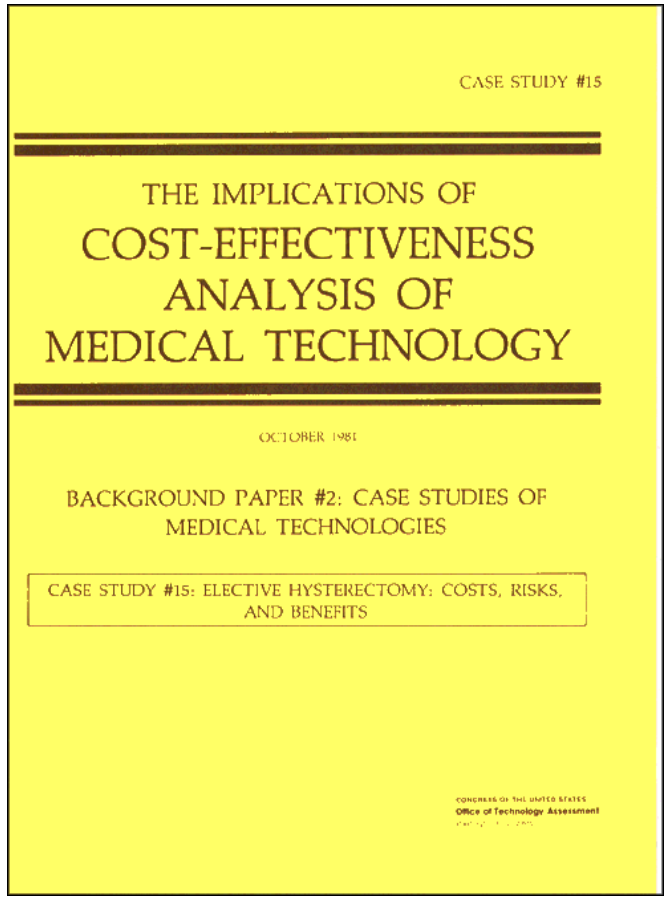
Elective Hysterectomy: Costs, Risks, and Benefits

October 1981

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THE IMPLICATIONS OF COST-EFFECTIVENESS ANALYSIS OF MEDICAL TECHNOLOGY

OCTOBER 1981

BACKGROUND PAPER #2: CASE STUDIES OF MEDICAL TECHNOLOGIES

CASE STUDY #15: ELECTIVE HYSTERECTOMY: COSTS, RISKS, AND BENEFITS

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OTA Background Papers are documents that contain information believed to be useful to various parties. The information undergirds formal OTA assessments or is an outcome of internal exploratory planning and evaluation. The material is usually not of immediate policy interest such as is contained in an OTA Report or Technical Memorandum, nor does it present options for Congress to consider.

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D C 20510

Foreword

This case study is one of 17 studies comprising Background Paper #2 for OTA's assessment, The Implications of Cost-Effectiveness ***Analysis of Medical Technology.*** That assessment analyzes the feasibility, implications, and value of using cost-effectiveness and cost-benefit analysis (CEA/CBA) in health care decisionmaking. The major, policy-oriented report of the assessment was published in August 1980. In addition to Background Paper #2, there are four other background papers being published in conjunction with the assessment: 1) a document which addresses methodological issues and reviews the CEA/CBA literature, published in September 1980; 2) a case study of the efficacy and cost-effectiveness of psychotherapy, published in October 1980; 3) a case study of four common diagnostic X-ray procedures, to be published in summer 1981; and 4) a review of international experience in managing medical technology, published in October 1980. Another related report was published in September of 1979: ***A Review of Selected Federal Vaccine and Immunization Policies.***

The case studies in ***Background Paper*** #2: ***Case Studies of Medical Technologies*** are being published individually. They were commissioned by OTA both to provide information on the specific technologies and to gain lessons that could be applied to the broader policy aspects of the use of CEA/CBA. Several of the studies were specifically requested by the Senate Committee on Finance.

Drafts of each case study were reviewed by OTA staff; by members of the advisory panel to the overall assessment, chaired by Dr. John Hogness; by members of the Health Program Advisory Committee, chaired by Dr. Frederick Robbins; and by numerous other experts in clinical medicine, health policy, Government, and economics. We are grateful for their assistance. However, responsibility for the case studies remains with the authors.



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Preface

This case study is one of 17 that comprise Background Paper #2 to the OTA project on the ***Implications of Cost-Effective) less Analysis of Medical Technology.*** * The overall project was requested by the Senate Committee on Labor and Human Resources. In all, 19 case studies of technological applications were commissioned as part of that project. Three of the 19 were specifically requested by the Senate Committee on Finance: psychotherapy, which was issued separately as Background Paper #3; diagnostic X-ray, which will be issued as Background Paper #.5; and respiratory therapies, which will be included as part of this series. The other 16 case studies were selected by OTA staff.

In order to select those 16 case studies, OTA, in consultation with the advisory panel to the overall project, developed a set of selection criteria. Those criteria were designed to ensure that as a group the case studies would provide:

- examples of types of technologies by function (preventive, diagnostic, therapeutic, and rehabilitative);
- examples of types of technologies by physical nature (drugs, devices, and procedures);
- examples of technologies in different stages of development and diffusion (new, emerging, and established);
- examples from different areas of medicine (such as general medical practice, pediatrics, radiology, and surgery);
- examples addressing medical problems that are important because of their high frequency or significant impacts (such as cost);
- examples of technologies with associated high costs either because of high volume (for low-cost technologies) or high individual costs;
- examples that could provide informative material relating to the broader policy and methodological issues of cost-effectiveness or cost-benefit analysis (CEA /CBA); and
- examples with sufficient evaluable literature.

