A Methodology for the Planning of Therapeutic Abortion Services

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THE METHODOLOGY developed for a national health planning study for abortion services (*1*) is presented here to demonstrate an application of management science to the planning of medical care. The study included determinations of potential mortality, morbidity, costs, and resource requirements resulting from various levels of demand for therapeutic legal abortion services. A further aspect was an examination of the type of surgical techniques used, facility utilization, and other practical considerations needed to provide therapeutic abortion services in a nonrestrictive environment (*2–4*). In applying analytical concepts of scientific management to an evaluation of the delivery of therapeutic abortion services, a combination of qualitative and quantitative methodologies, with emphasis on the development of descriptive models for the provision of medical services, was used.

The operational aspects of delivering therapeutic abortion services with the objective of developing planning strategies was the focus of the study. The manner in which women obtain legal therapeutic abortions, including the alternative surgical approaches and their respective morbidity, costs, and resource requirements, was emphasized. Mathematical procedures were used in the analysis of data, but the conceptualization of the therapeutic abortion services system, the identification of where morbidity might occur and the type of morbidity, the identification of costs related to delivering these services, and similar elements of the interactions between women seeking abortions

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and the medical system were the central factors in the study.

The conceptualization of the alternatives available to women seeking abortions and the response of the professionals in the medical system are given first. The mathematical structure used as an aid in evaluating the implication of various policies is then described. Finally, an application of the mathematical structure is given. This simplified example is designed to demonstrate how the conceptualization and understanding of the system leads to the selection of hypotheses for testing and the subsequent analysis of the data. A recommendation as to how the delivery system should be altered is not included because this analysis is designed to provide decision makers with objective information indicating the effects of various decisions and is not designed to impose any particular set of decisions.

A Model of the Abortion System

The model is a basic concept of management science and represents the interactions observed in the system under study. A model may assume numerous formats, and no one ideal approach to the modeling procedure exists. Indeed, many persons frequently develop and apply models without realizing that their decision process includes the use of a model.

The initial model developed for this study was designed to represent the macrolevel interactions between women seeking abortions and three possible avenues for obtaining an induced abortion. These three avenues are physician-performed therapeutic abortion, illegally induced abortion by a nonphysician, and self-induced abortion.

These interactions are initiated when a pregnant woman determines that continuing her pregnancy is no longer desirable and seeks an abortion, legal or otherwise, or is advised by a physician that an abortion is indicated for medical or psychiatric reasons. The most significant aspects of these interactions are qualitatively described in figure 1.

The target population described in figure 1 consists of all women of childbearing age who are physiologically capable of pregnancy, excluding women who are effectively using contraception, have been sterilized, or are currently pregnant. A woman in the target population, when pregnant, may seek an abortion from a physician in the recognized medical system, attempt self-induced abortion, or seek an illegal abortion.

A woman who seeks to terminate a pregnancy through a physician in the recognized medical system must find one who is willing to evaluate her suitability for an abortion procedure. A referral agency, a personal physician, or friends may facilitate the search. The physician, for his part, must determine if an abortion is indicated on the basis of such factors as period of gestation and the patient's medical, psychiatric, or social situation, or occasionally simply whether he is willing to do the abortion on her request. If he is not willing to perform the abortion, the woman has the alternative of seeking an abortion from another source or continuing the pregnancy.

Abortions obtained from physicians within the recognized medical system and illegal abortions not performed by a physician may result in medical complications or death. When abortions are performed by licensed physicians, family planning assistance or sterilization may be provided as components of more comprehensive care. Finally, persons who do not successfully practice contraception, upon a subsequent pregnancy must again decide whether to continue the pregnancy or end it. If the decision is to terminate the pregnancy, then the same decisions and procedures must again be made.

Within this overview is another more strictly defined system which encompasses only the interactions between patients seeking abortions through licensed physicians and those aspects of the national health care delivery system providing abortion services. Illegal and self-induced abortions are excluded. This system is represented as the Therapeutic Abortion Process Model and is designed to provide a framework for estimating the morbidity, mortality, resource requirements, and costs needed to provide legal therapeutic abortion services. Within the context of the national health care delivery system, the Therapeutic Abortion Process Model includes screening, the selection of an appropriate surgical approach, and the choice of a facility in which to perform the abortion. Resources needed for the performance of the procedure, treatment of any medical complications following the abortion, followup care, and family planning services are also included.

