

## Potential demand for voluntary female sterilization in the 1980s: the compelling need for a nonsurgical method

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Voluntary sterilization is the most prevalent method of fertility regulation, and its use is widespread in both developed and developing countries. The estimated number of couples controlling their fertility through sterilization has increased dramatically from 15 million in 1970<sup>1</sup> to 100 million in 1980.<sup>2</sup> The country reporting the highest prevalence of use is the United States, where 31.3% of married women of reproductive age are protected by surgical sterilization or by vasectomy of their husbands.<sup>3</sup> This high prevalence in the United States has been almost stationary over the past few years. The increasing number of surgical procedures required to maintain this prevalence in a slowly growing population is well within the capabilities of the health service delivery system of the United States. Other developed countries have the capability of achieving a similar prevalence within a period of several years.

In the developing world, especially in the most populous countries, the demand for sterilization is steadily rising, the preference being for female sterilization. However, the demand far exceeds the supply of services, which are virtually nonexistent in the rural areas, where most of the women live.

This communication examines the benefits of sterilization and projects the potential demand or need for services. The shortcomings of existing sterilization technology is examined, as well as the hopelessness in meeting the potential demand if existing technology is relied upon. Nonsurgical female sterilization via intrauterine administration of quinacrine appears to stand alone in having the potential to meet the projected demand for female sterilization in the 1980s. The reasons for

the belief that chemical sterilization will follow the same technology diffusion path (namely, from developing to developed world) as that for surgical sterilization via minilaparotomy technology are also discussed.

### BENEFITS OF STERILIZATION

In the developing world, the risk of maternal and infant mortality is high,<sup>4</sup> and such risks are greater for high-parity women, even in developed countries.<sup>5</sup> Maternity is the single greatest cause of death in women of reproductive age in developing countries and is mainly due to high-order pregnancies and births (> 4). High-order births (> 4) in the least developed countries account for a full one-half of all infant deaths, partly because of the large number of such births, but also because of these infants' higher risk of mortality.<sup>6</sup> Estimates of births averted by sterilization indicate that, on the average, the highest two parities are prevented among women with little access to other contraceptive methods.<sup>7</sup> It follows that dramatic improvement in the major health indices is possible through the extension of sterilization services. In most developing countries there is no other feasible health service that could match the positive impact of sterilization on health.

In developing countries (where most of the world's women live), a health service infrastructure necessary to meet the needs of women using temporary fertility regulation methods, including abortion, is lacking. That sterilization is frequently their method of choice is evidenced by the fact that when given the option, tens of millions of women have chosen to be sterilized.

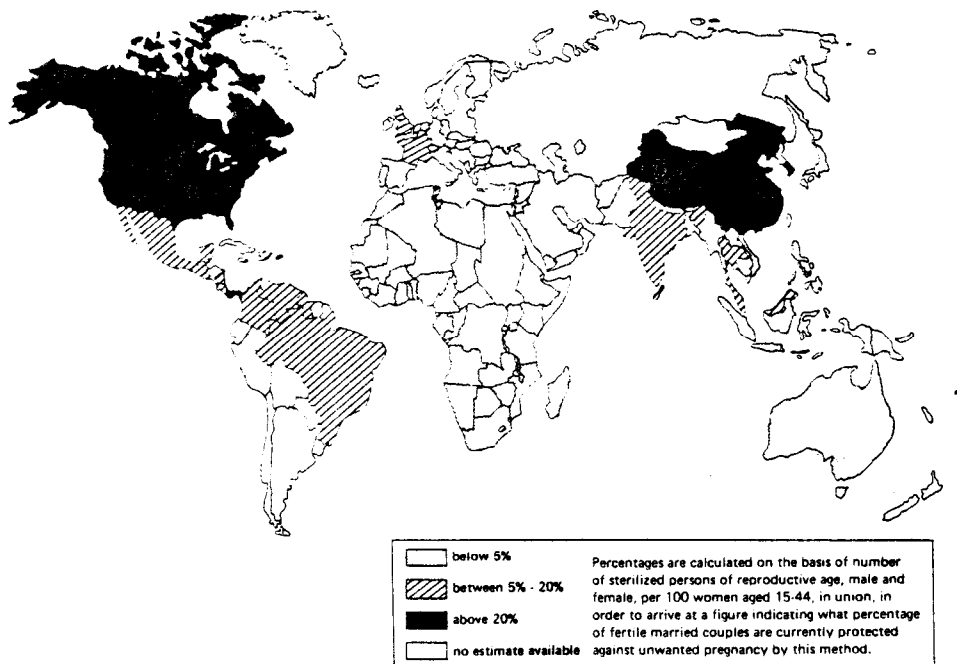


Figure 1  
Estimated world prevalence  
of voluntary sterilization in  
1980.

