	0.71
Transition time before next client[8]—simultaneous	0.39	-0.33	0.20	-0.53

Note: Highlighted cell signifies that difference is statistically significant at p<.05, using 2-tailed t-test for unequal variance.
1. Positive value signifies that APHIA II required more time. 2. Positive value signifies that "base" required more time. 3. Positive value signifies that "outreach" required more time.

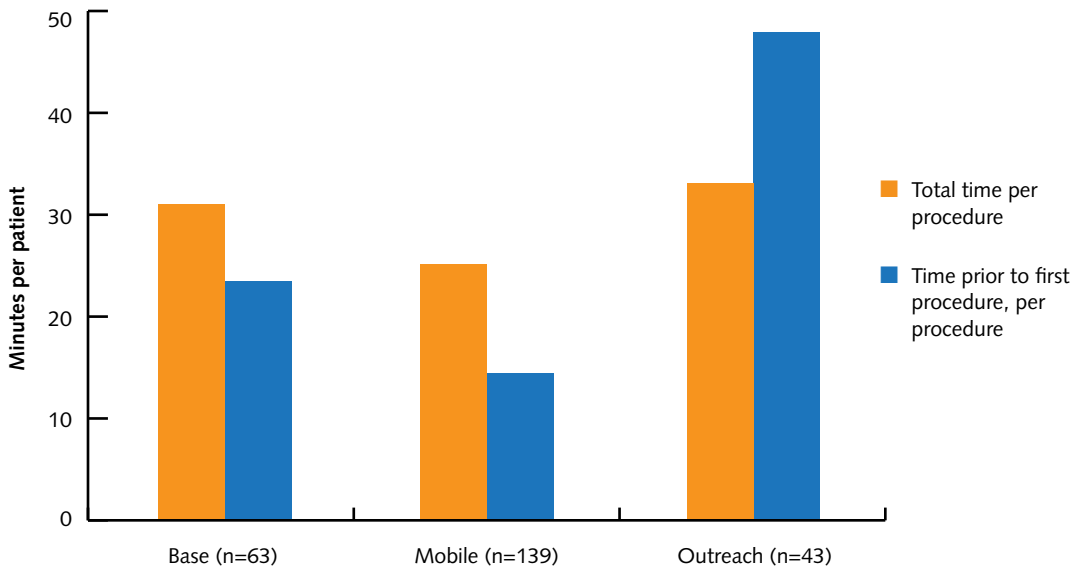
begin for the first patient. Figure 6 summarizes these findings by showing the waiting time divided by the average number of MCs performed per surgery-day. The waiting time varied substantially, from 48.8 minutes per case performed at Outreach sites to 14.3 minutes per case performed at mobile sites.

At APHIA II–supported services, the waiting times varied from an average of 1.0 hours at base to 1.7 hours at mobile and 2.7 hours at outreach sites. At the NRHS-supported services, they varied from 1.9 hours at base to 1.6 hours for combined outreach/mobile modalities. The waiting time prior to the first surgery exceeded the differences in procedure time shown in the second column of Table 7. This suggests that there may be greater opportunities for economies by implementing strategies for reducing the waiting time at the start of the day than by seeking to further optimize the surgical procedure itself.

Would an increase in demand increase productivity without further programmatic inputs? It is possible that underutilized personnel resources might be tapped by the need to meet higher client demand. Using T&M data from both APHIA-II and NRHS, we addressed this question by calculating (1) the correlation between the number of MCs performed per surgery-day (productivity) and the waiting time at the start of the day (potentially underutilized resources) and (2) the correlation between cases per surgery-day and the average length of time for the MC procedures. We conducted these analyses for the months of May and June 2010, the period of the T&M study.

As shown in the results of the bivariate analysis (Figure 7), the number of surgeries per day is essentially unrelated

FIGURE 6. NUMBER OF MINUTES REQUIRED PER MC CASE, BY MODALITY, COMPARING PROCEDURE DURATION WITH ELAPSED TIME BETWEEN ARRIVAL OF SURGICAL TEAM AND FIRST OPERATION, DIVIDED BY NUMBER OF CLIENTS RECEIVING SURGERY THAT DAY



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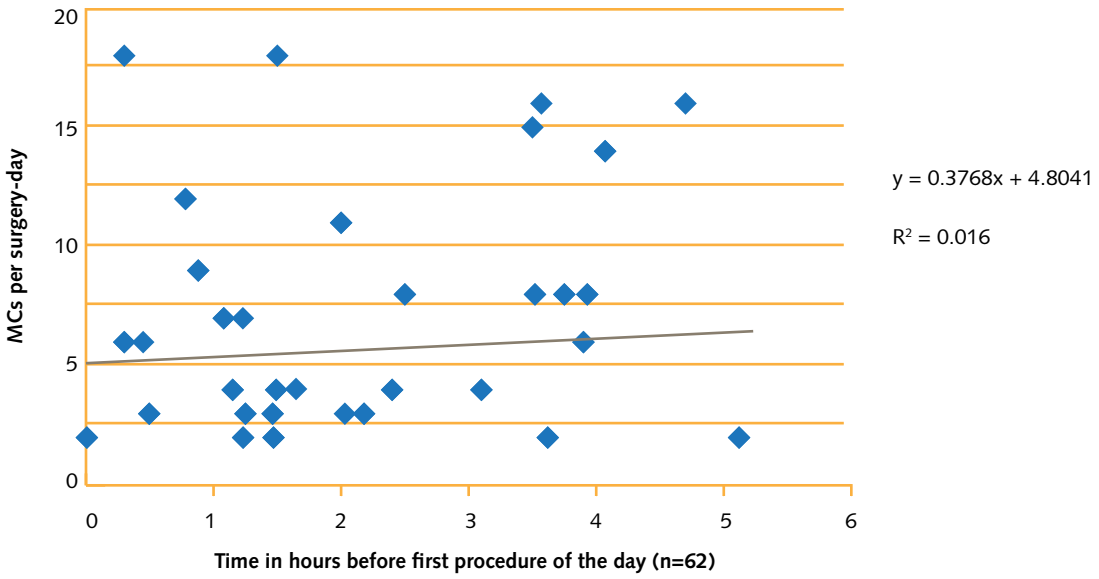
to waiting time at the start of the day. However, because the NRHS has higher caseloads, it is possible that these summary data are masking differences between the approaches. Specifically, a plausible hypothesis is that once caseloads reach a certain high level, programs respond to reduce inefficiencies, such as the waiting time before the start of the first surgery. However, when the data shown in Figure 7 are disaggregated by approach, NRHS shows a correlation between time before first case and the number of cases per day of surgery, (0.37), while APHIA II showed a correlation of –0.04. Thus, we see no strong associations between the number of surgeries performed per day and the waiting time before the first surgery of the day. In the case of the NRHS, the direction of the association is the opposite of what we might have expected; more cases per day are (weakly) associated with a longer average waiting time before the first surgery of the day. One caveat is that the T&M study was performed during a two-month period (May and June, 2010) when NRHS caseloads were somewhat lower than the average for the 12-month period that ended on June 30, 2010 (3,313 vs. 3,732 per month) (see Figure 8).

