

Chapter 7

Surgery for Family Planning, Abortion, and Postabortion Care

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INTRODUCTION

This chapter discusses two related but conceptually distinct health concerns in low- and middle-income countries (LMICs): (a) voluntary family planning, and (b) abortion, including postabortion care. In the first section, on family planning, the health condition of interest is unmet need: the percentage of women who would like to either stop or delay childbearing but who are not using any contraceptive method to prevent pregnancy. The unmet need for family planning (to either limit family size or determine the intervals between children) results in unintended and unwanted pregnancies, which in turn lead to a broad range of maternal and child conditions that increase morbidity and mortality. Surgical procedures for family planning can help reduce this unmet need, particularly the need to limit childbirth.

The second section concerns surgery for induced abortion (as opposed to spontaneous abortion, or miscarriage) and the surgical management of the complications of induced, mostly unsafe, abortion.¹ Unsafe abortion is defined as abortion performed outside of health facilities (or any other place legally recognized for the procedure) or by an unskilled person (WHO 1992). The demand for abortion is high in many LMICs, and the illegality of the procedure in most of these countries increases the likelihood of postabortion

complications from clandestine, unsafe procedures (Grimes and others 2006; Shah and Ahman 2009; Singh and others 2006; Singh 2010). Therefore, postabortion care is a significant health issue in LMICs. Timely, safe surgical interventions can reduce the morbidity and mortality associated with unsafe abortions.

The same surgical procedures used for abortion are also used to manage incomplete abortion, which is one of the most common postabortion complications and is often accompanied by other complications such as bleeding, sepsis, and genital injury. The surgical procedures used to manage such complications include laparotomy for sepsis and uterine injury and a wide range of minor procedures to repair injuries to the proximal birth canal.

Both sections discuss the burden of reproductive health conditions, including morbidity, mortality, and other effects. We discuss surgical procedures (their performance, inputs, and implementation) and the health workforce implications of scaling up those procedures in LMICs. We also explore evidence on the procedures' effectiveness in reducing morbidity and mortality and improving quality of life as well as evidence on their cost-effectiveness. Finally, we outline future directions—including implementation challenges and considerations for increasing access to these surgical interventions—and conclude by summarizing the findings and recommendations.

SURGERY FOR FAMILY PLANNING

Importance of Family Planning

Family planning is a pillar of reproductive and overall health in several ways:

- Reducing maternal mortality by reducing the number of times women are pregnant, including high-risk pregnancies associated with very young or older women (Ahmed and others 2012)
- Preventing high parity (among the potential factors leading to anemia in pregnancy)²
- Lengthening the intervals between pregnancies, which also improves perinatal outcomes and reduces child mortality (Cleland and others 2012)
- Decreasing the number of pregnancies that would have ended in induced, mostly unsafe, abortions in LMICs.

Recent data illustrate how high the stakes can be, although some trends have improved during the past two decades. The Global Burden of Disease (GBD) Study 2010 estimated that almost 254,700 deaths (4 per 100,000) globally were attributable to maternal conditions in 2010, a 29 percent decrease from 1990, when there were 358,600 maternal deaths (7 per 100,000) (Lozano and others 2013). Almost 1.8 million years lived with disability (YLDs) globally were attributable to maternal conditions in 2010, a 28 percent increase from 1990, when there were nearly 1.4 million YLDs (Vos and others 2013).³

Family planning is one of the most effective, and cost-effective, interventions against maternal mortality and disability. Increasing contraceptive coverage was primarily responsible for a substantial reduction in global fertility rates (from 3.63 births per woman in 1990 to 2.83 in 2005), also averting 1.2 million deaths (Stover and Ross 2010). Despite a 42 percent increase in the number of women of reproductive age (15–49 years old) between 1990 and 2008, the number of births per year remained constant, and the mortality risk per birth decreased (Ross and Blanc 2012). Meeting the need for family planning globally would further reduce maternal mortality by an estimated 29 percent, a reduction of more than 100,000 deaths annually (Ahmed and others 2012).

Moreover, family planning has both household and macroeconomic benefits. At the household level, it reduces fertility—an important attribute given that women in LMICs increasingly desire better-planned and better-spaced families (Darroch 2013; Darroch and Singh 2013). Family planning not only improves birth spacing but also increases women’s earnings, assets, and body mass indexes, and improves children’s

schooling and body mass indexes (Canning and Schultz 2012). At the macroeconomic level, it reduces youth dependency and increases labor force participation by women, thereby enhancing economic growth (Canning and Schultz 2012). Increasing access to family planning will slow population growth, conveying environmental benefits such as substantial reductions in global carbon dioxide emissions (O’Neill and others 2012).

Conversely, when LMICs lack affordable, accessible, acceptable, and sustainable family planning methods, tangible economic development becomes more difficult: without low fertility, countries cannot attain the well-documented “demographic dividend” that has benefited several formerly low-income countries (Bloom, Canning, and Sevilla 2003).⁴

Family Planning Methods

Family planning comprises both traditional and modern methods of contraception. Traditional methods, including withdrawal and fertility awareness, have low efficacy; up to 24 percent of women who use them will have unintended pregnancies within one year (Trussell 2011a). Modern methods—including sterilization, intrauterine devices (IUDs), injections, implants, pills, and mechanical methods such as condoms—have higher effectiveness, resulting in lower rates of unintended pregnancies (Trussell 2011a).

Sterilization is the most common method of permanent family planning; most other methods are temporary. Permanent methods are indicated for couples who consider their families to be complete and would like to stop childbirth (limit the number of children). Temporary methods are indicated for couples who would like to delay childbirth to space children further apart or for other reasons.

Contraception can also be divided into surgical methods, methods that employ minor surgery (for insertion and removal), and nonsurgical methods (table 7.1). Methods involving surgery or minor surgery are generally more effective than the nonsurgical methods. Surgery is employed primarily for sterilization. The most common male sterilization procedure is vasectomy, and the most common female sterilization procedure is tubal ligation.

Vasectomy and tubal ligation are among the most effective of the modern contraceptive methods, having first-year failure rates of 0.15 percent and 0.5 percent, respectively (Trussell 2011b). Although some nonsurgical forms of female sterilization exist, they are either not available or not practicable for LMICs in the foreseeable future.⁵ Therefore, this chapter focuses on tubal ligation and vasectomy.

Table 7.1 Primary Contraceptive Methods by Degree of Surgical Involvement

Surgery	Minor surgery	Nonsurgical
Female sterilization: tubal ligation	Intrauterine device (IUD) <ul style="list-style-type: none"> • Copper IUD • Hormonal IUD (for example, Mirena) 	Fertility awareness <ul style="list-style-type: none"> • Standard days method^a • Sympto-thermal^b • Ovulation^c
Male sterilization: vasectomy	Subdermal implant (for example, Implanon, Jadelle)	Barrier <ul style="list-style-type: none"> • Spermicide • Sponge • Male condom • Female condom • Diaphragm Hormonal <ul style="list-style-type: none"> • Injection (for example, Depo-Provera) • Birth control pill • Vaginal ring (for example, NuvaRing) • Transdermal patch (for example, Ortho Evra) Other <ul style="list-style-type: none"> • Lactational amenorrhea^d • Withdrawal

a. In the “standard days” method, a calendar (using colored beads, for example) is used to track the menstrual cycle as an aid to abstinence from unprotected vaginal intercourse during peak fertility periods.

b. The symptothermal method usually combines a number of fertility awareness methods, including observation of primary fertility signs (such as basal body temperature and cervical mucus) and the calendar-based methods.

c. The ovulation method identifies patterns of relative fertility and infertility during the menstrual cycle based on vulvar sensation and the appearance of vaginal discharge.

d. Lactational amenorrhea is the temporary postnatal infertility that occurs when women are actively breastfeeding.