From a socioeconomic point of view, high-parity women tend to belong to the least privileged segments of society, who are, generally, in greatest need of controlling their fertility. Because higher fertility frequently leads to greater poverty and because sterilization is ultimately the most cost-effective of the available methods, it has the most to offer from a socioeconomic standpoint.

Not to be ignored are the disastrous implications of world overpopulation, best summarized in the recent United States Government's heavily documented *Global 2000 Report*.<sup>7</sup> If the dire projections set forth in this report are to be avoided and any nation is to enter the 21st century peacefully and secure, sterilization is certain to play an important role.

#### ESTIMATE OF THE POTENTIAL DEMAND FOR STERILIZATION IN THE DEVELOPING WORLD (EXCLUDING CHINA) IN THE 1980s

In all countries where sterilization is made readily available, high levels of prevalence occur (Fig. 1). The existing technology will be adequate to meet the demand for sterilization in the slow-growing developed world and in China. Attention will, therefore, be directed to the potential demand for services in the developing world, and all following estimates and statements will exclude China.

The basis for this estimate is the experience with sterilization in the United States, where this

service can be considered nearly fully available. The prevalence of sterilization in the United States has plateaued since 1975 at 31.3%<sup>3</sup> of married women of reproductive age. The authors make the assumption that if sterilization were made fully available, the rate of the United States would prevail worldwide. Panama has already achieved a prevalence of 30%; Puerto Rico, in many ways a developing part of the United States, has maintained a prevalence of about 33% for more than two decades; Singapore has already achieved a prevalence of 22%; India and Korea, 20%; and Sri Lanka and El Salvador, 18%.<sup>9</sup>

Also supportive of this assumption is the high proportion of all contraceptors who have chosen sterilization in selective countries: in India, 87%; Nepal, 67%; Piaui State in Brazil, 48%; Dominican Republic, 39%; Tunisia, 35%; and Guatemala, 33%.<sup>9</sup> Mexico experienced the largest increase in voluntary sterilizations reported by any large country in the world, from 13,000 in 1974 to 130,000 in 1977,<sup>10</sup> a 10-fold increase.

Present increases in contraceptive prevalence and the heavy reliance on sterilization by major developing countries point to the reasonableness of the assumption that if sterilization were made fully available, the United States rate of 31.3% would prevail worldwide.<sup>9</sup> Based on this assumption, the estimate of sterilization needs in the 1980s is made in the following manner. The number of women of reproductive age (15 to 44 years of age) in the less developed world, excluding

China, was 488,426,000 in 1980 and will grow to 647,416,000<sup>11</sup> in 1990. Assuming that 80% of these 647,416,000 women are married, then 517,933,000 married women are in the reproductive age group. In 1980, there were 34,500,000<sup>12</sup> sterilized couples in the less developed world. To achieve the 1975 United States sterilization prevalence of 31.3% of couples in which the wife is aged 15 to 44 years, the number of sterilized couples in the less developed world would need to be 163,150,000 by 1990. The ratio of the estimated number of couples using sterilization by 1990 as compared with the number using this method in 1980 would be 163,150,000: 34,500,000 or about five times the number currently sterilized.

In converting this estimate of prevalence to an estimate of the number of sterilization procedures needed to reach the 1990 prevalence, an additional factor must be considered. A proportion of women protected by sterilization in the 1980s will leave their reproductive years by 1990, requiring additional procedures to reach the projected prevalence. If the average age (35 years) of women who have participated in International Fertility Research Program (IFRP) sterilization studies in developing countries is indicative of the average age of those who will participate in the 1980s, and if there were an equal number of sterilizations performed each year, then the total number of sterilizations would have to be approximately 25% greater than the number needed to reach a 31.3% prevalence by 1990. However, it can be expected that the growth in the number of procedures performed will approximate an exponential rather than a linear growth curve and that the average age of sterilization acceptors will fall. The number of procedures to reach the estimated 1990 prevalence might require an addition of 10% over the prevalence, or approximately 180 million procedures in the 1980s.