On the basis of these criteria and recommendations by panel members and other experts, OTA staff selected the other case studies. These 16 plus the respiratory therapy case study requested by the Finance Committee make up the 17 studies in this background paper.

All case studies were commissioned by OTA and performed under contract by experts in academia. They are authored studies. OTA subjected each case study to an extensive review process. Initial drafts of cases were reviewed by OTA staff and by members of the advisory panel to the project. Comments were provided to authors, along with OTA'S suggestions for revisions. Subsequent drafts were sent by OTA to numerous experts for review and comment. Each case was seen by at least 20, and some by 40 or more, outside reviewers. These reviewers were from relevant Government agencies, professional societies, consumer and public interest groups, medical practice, and academic medicine. Academicians such as economists and decision analysts also reviewed the cases. In all, over 400 separate individuals or organizations reviewed one or more case studies. Although all these reviewers cannot be acknowledged individually, OTA is very grateful for their comments and advice. In addition, the authors of the case studies themselves often sent drafts to reviewers and incorporated their comments.

These case studies are authored works commissioned by OTA. The authors are responsible for the conclusions of their specific case study. These cases are not statements of official OTA position. OTA does not make recommendations or endorse particular technologies. During the various stages of the review and revision process, therefore, OTA encouraged the authors to present balanced information and to recognize divergent points of view. In two cases, OTA decided that in order to more fully present divergent views on particular technologies a commentary should be added to the case study. Thus, following the case

*Office of Technology Assessment, U.S. Congress, *The Implications of Cost-Effectiveness Analysis of Medical Technology*, GPO stock No. 052-003-00765-7 (Washington, D.C.: U.S. Government Printing Office, August 1980).

studies on gastrointestinal endoscopy and on the Keyes technique for periodontal disease, commentaries from experts in the appropriate health care specialty have been included, followed by responses from the authors.

The case studies were selected and designed to fulfill two functions. The first, and primary, purpose was to provide OTA with specific information that could be used in formulating general conclusions regarding the feasibility y and implications of applying CEA/CBA in health care. By examining the 19 cases as a group and looking for common problems or strengths in the techniques of CEA/CBA, OTA was able to better analyze the potential contribution that these techniques might make to the management of medical technologies and health care costs and quality. The second function of the cases was to provide useful information on the specific technologies covered. However, this was not the major intent of the cases, and they should not be regarded as complete and definitive studies of the individual technologies. In many instances, the case studies do represent excellent reviews of the literature pertaining to the specific technologies and as such can stand on their own as a useful contribution to the field. In general, though, the design and the funding levels of these case studies were such that they should be read primarily in the context of the overall OTA project on CEA/CBA in health care.

Some of the case studies are formal CEAs or CBAs; most are not. Some are primarily concerned with analysis of costs; others are more concerned with analysis of efficacy or effectiveness. Some, such as the study on end-stage renal disease, examine the role that formal analysis of costs and benefits can play in policy formulation. Others, such as the one on breast cancer surgery, illustrate how influences other than costs can determine the patterns of use of a technology. In other words, each looks at evaluation of the costs and the benefits of medical technologies from a slightly different perspective. The reader is encouraged to read this study in the context of the overall assessment's objectives in order to gain a feeling for the potential role that CEA/CBA can or cannot play in health care and to better understand the difficulties and complexities involved in applying CEA/CBA to specific medical technologies.

The 17 case studies comprising ***Background Paper #2*** (short titles) and their authors are:

Artificial Heart: Deborah P. Lubeck and John P. Bunker
Automated Multichannel Chemistry Analyzers: Milton C. Weinstein and Laurie A. Pearlman
Bone Marrow Transplants: Stuart O. Schweitzer and C. C. Scalzi
Breast Cancer Surgery: Karen Schachter and Duncan Neuhauser
Cardiac Radionuclide Imaging: William B. Stason and Eric Fortess
Cervical Cancer Screening: Bryan R. Luce
Cimetidine and Peptic Ulcer Disease: Harvey V. Fineberg and Laurie A. Pearlman
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Selected Respiratory Therapies: Richard M. Scheffler and Morgan Delaney

These studies will be available for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Call OTA's Publishing Office (224-8996) for availability and ordering information.

Case Study #15

Elective Hysterectomy: Costs, Risks, and Benefits

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INTRODUCTION

Hysterectomy, surgical removal of the uterus, is performed at a rate higher than that of any other major operation. The National Center for Health Statistics (NCHS) estimates that in 1977 704,800 hysterectomies were performed in the United States (57). This represents a rate of 817.3 per 100,000 females 15 years old and over. [1] It is frequently alleged that many hysterectomies are performed "unnecessarily," an allegation that leads to unresolved controversies over the definition of "necessary care. " A more useful approach, which we adopt in this case study, is to consider hysterectomies that are performed for indications that could be treated by alternative therapies or by no therapy at all, with fewer resultant health risks to the woman and lower economic costs in general. In this category, we focus special attention on hysterectomies carried out for sterilization and cancer prophylaxis.

Professional Standards Review Organizations (PSROs) in 1977 provided a list of medically appropriate indications for hysterectomy (see table 1). Included on the list are malignant and premalignant disease of the endometrium (mucus membrane of the uterus) and cervix; fibroma (tumor) of the cervix, fundus, or broad ligament; abnormal bleeding; and prolapsed uterus (protrusion of the uterus through the vaginal orifice). Anatomic proximity to malignant or infectious disease (e.g., cancer of the colon and tubal infections) or conditions in conjunction with vaginal repair are also included as medical justifications for hysterectomy. Sterilization in the absence of concomitant uterine disease, however, is specifically excluded from the list.