Contraceptive Prevalence and Unmet Need

Contraceptive Prevalence. Globally, total contraceptive prevalence is 63 percent, defined as the percentage of women of reproductive age who report that they or their partners use at least one traditional or modern contraceptive method. Countries vary widely in this estimate by development status: contraceptive prevalence is 72 percent in developed countries and 54 percent in developing countries (excluding China). In Africa, it is even lower, at 31 percent; some countries, such as Chad, Mali, Sierra Leone, and Republic of South Sudan, have a contraceptive prevalence of less than 10 percent (Alkema and others 2013).

In LMICs, more than 25 percent of almost 820 million sexually active women of reproductive age use low-efficacy traditional methods or no method at all. This percentage rises to 38 percent in Sub-Saharan Africa, South and Central Asia, and Southeast Asia. Among women in LMICs who use modern contraceptive methods, a substantial proportion report that they or their partners use male

or female sterilization: 10 percent in Sub-Saharan Africa, 64 percent in South and Central Asia, and 13 percent in Southeast Asia (Darroch, Sedgh, and Ball 2011; Singh and Darroch 2012).

Many factors, besides inadequate knowledge and poor-quality family planning services that are difficult to access, contribute to non-use of contraception:

- Ambivalence about pregnancy (Frost, Singh, and Finer 2007)
- Underestimation of the risk of pregnancy at the time of sexual intercourse (Nettleman and others 2007)
- Historical, cultural, and religious beliefs (Schuler, Choque, and Rance 1994; Thorburn and Bogart 2005; Wickstrom and Jacobstein 2011)
- Low levels of education (Ali and Okud 2013; Frost, Singh, and Finer 2007; Muyindike and others 2012; Tawiah 1997)
- Low income or poverty (Asiimwe, Ndugga, and Mushomi 2013; Muyindike and others 2012)

Other variables affecting contraceptive use or non-use include the number of children already born (Muyindike and others 2012), age (Muyindike and others 2012), and race (Frost, Singh, and Finer 2007). In LMICs overall, however, it is the most disadvantaged members of society who use contraceptives less often and have a higher unmet need for them.

Unmet Need for Contraception. Globally, at least 150 million women ages 15–49 years in a marriage or union have an unmet need for contraception, meaning that they want to either stop or delay childbearing but are using no contraceptive method to prevent pregnancy. This corresponds to 11–14 percent of these partnered women, varying widely by income status. In high-income countries (HICs), the unmet need is 9 percent and in developing countries, 13 percent (16 percent if China is excluded). In Africa, the unmet need is 23 percent, exceeding 35 percent in some countries, including Kenya, Rwanda, and Togo (Alkema and others 2013).

Among all women of childbearing age in developing countries who want to avoid pregnancy, more than 200 million, or 26 percent, have an unmet need for modern contraceptive methods. This unmet need varies widely by region: it is much higher in Africa (53 percent; 60 percent in Sub-Saharan Africa) than in Latin America and the Caribbean (22 percent) and Asia (21 percent) (Darroch and Singh 2013).

Among all women of reproductive age who want to either stop or delay childbearing but use no contraception, the proportion of those who want to have no (or no more) children is a crude indicator of potential demand for permanent contraception, that is, sterilization. This proportion varies substantially by geography: it is 32 percent in Sub-Saharan Africa, 41 percent in North Africa, 50 percent in Central America, 57 percent in the Caribbean, 63 percent in Asia (excluding China), and 64 percent in Southeast Asia (Clifton and Kaneda 2013). Despite substantial variation, many women would like to avoid all (or further) childbirth and could benefit from expanded access to sterilization methods, which are predominantly surgical.

Trends in Prevalence and Unmet Need. During the period 1990–2010, global contraceptive prevalence increased by 8 percentage points, from 55 percent to 63 percent. During the same period, unmet need for contraception decreased by 3 percentage points, from 15 percent to 12 percent (Alkema and others 2013).

However, prevalence has plateaued since 2000, especially in the use of modern contraceptives (Singh and Darroch 2012): Among all women of reproductive age in LMICs, 57 percent used modern contraceptives in

1990, 55 percent in 2000, and 55 percent in 2009. Among women in the poorest countries, use of modern contraception increased marginally, from 39 percent in 2008 to 40 percent in 2012.

Meanwhile, the unmet need for modern contraceptive methods in developing countries decreased from 29 percent in 2003 to 26 percent in 2012 (Darroch and Singh 2013). Although the unmet need decreased during this period in all LMICs, it remained far higher in Africa (despite a reduction from 60 percent to 53 percent), particularly in Sub-Saharan Africa, where it decreased from 68 percent to 60 percent (Darroch and Singh 2013).

Moreover, modern contraceptive users in developing countries shifted away from surgical contraception (sterilization) to other forms. The proportion using sterilization declined, on average, from 47 percent to 38 percent. In Africa overall, where sterilization use was already extremely low, it declined from 9 percent to 8 percent of modern contraceptive use, and in Sub-Saharan Africa, from 12 percent to 10 percent (Darroch and Singh 2013). This decline is, however, relative: sterilization use is increasing in absolute terms, but use of other modern methods is increasing at an even faster rate.

In addition to unwanted pregnancies, an unmet need for accessible, modern contraception has a variety of other consequences:

- Poorly timed and closely spaced pregnancies increase child mortality.
- Maternal deaths during childbirth also increase child mortality.
- Unwanted pregnancies lead to increased pregnancy complications, abortions (including unsafe, illegal abortions), childhood illnesses, and the overall disease burden.
- Excess fertility has negative economic and social results.

Surgical Contraception

Advantages of Sterilization. Sterilization is highly effective and offers permanent protection from unwanted pregnancy with none of the potential side effects of temporary contraceptive methods. Sterilization, whether of males or of females, eliminates the need for continuous involvement in family planning activities. It also spares couples and individuals some of the common worries associated with temporary methods, including partner compliance, domestic violence (arising from disagreements between partners about fertility goals), inconvenience, side effects, supply needs, and the consequences of forgetfulness (WHO 1999).

Convenience and the longer duration of effective action are often the overriding factors in choosing contraceptives, and sterilization provides both of these advantages (Steiner and others 2006). These positive factors may be even more attractive to couples in the lowest-income countries, where supplies may be irregular and health facilities may be substandard or far away from their homes. However, surgical contraception and other nonbarrier methods also have an important limitation: they do not protect against human immunodeficiency virus (HIV) and other sexually transmitted infections.

Barriers to Access. LMIC populations face a variety of demand- and supply-side barriers to access to surgical methods of family planning. Among the most important are individual attitudes and motivations: Some women want to have many children as a defense against high child mortality or as a source of future farm labor. Interpersonal factors may play a role—for example, women often reject long-acting or permanent surgical contraceptive methods in deference to their spouses' (or the community's) desire for fertility. Cultural and religious norms also impede access to surgical contraception. Some cultures value high fertility, and some religions prohibit any form of contraception.