#### OVERVIEW OF EXISTING STERILIZATION METHODS

A wide range of female sterilization methods are available. We can first identify methods with a large experience that definitely show inferior results. Both colpotomy<sup>13</sup> and culdoscopy<sup>14</sup> were widely used in the early 1970s but showed high complication rates, particularly pelvic infection. The tantalum clip,<sup>15</sup> frequently used with culdoscopy sterilization, was the first tubal occlusive clip, but it had an unacceptably high failure rate.

Hysteroscopy using an electrocoagulation probe inserted into the ostia has been disappointing in terms of complication and failure rates,<sup>16</sup> although Quinones and colleagues in Mexico have had satisfactory results." Other hysteroscopic techniques are experimental and have little chance of broad use in the 1980s, especially in developing countries. Of the nonexperimental methods, this leaves laparoscopy and minilaparotomy methods for consideration.

Laparoscopic sterilization, techniques have proven to be both safe and effective in the hands of well-trained surgeons in appropriate settings. Laparoscopy may be performed by either a single- or double-puncture approach with the use of any one of several occlusive techniques.

The IFRP has recently analyzed data on 22,115 laparoscopic sterilization procedures from 64 centers in 27 countries using a common protocol.<sup>18</sup> Three tubal occlusive techniques were compared with the use of conventional laparoscopy, namely, electrocoagulation (n = 12,643), tubal ring (n = 7766), and Rocket clip (n = 702). The tubal ring was also used in open laparoscopy (n = 1004). The study centers were generally affiliated with medical schools in urban settings. The findings showed that all techniques were safe and effective and comparable. No one technique was particularly better than any other.

However, evidence is accumulating that shows laparoscopic techniques performed outside major urban centers by less than the most highly-trained surgeons may not be appropriate. Chaturachinda,<sup>19</sup> in a study of the use of laparoscopy in rural Thailand, found higher death, complication, and failure rates with laparoscopy than with minilaparotomy.

Of the existing female sterilization methods currently widely used, minilaparotomy with modified Pomeroy occlusion appears to be superior to laparoscopy. The most comprehensive analysis of a comparison of laparoscopy and minilaparotomy in terms of efficacy and safety was made by the IFRP.<sup>20</sup> Studies from 23 countries were utilized to accumulate data on laparoscopy with occlusion by the tubal ring (7053 cases), minilaparotomy with occlusion by the tubal ring (3033 cases), and minilaparotomy with occlusion by the modified Pomeroy technique (5081 cases).

The method failure rate and the complication rate for laparoscopy/ring were twice those for minilaparotomy/Pomeroy (0.60 versus 0.30 and 2.01 versus 0.95 per 100 women, respectively). The authors also note that these laparoscopy pro-

Table 1. Estimated Mortality Associated with Maternity and the Use of Sterilization by Age, Method, and Country Setting<sup>a</sup>

Method and country setting	Age group (yr)					
	15-19	20-24	25-29	30-34	35-39	40-44
Death due to pregnancy and childbirth (per 100,000 live births,						
Developed countries	11.1	10.0	12.5	24.9	44.0	71.4
Advanced developing countries	20.0	20.0	25.0	50.0	100.0	150.0
Less-advanced developing countries	700.0	400.0	500.0	500.0	500.0	800.0
Death due to female sterilization (per 100,000 operations)						
Developed countries	10.0	10.0	10.0	10.0	15.0	20.0
Advanced developing countries	20.0	20.0	20.0	20.0	30.0	40.0
Less-advanced developing countries	50.0	50.0	50.0	50.0	75.0	100.0

<sup>a</sup>From Green.<sup>22</sup>

cedures were performed by the more experienced senior physicians, while most of the minilaparotomy/Pomeroy procedures were done by less specialized junior physicians, suggesting that if these data had been generated by a randomized comparative trial, the differences in complication and failure rates would have been even greater.