The PSRO list of indications for hysterectomy is intended to include all acceptable medical indications. However, the presence of one or more such indications does not alone mandate a hysterectomy as the only, or even the

[1] This rate is calculated on the basis of the entire female population over 15 years of age. When corrected for women who have already undergone hysterectomy, a rate of **937.1** per 100,000 females at risk is obtained. The number of hysterectomies for females under **15** was reported by NCHS to have increased from **200 to 3,300 between 1967** and **1977.** (These figures are below the standards of reliability of precision of the National Hospital Discharge Survey.)

Table 1.--PSRO List of Medical Indications for Vaginal and Abdominal Hysterectomy

Vaginal hysterectomy
Reasons for procedure **(one of the following):**
1. **Premalignant lesions of the endometrium (e.g., adenomatous hyperplasia)**
2. **Premalignant and malignant conditions of the uterine cervix (e.g., dysplasia or carcinoma in situ)**
3. **Continued severe bleeding after several menstrual periods and two nondiagnostic dilatation and curettage**
4. **In conjunction with vaginal repair of cystocele, rectocele, or enterocele.**
5. **Uterine prolapse.**

Comment: Sterilization by vaginal hysterectomy is acceptable only in the presence of concomitant uterine disease.

Abdominal hysterectomy
Reasons for procedure **(one of the following:**
1. **Malignant disease of cervix, uterus, ovaries, or fallopian tubes**
2. **Nonmalignant disease of the tubes and ovaries where the uterus is not primarily involved in disease, but is removed because of its anatomic proximity to diseased adnexa or appendages, such as in chronic advanced tubal infections or extensive endometriosis**
3. **Removal of the uterus in nongynecologic pelvic surgery where necessary to encompass disease originating elsewhere, as in uterine involvement in colon cancer or in abscess secondary to diverticulitis**
4. **Obstetrical catastrophes, such as uncontrollable postpartum bleeding, uterine rupture, uncontrolled uterine sepsis developing from septic abortion, etc.**
5. **in the absence of any of the above indications, and in patients whose disease process apparently is confined to the uterus, one of the following:**
   a. **Continued severe bleeding after several menstrual periods and two nondiagnostic dilatation and curettage, or**
   b. **Fibroids that are either:**
   (1) **Symptomatic (e.g., causing bladder pressure),**
   (2) **Submucous with bleeding,**
   (3) **Asymptomatic, but uterus and fibroid are 12 cm or more in diameter,**
   (4) **Showing progressive enlargement, or**
   (5) **Failing to atrophy after menopause.**

Comment: **Sterilization by abdominal hysterectomy is acceptable only in presence of concomitant uterine disease.**

These sample criteria are for screening patient care for subsequent physician review only and do not constitute standards of care.

SOURCE: Professional Standards Review Organizations Program, fiscal **year 1977**

best, means of treatment. The indications for hysterectomy comprise a spectrum from saving life at one end to improving it at the other end. Thus, the Executive Board of the American College of Obstetricians and Gynecologists has recently distinguished five levels of urgency for hysterectomy :[2] emergency, mandatory, urgent, advisable, and elective (see table 2). Elective hysterectomies, according to this classification, would include those for sterilization and for prophylaxis against potential disease such as uterine cancer.

Personal circumstances may play an important role in the selection of hysterectomy over other modes of treatment, whether the decision is made primarily by the patient or by the physician. For example, a desire to end troublesome menstruation, a wish to avoid contraceptive failures (especially in conjunction with termination of an existing unwanted pregnancy), or a fear of cancer (especially in a woman with a family history of cervical cancer) may motivate a patient to request her physician to prescribe a hysterectomy.

Any overuse of hysterectomy for personal reasons, either the patient's or physician's, is a matter of concern. Given limited resources for health care and the health risks of undergoing surgery, it is important to identify and to minimize low-priority hysterectomies. In this case study, we adopt the American College of Obstetricians and Gynecologists classification of hysterectomies performed for sterilization and for cancer prophylaxis as "elective." This definition of elective hysterectomy is basically a con-

'Hysterectomies are performed mainly by gynecologists, but also by general surgeons, and, to a lesser extent, general practitioners. Board-certified gynecologists perform four to five times **as** many abdominal hysterectomies as general surgeons. Vaginal hysterectomies are performed much more frequently by gynecologists than general surgeons (1).

Table 2.—indications for Hysterectomy: Five Levels of Urgency

1. *Emergency: e.g.,* **intra-abdominal hemorrhage such as a ruptured ecotopic pregnancy.**
2. *Mandatory.' e.g.,* **the presence of a malignancy such as an adenocarcinoma of the endometrium.**
3. *Urgent: e.g.,* **abnormal uterine bleeding which requires further diagnostic evaluation or definitive treatment.**
4. *Advisable: e.g.,* **pelvic relaxation such as that associated with urinary stress incontinence.**
5. *Elective: e.g.,* **surgical procedures for family planning purposes such as sterilization.**

SOURCE: American College of Obstetricians and Gynecologists, executive board statement **of policy, May 7, 1977.**

servative one. There do exist other minor gynecological conditions that can be satisfactorily treated with alternative therapies or no therapy at all.