In addition, lack of information leads to misunderstanding, misconceptions, and myths about tubal ligation and vasectomy. Generally, information on surgical contraception is limited, particularly among unmarried individuals. Myths about surgical methods of contraception are also common. For instance, in Uganda, some men equate vasectomy to castration or loss of manhood, and some women associate tubal ligation with laziness, disinterest in sex, loss of menstrual regularity, and weight gain (Kasedde 2000).

Other barriers include fear of surgery, poverty and other economic barriers, geographic impediments such as living in remote rural areas, and poor health services and facilities (Gaym 2012; Kasedde 2000). Studies also suggest that providers often have insufficient knowledge or motivation to provide surgical contraception (Gaym 2012).

Surgical Procedures. Surgical procedures for family planning include tubal ligation for female sterilization and vasectomy for male sterilization. Before either are performed, potential recipients should be carefully selected and counseled (ACOG 1996; Pollack and Soderstrom 1994). As part of the comprehensive consent process, clients should be informed about sterilization options (male or female sterilization) as well as

other contraceptive methods. The reasons for choosing sterilization should be clear, and potential recipients should understand that the procedures are meant to be permanent methods of family planning, to be chosen only if they are certain they do not want more children. Clients should also receive information on the potential for reversal and chances of success. The most common reasons for sterilization regret—such as young age or marital instability—should be assessed and addressed before surgery.

The details of surgery, including the risks of anesthesia (particularly for tubal ligation), should be clearly communicated and informed consent obtained. Prospective tubal ligation recipients should understand the chance of procedure failure and the risk of ectopic pregnancy (estimated at 7.3 per 1,000 procedures [Peterson and others 1997]), which is quadruple the risk for women using oral contraceptives and triple the risk for women using barrier methods (Holt and others 1991). Women should be prepared for potential postsurgical physiological changes such as menstrual disorders, which may increase the chance of postprocedure hospitalization (Shy and others 1992). Potential recipients should also know that sterilization does not protect against sexually transmitted infections, including HIV and acquired immune deficiency syndrome (AIDS). Medical personnel and other providers should offer an opportunity to ask further questions regarding the procedure and its associated risks.

Female Sterilization: Tubal Ligation. Female sterilization (tubal ligation) prevents pregnancy by blocking the fallopian tubes so that the egg and sperm cannot unite. It involves surgery to (a) isolate the tubes and (b) achieve tubal occlusion (blockage) through a choice of methods.

Timing. The surgery can be performed postpartum, postabortion, or during time periods unrelated to pregnancy (interval tubal ligation). This timing affects the type of counseling, the type of surgery, and the method of tubal occlusion used, as described below (ACOG 1996):

Postpartum procedures. Postpartum tubal ligation may follow either (a) a cesarean section with the abdomen still open, or (b) a vaginal birth using minilaparotomy under local anesthesia with sedation, regional anesthesia, or general anesthesia. A postpartum minilaparotomy is conducted before full uterine involution but after a full assessment of mother and child. It uses a subumbilical incision, which allows easy access to the abdomen because the wall is thin at this point just above the uterine fundus. Laparoscopy should not be performed postpartum because of the nonoptimal

orientation and the technical difficulty that may arise from the size and vascular nature of the postpartum uterus (WHO 1999).

Postabortion procedures. Following a first-trimester abortion, tubal ligation may be performed by either laparoscopy or minilaparotomy using a suprapubic incision. Following a second-trimester abortion, a minilaparotomy using a small vertical midline incision is preferred. The risk of perforating the soft uterus with the laparoscopic trocar may warrant either the use of open laparoscopy using the Hasson cannula or waiting for uterine inversion and performing an interval procedure.

Interval procedures. Interval sterilization procedures may be performed at any time during the menstrual cycle, preferably during the follicular phase to reduce the risk of a luteal-phase pregnancy (a pregnancy in which conception occurs before sterilization). However, because of nonoptimal uterine and tube positioning, tubal ligation should be avoided during pregnancy or between days 8 and 41 after delivery; it should be performed only with special care between days 3 and 7 postpartum (WHO 1999). On the day of the interval procedure, it is good practice to confirm that a woman is using contraception and to perform a pregnancy test. Interval procedures may be performed transvaginally (Kondo and others 2009) through posterior colpotomy (Ayhan, Boynukalin, and Salman 2006) or transcervically using hysteroscopy (Castano and Adekunle 2010).

Laparoscopy versus minilaparotomy. Laparoscopy emerged in the 1960s and 1970s; by 1990, one-third of all tubal ligations were performed using this method. Laparoscopic sterilization can be closed or open. In the closed procedure, the laparoscopic incision is made just below the umbilicus, through which the trocar is inserted into the peritoneum. In the open procedure, the incision goes through all abdominal wall layers, and the peritoneum is entered directly.

The advantages of laparoscopic sterilization include a quick recovery and minimal blood loss and postoperative pain; small, barely visible scars; and the opportunity to inspect internal organs. The disadvantage is that the trocar could injure organs.

Minilaparotomy became another option after its development in the 1970s, and most tubal ligations use this method. In minilaparotomy, an incision of 2–3 centimeters is placed in relation to the uterine fundus. For interval sterilization, a uterine manipulator is used to bring the uterine fundus close to the incision.

Both minilaparotomy and laparoscopy are safe and effective and can be performed in outpatient facilities

and under local anesthesia and conscious sedation. Complications from female sterilization are rare and include immediate complications such as anesthetic issues, uterine injury and perforation, and organ injury. There is an increased chance of ectopic pregnancy (Holt and others 1991; Peterson and others 1996), which can be lethal, particularly in LMICs (Goyaux and others 2003).

On balance, minilaparotomy may be better suited to LMICs because it is simple and inexpensive, uses basic surgical equipment, may be performed by general practitioners and paramedics in maternity and health centers, and is recommended for both postpartum and interval procedures (WHO 1999). In contrast, laparoscopy—despite its smaller incision, lesser pain, smaller probability of complications, shorter recovery time, and smaller scar—requires specially trained surgeons; equipment that is sophisticated, expensive, and difficult to maintain; and fully equipped tertiary hospitals with sterile equipment and a surgical theater to reduce the risk of infections (WHO 1999).

Tubal occlusion methods. During female sterilization, tubal occlusion is achieved through electrical methods, mechanical methods, or ligation and excision as follows:

- *Monopolar and bipolar electrocoagulation* are the most commonly used tubal occlusion methods during laparoscopic procedures.
- *Tubal clips or rings* may be used to mechanically block the tubes. Similarly, in the Pomeroy method, a loop of tube is “strangled” with a suture, a cut, and the cauterization of the ends. Reversal of sterilization is easier with clips and rings than with electrocoagulation because clips destroy a smaller portion of the fallopian tube.
- *Ligation and excision*, severing of the tubes followed by ligation using a variety of techniques, is the most common procedure for tubal occlusion during laparotomy or at cesarean section.
- *Fimbriectomy*, which removes the part of the tube closest to the ovary, involves the modified Irving procedure in which ligatures are placed at two points on the tube, the segment between them is removed, and the ends are attached to the back of the uterus and connective tissue.
- *The Essure method*, a newer method, places small metal and fiber coils in the tubes to induce scarring and block the fallopian tubes.⁶

During interval sterilizations, ligation and mechanical devices can be used, but in the immediate postpartum period, ligation using clips, rings, or bands is

preferred (WHO 1999). In the postabortion period, both blocking methods are acceptable (with special care when using mechanical devices to avoid injuring enlarged tubes) (WHO 1999).