A simplified representation of all components included in this model, in which the length of pregnancy (LMP) is used as the decision variable, is shown in figure 2. The initial screening of women, an abortion procedure phase, and a followup phase are shown. Screening includes serv-

Figure 1. Interactions of pregnant women when faced with decision alternatives offered by society

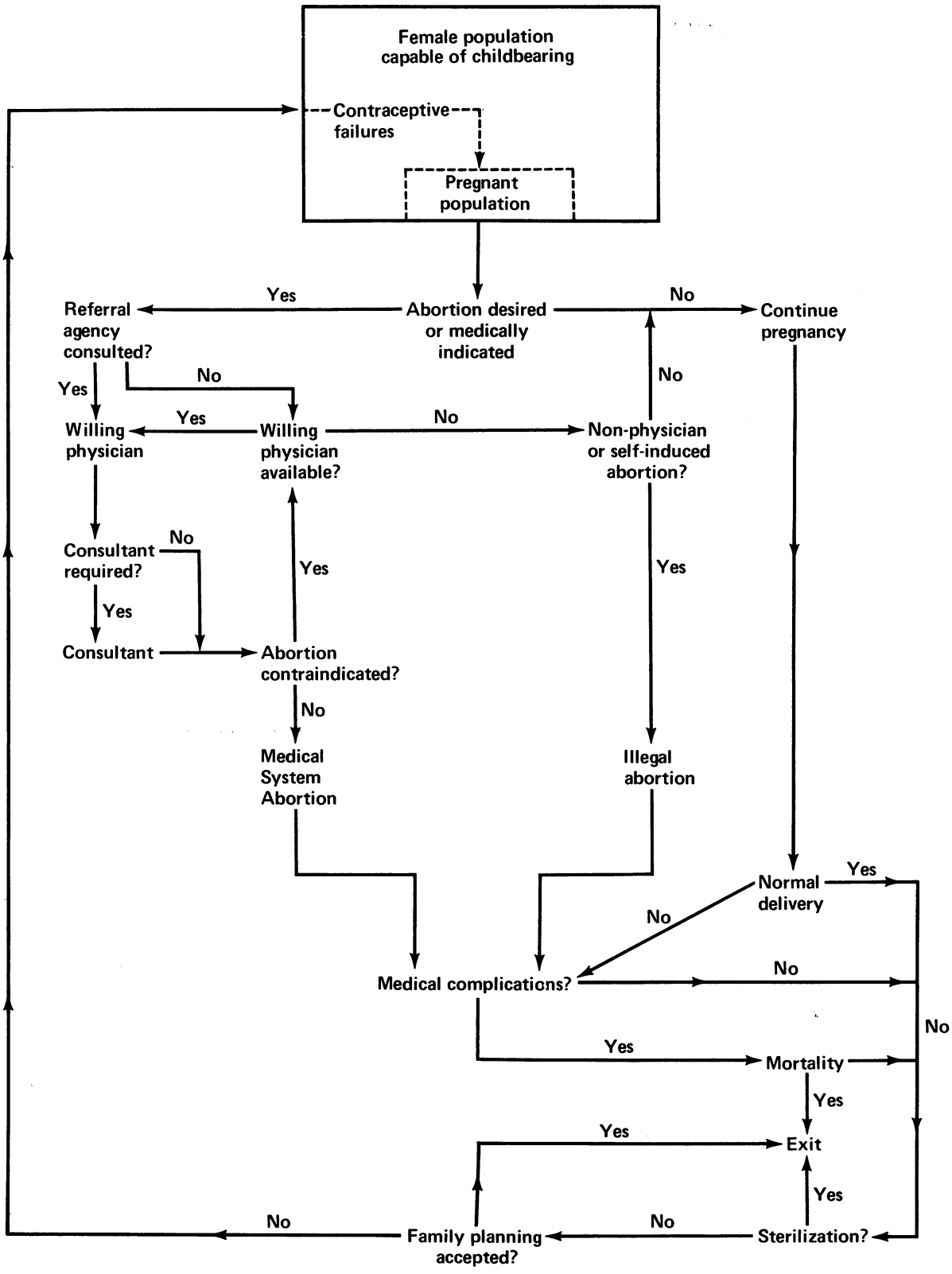
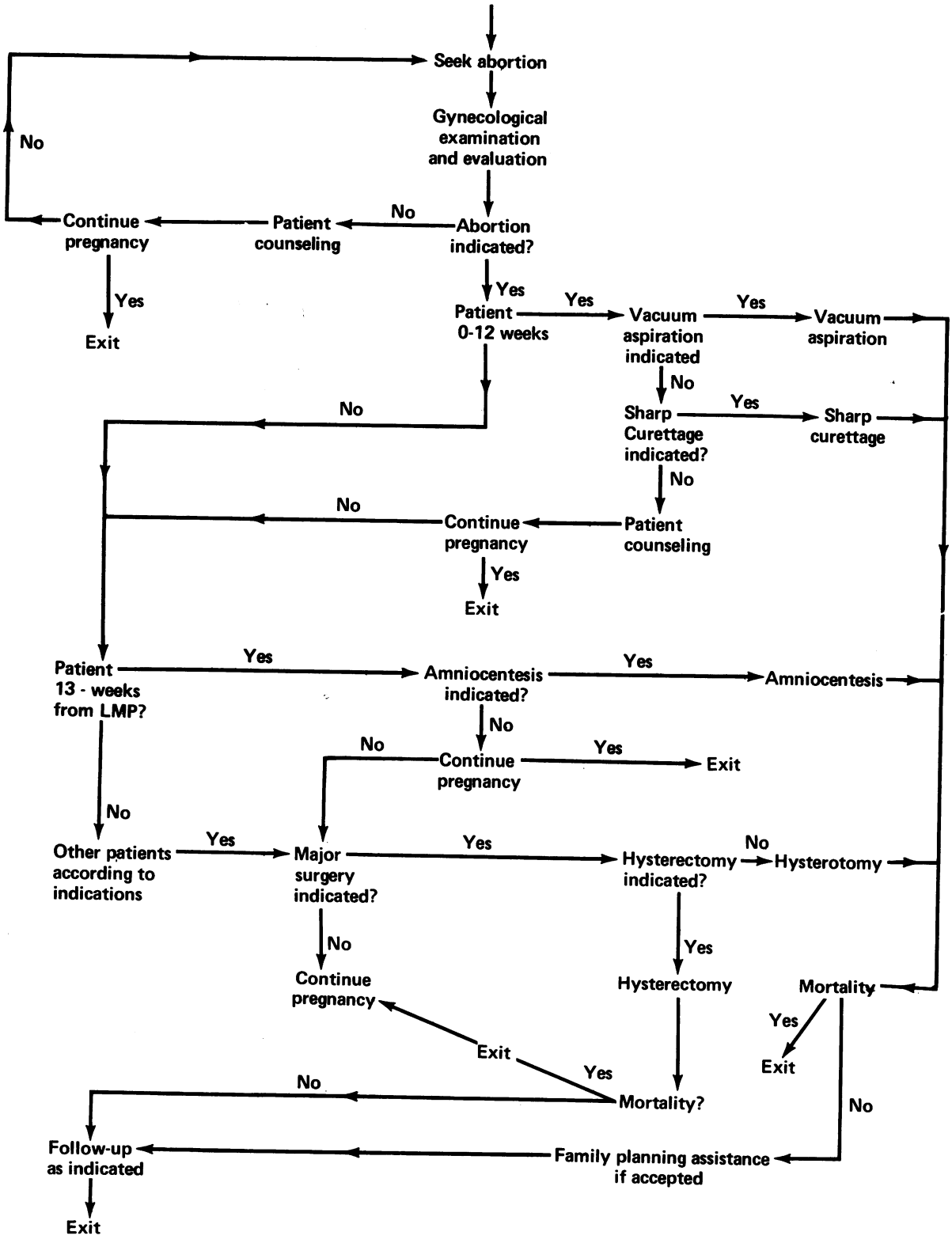