In addition, 3,313 is a much smaller amount than the peak of 12,173 MCs seen in December 2009 during the RRI. It is possible that at higher caseload levels, waiting times were lower. However, for APHIA II, the T&M data were collected at a period of high case volume—979 per month (in May and June 2010), vs. 547 for the 12-month period ending on June 30, 2010. and the rate of 979 per month is not far below APHIA II's peak of 1,182 on December 2009. The available data thus provide substantial (though not definitive) evidence that higher caseloads or higher numbers of cases per day are not associated with lower waiting times.

The data in Table 9 suggest that greater effective demand (as indicated by cases performed per surgery-day) is also

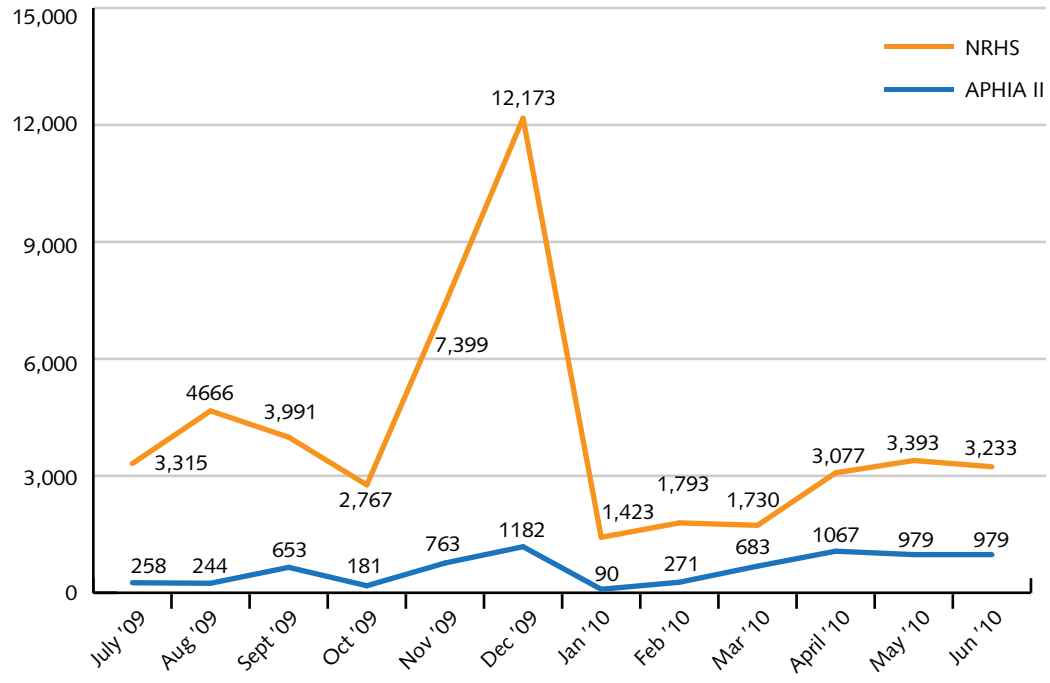
FIGURE 7. RELATIONSHIP BETWEEN TIME BEFORE FIRST SURGERY OF THE DAY AND MC PROCEDURES PERFORMED ON THAT DAY, BY SERVICE DELIVERY MODE



not associated with the time required per MC procedure. The number of cases per day explains only a small part of the variation in time required per procedure, and the relationship between the two variables is weak. For example, the linear regression slope of –0.53 indicates that for every additional MC performed in one surgery-day, the time required to conduct the average MC declines by 0.53 minutes (32 seconds).

Taken together, the data shown in Figures 7 and 8 and in Table 9 suggest that efficiency gains (as indicated by waiting times and time required per procedure) are unlikely to be achieved simply by increasing caseloads, unaided by more active measures to increase efficiency.

FIGURE 8: CASELOAD TRENDS FOR NRHS AND APHIA II, JULY 2009–JUNE 2010



Note: T&M data were collected in May and June 2010.

TABLE 9. CORRELATION AND SLOPE (IN PARENTHESIS) OF BIVARIATE REGRESSION BETWEEN AVERAGE MC CASES PER SURGERY-DAY AND THREE MEASURES OF THE AVERAGE TIME REQUIRED TO PERFORM EACH MC ON THAT DAY

Approach	Total MC Time	Procedure Time	Surgeon Time
NRHS & APHIA II (n=54)	–0.19 (–0.43)	–0.19 (–0.42)	–0.31 (–0.53)
APHIA II (n=23)	–0.12 (–0.34)	0.10 (0.30)	–0.19 (–0.38)
NRHS (n=31)	–0.25 (–0.53)	–0.25 (–0.52)	–0.34 (–0.55)

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Differences in HIV Cases Averted and Potential Savings in HIV Treatment Costs

In this section, we summarize the relationship between MC cost and epidemic effect, and we explore five types of potential efficiencies in MC delivery using the forceps-guided method.