Male Sterilization: Vasectomy. Vasectomy includes three steps: anesthesia, delivery and isolation of the vas deferens from the scrotal sac, and vas occlusion.

Anesthesia. The most common anesthesia is a local vasal block using lidocaine without epinephrine (Li and others 1992). Other techniques to improve anesthetic quality and comfort include the use of eutectic mixture of local anesthetics (EMLA) creams as an adjunct to the vasal block, buffered anesthesia, the spermatic cord block, the no-needle injector, and the mini-needle technique (Shih, Turok, and Parker 2011; Weiss and Li 2005). Vasectomy may be performed under general anesthesia in exceptional circumstances such as previous adverse reactions to local anesthesia, scarring or deformity that make local anesthesia difficult, current anticoagulation therapy (which increases the chance of hematoma formation), and when vasectomy is part of a series of procedures to be performed on the same day.

Isolation of vas deferens. In the traditional vasectomy, following anesthesia, two small incisions are made on each side of the scrotum with a scalpel, and both vas deferens are isolated for excision, followed by vassal occlusion (Cook, Pun, and others 2007). Alternatively, the no-scalpel method, or keyhole vasectomy, uses a sharp pair of forceps in lieu of a scalpel to puncture the scrotum. The no-scalpel method reduces bleeding and hematoma formation, reduces the probability of infection, removes the need for stitches, and increases healing time (Cook, Pun, and others 2007). The open-ended vasectomy leaves the testicular end of the vas open to allow a continuous stream of sperm into the scrotum. This procedure reduces the risk of postvasectomy pain syndrome and congestive epididymitis (Christiansen and Sandlow 2003; Moss 1992; Shapiro and Silber 1979).

Vas occlusion. The most common, but relatively less effective, method of vas occlusion is ligation and excision. (Vasectomy failure rates are estimated at less than 3 percent, but some studies suggest the rate is higher for ligation and excision [Aradhya, Best, and Sokal 2005]).⁷ Other methods include electrical and thermal cautery, fascial interposition (FI), and vas irrigation (Shih, Turok, and Parker 2011). Both FI and vas irrigation are highly effective but rarely used (Cook, van Vliet, and others 2007). Reviews suggest that cautery combined with FI is the superior occlusion method (Cook, van Vliet, and others 2007; Labrecque and others 2004).

FI is commonly performed during vasectomy to prevent recanalization, a common cause of vasectomy failure. This procedure, which significantly increases the success rate of vasectomy, positions the prostatic end of the vas outside the fascial sheath of the scrotal sac, leaving the testicular side inside the fascia (Sokal and others 2004). Irrigation of the distal vas with sterile water or the spermicide euflavine is sometimes used to reduce time to achieve azoospermia (lack of measurable sperm in the semen).

Vas occlusive contraception also includes some newer, nontraditional methods. One of them—the use of clips without vas severance—has shown unacceptably high failure rates despite the procedure’s higher potential for reversal (Levine, Abern, and Lux 2006). Another new, nonocclusive method involves insertion of a soft silicone or urethane intra vas device (IVD) that contains a set of tiny implants to block the flow of sperm, enabling the vas to remain intact and easing reversal. Although human clinical trials of the IVD have been conducted (for example, Song and others 2006), it has been neither marketed nor approved for general use as of this writing.

Safety and Effectiveness of Tubal Ligation and Vasectomy. Vasectomy is generally more effective and safer than tubal ligation (table 7.2). In addition, following attempted reversal, both procedures have similar success rates as measured by pregnancy after reversal (Cos and others 1983; Fox 1994; Henderson 1984; Lee 1986; Rock and others 1982; Spivak, Librach, and Rosenthal 1986). Tubal ligation is comparatively riskier, at least in part because either method (laparoscopy or minilaparotomy) could proceed to an open laparotomy if internal organs, especially major vessels, are injured, resulting in life-threatening hemorrhage (Hendrix, Chauhan, and Morrison 1999).

The vasectomy procedure is almost always performed under a local anesthetic and does not require as much technical expertise as tubal ligation does. Nurses in LMICs who are knowledgeable about anatomy can be trained to perform vasectomies because of their relatively less severe complications.

Costs and Cost-Effectiveness of Surgical versus Nonsurgical Contraception

Along with a higher success rate, surgical contraception generally costs more than nonsurgical interventions. In this section we evaluate evidence of the costs and cost-effectiveness of surgical versus nonsurgical methods of contraception. We also attempt to assess whether the added costs would represent value for money if scaled up in LMICs.

Table 7.2 Safety and Effectiveness of Surgical Sterilization, by Procedure

	Tubal ligation	Vasectomy
Failure rate (%) ^a		
Year 1	0.55	0.15
Year 2	0.29	0.01
Year 3	0.15	0.01
Year 4	0.19	0.01
Year 5	0.13	0.01
Cumulative probability of postprocedure failure (number per 1,000 procedures) ^b		
Year 1	7.4	5.5
Year 5	11.3	13.1
Pregnancy rate after reversal (%) ^c	40.0–60.0	42.0–74.0
Reversal requests after five years (%) ^d	6.0	6.0
Timing of efficacy ^d	Immediate	Delayed until azoospermia ^e
Relative rate of complications ^f	High (20 times that of vasectomy)	Low (1/20 that of tubal ligation)
Relative rate of mortality ^f	12 times that of vasectomy	1/12 that of tubal ligation

Sources:

a. Trussell 2011b.

b. Jamieson and others 2004; Peterson and others 1996.

c. Cos and others 1983; Fox 1994; Henderson 1984; Lee 1986; Spivak, Librach, and Rosenthal 1986.

d. Shih, Turok, and Parker 2011.

e. Azoospermia is lack of measurable sperm in the semen.

f. Hendrix, Chauhan, and Morrison 1999.

Note: The “failure rate” refers to the probability of pregnancy.

Costs. Surgical sterilization methods generally carry higher up-front or unit costs than nonsurgical methods. Notably, however, a single surgical set can be used for many years if well used and maintained, thus offsetting the up-front costs. However, the cost of continuously sterilizing and maintaining equipment is also important.

Among the surgical procedures, vasectomy, in addition to being more effective and safer, costs less than tubal ligation by either laparoscopy or laparotomy (Smith, Taylor, and Smith 1985). Increasing the number of vasectomies relative to tubal ligations would substantially reduce overall procedural costs and the costs of managing adverse events (Hendrix, Chauhan, and Morrison 1999).

Looking solely at *per use* commodity costs, the drugs and supplies for female sterilization cost \$9.09 (in 2009 U.S. dollars) and, for male sterilization, \$4.95. By comparison, oral contraceptives cost \$0.21 per use; IUDs, \$0.37; and injectable hormonal contraceptives, \$0.87 (Ross, Weissman, and Stover 2009). However, some proprietary implants such as Implanon (an etonogestrel implant effective for three years) cost more (\$24.09) than surgical methods (Ross,

Weissman, and Stover 2009). However, direct cost comparisons on this basis are difficult because contraceptive methods vary widely in duration of effectiveness.