It is the purpose of this case study to ascertain, insofar as possible using existing data, the risks, costs, and benefits associated with hysterectomies for sterilization and cancer prophylaxis. The case study encompasses five areas for consideration in cost-benefit analyses (CBAs):

1. hysterectomies for sterilization and cancer prophylaxis:
   —evidence of medical acceptance of sterilization and cancer prophylaxis as indications for hysterectomy, and
   —evidence of extent to which elective hysterectomies are performed;
2. health risks of (all) hysterectomies:
   —operative and early postoperative complications, and
   —long-term postoperative complications;
3. comparison of health risks of hysterectomy with those of tubal ligation (ligation of the uterine tubes for purposes of sterilization);
4. comparison of health risks of hysterectomy with those of future cancer; and
5. quantitative evaluation of risks, costs, and benefits of elective hysterectomy.

HYSTERECTOMIES FOR STERILIZATION AND CANCER PROPHYLAXIS

Legal and social changes in the late 1960's, particularly the emphasis on limiting population, increased acceptance of sterilization as a means of contraception. Gynecologists for the first time recommended that hospitals no longer require a medical staff committee to review requests for sterilization based on parity and age. In 1969, Wright (86) wrote of the "radical changes" then occurring in the indications for hysterectomy to explain why tissue committees were presented with such large numbers of uteri free of pathological changes. Concerning sterilization, he wrote (86):

> To sterilize a patient and allow her to keep a useless and potentially lethal organ is incompatible with modern gynecologic concepts. Hysterectomy is the only logical approach to surgical sterilization.

And in view of the precedent set with the acceptance of total hysterectomies in the mid-1940's,[3] of cancer prophylaxis, he wrote (86):

> Today, when laparotomy becomes necessary for adnexal disease, and the patient has completed her family, total hysterectomy should be performed as a prophylactic procedure. Under these circumstances, the uterus becomes a useless, bleeding, symptom-producing, potentially cancer-bearing organ, and therefore should be removed.[4]

Whether or not gynecologists agreed with the rationale given by Wright, physicians attending a general meeting of the American College for Obstetricians and Gynecologists on June 15, 1971, voted by applause to support sterilization as an appropriate medical indication for hysterectomy.

From published reports, it is apparent that sterilization became a primary indication for hysterectomy in the late 1960's. Laros and Work (46) reported that 68.5 percent of the vaginal hysterectomies they analyzed at the University Hospital and Wayne County General Hospital in Ann Arbor, Mich., between 1965 and 1970 were primarily for sterilization for "socioeco-

[3] 'Since the mid-1940's, most gynecologists have performed total hysterectomies. Prior to that time, "subtotal hysterectomies" leaving a cervical stump were performed, primarily because subtotal hysterectomy was faster and there was generally a lack of adequate blood transfusions. The retained cervix did become cancerous in some women, and eventually, with the advent of improved surgical techniques and supporting technologies, total hysterectomy became the predominant type of hysterectomy (59,63).

[4] In a reply to Wright's editorial, Dr. Stanley Friedman wrote (35): "From 1960 to 1965 the death rate from prostatic cancer was about equal to that from all uterine cancers (National Vital Statistics Division and Bureau of the Census, United States). Applying Wright's 'logic of one basic principle, ' it would seem equally rational to perform elective prostatectomy *on* every male whose wife is to undergo elective hysterectomy y."

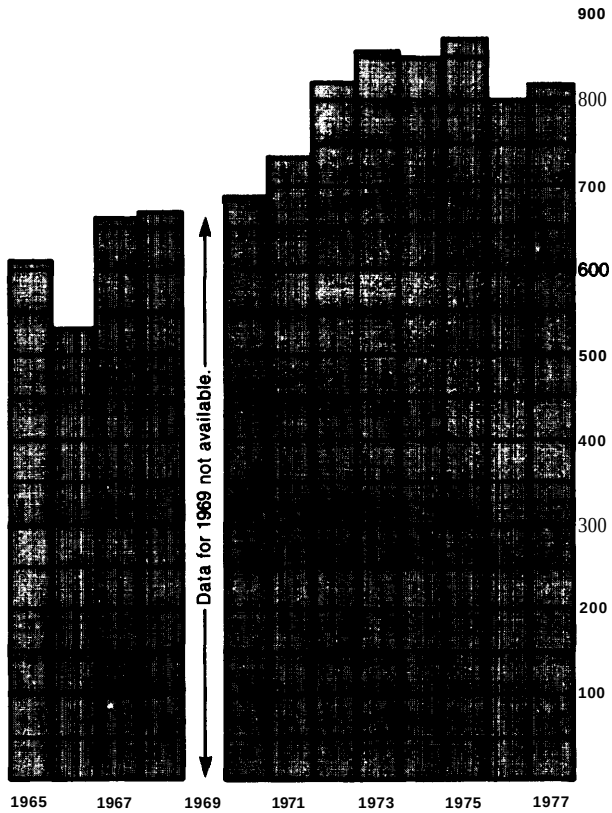
nomic" and "multiparity" reasons. Hibbard (36) reported that in 1970, 20 to 25 percent of hysterectomies at Los Angeles County University of Southern California Medical Center were solely or primarily for sterilization. Hibbard also reported that the rate of sterilization by hysterectomy rose 293 percent between June 1968 and January 1970. California Blue Cross reported an increase of 79 percent in hysterectomies during just the first 6 months of 1970, which one B1ue Shield reviewer attributed to the liberalization of California State abortion and sterilization laws (37).[5] Of 242 selected hysterectomies performed at the time of cesarean sections at the University of Arkansas Medical Center between 1970 and 1974, 68 percent were for sterilization (6).