Epidemic Effects

The epidemic effect of MCs and the efficiency of its delivery can be summarized well in a single value: the number of HIV infections averted (HIAs) per $1 million of MC program expenditures. Two inputs are required to estimate this value: the average cost of MCs (which can be expressed as the number of MCs performed for $1 million) and the number of MCs required to avert one HIV infection.

The unit cost of an MC using the forceps-guided method (shown in the first line of Table 10) ranges from $29.32 to $46.20. The number of MCs that can be performed for a budget of $1 million thus varies from 21,643 to 34,103.

Previous work modeling the MC and the HIV epidemic (Kahn, 2006) and additional calculations together suggest that in a setting like Nyanza, with HIV prevalence around 20% (17% in uncircumcised men, 26% in women) (KAIS, 2009; KNBS, 2010)), 10 MCs avert about 2.5 HIV infections over 20 years, or 0.25 HIV infections averted per MC. The estimate includes indirectly averted infections (e.g., among female sex partners) and is discounted to the present, per normal practice. The resulting estimate of HIAs per $1 million ranges from 5,411 to 8,526, depending on the program approach and service delivery mode (Table 10).

The cost per HIV infection averted is also reported, in the last row. The range is $117.29 to $184.82. All of these values are far below the lifetime medical cost of HIV disease, estimated at $6,000 in East Africa. In Table 10, we report that each of the MC service delivery modes by either program approach results in substantial net savings. We do not consider the improved epidemic impact and cost-effectiveness associated with more rapid scale-up, as it was not one of our primary research questions. These gains have previously been documented in the literature (Stover et al, 2009; Kioko et al., 2010). In a relatively stable epidemic, as in Nyanza, delivering MCs sooner improves epidemic impact and cost-effectiveness. Thus, to the extent that the program approach and service delivery mode allow MC resources to be deployed quickly, there will be further improvements in cost-effectiveness.

Potential Efficiencies in MC Service Delivery

Based on the results of our analysis, we identified five potential strategies for improving the efficiency of MC service delivery using the forceps-guided method. In this section, we explore the potential effects of these strategies on cost, HIV infections averted, and cost-effectiveness, using specified assumptions.

TABLE 10. COST-EFFECTIVENESS OF MC PROGRAM, BY MODALITY AND AGENCY TYPE

	APHIA II			NRHS	
	Base	Outreach	Mobile	Base	Outreach/ mobile
Cost per MC	$38.33	$40.51	$29.32	$39.58	$46.20
MCs per budget	26,092	24,687	34,103	25,266	21,643
HIA per $1 million	6,523	6,172	8,526	6,316	5,411
Cost-effectiveness: Cost per HIA	**$153.30**	**$162.03**	**$117.29**	**$158.32**	**$184.82**

The five strategies are:

1. *Scheduling efficiency:* As noted in Figure 5, the mean number of MCs per day (approximately 3–7) is far less than team capacity (12–14, based on two MCs per hour). Often, the same MC team visits one location on two consecutive days. We therefore explored the question "what if the number of MC days was reduced by half?" That is, could all clients from two days be expected to come on one day? This would represent a doubling in the number of MCs performed per day, which would cut in half certain semi-fixed costs (e.g., transportation to the site, and the considerable length of time prior to the first MC) and which might also yield some administrative cost savings. However, it might also decrease effective demand, as some clients may not be able to reach the site on the one surgery day now available. In this example, to account for this problem, we assume 10% lower demand. Although this strategy is most likely to apply to outreach and mobile settings, we included base as well.

2. *Operational efficiency:* We identified a substantial period of time prior to the first surgery of the day similar to or greater than the time spent delivering the MC procedure. Thus, personnel costs are roughly doubled due to this operational inefficiency. We examined what costs would look like if the period prior to surgery was reduced by half, with no consequences on the number of MCs performed. This analysis assumes that staff time savings can be captured by reducing staff compensation or by having them perform other tasks.

3. *Administrative efficiency:* Administrative costs represent 15–40%of total costs. We explored the potential effect on total MC costs of reducing administration by half (doubling efficiency). These savings would be realized by reducing administrative staff—hiring fewer individuals, or, for programs with other services, reducing the time that existing staff spend on MC versus those other services.

4. *a) Technical efficiency—MC devices:* New MC devices, such as the Shang Ring, PrePex, and the Ellis Clamp, can reduce the duration of the circumcision surgical procedure and are simple to use. For example, the surgical portion of the MC procedure requires 6.5 minutes with the Shang Ring (EngenderHealth, 2010), compared with 14.2 minutes in our T&M observations. The Shang Ring also does not require sutures and reduces the amount of bleeding that clients typically experience. Such devices therefore also reduce the need for supplies and investment in surgical clamps. The most recent negotiated manufacturer's price for the version of the Shang Ring currently being used in research studies in Kenya and Zambia is $9. The negotiated manufacturer's prices for other devices were not available at the time of this study. We therefore used the pricing for the Shang Ring as a proxy for that of all MC devices.

   b) Technical efficiency—electrocautery: Bleeding during MC is often caused by transection of small blood vessels during foreskin removal. It can take several minutes to tie off these vessels and achieve hemostasis. Electrocautery is a much quicker alternative to stitching, saving an estimated 4 minutes per MC and thus reducing personnel costs by $0.59 (NRHS, 2011). Based on the use of electrocautery by NRHS-supported sites in Nyanza, we estimated that the reduced use of sutures and decreased wear on forceps saves an additional estimated $0.39. The electrocautery equipment, including coagulators, hand pieces, foot pedals, and electrodes, cost an estimated $2.00 per MC.

5. *Demand generation:* Relatively little is spent in either the APHIA II or the NRHS approaches on local mobilization to convince men to seek MC. As a result, it is likely that more demand could be generated with a concerted marketing effort. Since we do not have firm numbers on the cost of demand generation at various scales, we portray a variety of assumptions, including added cost per MC of $2.50 or $5, increases in the number of MCs

of 20% and 100%, and administrative costs unaffected (fixed) or partially affected (semifixed) by the increased number of MCs.