The cost per couple-year of protection (CYP), is generally lower for surgical methods than for nonsurgical methods (the exception being IUDs, which have the lowest cost per CYP of all methods). Table 7.3 compares the total annual direct and indirect costs of contraceptive methods in four Sub-Saharan African countries: Burkina Faso, Cameroon, Ethiopia, and Uganda.

Cost-Effectiveness. Modern contraception as evaluated in program settings is highly cost-effective by various metrics including cost per life year and cost per disability-adjusted life year (DALY):

- In India, intensive efforts to improve family planning, control fertility, and provide safe abortions would save nearly 150,000 lives and save \$1.5 billion over five years (Goldie and others 2010).
- In Uganda, universal access to contraception would reduce the average number of pregnancies per woman (15–50 years of age) by 1.6, reduce the fertility rate by 1.1 children per woman, improve

Table 7.3 Annual Cost per CYP of Contraceptive Methods in Selected African Countries
U.S. dollars per CYP

Method	Ethiopia (2008)	Uganda (2008)	Burkina Faso (2009)	Cameroon (2013)
Female sterilization	8.65	7.50	17.16	3.23
Male sterilization	8.26	7.24	3.07	2.42
Pill	31.43	23.66	28.51	17.00
IUD	5.24	4.14	6.51	23.35
Injectable or implant ^a	33.74	27.28	58.54	19.84
Condom	22.15	17.12	19.20	15.51
Other modern method ^b	23.14	18.05	18.66	16.26
Periodic abstinence	0.00	0.00	0.00	0.00
Withdrawal	0.00	0.00	0.00	0.00
Other traditional ^c	0.00	0.00	0.00	0.00

Sources: Vlassoff, Walker, and others 2009; Vlassoff and others 2011; Vlassoff and others 2012; Vlassoff, Jerman, and others 2014.

Note: CYP = couple-year of protection; IUD = intrauterine device.

a. Costs of injectables and implants were combined in the four studies.

b. The “other modern method” category includes other barrier methods such as spermicides, sponges, and diaphragms, as well as other hormonal methods such as the vaginal ring or transdermal patch.

c. The “other traditional” category includes fertility awareness methods that track the menstrual cycle or fertility signs and patterns.

maternal and child health outcomes, and save almost \$40 per woman in societal costs (Babigumira and others 2012).⁸

- Satisfying unmet need for modern contraception through increased family planning that reduces mother and newborn care costs would save a net \$112 million per year in Uganda (Vlassoff and others 2009). Similar studies found annual net savings of \$35 million in Ethiopia (Sundaram and others 2010) and \$32 million in Burkina Faso (Vlassoff and others 2011).

In the United States, one cost simulation found that the three most cost-effective contraceptive methods are vasectomy, the copper-T IUD, and a hormonal IUD (specifically, levonorgestrel [LNG]-20, marketed under brand names including Mirena). All other methods, including tubal ligation, were found to be less effective and more costly than the copper-T IUD (Trussell and others 2009).

A comprehensive review of the health economics of contraception supported the data presented above, finding that male and female sterilization and long-acting reversible methods such as IUDs and subdermal implants were the most cost-effective contraceptive options, followed by other hormonal methods such as oral contraceptives; the least cost-effective options were barrier and traditional behavioral methods (Mavranouzouli 2009).

Future Directions

Goals, Trends, and Challenges. As noted at the outset of this section, family planning is important to the development aspirations of LMICs. Specifically, increasing access to the highly efficacious and convenient surgical methods of contraception can enhance important health, social welfare, educational, and other benefits (Canning and Schultz 2012).

To that end, universal access to reproductive health by 2015 is a target of the United Nations–led Millennium Development Goals (MDGs): MDG 5 is “to improve maternal health.”⁹ Increased access to reproductive health and family planning would also help to achieve most of the other MDGs: MDG 1 (“eradicate extreme poverty and hunger”); MDG 2 (“achieve universal primary education”); MDG 3 (“promote gender equality and empower women”); MDG 4 (“reduce child mortality”); MDG 6 (“combat HIV/AIDS, malaria and other diseases”); and MDG 7 (“ensure environmental sustainability”).

Is access to family planning in the developing world expanding fast enough to contribute to those goals? Worldwide, sterilization is the most common form of modern family planning: 38 percent of women who used modern methods in 2012 chose sterilization. However, the reverse is true in LMICs, particularly in Africa, where contraceptive injections and pills dominate (Darroch and Singh 2013). Only 8 percent of women in Africa who use modern methods chose

sterilization; among the four main groups of modern methods (sterilization, barriers, hormones, and IUDs), sterilization is the least common (Darroch and Singh 2013).

In Africa, a variety of factors have constrained expansion of sterilization: lack of planning tools; technical and programmatic difficulty; relatively high commodity and provision costs; health system constraints; overemphasis on short-term, commodity-based contraceptive methods instead of services; and social and cultural barriers (Wickstrom and Jacobstein 2011).

The Malawi Model. In contrast to the general pattern in Africa, the use of female sterilization (as a percentage of all modern contraceptive use) doubled in Malawi in the decade from 2000 to 2010. Sterilization use was relatively equitable, as measured by rural-urban or education status, although disparities existed by income status (wealthy women used sterilization more than poor women). Jacobstein (2013) attributed the overall increase to several factors:

- Increased demand due to increased knowledge of female sterilization
- Increased desire to limit childbearing
- Improved service delivery due to expanded service access within a supportive and enabling health care system characterized by strong public-private partnerships
- Provision of free and widespread outreach services by dedicated providers

This evidence suggests that LMICs with conditions such as Malawi's have great potential to scale up access to surgical sterilization. However, almost all sterilizations in Malawi are female sterilizations (about 150 tubal ligations for every vasectomy), so efficacy and savings could increase further if this gender gap could be closed.

To overcome human resource constraints such as severe physician shortages—an important collective barrier to increased access to surgical contraception in LMICs—programs in Malawi have developed dedicated nonphysician cadres (clinical officers) to provide mobile contraceptive services including tubal ligation (Jacobstein 2013). To succeed, the programs depend on task shifting (delegating or shifting some tasks to less-specialized health workers [WHO 2007]) and task sharing (in which providers of different levels do similar work, rather than leaving all provision of a service to less-credentialed workers [Janowitz, Stanback, and Boyer 2012]). Only if less-specialized health workers can be trained to perform selected clinical tasks

(such as sterilizations) competently will such efforts substantially increase access to contraception including surgical contraception (Janowitz, Stanback, and Boyer 2012; WHO 2012).

Agenda for Action. LMICs can increase access to surgical contraceptive methods to the extent that they achieve these goals (Wickstrom and Jacobstein 2011):

- Improve quality of services
- Increase public-policy advocacy as well as provider and population awareness of surgical contraception
- Increase financing to procure theater equipment; strengthen human resources; and ensure adequate supply of surgical contraceptive equipment, instruments, and national essential drugs and equipment
- Implement service-oriented instead of only commodity-oriented programs
- Expand and update resources and tools to support contraceptive security (for example, by including surgical contraception methods in health care logistics training)¹⁰
- Clarify definitions, goals, and success indicators for contraceptive security promotion

LMICs also need to change how their health workers and service providers promote contraception to people. Instead of stating, “You need to use family planning to reduce your fertility,” they might ask the client, “What are your fertility desires, and how can we help you to have the number of children you can afford while also maintaining a productive lifestyle?” If LMIC populations receive enough information, education, and communication about the benefits of family planning and the available contraceptive methods, the planning of childbearing will begin to be their idea and they will start demanding family planning from their leaders as a basic need.