The reports on the safety and efficacy of female sterilization from urban centers of developed and developing countries tell us little about either the risks or feasibility of providing this surgical procedure in rural settings of less developed countries, where the majority of women desiring sterilization reside. Two approaches have been tried in delivering such rural services: camps in which a skilled team from an urban center visits a rural area, and the training of general practitioners in rural centers to perform minilaparotomy. A few carefully conducted studies of a camp experience indicate that early surgical complications may be only slightly higher than in urban settings. However, mortality rates of 40 per 100,000 procedures must be expected.<sup>21, 22</sup> Similar mortality has been reported from stationary rural services in developing countries.<sup>23</sup>

An additional question is whether it is feasible to deliver surgical female sterilization services in rural areas of most developing countries, since most sterilizations are currently performed on women in urban centers. This is an important consideration, since a 5-fold increase in services may require a 20-fold or more increase in rural areas in the balance of this decade.

Camp sterilizations have been most popular in India, where there are many well-trained gynecologists. One of the most impressive achieve-

ments was the completion of 5000 voluntary female sterilization procedures in 3 months in rural areas of Gujarat State by a team from Baroda Medical College.<sup>24</sup> If physicians from the more than 100 medical colleges of India were to match this feat, approximately half a million sterilizations could be performed. However, this represents less than 10% of the effort required to reach a prevalence of 15% of female sterilizations for women of reproductive age by 1990 and less than 25% of the female sterilizations needed to maintain such a prevalence, if ever achieved. It is clear that even in India, with its large number of gynecologists, the camp approach is unlikely to achieve the desired prevalence of female sterilization.

The use of general practitioners in fixed rural centers is equally discouraging. No staff of rural health centers in large developing countries has been able to perform a significant number of female sterilizations on a continuing basis. Physician staffing of such centers is generally inadequate and is subject to frequent transfers, usually to urban centers. Training general practitioners to perform a minilaparotomy sterilization procedure is itself a substantial and expensive effort. Motivating them to offer this service in a caring manner to rural women is a significant additional obstacle within the bureaucratic framework of most government rural services.

These are the realities that must be dealt with, despite the fact that female sterilization, even with its increased risks in developing countries, can save women's lives if the service can be delivered. This is demonstrated in Table 1, which shows the comparative maternal and surgical fe-

male sterilization mortality estimates by age of women and development status of the country.<sup>22</sup>

There are currently no plans for a large-scale government effort to train paramedical personnel to perform female sterilization in rural areas. An attempt for paramedical personnel to deliver surgical sterilization services on the scale needed to meet the demand and in the primitive operating conditions that exist would, in our judgment, result in unacceptably high mortality and morbidity rates.

With the exception of the United States, vasectomy has rarely been as widely used as female sterilization (Table 2).<sup>25</sup> Aside from the greater cultural inhibitions to the procedure shown by both providers and consumers, vasectomy, when performed in rural services in the developing world, is associated with significant risks of mortality and morbidity. The same study of stationary rural services mentioned above showed a risk of mortality of 20 per 100,000 procedures.<sup>23</sup> Unless there is a significant advance in techniques of nonsurgical male sterilization, it is likely that most of the sterilizations in the developing world for the balance of this decade will be performed on women.

It is unlikely that the number of sterilizations using the present surgical procedures will increase 5-fold in the less developed countries by the end of this decade in spite of the probable demand and realization of the benefits of the procedure. It is not possible to meet this demand with the sterilization techniques currently used, even with an increase in resources several times the level that can be reasonably expected.

#### PROMISING NEW STERILIZATION METHODS

The Erb method<sup>26</sup> uses liquid silicone rubber (Silastic, Dow Corning Corporation, Midland, MI) delivered through a hysteroscope to form a soft plug that conforms to the oviductal lumen. It is currently being tested at several locations in the United States and Europe and may receive United States Food and Drug Administration approval within 2 years. However, the hysteroscopic technique is one of very high technology that requires considerable surgical skill. While this technique may become widely available in the developed world, it can be safely predicted that its use in the developing world will be limited.

Research of immunologic sterilization continues. Talwar et al. have developed a vaccine by

Table 2. Percentage of Couples (Wives Aged 15 to 44) Currently Using Sterilization\*

Region, country, and year	Female	Male
Asia		
Republic of Korea, 1979	14.5	5.9
Thailand, 1978	13.0	3.4
Latin America and Caribbean		
Brazil		
Piaui State, 1979	15.4	0.0
Sao Paulo State, 1978	15.6	0.3
Colombia, 1978	7.4	0.2
Costa Rica, 1978	13.0	0.6
El Salvador, 1978	17.8	0.2
Guatemala, 1978	5.9	0.4
Jamaica, 1979	9.6	0.0
Mexico, 1978	7.4	0.1
Panama, 1979-1980	29.3	0.4
Other		
Tunisia		
Jendouba, 1979	16.1	0.0