The total number of hysterectomies performed nationally, as reported by NCHS, rose from 525,500 in 1970 to 690,000 in 1973, an increase of over 30 percent (57). Figure 1 presents hysterectomy rates for women aged 15 and over from 1965 through 1977. Note the sharp increase in rates between 1970 and 1973 and the relatively stable rates in the preceding and succeeding years.

A number of findings indicate that changes in hysterectomy rates are not a function of changes in pelvic disease or age patterns in the population. Hysterectomy rates have been shown to vary regionally and in ways that correlate with surgeon-to-patient ratios or hospital bed availability (14,78,79,80,81,82). Furthermore, medical audits have been shown to result in sharply decreased hysterectomy rates (30,48,50). Retrospective reviews of hospital charts have repeatedly found that at least 30 percent of hysterectomies performed were not justified by medical indications alone (28,33,36,54,76,84). The implications are—although there can be no proof—that many of these hysterectomies were performed for sterilization or cancer prophylaxis.

[5]Regulations in California since 1977 have prohibited elective sterilization within 14 days of the patient's signing the consent form for sterilization. The waiting period may be reduced to 72 hours if the patient voluntarily requests in writing that the procedure be performed sooner. Under no circumstances can persons under 18 years of age or persons judicially declared incompetent obtain an elective sterilization.

Figure 1 .-H ysterectomy Rates per 100,000 Women Aged 15 and Over, 1965=77



SOURCE: National Center for Health Statistlcs. Division of Health Resources Utilization Statistics, unpublished data from the National Hospital Discharge Survey for 1965-68 and 1970-77, n d.

The precise extent to which hysterectomies are performed for sterilization and cancer prophylaxis cannot be measured because of the unreliability of the written medical record. For many reasons, the true indications for hysterectomy are often not included in a patient's hospital charts (4,20). The reasons include peer review; nonreimbursement; and patient, physician, or hospital religious affiliations which make it expedient at some hospitals to write in only approved indications such as "abnormal bleeding" and "prolapsed uterus. "

Cava (20) has documented how indications for hysterectomies reported on hospital charts have changed over the years, with an increasing percentage of cases of "prolapsed uterus" (including "descensus" and "pelvic relaxation") in selected studies (see table 3). According to Cava, the increased use of prolapsed uterus as

Table 3.—Comparative Indications and Hysterectomies, 1945

	1945a	1956[b]	1968[c]	1972-73
Operation:				
Abdominal	65.8%[d]	69.2%	81 .0%	59.6%
Vaginal	4.8	25-30	15.5	40.0
Indications:				
Bleeding.	41.4%	43.2%	34.0%	35.7%
Prolapse.	4.4	12.5	20.5	37.9

[a]Data for 1945 from N. F. Miller, "Hysterectomy: Therapeutic Necessity or Surgical Racket," Am. J. Obstet. *Gyneco/.* 51:804, 1946.
[b]Data for 1956 from R. Brandfass and N. Nasser-Mehrigi, "Hysterectomies in Community Hospitals," *W. Va. Med. J.* 64:471, 1968.
[c]Data for 1968 from L. T. Hibbard, ".Sexual Sterilization by Elective Hysterectomy." *Am. J. Obstet. Gynecol.* 112:1076, 1972.
[d]Subtotal hysterectomy.

SOURCE: E. F. Cava, "Hysterectomy in a Community Hospital," Am. *J. Obstet. Gynecol.* 122:434, 1975.

an indication was due to the change in hospital practices to accommodate elective hysterectomy for sterilization at a time when third-party payment for hysterectomies for sterilization was unpredictable.[b]

Cancer prophylaxis is a much discussed by-product of hysterectomy for sterilization and is considered by some physicians to be an indication for hysterectomy by itself. To undergo periodic genital and breast examinations for the purpose of detecting cancer is the most frequent reason asymptomatic women seek gynecological care. Pap examinations can lead to hysterectomies directly by revealing an abnormal condition (e.g., severe dysplasia, carcinema in situ, or invasive carcinomas of the cervix) that may be appropriately treated by hysterectomy. Such examinations can also lead indirectly to hysterectomies by bringing asymptomatic women to gynecologists, who then detect in these women upon pelvic examination an abnormal condition (e.g., uterine myomas, mild cervical dysplasia, or minimal prolapse of the uterus or vagina without associated pain or pressure) which would not by itself justify a hysterectomy; for these women, elective hysterectomy may be prescribed with the argument that the uterus will probably develop more disease in time. It is also possible that women motivated to seek Pap smears may be particularly anxious to avoid cancer. Because socioeconomically disadvantaged women are more likely than others to develop benign or malignant disease of the cervix and dysfunctional uterine bleeding and are less likely to use medical services, some physicians prefer hysterectomies to tubal ligation for sterilization of these women at the time of delivery of the last desired child. It is argued that these women are less likely to have routine pelvic examinations and are therefore less likely to detect uterine disease at treatable stages (44,77).

Thus, it is clear that elective hysterectomies are frequently performed and are considered justified for purposes of sterilization or prophylaxis against future endometrial or cervical cancer or other uterine disease. Before these indications are accepted, however, the health risks and economic costs of the operation and its alternatives should be considered.

[e]Note that approved diagnoses such as "abnormal bleeding" or "prolapsed uterus" are consistent with a pathology report of "normal uterus."

HEALTH RISKS OF HYSTERECTOMY

In the following discussion of health risks, information has been almost entirely drawn from past studies which have not distinguished elective from all other kinds of hysterectomies. Use of this information was necessary, because there are no available data for elective hysterectomy as a separate category.[7] The health risks cited here are expected to surpass the risks encountered by an elective hysterectomy patient in good health prior to surgery.