Moreover, ethical concerns about coerced sterilization have been raised, especially regarding women with HIV/AIDS (Mallet and Kalambi 2008). LMICs need to step up education and communication efforts to ensure that surgical contraceptive services are scaled up ethically to avoid coercion, particularly in countries with high HIV prevalence (Delvaux and Nostlinger 2007).

Conclusions and Recommendations

In this section, we have discussed the unmet need for modern surgical methods of contraception; the potential benefits of increasing access to contraception (particularly male and female sterilization); and

both the effectiveness and cost-effectiveness of such an increase. Based on our findings, we offer the following conclusions and recommendations:

- The surgical methods of male and female sterilization (vasectomy and tubal ligation, respectively) are highly effective, cost-effective, and convenient. Although they constitute the most widely used contraceptive category worldwide, many LMICs, particularly in Sub-Saharan Africa, have not adopted them widely. We recommend that policy makers adopt policies to promote and ensure widespread access to surgical methods of family planning.
- As LMICs add, and expand access to, surgical facilities, equipment, and human resources, they should make increased access to surgical contraception a reproductive priority. Health workers should be trained to provide surgical family planning and, given the acute shortage of physicians, task shifting of surgical family planning to nurses and medical assistants should be encouraged.
- Contraception advocacy in LMICs needs to change such that the populations begin to own the idea of planning families and realize their ability to control their own fertility.
- Policy makers should advocate surgical methods of family planning because they provide value for money; despite relatively high up-front costs, they are among the most cost-effective contraceptive methods for LMICs in the long term.
- Policy dialogues on expansion of family planning programs should emphasize the greater effectiveness and cost-effectiveness of male sterilization (vasectomy) relative to female sterilization (tubal ligation).
- Policy makers and advocates in LMICs should encourage more qualitative and quantitative research on how to increase the quality, uptake, and impact of—and access to—surgical contraception.

SURGERY FOR ABORTION AND POSTABORTION CARE

Induced abortion is common in LMICs, particularly in those countries where the unmet need for family planning is high. Wherever abortion is legal, it can be performed safely in the first and second trimesters either medically or surgically. But in countries where abortion is legally restricted, most abortions are performed by poorly trained practitioners in clandestine locations using a variety of methods. Such abortions are, by the World Health Organization's definition, unsafe—that

is, performed outside of health facilities or other places legally recognized for the procedure, or by an unskilled person (WHO 1992).

Incomplete Abortion

Incomplete abortion is one of the most common complications of induced abortion, particularly in the case of illegal induced abortion. It occurs when the products of conception have not been fully expelled through the cervix (Bottomley and Bourne 2009). The symptoms and signs of abortion complications—vaginal bleeding, abdominal pain, fever, purulent or foul-smelling vaginal discharge, and shock—are usually present with incomplete abortion. In one study, even after clinical assessments had suggested that no products were retained (in this case, following first-trimester spontaneous abortions, or miscarriages), ultrasounds showed that 45 percent of the women had retained tissue (Alcázar, Baldonado, and Laparte 1995).

Studies in Rwanda and Uganda (where abortion is legally restricted) showed that 65–75 percent of all postabortion complications involved incomplete abortions (Vlassoff and others 2014; Vlassoff and others 2009). Sepsis and hypovolemic shock were among the common complications, together making up about a quarter of all postabortion complications in these two countries.

Global Demand for Abortion

Globally, almost 44 million induced abortions were performed in 2008—86 percent of them in developing countries (Sedgh and others 2012). Although the worldwide total declined from about 46 million in 1995 to 44 million in 2008 (a 4 percent drop), the proportion of abortions that were unsafe increased by 4 percentage points during the same period, from 44 percent to 49 percent (Sedgh and others 2012). Moreover, almost all abortions performed in Africa (97 percent) were unsafe in 2008, only a slight decline from 99 percent in 1995 (Sedgh and others 2012).

Of the 185 million pregnancies that occurred in developing countries in 2008, 40 percent were unintended (Singh, Sedgh, and Hussain 2010). Most unintended pregnancies (82 percent) occur among couples using either no method or traditional methods of contraception (Darroch, Sedgh, and Ball 2011; Singh and Darroch 2012). Many unintended pregnancies result in induced abortions. In 2008, 37.8 million induced abortions were performed in developing countries, 6.4 million of them in Africa, almost all being unsafe (Sedgh and others 2012).

Driving the demand for induced abortion, particularly in low-income settings, are both individual factors (such as educational level, marital status, family size and composition, fertility expectations, and contraceptive use) and systemic factors (such as service availability and quality, social conditions, economic pressures, religious and cultural beliefs, and societal norms and values) (Warriner and Shah 2006).

Consequences of Unsafe Abortion

Abortions performed correctly by trained practitioners are safe, with minimal risk of complications (Bartlett and others 2004; Grimes and others 2006; Henshaw 1993). The occurrence of complications following induced abortion depends on both the type of procedure and the type of provider. In Uganda in 2003, for example, at least one complication occurred in 25 percent of abortions induced by doctors, 45 percent induced by clinical officers, 50 percent induced by pharmacy workers, 66 percent induced by traditional healers or lay practitioners, and 73 percent that were self-induced (Henshaw 1993; Prada and others 2005; Singh and others 2006).

The rates of unsafe abortion and abortion complications as well as the demand for postabortion care also vary remarkably by geographic region. The hospitalization rate for abortion complications per 1,000 women in 2005 was 8.8 in Africa, 4.1 in Asia, and 5.7 in Latin America and the Caribbean (Singh 2006). In that year alone, more than 5 million unsafe abortions in developing countries resulted in hospital admission, 1.7 million of them in Africa (Singh 2006).

That LMICs exhibit the world's highest demand for postabortion care is understandable given that, in most of them, induced abortion is either completely illegal, legal only to save the mother's life or after rape or incest, or legal but with limited access by women who need it. In such settings, the only option for women wishing to end their pregnancies is to procure clandestine, usually unsafe, abortions—with substantial negative consequences for themselves, their families, and their societies (Singh 2010):

- Increased death and disability (Murray and others 2013; Okonofua 2006)
- Increased health care costs (Babigumira and others 2011; Benson and others 2012; Shearer, Walker, and Vlassoff 2010; Vlassoff and others 2009)
- Decreased quality of life and social support (Lubinga and others 2013)
- Reduced economic productivity (Singh 2010; Sundaram and others 2010).

The GBD Study 2010 tells the global story in hard numbers, estimating that more than 37,000 abortion-related deaths occurred in 2010, a 39 percent decrease from 1990 and corresponding to almost 0.5 deaths per 100,000 women (Lozano and others 2013). Almost 32,000 YLDs, corresponding to 1 YLD per 100,000 women, were attributable to abortion in 2010, a 20 percent increase from 1990 and corresponding to fewer than 0.5 YLD per 100,000 women (Vos and others 2013).¹¹ During the same period, in a welcome downward trend, the burden of disease due to abortion declined by 33 percent (Murray and others 2013).¹²

Barriers to Access to Surgical Procedures for Abortion and Postabortion Care

Legal prohibition of abortion is the main barrier to access to surgical abortion and postabortion care in LMICs. Many countries have one or more legal barriers to abortion, ranging from complete criminalization to limitation of services to specific periods during pregnancy. Other legal barriers include requirements that abortions be provided by more than one physician, that abortion be provided only at licensed facilities, that parents consent (for young girls), that women receive preabortion counseling, or that abortions be delayed by mandated preabortion “reflection” periods.