Savings per MC

Table 11 shows the potential savings per MC, estimated for each strategy. *Administrative efficiency* has the largest potential savings. If indeed administrative costs could be halved, the savings would total $3–$7.50 per MC, or 15–20% of total costs. *Scheduling efficiency* offers the next greatest potential savings (and higher savings for two service delivery modes), 8–20%. *Operational efficiency* (reducing down time at the start of the day) offers smaller savings.

Based on current costs of existing and new technologies, *technical efficiency* efforts are likely to result in greater costs per MC, in our analysis. Based on current manufacturer's negotiated pricing, MC devices are likely to increase costs by 12–25%, because the estimated cost of the device (currently $9) exceeds the value of saved supplies and personnel time. Similarly, electrocautery adds more costs than the relatively modest reduction in time and supplies produced by its use.

Demand generation can save or add costs, depending on the setting, even with one set of assumptions (in Table 11: $5 cost per MC, 20% more MCs, fixed administrative costs). Savings occur when spreading fixed costs saves more than the $5 added cost. We conservatively assume no savings in the unit cost of supplies due to increased scale. Other assumptions are explored below. Demand generation may also encourage faster surgeries and less down time; however, as described above, our data revealed no evidence of a substantial effect.

Savings or Added Costs for Total MC Spending

In Table 12, the savings per MC are translated into total savings (or added costs) against the initial budget of $1 million per modality. That is, we focus on the total cost implications of efficiency strategies. In general, the signs are the same as in Table 11: Total costs tend to change in the same direction as unit costs. This is predictable if the number of MCs remains unchanged. The largest added costs are for use of an MC device. However, for *demand generation*, a 20% increase in the number of procedures means that even with modest savings per MC, the total cost of all procedures is more than baseline, leading to a negative value for savings—i.e., added costs.

TABLE 11. COST SAVINGS PER MC FROM FIVE STRATEGIES INTENDED TO INCREASE MC DELIVERY EFFICIENCY

Savings per MC (adjusted for change in no. of MCs)					
	APHIA II			NRHS	
Strategy	Base	Outreach	Mobile	Base	Outreach/ mobile
1) Scheduling efficiency	$2.61	$8.30	$4.29	$3.30	$5.80
2) Operational efficiency	$1.00	$3.35	$1.10	$2.74	$2.93
3) Administrative efficiency	$7.53	$6.36	$5.71	$3.12	$6.65
4a) Technical efficiency—MC device	–$7.35	–$6.40	–$7.35	–$6.21	–$5.72
4b) Technical efficiency—electrocautery	–$1.22	–$0.79	–$1.22	–$0.48	–$0.30
5) Demand generation	**$0.85**	**$0.67**	**–$0.64**	**–$0.12**	**$0.80**

Change in HIAs

Table 13 shows the change in HIAs. This derives directly from the change in the number of MCs delivered. Four of the strategies, as we analyzed them, do not affect the number of MCs or HIAs. *Scheduling efficiency* is expected to decrease the number of infections averted, because lowering the number of days in which staff are present may mean that some clients will be unable to attend services (we assumed a 10% decline). In contrast, *demand generation* increases MCs and HIAs, reflecting an assumption of 20% growth in demand for and provision of MCs.

Table 14 summarizes the incremental cost-effectiveness of the two strategies that affect HIAs (as well as costs, which

TABLE 12. EFFECT ON TOTAL MC SPENDING OF FIVE STRATEGIES INTENDED TO INCREASE EFFICIENCY OF MC SERVICE PROVISION

Savings (added costs) for total MC spending					
	APHIA II			NRHS	
Strategy	Base	Outreach	Mobile	Base	Outreach/ mobile
1) Scheduling efficiency	$161,351	$284,473	$231,568	$174,995	$213,064
2) Operational efficiency	$26,028	$82,766	$37,412	$69,350	$63,438
3) Administrative efficiency	$196,558	$156,929	$194,892	$78,874	$143,908
4a) Technical efficiency—MC device	–$191,806	–$158,093	–$250,611	–$156,980	–$123,734
4b) Technical efficiency—electrocautery	–$31,723	–$19,396	–$41,515	–$12,006	–$6,396
5) Demand generation	**–$173,275**	**–$180,229**	**–$226,263**	**–$203,606**	**–$179,134**

TABLE 13. EFFECT ON HIAS OF FIVE STRATEGIES INTENDED TO INCREASE EFFICIENCY OF MC SERVICE PROVISION

Change in HIV infections averted					
	APHIA II			NRHS	
Strategy	Base	Outreach	Mobile	Base	Outreach/ mobile
1) Scheduling efficiency	(652)	(617)	(853)	(632)	(541)
2) Operational efficiency	–	–	–	–	–
3) Administrative efficiency	–	–	–	–	–
4a) Technical efficiency—MC device	–	–	–	–	–
4b) Technical efficiency—electrocautery	–	–	–	–	–
5) Demand generation	**1,305**	**1,234**	**1,705**	**1,263**	**1,082**

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all strategies do). Cost-effectiveness is expressed as a cost-effectiveness ratio; here, we use cost per HIA. *Demand generation* is easy to understand: Given assumptions about the cost of mobilization ($5 per MC) and the increased number of MCs (20%), the estimated cost per HIA varies from $133 to $166, slightly less than the cost-effectiveness ratios for the overall MC strategies. Of course, the cost-effectiveness ratio would be less attractive if there were fewer added MCs or higher mobilization costs, as we explore below.

Scheduling efficiency saves money but, in our analysis, reduces the number of MCs. Thus, the cost-effectiveness ratio in Table 14 is the cost per HIA of ***not*** adopting this strategy (i.e., returning from the more efficient strategy to the baseline approach). The values are higher than the overall cost-effectiveness ratios for MC. This suggests that if our inputs are accurate, it would make more sense economically to do more MCs (in other locations) than to return to the same site two days in a row or to generate demand. However, if no other viable MC sites are available, even the highest cost-effectiveness ratio ($461 per HIA) yields considerable net savings after taking into account the averted lifetime costs of HIV care ($6,000).