\*From Contraceptive prevalence.<sup>25</sup>

linking the beta fraction of human chorionic gonadotropin (hCG) to tetanus toxoid.<sup>27</sup> To date, consistently high titers of antibodies to hCG have not been achieved. This kind of research requires prolonged studies of safety to assure there are no cross-reactions with other tissues or ill effects to future offspring conceived during declining titers of antibodies. Although we believe that immunologic approaches may ultimately offer the near-perfect methods of both temporary and permanent contraception, they are many years away.

Two chemical approaches to female sterilization have advanced to clinical trials: methylcyanoacrylate (MCA) and quinacrine. MCA is a tissue adhesive that can be instilled into the fallopian tubes transcervically as a blind procedure using a specially designed device.<sup>28</sup> The MCA polymerizes in the tubes and causes a local reaction leading to fibrotic occlusion over a period of 3 months, during which time the MCA is degraded and eliminated from the body. In animal studies, no deleterious effects resulted from the spillage of MCA into the peritoneal cavity. At this time, limited clinical trials using hysterosalpingography show that bilateral tubal occlusion is achieved with a single instillation in 80% of cases. Efforts are in progress to improve this rate by the use of drugs to prevent spasm of the tubes or by administration of a second instillation. Larger trials with pregnancy as an end point are also planned.

To date, the MCA method failures have been established using hysterosalpingography, which effectively eliminates the opportunity to measure the proportion of ectopic pregnancies among

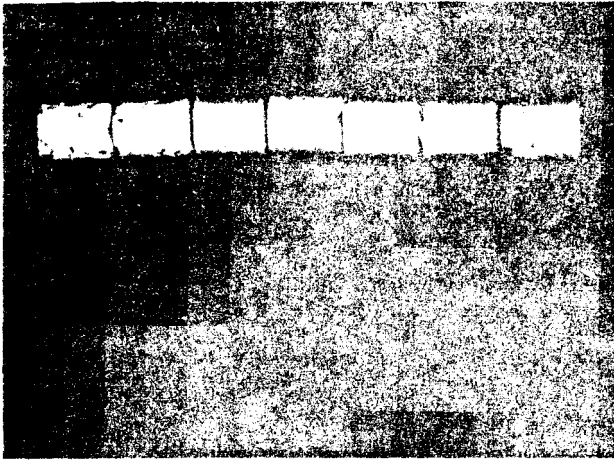


Figure 2  
One insertion of quinacrine pellets (250 mg); length in centimeters.

pregnancy failures. To document the safety of MCA in terms of ectopic pregnancy will take at least 5 years if a vigorous effort is begun now. Clearly, however, this research should proceed with deliberate speed.

For more than 10 years, Zipper et al. have investigated quinacrine as a method of transcervical female sterilization, using pregnancy rates to determine efficacy.<sup>29</sup> The first studies utilized a liquid slurry of 1.5 gm of quinacrine in water or lidocaine instilled into the uterine cavity with an intrauterine device (IUD) inserter and syringe. Three instillations were required. However, the pregnancy rates, both before completion of the third instillation (12.7%) and after the third instillation (6.1%), were high. Additionally, 2% of the patients experienced cortical excitation at the time of the instillation.

In an effort to overcome these difficulties, Zipper et al. initiated a trial of quinacrine pellets (250 mg)<sup>30</sup> (Fig. 2) inserted through an IUD inserter (Fig. 3) at monthly intervals for three insertions. A 20-mg tablet of sodium thiopental was added to increase viscosity of the uterine fluid in the hope of reducing risk of expulsion of the quinacrine pellets. In this trial, the potentially dangerous side effect, of cortical excitation disappeared, and the 12-month pregnancy rate per 100 women after completion of three applications of quinacrine pellets was reduced to 2.5. It is now presumed that the cortical excitation was caused by accidental intravenous absorption of the liquid slurry as it was administered under pressure, a problem eliminated by the pellet delivery system. Only 1 of the 139 subjects in this study became

pregnant before completion of the three insertions.