Operative and Early Postoperative Outcome

Death, although an infrequent consequence of hysterectomy, is of particular concern when any major surgery is undertaken for purely elective reasons and less risky alternatives are available.

[7]Because of the absence of a study of morbidity and mortality in elective hysterectomy patients, we are currently studying the indications for surgery and outcomes of 2,600 hysterectomy patients in the Stanford study (73). Preliminary results are cited in this study .

Through the years, hysterectomy has had an associated mortality rate of 0.1 to 0.4 percent in studies compiling postoperative outcomes of 500 patients or more (3,23,38,47,83). The Commission on Professional and Hospital Activities (CPHA) reported mortality rates for surgical procedures performed at 1,592 Professional Activity Study hospitals in 1972-73 (22). The reported mortality rate for abdominal hysterectomy was 0.17 percent (350,661 patients) and for vaginal hysterectomy was 0.08 percent (155,589 patients).[8] Mortality reported in the prospective study of surgical care in hospitals conducted by the staff of the Stanford Center for Health Care Research—hereafter referred to as the Stanford study (72,73)—with information from 17 hospitals participating in the Professional Activity Study in 1972, was 0.1 percent within 7 days and 0.3 percent within 40 days after abdominal hysterectomies (1,491 patients) (see table 4).[9] No deaths occurred within 40 days among the 1,124 women on whom vaginal hysterectomies were performed (see table 4). By way of comparison with other major operations in the same study, the mortality rate in women (1,059 patients) within 40 days after cholecystectomies (surgical removal of the gall bladder) was 0.9 percent, or more than twice as high as the mortality rate for abdominal hysterectomies; there were no deaths after appendectomies for women in the same study (272 patients).

[8]Abdominal hysterectomy is excision of the uterus through an incision in the abdominal wall; vaginal hysterectomy is excision of the uterus through the vagina.

[9]In the Stanford study (72, 73), patients with gynecologic malignancies were excluded from the analysis. All five patients who died had undergone nonemergency abdominal hysterectomies, and all died within 14 days of surgery.

Although the mortality rate for hysterectomy is low, the number of hysterectomies performed is so large that the number of women who die each year is substantial. If 30 percent of hysterectomies are elective (as estimated by studies reviewed earlier), and we assume a mortality rate for abdominal and vaginal hysterectomies of 0.1 percent (which is low), with the 704,800 hysterectomies performed in the United States in 1977 (57), we estimate that at least 210 women died that year during or soon after elective hysterectomy. Of special importance to the present study is whether women undergoing elective hysterectomies had an even lower risk of death than other women undergoing hysterectomies because of the former's presumed better general health at the time of surgery. One must bear in mind, however, that the total number of women undergoing hysterectomy for sterilization and cancer prophylaxis is considerably underreported. In the Stanford study (72,73), none of the 155 women for whom "sterilization, " "abortion," or "multiparity" was one of the stated indications for surgery died. [10] The average age, physical status, and cardiovascular status at the time of surgery of the five hysterectomy patients who did die in the Stanford study, however, were only slightly less favorable than the average for all hysterectomy patients.

Much more common outcomes following hysterectomy than death are nonfatal operative and postoperative complications. Operative

10That none of these women died does not mean that the mortality risk is zero, but that many more cases are needed to determine mortality risks.

Table 4.—Comparative Incidence and Rates of Mortality Among Patients Undergoing Hysterectomy, Cholecystectomy, or Appendectomy

Operation	Total number of women patients	7 days postoperative		40 days postoperative	
		Number of deaths[a]	Percentage of patients	Number of deaths[a]	Percentage of patients
Vaginal hysterectomy.	1,124	0	0%	0	0%
Abdominal hysterectomy.	1,491	2	0.1	5	0.3
Cholecystectomy	1,176	1	<0.001	10	0.9
Appendectomy	272	0	0	0	0

[a]None of the patients who died underwent emergency surgery.

SOURCES: Stanford Center for Health Care Research, *Study of the Institutional Differences in Post-Operative Mortality, 1974;* and Stanford Center for Health Care Research, *Impact of Hospital Characteristics on Surgical Outcomes and Length of Stay, 1978.*

complications of hysterectomy can include bleeding and, with considerably less frequency, bladder, urethral, and rectal injuries. Bleeding, if severe, requires transfusions; the other complications require corrective surgery at the time of operation or later (if not discovered during surgery) (23,83). There is no accepted definition of postoperative morbidity and no uniformity in the registration of complications. Fever is the most common postoperative complication after hysterectomy, but hemorrhage and transfusion, urinary dysfunction, wound and pelvic infections, intestinal obstruction, and thromboembolic disease are quite frequent (3,23,83).

Anywhere from 62 percent (41) to 81 percent (46,83) of hysterectomy patients have been reported to develop some degree of morbidity after the operation. Seven days after surgery in the Stanford study (72,73), there was some degree of morbidity in 64 percent of the nonemergency abdominal hysterectomy patients (see table 5). [11] Of greater consequence, 7.5 percent of nonemergency abdominal hysterectomy patients in this study experienced moderate to life-threatening complications. Moderate morbidity was reported for **7.0** percent of the nonemergency vaginal hysterectomy patients, with no complications in the severe and life-threatening categories. In a measure of morbidity of seven separate organ systems, urinary system morbidity was higher for vaginal hysterectomies (4.9 percent of the patients had moderate or severe complications) than for abdominal hysterectomies (1.1 percent had moderate and severe complications). This difference has been noted by others and has been attributed to the longer use of indwelling urethral catheters in vaginal hysterectomy patients (23,83). In the Stanford study (72,73), more vaginal hysterectomy patients had indwelling "tubes" of one type or another at 7 days after surgery than did abdominal hysterectomy patients.