In Table 15, we report the cost-effectiveness associated with different input assumptions about demand generation. We vary three assumptions: the percentage rise in the number of MC procedures (20% or 100%); the increase in the cost of mobilization ($5 or $2.50) per MC; and how administrative costs are affected (fully fixed or 50% fixed/50% variable). The 20% increase in the number of procedures represents the actual difference for the APHIA II program between peak demand during school holidays and the two months following, during which we collected T&M data. One hundred percent is an estimate of manageable daily MC production. The 100% increase in the number of MCs represents reaching the approximate capacity for MCs per day within the current team configuration. NRHS had a large increase in monthly services (more than 500%) between our visits and the peak season. We examine the potential 100% increase within teams, assuming that further increases will be handled by deployment of new teams.

The first scenario (a) is the same as reported in Table 12, with a cost-effectiveness ratio of $133–166 per HIA. Allowing administrative costs to rise with increased numbers of MCs (50% variable, scenario b) increases the

TABLE 14. EFFECT ON COST PER HIA (COST-EFFECTIVENESS) OF FIVE STRATEGIES INTENDED TO INCREASE EFFICIENCY OF MC SERVICE PROVISION

Cost per HIV infection averted (unadjusted for reduced HIV care costs)					
	APHIA II			NRHS	
Strategy	Base	Outreach	Mobile	Base	Outreach/ mobile
1) Scheduling efficiency	$247	$461	$272	$277	$394
2) Operational efficiency	n/a	n/a	n/a	n/a	n/a
3) Administrative efficiency	n/a	n/a	n/a	n/a	n/a
4a) Technical efficiency—MC device	n/a	n/a	n/a	n/a	n/a
4b) Technical efficiency—electrocautery	n/a	n/a	n/a	n/a	n/a
5) Demand generation	**$133**	**$146**	**$133**	**$161**	**$166**

cost-effectiveness ratio to $153–190 per HIA. If demand generation doubles the number of MCs with fixed administrative costs (scenario c), the cost-effectiveness ratio drops sharply, to $46–66 per HIA. With semifixed administrative costs (scenario d), cost-effectiveness rises to $62–85 per HIA. With a 20% increase in demand but mobilization costs of only $2.50 more per MC, the cost-effectiveness ratios are $83–116 and $103–140 per HIA for fixed and semifixed costs, respectively (scenarios e and f).

Finally, we conducted a threshold analysis. Table 15 shows that the cost of mobilization required to keep the cost per HIA similar to overall MC cost-effectiveness, with a 20% increase in MCs and semi-fixed administrative costs, is about $4.50 and varies by MC type.

Analysis of Interview Data

During the study period, the data collection team conducted four structured interviews with the following MC program officials:

- Chief medical officer
- Registered nurse
- Counselor
- Clinical officer in charge

The interview was designed to elicit information that would reflect on key issues related to program efficiency, as represented in the frequency of responses. Table 16 summarizes the responses from a total of four interviews that included responses reflecting the respondents' opinions on five key themes that emerged from the data.

Underutilized Resources

The facilities where the respondents were working currently handle about three MC surgeries per day. Three out of four respondents indicated that there is underutilized capacity at these facilities:

> *Before MC, several staff were already stretched thin. Therefore, when a client comes, we would have to tell him to come back five days later. On an ongoing basis, we could accommodate 15–20 cases.* (Chief medical officer)

> *We could do 8–12 per day.* (Counselor)

> *We could perform 20 cases per day with existing personnel and resources. Some staff were trained for MC, but they are not interested in providing the service. This is not easily solvable.* (Registered nurse)

TABLE 15. EFFECT OF DEMAND GENERATION ON COST PER HIA (COST-EFFECTIVENESS), BY VALUE OF INPUT ASSUMPTIONS

Demand generation: cost per HIV infection averted (unadjusted for HIV care costs)					
Rise in no. of MCs; mobilization cost per case; admin. costs fixed or semi-fixed	APHIA II			NRHS	
	Base	Outreach	Mobile	Base	Outreach/ mobile
a. 20%; $5; fixed	$133	$146	$133	$161	$166
b. 20%; $5; semi-fixed	$160	$169	$153	$173	$190
c. 100%; $5; fixed	$46	$53	$46	$66	$67
d. 100%; $5; semi-fixed	$67	$70	$62	$75	$85
e. 20%; $2.50; fixed	$83	$96	$83	$111	$116
f. 20%; $2.50; semi-fixed	**$110**	**$119**	**$103**	**$123**	**$140**

FINDINGS

Strategies for Increasing MC Demand

Three out of the four respondents identified strategies that had been used for generating demand for MC services, including radio. The responses suggested that radio is a good strategy that may not be as labor-intensive or costly as other strategies, such as providing a fee for mobilizers. The responses also suggest that school holidays represent an opportunity for increased volume if staff schedules can be arranged to handle the level of demand:

> *Events in the community affected clients coming for services. APHIA had a slot every Saturday on radio and people could call in. This was very effective. It was listened to in all corners of the province. Tell friend about service and when they come give 2 bottles of soda. Giving a voucher may work. The community health worker would give them out.* (Chief medical officer)

> *In September 2009, mobilization was done in a nearby school and 50 students turned up. The situation was resolved by booking the clients for another day.* (Counselor)

Challenges to Service Delivery

All four respondents identified a number of challenges to service delivery, including inconsistent availability of MC supplies, lack of adequate space for conducting surgeries, and scheduling problems with MC services:

> *If support from the donor was not there, MC could not go on. So far we have not had to stop MC because supplies have been adequate.* (Clinical officer in charge)

> *Limited supplies (consumables), hence they do very few clients.* (Registered nurse)

> *The MC room is too small.* (Counselor)

> *We need to build up space. Space is a challenge to the long-term goal. We need to get two rooms and a recovery room outside of the main theater. We came up with a plan but don't know what happened.* (Chief medical officer)