Figure 2. Model of services for therapeutic abortion showing flow of patients through medical services system



ices such as a physical examination, laboratory tests, medical consultations, and counseling. The procedure phase consists of all surgical services required to perform the appropriate abortion procedure, including treatment for complications. Followup includes postoperative care through the first postpartum visit and includes assistance in selection of appropriate contraceptive measures.

The selection of an appropriate procedure for a therapeutic abortion is usually determined by period of gestation and whether the abortion can be performed by vacuum or sharp curettage, amniotic fluid exchange, hysterotomy, or hysterectomy. Each procedure has a unique set of complications associated with it which may need medical or surgical treatment, depending on the type of complication. Curettage procedures are associated with uterine perforation, pelvic infection, and hemorrhage; amniocentesis complications include infection and hemorrhage.

Further surgery may be required to treat some complications. Sharp curettage may be indicated in an incomplete vacuum abortion, or laparotomy for severe perforations, hemorrhage, or infection. The reoperation possibilities considered in the Therapeutic Abortion Process Model are as follows.

Original procedure	*Reoperation (second) procedure*
Vacuum curettage	Sharp curettage
Vacuum curettage	Laparotomy
Sharp curettage	Sharp curettage
Sharp curettage	Laparotomy
Amniocentesis	Sharp curettage
Amniocentesis	Amniocentesis
Amniocentesis	Laparotomy
Hysterotomy	Laparotomy
Hysterectomy	Laparotomy

The transition from a qualitative description of patients seeking therapeutic abortions from physicians in the medical system to a flexible, adaptable, and easily manipulated format for policy analysis is accomplished by representing the patient flow model in mathematical equations. This quantification is based on the patient flow model shown in figure 2. Blumstein and Larson developed a mathematical flow model for the criminal justice system (*5*), and others have applied quantified flow models to various managerial problems.

As an example of the parameterization equations in this flow model, consider the decision to either seek an abortion or continue the pregnancy. The target population is composed of all pregnant women, of whom a fraction decide that the continuation of their pregnancy, based on medical, economic, or social reasons, is undesirable. This situation can be parameterized using the following variables:

NP = the number of pregnant women in the target population

NC = the number of women who decide to continue their pregnancy

NS = the number of women who decide to seek an abortion

PS = the branching probability representing the fraction of women in the target population who seek abortions.

The branching probability, PS, is a function of the availability of abortion services, societal values, economic considerations, and the extent of medical and psychiatric needs which indicate therapeutic abortion as the treatment of choice. The values of NC (women continuing the pregnancy) and NS (women seeking abortions) approximate the number of women in each category. The accuracy of these values is a function of the accuracy of NP and PS and may be determined by extrapolation of epidemiologic information by the estimate of experts, possibly with the aid of decision-theory techniques such as discussed by Raiffa (6), by the subjective estimate of the model user, or by the collection of new data.

This initial parameterization also represents the point at which the Therapeutic Abortion Process Model is first differentiated from the overview shown in figure 1. The overview model was developed as an aid to conceptualization of the broader interactions between society and the patient seeking an abortion and was not parameterized. All characteristics created by the flow of patients in the Therapeutic Abortion Process Model stem from NS, and further definition of the patient flow is shown by additional variables and equations in the process model.

The number of women who seek an abortion from physicians in the medical system is separated into those women who find a physician willing to perform the abortion and those who do not. The following variables are defined:

NA = number of women who seek a therapeutic abortion

PAP = probability of finding a willing physician

NAP = number of women who find a willing physician

$NAPB$ = number of women who do not find a willing physician.

The following relationships can then be expressed:

$$NAP = NA \cdot PAP$$

and

$$NABP = NA \cdot (1-PAP).$$

The probability of finding a physician willing to perform the abortion is a function of the availability of medical services for therapeutic abortion, the attitudes of physicians, legal conditions in the region, and travel alternatives. The parameterization is continued below only for patients on whom an abortion by vacuum aspiration is indicated. The complete parameterization of the model is presented elsewhere (*7*).

The total number of patients indicated for vacuum curettage by facility is

$$NVC = NAP \cdot PVC$$
$$NVCC = NVC \cdot FVCC$$
$$NVCH = NVC \cdot FVCH,$$

where the variables are defined as follows:

- NVC = number of vacuum curettage patients
- PVC = fraction of patients for whom vacuum curettage is the treatment of choice
- $NVCC$ = number of vacuum curettage patients aborted in clinics
- $FVCC$ = fraction of vacuum curettage procedures performed in clinics
- $NVCH$ = number of vacuum curettage patients whose procedures are performed in the hospital
- $FVCH$ = fraction of vacuum curettage procedures performed in hospitals.

Clinics studied include hospital-based and freestanding clinics in which the therapeutic abortion is performed on an outpatient basis.

Morbidity is considered in two classifications: (*a*) complications that require medical treatment and (*b*) complications that require reoperation.