Three confirming trials<sup>31</sup> of three insertions of quinacrine pellets without sodium thiopental at monthly intervals led to a still further reduction in the pregnancy rate to 1.5 per 100 women at 12 months. It is estimated that the lifetime failure rate will approximate 3 per 100 women. The results of the quinacrine trials are summarized in Table 3.<sup>31</sup>

Tissue damage and fibrosis following intrauterine administration of quinacrine is limited to the cornual area of the uterus and interstitial portion of the fallopian tubes. Ectopic pregnancies have been absent in studies to date among over 200 reported pregnancies in women who have had one or more instillations of quinacrine. In this respect, this method is unique among all carefully studied sterilization procedures. This apparent safety factor places the quinacrine method several years ahead of the MCA method.

The complications of the quinacrine pellet method are both of low incidence and of less importance in terms of a threat to life, as compared with surgical methods of sterilization.<sup>30</sup> Confirming the findings of the study by Zipper et al., no life-threatening complications have been reported in ongoing quinacrine pellet studies with more than 1500 insertions and more than 5000 woman-months of use.

It is fortunate that there has been wide and chronic use of quinacrine as an antimalarial, es-

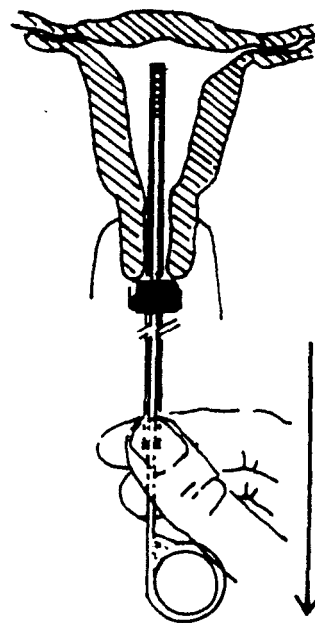


Figure 3  
Quinacrine pellet insertion technique using an IUD inserter.

**Table 3. Gross Life-Table Pregnancy Rates for Women Who Completed Three Administrations of Quinacrine Hydrochloride\***

	6-Month rate	Woman-months	12-Month rate	Woman-months
Quinacrine solution ( <i>n</i> = 200)	5.7 ± 2.1	729	9.1 ± 2.6	1375
Quinacrine pellets with sodium thiopental ( <i>n</i> = 139)	0.8 ± 0.8	741	2.5 ± 1.4	1422
Quinacrine pellets without sodium thiopental ( <i>n</i> = 267)	1.5 ± 0.9	1217	1.5 ± 0.9	2035

\*From International Fertility Research Program.<sup>31</sup>

pecially during World War II. The safety of quinacrine is well known for this use, in spite of the fact that the drug is known to combine with deoxyribonucleic acid and to have a positive result in the Ames test. In recent quinacrine toxicology and teratology studies completed at The Johns Hopkins University using rats and cynomolgus monkeys, no chromosomal abnormalities or teratologic defects attributable to quinacrine were found. Quinacrine was widely distributed in body tissues of monkeys after intrauterine administrations, but tissue concentrations were very low after 30 days. Because of the possibility of perforation of the uterus in clinical practice, toxicology studies included purposeful perforation of the monkey uterus. Intraperitoneal administration of quinacrine comparable to the human dose caused no systemic effects but adhesions in one of three monkeys. At ten times the human dose, one of three monkeys had a seizure. At 20 times the human dose, two of three monkeys died and the third had a seizure. At dose levels required for tubal occlusion, these results are reassuring. Like many other drugs, an overdose of quinacrine is dangerous. To establish the risk of serious side effects at recommended intrauterine dosage levels will require larger clinical trials.

Even though first teratologic studies of intrauterine administration of quinacrine show negative results, precautions should nevertheless be taken. Insertions are made in the proliferative phase of the menstrual cycle, which should reduce the risk of pregnancy, but abortion for medical reasons should be recommended for pregnancies conceived before or within 1 month of intrauterine administration of quinacrine. Menstruation is generally unaffected by quinacrine pellet sterilization, although there is occasional transient amenorrhea caused by intrauterine quinacrine. Even in countries where abortion is restricted, it is generally provided following accidental hysterosalpinography in early pregnancy.

The same would likely be the case for accidental administration of quinacrine in early pregnancy.

Tietze and Lewit have concluded that use of the condom, with abortion as a backup, is the safest combination of family planning methods currently in use in the United States.<sup>32</sup> Since the lifetime failure rate of the condom far exceeds 3 per 100 women, the quinacrine technique, using abortion as a backup, could possibly replace condom/abortion as the safest family planning method available. It, of course, has both the limitations and advantages of being a permanent method of contraception.