> *Yes, during mobilization there were many clients who came for services. We managed this by having staff working late, up to 9 pm. For example, on one day, 30 men came in for MC. This could not continue, since we did not want to tire the staff. To solve this problem, we booked those whom we could not see for another day and they returned on the day they were booked for services.* (Clinical officer in charge)

Solutions for Increasing Service Volume

To address operational challenges, all four respondents identified solutions needed to increase MC service volume, including ensuring sufficient numbers of trained and well-motivated MC staff, consistent availability of MC supplies, and adequate space for conducting MC procedures:

TABLE 16. RECURRING THEMES DURING QUALITATIVE INTERVIEWS

Theme	Total	Chief Medical Officer	Registered Nurse	Counselor	Clinical Officer in Charge
Underutilized resources	4	1/1	1/1	1/1	1/1
Strategies for increasing demand for services	4	1/1	1/1	1/1	1/1
Challenges to service delivery	4	1/1	1/1	1/1	1/1
Solutions to increase service volume	4	1/1	1/1	1/1	1/1
Ways to improve efficiency	2/4	0/1	1/1	1/1	0/1

It would be better to have people constantly in theater who are trained. Don't have to call people from home or pay for transportation. (Chief medical officer)

Motivation of staff. (Registered nurse)

Consumables—if we had a steady supply, we would not have to depend on partners. Spacing is an issue as well. Previously, there was a room set aside for MC, but that room has been used for something else (pharmacy). Have a room that is used for two days per week for a clinic and can be used other days for MC. (Clinical officer in charge)

Ways to Improve Efficiency

Two out of four respondents also identified a number of strategies for improving the efficiency of MC service delivery, including training and incentives for mobilizers:

Training all of the hospital staff and allowing for staff rotation so that at any given moment there's someone doing the MC and he/she has no choice (task shifting). (Registered nurse)

Phone calls to school heads requesting them to make their students available for MC can increase the caseloads. Animators should be given an allowance for their good work—failure to do this leads them to oppose MC activities. (Counselor)

DISCUSSION

Cost Differences between Program Approaches

The most important overall finding of this study is that the cost differences between the two approaches represented by APHIA II (horizontal) and NRHS (diagonal) are not dramatic. This is especially apparent when one considers the overall unit costs—$38.62 for APHIA II and $44.62 for NRHS. However, 90% of the MCs conducted during the study period were through the NRHS diagonal approach and 10% through the APHIA II horizontal approach. This can be explained by the use of MC teams in the NRHS approach who provide MC services 100% of the time to supplement those services being provided by the MOH, whereas the APHIA II approach uses nondedicated MOH teams providing MCs 12–38% of the time. NRHS also deployed 2–9 dedicated teams per district, compared with 2–3 nondedicated teams deployed by the MOH with APHIA II support.

The larger NRHS service volume to date may suggest that the diagonal NRHS approach can be scaled up more quickly in the short term and can increase service volumes over time. However, it is not clear what future operational challenges might arise as it seeks to achieve fuller integration with existing MOH MC services. The horizontal APHIA II approach, on the other hand, while generating lower service volumes, has also demonstrated a steady increase in service *volume*. Over the long run, it is possible that this approach may be more sustainable, because from program initiation it has been more thoroughly integrated with the Kenyan health care system.

The findings also indicate that with limited additional resources to train and deploy more nondedicated MC teams in either approach, more men in need of MC could be reached in the short term. Alternatively, if significant resources could be mobilized to recruit, train, and retain more dedicated MC teams, even greater service volumes could be achieved through use of either approach in the short term.

However, given the preexisting shortage of health workers in Nyanza across all cadres (Odingo et al., 2011), moving in the direction of either approach in the short term should not be seen as a substitute for other long-term investments to increase the overall workforce. Significant investments in rapid strengthening of human resources will be critical, including hiring more health workers from among the current pool of unemployed nurses and recent graduates from medical and nursing colleges. Hiring additional health workers should be done in a way that ensures the right balance of nondedicated and dedicated health workers to provide stability across health services and achieve the greatest impact on the HIV epidemic in the short term. Disparities in health worker wages can potentially contribute to inequities through internal migration of health workers to MC from other important health services and from one geographic area to another. Wage disparities may also contribute to poor motivation among existing MOH staff in the absence of MC-specific incentives. Decisions regarding which MC program approaches to choose should consider preexisting human resource shortages, cost, and the potential for long-term sustainability within the aims and purpose of national human resources for health policies and strategies.

Unit Costs by Service Delivery Mode

When looking at unit costs by mode, a more complex picture emerges. Unit costs for MCs delivered at base facilities converge—$38.33 and $39.58 at APHIA II and NRHS, respectively. This is likely due to the fact that the majority of NRHS-supported base sites are MOH sites. The difference between outreach at APHIA II and combined outreach/mobile at NRHS sites is also modest ($40.51 vs. $46.20, a difference of 14.1%).

However, the differences in unit cost between mobile MCs supported by APHIA II and outreach/mobile service provision supported by NRHS are more substantial (36.5%). Part of this difference can be explained simply:

Compensation for direct service providers at the APHIA II–supported sites are 45% of the level of equivalent staff compensation at NRHS. If we reduce the cost of direct service personnel at NRHS accordingly, the difference in unit costs for this portion of field activities drops to 22.1%, and the direction reverses: The unit costs of outreach at APHIA II–supported sites exceed the cost of outreach/mobile at NRHS ($40.51 vs. $37.61).

Thus, it is hard to explain these differences by factors that are inherent in the relative virtues of a more horizontal approach (APHIA II) versus the more diagonal approach of the NRHS. On balance, we believe that higher efficiencies are more likely to be attained by adjusting the way MC activities are implemented within the service delivery modes in either approach than by attempting to select one broad approach as generally more efficient than the other.