Social and cultural norms constitute another important barrier to access to surgical abortion and postabortion care. In many LMICs, the culture so disapproves of sexual activity by young women that, when they get pregnant, they often travel long distances to ensure confidentiality. They are stigmatized for getting pregnant, seeking abortions, and seeking postabortion care. Pregnancy or abortion may also be associated with gender-based violence in some areas.

Low-quality health services present yet another barrier to access to surgical services for abortion and postabortion care. In LMICs that lack good health systems or quality of service, surgical methods are often unavailable as choices, health workers are rude or judgmental toward women who seek abortion or postabortion care, confidentiality is limited, and health workers are absent or poorly trained. Moreover, the health systems in many LMICs are unaffordable, limited in number and distribution, and lacking drugs and equipment.

Surgical Procedures

The long-standing standard for safe induced abortion is surgery through either dilation and curettage (D&C) or vacuum aspiration (VA). However, medical abortion (which induces abortion nonsurgically, using medicines)

is now considered a safe and viable alternative (Neilson and others 2010, 2013; Ngo and others 2011).

In low-income settings, postabortion surgical intervention is most commonly a result of incomplete abortion, which presents with sepsis and hemorrhage. Management of incomplete abortion comprises three types:

- *Expectant management*, which allows products of conception to be spontaneously evacuated
- *Medical management*, which uses medications to induce evacuation
- *Surgical management*, which uses either sharp metal curettage (with or without cervical dilation) or VA (manual vacuum aspiration [MVA] or electric vacuum aspiration [EVA]).

Other surgical procedures are necessary to manage the complications of induced abortions, particularly those that are clandestine and unsafe. These include surgery to repair tears and perforations in the genital tract, laparotomy for reasons such as repairs and sepsis management, and hysterectomy.

Dilation and Curettage. Sharp metal curettage involves evacuation of the retained products of conception using forceps and a sharp metal curette. In most cases following incomplete abortion, the cervix is already open and no dilation is needed. If the cervix is open, curettage is preceded by evacuation.

Sharp metal curettage is usually performed in an operating room under general anesthesia, but in some countries it is performed under mild sedation with analgesics and in minor theaters. Some practitioners administer medications for presurgical preparation of the cervix, using prostaglandin gels or pessaries to reduce trauma to the cervix and uterus. Pessaries and gels also reduce the technical difficulties of performing the procedure, thereby reducing the procedure time and postprocedural pain and discomfort.

The curette has a handle at one end and a sharp loop at the other. After administering anesthesia, if the cervix is still closed, it is gently dilated by inserting serial Hegar's dilators until an appropriately sized curette can be introduced safely without force to avoid lacerating or tearing the cervix (which would create a false passage into the cervix and risk torrential bleeding and severe uterine perforation). The curette is then used to gently scrape the uterine wall and remove tissue in the uterus, which is examined to ensure the procedure is complete.

In addition to the complications of anesthesia, D&C may result in uterine perforation, infection, and

adhesions (Asherman's syndrome), the latter of which increases the risks of future ectopic pregnancy, miscarriage, or abnormal placentation (placenta previa and accreta) (Dalton and others 2006).

Vacuum Aspiration. VA uses suction to remove retained products of conception through the cervix. Generally performed in an outpatient setting under local anesthesia or with analgesics, VA has been documented in multiple studies to be safe (Greenslade and others 1993), although complications can include hemorrhage, infection, cervical and uterine injury, and adhesions (Dalton and others 2006).

The procedure was pioneered in 1958 by Chinese physicians Wu Yuntai and Wu Xianzhen (Wu and Wu 1958). Improvements in the West over the years led to the development of a soft, flexible device, the Karman cannula, which removed the need for cervical dilation and reduced uterine injury. MVA uses a manual vacuum syringe and cannula, and EVA uses an electric pump. In both methods, the pump mechanism creates a vacuum that empties the uterus.

Effectiveness of Methods

To avoid anesthesia and surgery, some women prefer medical (drug-induced) abortion. However, medical abortion is associated with more pain and bleeding, more distress after the procedure, and more side effects in general than surgical abortion (Grimes, Smith, and Witham 2004; Grossman, Blanchard, and Blumenthal 2008; Grossman and others 2011; Kelly and others 2010; Lohr, Hayes, and Gemzell-Danielsson 2008). In the first trimester, medical abortion is more painful, is associated with more negative experiences and complications after the procedure, and is both less effective and less acceptable than surgical abortion (Robson and others 2009; Say and others 2005). In the second trimester, surgical abortion is similar in efficacy to medical abortion (Grossman and others 2011; Grossman, Blanchard, and Blumenthal 2008; Lohr, Hayes, and Gemzell-Danielsson 2008; Kelly and others 2010).

Regarding the three methods for management of incomplete abortion—expectant, medical, and surgical—a 2005 meta-analysis found that surgical management was more likely to complete uterine evacuation than medical management, which in turn was more effective than expectant management (Sotiriadis and others 2005). However, studies report mixed results regarding the overall advantages and disadvantages of medical versus surgical management of incomplete abortion or miscarriage. One study reported

that surgical management resulted in more infections but less pain, a lower chance of retained products, and greater satisfaction than medical management (Niinimaki and others 2006; Niinimaki and others 2009). A Cochrane review found that, compared with expectant management, surgical management reduced the risk of incomplete abortion or miscarriage, need for additional surgery, bleeding, and transfusion despite being less costly; however, the two methods carried similar risks of infection and psychological issues (Nanda and others 2012).

Specifically comparing surgical methods, a 2010 Cochrane review found that VA was safer, quicker, and less painful than sharp metal curettage and also led to less blood loss. However, differences were nonsignificant in the incidence of sepsis postprocedure, uterine perforation, or the need for reevacuation (Forna and Gulmezoglu 2001; Tuncalp, Gulmezoglu, and Souza 2010). MVA and EVA do not appear to differ substantially in efficacy (Mittal and others 2011).

Additionally, VA can be performed in the absence of a fully equipped facility and at secondary health facilities, with or without electricity, and without the capacity for general anesthesia. It is better suited for low-income settings because it is more accessible and reduces the consequences of blood loss and worsening infection associated with transportation to tertiary health facilities.

Despite its advantages over sharp metal curettage, VA has not been adopted in many LMICs, particularly in Sub-Saharan Africa, because practitioners generally lack the knowledge and training to perform it, lack the necessary equipment, or remain unconvinced of its effectiveness and safety.

Cost-Effectiveness of Methods

Relative to unsafe abortion, provision of safe abortion is highly cost-effective in LMICs (Hu and others 2009; Hu and others 2010). Studies that compare the cost-effectiveness of safe procedures break down their findings by trimester of the procedure, usually finding surgical management to be the most cost-effective method. The conclusions are far more mixed, however, concerning the distinct circumstances of spontaneous abortion (miscarriage).