The aggregate number of women who require medical treatment for complications and for whom vacuum curettage was performed is

$$NCVC = NVC \cdot PCVC$$

where

$$PCVC = PCVCP + PCVCI + PCVCH + PCVCO.$$

$PCVC$ denotes the total incidence rate of complications requiring only medical treatment, $PCVCP$ denotes the incidence rate of perforation, $PCVCI$ denotes infection, $PCVCH$ denotes hemorrhage, and $PCVCO$ denotes other complications not requiring surgical intervention. The number of women whose pregnancy has been terminated by vacuum curettage and who have complications such as perforation, infection, hemorrhage, and other complications not requiring surgical treatment is

$$NCVCP = NVC \cdot PCVCP$$
$$NCVCI = NVC \cdot PCVCI$$
$$NCVCH = NVC \cdot PCVCH$$
$$NCVCO = NVC \cdot PCVCO$$

where

- $NCVCP$ = number of vacuum curettage patients experiencing a perforation
- $NCVCI$ = number of vacuum curettage patients experiencing an infection
- $NCVCH$ = number of vacuum curettage patients experiencing a hemorrhage
- $NCVCO$ = number of vacuum curettage patients experiencing other complications not requiring reoperation.

Mortality caused by complications is represented as the number of patients who undergo a procedure multiplied by the procedure-specific mortality rate. It is an aggregation of mortality because of complications requiring medical treatment and those requiring surgery. Further disaggregation of mortality is not currently possible because of the manner in which statistics are collected. The number of deaths among patients from vacuum curettage is represented as

$$NMVC = NVC \cdot PMVC$$

where $PMVC$ is the mortality rate for vacuum aspiration procedures. The number of women who survive is

$$NMVCB = NVC \cdot (1-PMVC).$$

Finally, the number of women requiring followup and family planning services is parameterized for patients who survive by the fraction accepting such services. These equations and those for morbidity requiring reoperation are presented elsewhere (7).

The model, as presented thus far, determines the number of patients characterized by the descriptive variables in the model. For example, the

number of patients by procedure, facility, and type of complications, if any, can now be determined. To project total costs and resource requirements, the patient flow projections are then multiplied by unit cost and resource requirements. Thus, the number of patients in each category of procedure not experiencing a complication is multiplied by procedure-specific costs to yield the cost of all procedures, excluding screening, family planning, sterilization, and followup for uncomplicated therapeutic abortions.

Other costs for screening, family planning, sterilization, followup, and medically or surgically treated complications are similarly represented. Hospital patient-days and physician man-hours required to perform a therapeutic abortion and any reoperation procedures are also computed within the structure of the model. An application of this structure is given in the following example of a policy analysis useful for decision making.

An Application

For each of the alternative facilities in which a therapeutic abortion may be performed, a nationwide average cost for the procedure can be specified. By varying patient loads on each facility, the total costs for providing services in each type of facility can be measured. In one aspect of the study, this concept was explored with the objective of determining cost differentials between each facility when the fraction of abortions was varied as a function of the facility.

Because the procedure most often performed in nonhospital facilities is vacuum aspiration of the uterus, this procedure was given the most attention in the analysis. Vacuum aspiration procedures may be performed on a woman in the hospital or in a clinic where the woman is an outpatient, and the clinic may be either hospital based or freestanding. Three hypotheses were examined. First, the physicians may be required by law to use inpatient hospital facilities only. Second, nationwide, presently about 67 percent of these procedures are being performed in clinics not requiring an overnight stay (*8*). Third, if therapeutic abortion services were widely available and outpatient facilities were also widely available, as many as 90 percent of the procedures used in abortions performed in the first trimester could be performed in clinics with the woman as an outpatient.

Extensive data are required by the model, including reoperation rates for severe complications, morbidity and mortality rates, and family planning and followup acceptance rates, to calculate the flows of patients defined by the parameterization. As noted, these patient flows are multiplied by cost and other data to determine costs, hospital patient-days, and physician man-hour requirements. Some of these data are given in the following tabulations, and other data are presented more completely elsewhere (*1*). These data are based on preliminary estimates and are presented here for illustrative purposes.

Procedure	*Clinic (outpatient)*	*Hospital (inpatient)*
Vacuum curettage	$115	$ 250
Sharp curettage	135	250
Amniocentesis	0	490
Hysterotomy	0	880
Hysterectomy	0	1,175

Added to the initial cost of treatment is the estimated cost of complications not requiring reoperation.

	Complications not requiring reoperation			
Procedure	*Perforation*	*Infection*	*Hemorrhage*	*Other*
Vacuum curettage	$160	$320	$160	$140
Sharp curettage	160	320	160	140
Amniocentesis	0	160	320	140

Reoperation costs are as follows:

Procedure	*Costs added to patients' original procedure*	*Costs to patients' newly admitted to hospital* [1]
Sharp curettage	$220	$ 250
Amniocentesis	280	0
Hysterotomy	540	880
Hysterectomy	620	1,175

[1] Costs are additional costs to patient and are added to those of the original procedure which was performed in clinic or office.