It is helpful in this regard to place these results in a broader context. The unit costs are of the same general magnitude as those reported elsewhere in the MC cost literature. For example, the USAID-funded Health Policy Initiative has empirically estimated the unit cost of MCs in various African settings at $35–50. Modeling of MC scale-up in 16 geographic areas estimated an average of $168 per HIA and 5.6 MCs per HIA, thus implicitly $30 per MC (Auvert et al., 2008).

The observed variation in unit costs for these MC programs in Nyanza must also be considered in the context of far wider unit cost variation observed previously. In our five-country study of 215 HIV prevention programs (the Prevent AIDS Network for Cost-Effectiveness Analysis [PANCEA] Project), we found variations in unit cost of 10- to 100-fold within prevention strategy and country (Marseille et al., 2007). These differences represented mainly large variations in the number of delivered units of service, accompanied by some variation in the intensity of service per client, with relatively fixed personnel and other input costs. By comparison, the differences between MC approaches in Nyanza are very small and are largely explained by variations in the price of inputs (e.g., salaries). The roughly similar cost may reflect multiple homogenizing factors, including standardization of the service content; communication and coordination among the MC partners; and similar motivations by both APHIA II and NRHS program managers to try to optimize performance.

Our analyses of caseload trends, the average number of cases per surgery-day (effective demand), waiting time before the first surgery of the surgery-day, and the time required per MC procedure (efficiency) indicate that there is no pattern of association between effective demand and efficiency. This implies that program expansion in itself is unlikely to reduce these two important components of unit cost; rather, proactive measures will be needed.

Another important finding is that further refinements in the staffing and logistical organization of the MC procedure itself may also yield only modest gains in efficiency. This is because the marginal cost of supplies and personnel for each procedure is a small portion of the total unit cost. On the one hand, a dollar deducted from costs represents resources that can be freed to expand services, whatever the source of these savings. We therefore support further operations research into the possibility of streamlining the surgical procedure and immediately proximate activities. However, our data suggest that once programs have trained lower cost surgical staff, (e.g., clinical officers and nurses, rather than medical officers), large further reductions in costs are more likely to be found elsewhere.

To reduce costs further, increased efficiency should be placed in the broader context of cost-effectiveness, using the cost per HIA metric. This approach is helpful because it takes into account the possible trade-offs between potential economies and the short-term number of MCs delivered.

DISCUSSION

Strategies for Increasing Efficiency

We examined five strategies for increasing efficiency. These include scheduling, operational, administrative, and technical strategies, as well as demand generation. Of these, scheduling and administrative efficiencies appeared most likely, if feasible, to yield a substantial reduction in cost per MC and thus per HIA. Operational efficiency (reducing start-up time on MC days) appears to offer more modest gains. All three of these pertain to the management and deployment of program resources. The two technical innovations we evaluated—cautery and MC devices—are unlikely to save money, and in our analysis they resulted in net additional costs. However, there may be other reasons to use both of these technologies that are not captured in our analysis, which focuses exclusively on their net costs. Also, if the unit cost of these technologies can be lowered in the future, they could become cost-saving.

Our study suggests that there is significant underutilized capacity to deliver MC services within current resource constraints. To take one example, travel costs, including foregone staff time, can be thought of as a fixed cost for a day of field-based services. The overall efficiency per surgery-day is then largely determined by how many cases can be completed during that day. Any increases from the current levels of 3.8, 3.1, and 7.1 per day for base, outreach, and mobile services thus represent important efficiency gains. Since demand generation activities are currently a small portion of total costs, and since compensation and incentives to community mobilizers tend to be inexpensive (e.g., 750 Kenyan shillings per day), it may be feasible to increase uptake per surgery-day at a greater rate than increased mobilization costs contribute to the cost per MC. We refer to these benefits in the previous section as the efficiency of demand generation. Similarly, by decreasing the number of multiple field days to the same outreach or mobile sites, it may be possible to decrease transportation and daily start-up costs such that freed resources can fund expansion of MC activities elsewhere. These suggestions are particularly salient, given our finding that efficiency as represented by the time per procedure and the waiting time at the start of each surgery data is unrelated to the number of surgeries performed on the respective surgery days.

The interview data corroborate the findings regarding efficiency strategies. However, a disconnect emerges when one compares the respondents' opinions regarding perceived capacity for increased MC volume and the actual numbers of MCs currently conducted through the APHIA II approach. The current low volume of MCs at APHIA II–supported sites, despite adequate information, equipment, and supplies, suggests that other factors may be at play in a horizontal program approach. Other research in Nyanza has found that some providers are reluctant to take on additional responsibilities associated with MC. In addition to lack of appropriate resources, increased workload without any financial compensation was associated with a lack of motivation among MC health workers (Odingo et al., 2011). Some health workers expect to be financially compensated for providing the service, because this is what they are accustomed to. Yet other providers view other non-MC chronic health services as a higher priority.

To date, there has been no assessment of either financial or nonfinancial incentives or performance-based incentives as means by which to retain and enhance the performance of MOH staff in MC service delivery in Kenya. It is also not clear to what extent lack of motivation can be attributed to incentives alone in a more horizontal approach. Other factors that may affect MC service volume include human resource shortages, demand for MC services, and the degree to which MOH staff are mandated to provide MC as part of their routine services.

Study Limitations

This report is limited to retrospective data from 35 MC delivery sites/locations over an 18-month period and T&M data from 246 procedures. While these are sufficient to document unit costs and their variations, they are insufficient to support a robust multivariate analytic

approach that more definitively identifies the correlates of efficiency.

Given a restricted sample size and limited research resources, there is no iron-clad method for assigning allocations. For example, the precise allocation of indirect costs to MC activities would require a detailed review of program records combined with the guidance from program managers obtained via interviews. When this information was absent, we allocated according to the proportion of hospital caseload that was MC, using WHO's inpatient equivalence method.

Costs were sometimes unavailable in the form that would have been most useful for our purposes. In some cases, these costs were excluded from the analysis. For example, due to the absence of comparable data by modality or approach on the incidence, severity, and costs of treating AEs, we excluded these costs. In other cases, it was necessary to impute costs by applying cost data valid for one setting and assuming that they were the same in other, similar settings. For example, we used per-km vehicle costs derived from NRHS records and applied them to calculate transportation costs for the APHIA II program.