Despite a failure rate higher than that found with surgical sterilization and in light of the low incidence of nonlife-threatening complications, the quinacrine pellet method appears to be ready for large field trials in multiple locations.

The delivery of this nonsurgical sterilization product is virtually comparable to an IUD insertion and offers the opportunity for a wide variety of delivery services. While there are no large-scale government efforts presently planned to train paramedical personnel to perform surgical sterilization in rural areas, an increasing number of countries are training nurse-midwives to perform IUD insertions.<sup>33</sup> It has been demonstrated that large numbers of IUDs can be inserted in rural areas of a developing country in a short period of time. During a 3-year period (1965 to 1968) in India, 2.5 million IUDs were inserted, 82% inserted in women who lived in rural

**Table 4. Hypothetical Example of the Costs of Surgical and Quinacrine Sterilization**

Cost	Surgical sterilization	Quinacrine sterilization
Procedure	\$350	3 × 50 = \$150
Complications	20	10
Failures	0	0.03 × 500 = 15
Total	\$370	\$165

areas.<sup>34</sup> The cost of quinacrine sterilization would be comparable to that of three IUD insertions. In the developed world, even including the cost of abortion and surgical re-sterilization for the increased risk of failure, the cost per completed procedure would be about half that of surgical sterilization. An illustration of financial savings can be seen in Table 4. Assume that the cost of surgical sterilization in a developed country is \$350 and the average cost of treatment of complications is \$20, the cost of three insertions of quinacrine pellets is \$150 and average treatment of complications is \$10, and finally 3% of quinacrine sterilizations will require an abortion and surgical sterilization at a cost of \$500. Quinacrine sterilization is thus projected to cost half that of surgical sterilization.

While there are several improvements of the quinacrine method currently underway, each will require at least several years to evaluate. The IFRP is currently developing a number of potential improvements.<sup>31, 35</sup> The number of insertions of quinacrine pellets may be reduced to one or two by use of an adjuvant to quinacrine. The effect of different release rates of the quinacrine and delivery systems to deploy the quinacrine at the cornual area are under study. If one or more of these potential improvements is documented to be superior to the present three insertions of quinacrine pellets, it can be quickly adopted. It does not appear justifiable to delay use of the existing quinacrine techniques in the hope that improved techniques will prove themselves in later years.

It appears that more accurate and less expensive pregnancy tests and an effective pharmacologic method of early abortion or menstrual regulation to deal with any failures may appear in the 1980s. This will further enhance the acceptability of a permanent method of contraception with a failure rate.

Minilaparotomy is an example of a superior sterilization technique developed and proven in developing countries and transferred to the developed world. We are confident that the quinacrine female sterilization technique will follow the same diffusion path and emerge as a popular method in the developed world in the 1980s. For developing countries, a nonsurgical method of female sterilization is a compelling need. For developed countries, it is a reasonable alternative.

Given the likelihood that only one-fourth to one-third of the potential demand for sterilization in developing countries can be met in the 1980s if

surgical sterilization is relied upon, it appears that the quinacrine method of female sterilization offers the best hope for meeting the full demand. Most of the demand in the rural areas, where 80% of developing world women live, will otherwise simply go unmet. It follows that markedly expanded trials of the quinacrine pellet method is the highest priority for fertility research.

## CONCLUSIONS

Sterilization has become the world's most prevalent method of fertility regulation. The health and socioeconomic benefits of sterilization, especially in developing countries, are achieved by eliminating high-parity births and contributing to slower population growth. An estimate of voluntary sterilization needs in the 1980s in developing countries, excluding China, indicates a demand for approximately 180 million procedures. This represents a 5-fold increase over the number of sterilization procedures presently performed and could mean a 20-fold increase in rural areas. The current state of female sterilization technology has been reviewed. Because of the fragile condition of health care delivery systems in the developing world and the rural residence of the population, it is unlikely that surgical sterilization can meet the projected need.

Progress has been made in the development of the intrauterine administration of quinacrine pellets for nonsurgical female sterilization. In spite of the estimated lifetime failure rate of 3 per 100 women, it is seen as a safe and deliverable method that has potential to meet the expected demand for sterilization in the 1980s.

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