Costs and patient days for 517,000 abortions (used here as an estimate of the number of abortions performed annually, of which 67 percent are performed by vacuum aspiration) are given as follows:

Percentage of vacuum aspiration performed, by facility		*Hospital patient-days (all procedures and treatment of complications)*	*Cost of services (vacuum aspiration patients only)*[1]	
Clinics, outpatient	*Hospitals, inpatient*		*Total*	*Average*
0	100	1,030,900	$108,980,484	$315
70	30	767,329	71,528,628	206
90	10	695,626	62,297,681	180

[1] Includes screening, family planning and followup services, and treatment for complications.

As the percentage of vacuum aspiration procedures performed on an outpatient basis increases from 0 to 70, the inpatient hospital days for all patients given therapeutic abortions, including hospitalization for subsequent morbidity, decreases by about one-fourth. A similar decrease in the total cost for providing all required care to women whose abortions were performed by vacuum aspiration also occurs. A striking decrease of $109 in the average cost occurs (a reduction from $315 to $206).

With a further increase in outpatient procedures to 90 percent of all vacuum aspiration patients, additional decreases occur in hospital days required and costs, both showing reductions of about 10 percent. A further decrease in the fraction of inpatient vacuum aspiration procedures is probably unrealistic because of the prevalence of apprehension, systemic disease, and other contraindications to outpatient surgery.

Other factors may also be involved, although they are not quantifiable. For example, mortality may actually be greater in clinics apart from hospitals (*9*). Further, the use of potentially safer, but more costly, hospital inpatient services may result in a decreased accessibility of services and a consequent higher incidence of illegal abortions with associated morbidity and mortality.

The structured model is only an aid to analysis and the investigation of each policy alternative; to be complete, it would require comprehensive investigation of all relevant factors. In this instance, for example, a lack of continuing family planning services in freestanding clinics and some hospital facilities may induce poor contraceptive habits, which might be averted, at a higher initial cost, by hospital-based procedures integrated into more comprehensive family planning programs. The model approach is designed, in part, to facilitate the conceptualization of such interaction and to test hypotheses experimentally without intervention in the actual system.

Implementation of this type of policy analysis may assume many forms. As a nationally based examination of facility implications, the approximate cost factors related to any national regulation of therapeutic abortion services can be evaluated. The hospital patient-days and costs are approximate estimates of the actual values under each of the three decision alternatives and imply financial requirements on such Federal programs as Medicaid and any potential programs providing financing for this aspect of medical care as an element of complete family planning or maternal health services. The average costs under each of the alternatives should be considered by State officials. But these values are only one aspect of the analysis and, as noted previously, policy decisions must also consider such factors as potentially higher mortality in the lower cost clinics.

Extensions

Because many of the important considerations central to informed policy decisions related to therapeutic abortion services remain obscure, further research is required. The research described in this paper is currently being extended for this purpose. Additional epidemiologic information is being collected and analyzed, further refinement of the mathematical support model is being designed so that more interactions for which data are available can be included in the projections, and other elements central to a more complete understanding of the system are being sought. Data still lacking include potential long-term effects of induced abortion, which should be considered in any policy deliberations, such as infertility, miscarriage, and prematurity. Comprehensive policy planning for therapeutic abortion services is ongoing and requires that the current horizon of knowledge be extended in such a manner as to enable decision makers to take advantage of the estimated effects implied by each alternative they consider.

Conclusion

The analytical approach to public health problems provides a well-structured framework within which policy analysis and health planning activities can be conducted. Eventual expansion of the model into a more refined and possibly interactive computer format could enable local, State, and Federal officials to test the effects of their own hypotheses on the abortion services system. Estimates of mortality, morbidity, resource requirements, and costs may be projected under various assumptions to examine such issues as cost and hospital patient-day requirements resulting from various decisions by Medicaid officials. Finally, the collection and analysis of more accurate and complete data can lead to further refinements in resource projections.

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An application of the management science approach to the planning of health care delivery systems is described in this paper. The operational aspects of the delivery of therapeutic legal abortion services were investigated with the objective of developing a framework for planning and for examination of the effects of alternative policy decisions. Measures were structured in terms of morbidity, mortality, resource requirements, and costs. An example is presented showing the cost of using various facilities for the performance of therapeutic abortion procedures.