Additionally, NRHS costing data for outreach and mobile services were unavailable in a disaggregated form, making only rough comparisons between the NRHS and APHIA approaches for outreach and mobile service delivery modes possible. The results might be quite different if mobile and outreach modes were separated for the NRHS approach. This is suggested by our finding that there were statistically significant differences in most of the variables in the T&M data between outreach and mobile modes for the APHIA II approach.

The observed unit costs for MC programs in Nyanza, while likely to be similar in other provinces in Kenya, must also be considered in the context of far wider unit cost variation observed previously in the region and based on the surgical method used for MC. In particular, the relative personnel and supply costs will be different in countries using the dorsal slit and sleeve resection methods. In addition, the unit costs associated with personnel are most relevant to countries that have a clinical officer cadre. The relative cost of personnel will be different in countries in which medical officers take part in MC surgery. All of the MCs studied used the forceps-guided method. All else being equal, programs that use the dorsal slit or sleeve resection techniques may have different marginal costs for the surgical procedure itself—though, as we have shown, this is a small portion of total unit costs. While not directly generalizable to other countries where MC programs are being implemented, the findings of this study do offer insights into expected cost-efficiencies and cost-effectiveness where similar types of program approaches and service delivery modes are being implemented.

Finally, we did not consider the improved epidemic impact and cost-effectiveness associated with more rapid scale-up in Nyanza. However, other research has demonstrated that in a relatively stable epidemic, as in Nyanza, delivering MCs sooner improves epidemic impact and cost-effectiveness (Stover et al., 2009; Kioko et al., 2010; UNAIDS, 2009). Thus, to the extent that the program approach and service delivery mode allow MC resources to be deployed quickly, there will be further improvements in efficiency.

CONCLUSION & RECOMMENDATIONS

This study provides substantial evidence for the similar efficiency of horizontal and diagonal approaches to support the Government of Kenya's scale-up of its national MC program in Nyanza Province. Differences in unit cost using the forceps-guided method between APHIA II and NRHS are modest (less than one-third), not consistently in the same direction, and to a large extent explained by differences in compensation levels.

This compares with more than 10-fold variations in unit costs for other prevention strategies previously reported by the PANCEA project and other studies (Dandona et al., 2008; Marseille et al., 2007; Stover & Forsythe, 2010).

However, 90% of the MCs performed during the study were conducted through the NRHS approach, versus 10% through the APHIA II approach. The disparity may be due to the NRHS's ability to deploy its own dedicated MC teams that provide MCs 100% of the time. This contrasts with the use of existing MOH staff in the APHIA II approach, who provide MCs only 12–38% of the time. The larger NRHS service volume to date may suggest that the diagonal NRHS approach can be scaled up more quickly in the short term, though with possibly larger future impediments to full integration with the MOH's services.

Both MC program approaches we assessed rely largely on external financial support. It is therefore plausible that with additional funding, either could attain higher service volumes, through intensified efforts in existing service areas or through expansion of activities to new, underserved areas. Overall, community-based services dominated the caseload in either approach, with 68.6% of MCs delivered at either mobile or outreach sites and the balance at base facilities. This indicates that access to MCs for rural and remote populations can be improved through either approach, utilizing outreach and mobile modes of service.

The observed MC costs correspond to an estimated programmatic cost per HIV infection averted of $117 to $185. These are all far less than the averted estimated $6,000 lifetime cost of treating HIV disease and thus lead to substantial net savings. The extent to which the program approach and service delivery mode allow MC resources to be deployed quickly could lead to further improvements in cost-effectiveness.

Another important finding is that further refinements in the staffing and logistical organization of the MC procedure itself using the forceps-guided method may also yield only modest gains in efficiency. We found that if they are feasible to implement, improvements in scheduling and administrative efficiencies would yield up to a 20% drop in cost per MC, with operational efficiency (reducing start-up time on MC days) offering smaller savings. Two technical innovations (electrocautery and MC devices) appear to increase costs. Demand generation could efficiently increase services, potentially even reducing unit cost by distributing fixed costs over more MCs.

The findings and recommendations of this research, while not intended for generalization from one country to another, provide insights into the efficiency and cost-effectiveness of similar MC service delivery approaches, modes, and surgical methods being implemented elsewhere. As Kenya's government moves forward with its

ambitious plans to provide adult MC services, the health sector needs to ensure the availability of high-quality, high-volume services to meet short-term MC targets, while building local capacity and ownership to ensure sustainable MC services for any longer term goals.

The MC program approach and service delivery mode will vary from province to province, depending on the context (HIV and MC prevalence rates, levels of uptake of MC services, and the presence of existing HIV services—e.g., HCT). The Government of Kenya and donors can use these findings from Nyanza to inform ongoing decision making about MC program implementation and make course corrections, as needed.

This analysis lends support to the following recommendations:

- As additional resources are mobilized, expand access to MC services through a combination of both horizontal and diagonal MC program approaches—both are cost-effective, and neither has a marked advantage over the other.
- Continue the use of multiple MC service delivery modes: base, outreach, and mobile. The presence of all three modes increases access to MC services, and the three have similar unit costs.
- Develop, implement, and evaluate strategies to achieve efficiencies in scheduling, operations, and administration in program approaches and service delivery modes.
- Develop, implement, and evaluate strategies for intensified demand generation in program approaches and service delivery modes.
- Seek lower purchase prices for technology, especially MC devices, to see if break-even cost can be achieved.

The implications of the findings also point to a number of unaddressed research questions, including:

- What is the feasibility of adjusting scheduling and administrative efficiencies in multiple MC approaches and modes to yield a substantial reduction in cost per MC and thus per HIA.
- What are the reasons, from both a provider and a client perspective, that would justify the use of new and existing technologies despite their current prohibitive net costs?
- What are the most feasible demand generation strategies with which to increase uptake per surgery-day at a greater rate than the required increase in mobilization costs?. ■

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