Patients undergoing vaginal hysterectomy are more likely than patients undergoing abdominal hysterectomy to have postoperative fever (38 v. 31 percent) and to receive antibiotic treatment (54 v. 45 percent) (47), (69.7 v. 49.6 percent) (73). **Vaginal hysterectomy** patients may undergo further surgery at a rate as high as 5 to 10 percent (41,46,83).[12] Patients undergoing abdominal hysterectomies were reported to be more likely than those undergoing vaginal hysterectomies to receive blood transfusions (17 v. 13 percent) and to receive anticoagulants during their hospital stay (1.4 v. 0.7 percent) (47). The average length of postoperative hospital stay of abdominal hysterectomy patients tends to be longer than that of vaginal hysterectomy patients, but the reported difference is not statistically significant (46).

[11] Morbidity is measured as the extent of overall complications as assessed by the patient's nurse on the ward. The percentage expressed here is the proportion experiencing at least minimal problems 7 days after surgery.

[12] White, et al. (83) reported that 5 percent of 600 patients studied had a second operation. Eight patients had one during the initial hospital stay; 22 returned to the hospital later. The second operations were for incisional hernias, intestinal obstruction, vaginal hemorrhage, intra-abdominal hemorrhage, septic vaginal or pelvic hematomas, stress incontinence (recurrent or new), ovarian cysts, appendicitis, prolapsed fallopian tube, and ulcer in the sacral region.

Table 5.—Morbidity and Mortality 7 Days After Hysterectomy

	Abdominal hysterectomy patients				Vaginal hysterectomy patients			
	Number		Percentage		Number		Percentage	
Evaluation of health status[a]	NE[b]	Total	NE[b]	Total	NE[b]	Total	NE[b]	Total
No problems	529	535	36.2%	35.9%	305	305	27.3%	27.1%
Minimal problems	821	838	56.2	56.2	735	741	65.7	65.9
Moderate problems	97	102	6.6	6.8	78	78	7.0	6.9
Severe problems	13	14	0.9	0.9	0	0	0	0
Life-threatening problems	0	0	0	0	0	0	0	0
Dead	2	2	0.1	0.1	0	0	0	0
Total	1,462	1,491	100%	100%	1,118	1,124	100%	100%

[a] Evaluations of morbidity were made by a nurse in attendance to the patient

[b] NE means nonemergency status, as rated by the anesthetist at the time of surgery according to the American Society of Anesthesiologists' definition

SOURCES. Stanford Center for Health Care Research, *Study of the Institutional Differences in Post. Operative Mortality.* 1974, and Stanford Center for Health Care Research, *Impact of Hospital Characteristics on Surgical Outcomes arid Length 01 Stay, 1978*

Long-Term Postoperative Complications

How rapidly hysterectomy patients recover their normal functional level has not been well documented; for elective hysterectomy patients, this information has not even been sought. In a questionnaire given 3 years after their surgery, Richards (66) asked 56 patients undergoing hysterectomies and 56 patients undergoing cholecystectomies, appendectomies, or partial mastectomies how long it took for them to recover fully from surgery. Hysterectomy patients reported an average of 11.9 months, whereas the others reported 3 months. In the Stanford study (72,73), 40 days after surgery, 35.9 percent of abdominal hysterectomy patients and 34.0 percent of vaginal hysterectomy patients reported that they still had some problem related to their operation (see table 6). For each operation, about 30 percent of the problems remaining were categorized by the patients as "minor" problems. For both operations, about 65 percent of patients reported feeling "better" or "much better" than they had been 30 days prior to surgery (see table 7). By way of comparison, 7.4 percent of cholecystectomy and appendectomy patients reported feeling "worse" or "much worse."

Roos and Roos (69), using claims data from the Manitoba National Health Insurance system, have analyzed the pattern of hospital admissions and visits to physicians in 1,075 women during the 12 months before and the 12 months following hysterectomy for all indications. Their study, hereafter referred to as the Manitoba study, is described in appendix A. The data in the Manitoba study are for elective and nonelective hysterectomies, since there was insufficient information in the claims forms to distinguish elective from nonelective hysterectomies, but they do give an idea of the overall effect of hysterectomy on health. Roos and Roos found that in the year following hysterectomy, fewer women were hospitalized (13.4 percent) than in the year preceding hysterectomy (31.1 percent). Additionally, the total number of hospital admissions was reduced from 488 prior to hysterectomy to 191 after (see table 8). These investigators also found that the number of women making one or more visits to hospital outpatient and emergency rooms decreased in the year following hysterectomy (31 percent compared to 24 percent), and that the total number of visits was also reduced (611 compared to 520). Over 90 percent of the women had contact with a physician (office or home visit) in both the year before and the year after hysterectomy, but the number of visits fell from 9,106 in the year before to 7,394 in the year after (see table 9).

Table 6.—Morbidit y and Mortality 40 Days After Hysterectomy: Remaining Health Problems'

Responses to the question, "Do you have any remaining problems related to your operation?"

	Abdominal hysterectomy patients		Vaginal hysterectomy patients	
Response	Number	Percentage	Number	Percentage
None	877	64.2%	675	66.0%
Minor	393	28.8	285	27.9
Moderate	73	5.3	47	4.6
Considerable	19	1.4	15	1.5
Dead	5	0.4	0	0
Total[b]	1,367	100%	1,022	100%

devaluations were responses of patients to questions on a questionnaire.