First-trimester abortion. Clinic-based MVA is the most effective and most cost-effective method in Mexico, Nigeria, and the United States, far surpassing D&C and medical abortion (Hu and others 2009; Hu and others 2010; Rocconi and others 2005). In Ghana, however, medical abortion was found to be more cost-effective than clinic-based MVA (Hu and others 2010).¹³

Second-trimester abortion. D&C is less expensive and more effective than medical induction for second-trimester abortion (Cowett, Golub, and Grobman 2006). Others suggest that medical management is less preferable economically because its higher probability of abortion failure and bleeding increases costs (Xia, She, and Lam 2011).

Miscarriage. Medical management of miscarriage using the labor-induction medication misoprostol is less costly than expectant management, which in turn is less costly than surgical management of first-trimester miscarriage (You and Chung 2005). However, to treat first-trimester miscarriage or incomplete abortion, medical management is more efficacious and cost-effective (Tasnim and others 2011). Some studies indicate no clear preference concerning the cost-effectiveness of medical versus surgical management but cite other advantages associated with both (Niinimaki and others 2009). Others suggest that either expectant or medical management of first-trimester miscarriage would be more cost-effective than traditional surgical management (Petrou and others 2006). For first-trimester pregnancy loss, surgical management is more cost-effective and more efficacious than medical management when performed in the outpatient setting (Rausch and others 2012). For incomplete or inevitable abortion, medical management is cost-effective and more efficacious (Rausch and others 2012). Among the surgical procedures, MVA is more cost-effective than EVA because it costs less, does not require general anesthesia, and is more suited to LMICs (Tasnim and others 2011).

Future Directions

Surgical methods for safe abortion are unlikely to be used in most LMICs because prevailing legal restrictions force women to seek clandestine, usually unsafe, abortions. Therefore, surgical methods will likely play a more significant role in the management of abortion complications, particularly incomplete abortion.

Although medical management will probably constitute a substantial proportion of management of incomplete abortion in LMICs in the future, surgery will continue to be important as long as medical management remains inaccessible to many, if not most, women in need. To date, the use of medical management is limited because of high drug costs and health systems that lack adequate ability to provide careful follow-up and continuous access to medical care (Ballagh, Harris, and Demasio 1998).

Ultimately, comprehensive family planning would reduce unintended pregnancies and therefore the

incidence of unsafe abortions. For example, universal access to contraceptives by women who express the need for them would reduce unintended pregnancies in developing countries by more than two-thirds—from 80 million to 26 million (Singh and Darroch 2012). Such a massive decline would reduce the number of induced abortions by an estimated 26 million, unsafe abortions by 14.5 million (from 20 million to 5.5 million), and unsafe-abortion-related deaths by more than four-fifths, from 46,000 to 8,000 (Guttmacher Institute 2010; Singh and Darroch 2012).

Conclusions and Recommendations

In this section, we discuss the burden of unintended pregnancy and the demand for both abortion and postabortion care in LMICs, the potential benefits of increased access to surgical services for abortion and postabortion care, and the potential health and economic results of such an increase. Based on our findings, we offer the following conclusions and recommendations:

- Surgical methods for abortion and the management of incomplete abortion are more effective and more cost-effective than medical management, particularly in LMICs where access to medical interventions might be limited. They are associated with fewer side effects such as pain and bleeding—a critical advantage in LMICs, where health facilities might be distant and transportation difficult.
- Access to VA and D&C should be increased by training more health workers and investing in surgical equipment in secondary health care settings.
- Although surgical management of incomplete abortion predominates where such services are available in LMICs, increased access should be a priority to improve postabortion care and reduce abortion-related morbidity and mortality.
- Safe surgical abortion is not a current option in most LMICs, given their legal restrictions; expanding access to it will be impossible for the foreseeable future. That these restrictions encourage women to seek unsafe abortions, with their higher complication rates, only heightens the need to expand access to surgical management of incomplete abortion.
- Increased investment in family planning will help satisfy the large unmet need for contraception in LMICs and, by reducing the number of unintended pregnancies, dramatically lower maternal mortality and morbidity as well as the number of unsafe abortions.

NOTES

The World Bank classifies countries according to four income groupings. Income is measured using gross national income (GNI) per capita, in U.S. dollars, converted from local currency using the *World Bank Atlas* method. Classifications as of July 2014 are as follows:

- Low-income countries (LICs) = US\$1,045 or less in 2013
- Middle-income countries (MICs) are subdivided:
 - Lower-middle-income = US\$1,046 to US\$4,125
 - Upper-middle-income (UMICs) = US\$4,126 to US\$12,745
- High-income countries (HICs) = US\$12,746 or more

1. This section considers surgery for induced abortion only. We do not consider induced abortion to be a method of family planning (although some people use it as such). In this regard, we follow the global policy community, which has considered family planning and induced abortion to be separate concerns.
2. There is no consensus on the definition of “high parity”: some authors suggest a threshold of more than five viable pregnancies, and others suggest a threshold of more than eight births (Aliyu and others 2005).
3. Increased population and aging drove the seemingly paradoxical increase in YLDs during a decrease in the YLD rate. Although the absolute number of YLDs increased by 28 percent from 1990 through 2010, the number of YLDs per 100,000 declined by 1.2 percent (Vos and others 2013).
4. The “demographic dividend” refers to the increased economic growth that changes in the age structure of a country’s population can generate as it transitions from high birth and death rates to low ones.
5. Nonsurgical female sterilization techniques include transcervical tubal occlusion, which emerged in 2003 (Bartz and Greenberg 2008; Zite and Borrero 2011), and chemical sterilization using the cytotoxic agent quinacrine sulfate, which has been proposed but not approved by the U.S. Food and Drug Administration (Zipper and Kessel 2003). Transcervical tubal occlusion is not feasible for LMICs in the near future because it requires high-technology (hysteroscopic) equipment, highly skilled surgeons, and high equipment maintenance costs.
6. A similar method, the Adiana method, which used silicone to induce scarring, was removed from the market for infringing on the Essure patent.
7. The “failure rate” of vasectomy is defined as the presence of motile sperm in the postvasectomy ejaculate. Early failure occurs within three to six months after the vasectomy, and late failure occurs if motile sperm appear in the ejaculate after documented azoospermia in two postvasectomy semen analyses.
8. “Societal costs” refers to an all-inclusive set of costs including direct medical costs, direct nonmedical costs (such as transportation to receive health services), indirect costs (such as lost productivity while seeking health services), and program-related costs.

9. For more information about the eight MDGs, see the United Nations website: <http://www.un.org/millenniumgoals/>.
10. “Contraceptive security” refers to individuals’ ability to choose, obtain, and use reliable, high-quality contraceptives for family planning when they want them.
11. Increased population and aging drove the seemingly paradoxical 20 percent increase in YLDs from 1990 through 2010, even though, during the same 20-year period, the number of abortion-related deaths decreased by 39 percent (Vos and others 2013) and the burden of disease decreased by 33 percent (Murray and others 2013).
12. The World Health Organization (WHO) “burden of disease” refers to a time-based measure that combines the years of life lost from premature mortality and the years of life lost from being in less than full health (http://www.who.int/topics/global_burden_of_disease/en/). It is measured by disability-adjusted life years (DALYs).
13. The differences in the rank order of cost-effectiveness of medical abortion and MVA in the study by Hu and others (2010) were due to the country-specific and sector-specific variations in the baseline cost of service provision.

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