[b]total number of patients responding to this particular question. Note: 124 abdominal and 102 vaginal hysterectomy patients did not respond or did not return the questionnaire.

SOURCES: Stanford Center for Health Care Research, *Study 01 the Institutional Differences in Post-Operative Mortality, 1974;* and Stanford Center for Health Care Research, *Impact of Hospital Ctraracter/sties on Surgical Outcomes and Length of Stay, 1978.*

Table 7.—Morbidity and Mortality 40 Days After Hysterectomy: Comparative Health Status[a]

Responses to the question, "How does your present health compare to your health status a month before your recent hospitalization?"

	Abdominal hysterectomy patients		Vaginal hysterectomy patients	
Response	Number	Percentage	Number	Percentage
Much better now	342	25.4%	260	25.7%
Better now	537	39.9	392	38.7
About the same	389	28.9	319	31.5
Worse now	59	4.4	31	3.0
Much worse now	14	1.0	11	1.1
Dead	5	0.4	0	0
Total[b]	1,346	100%	1,013	100%

devaluations were responses of patients to questions on a questionnaire.

[b]Total number of patients responding to this particular question. Note: 145 abdominal and 111 vaginal hysterectomy patients did not respond or did not return the questionnaire.

SOURCES: Stanford Center for Health Care Research, *Study of the Institutional Differences in Post-Operative Mortality, 1974;* and Stanford Center for Health Care Research, *Impact of Hospital Characteristics on Surgical Outcomes and Length of Stay, 1978.*

Table 8.—Hospitalizations in the 12 Months Before and 12 Months After Hysterectomy[a]

Number of hospital discharges	12 months before hysterectomy		12 months after hysterectomy	
	Number of women	Percentage of total women	Number of women	Percentage of total women
0	741	68.9%	931	86.6%
1	238	22.1	109	10.1
2	60	5.6	26	2.4
3	21	2.0	6	0.6
4+	15	1.4	3	0.3
Total	1,075	100%	1,075	100%
Total discharges	488		191	

[a]See app. A.

SOURCE: N Roosand L Roos, University of Manitoba, Winnipeg, Manitoba, work in progress, 1979.

Table 9.—Hospital Outpatient and Emergency Room Visits and Physician Office and Home Visits in the 12 Months Before and 12 Months After Hysterectomy

Number of visits	12 months before hysterectomy		12 months after hysterectomy	
	Number of women	Percentage of total women	Number of women	Percentage of total women
Outpatient and emergency room visits				
0	740	68.8%	813	75.6%
1	219	20.4	166	15.4
2	60	5.6	49	4.6
3	29	2.7	22	2.1
4 to 9	23	2.1	21	2.0
10+	4	—	4	—
Physician office and home visits				
0	29	2.7%	79	7.3%
1 to 9	713	66.3	716	66.6
10 to 19	258	24.0	234	21.8
20+	75	7.0	46	4.3
Total outpatient and emergency room visits	611		520	
Total physician office and home visits	9,106		7,394	
Grand total visits	9,717		7,914	

[a]See app. A.

SOURCE: N. Roos and L. Roos, University of Manitoba, Winnipeg, Manitoba, work in progress, 1979

The reasons given most frequently in the Manitoba study for hospitalization prior to surgery were gynecological in nature (e.g., disorders for menstruation, uterine fibroids, and pregnancy-related diagnoses), although urinary tract infections, "neuroses and psychiatric disorders," and gallbladder disease were also frequent (see table 10). In the year following hysterectomy, the number of hospital admissions for most of these indications decreased. While there were fewer physician, outpatient, and emergency room visits for gynecological diagnoses in the year following hysterectomy, there was an increase in visits for urinary tract infections, neuroses and psychiatric disorders, infections and inflammatory conditions of the skin, and menopausal symptoms (see table 11). In addition, "back problems," which is at times given as an indication for hysterectomy, was associated with a small rise in visits (185 to 212) following hysterectomy.

Although the majority of women who have undergone hysterectomy for all indications report that they are glad they had the operation and many report feeling better emotionally (65), some women experience psychological disturbances as a late postoperative complication of hysterectomy. Some women are likely to experience concerns about sexual desire, loss of femi-

Table 10.-Selected Diagnoses Associated With Hospitalizations in the 12 Months Before and 12 Months After Hysterectomy[a]

	12 months before hysterectomy			12 months after hysterectomy		
Diagnosis (ICDA-8)	First diagnosis	Second diagnosis	Third diagnosis	First diagnosis	Second diagnosis	Third diagnosis
Uterine fibroma (218)	24	7	1	0	0	0
Benign neoplasms (219-228)	8	5	1	0	0	0
Neoplasms of unspecified nature (including carcinoma in situ) (234)	26	3	0	0	0	0
Disorders of menstruation (626)	111	27	9	1	0	0
Pregnancy-related diagnoses (632-661)	28	9	2	0	0	0
Anemia (280-285,289)	2	10	12	0	2	1
Neuroses and psychiatric disorders (291-307,780,790)	18	11	6	15	11	7
Diseases of kidney and urinary tract infections (580-599,786,789)	16	12	6	17	4	3
Diseases of parametrium and pelvic peritoneum (616)	14	6	1	6	1	0
Other diseases of uterus, including endometriosis (625)	14	22	4	0	1	
Gallbladder diseases (574-576)	28	1	1	10	0	0
Other miscellaneous diagnoses		199			142	
Total discharges		488			191	

[a]See app. A.

SOURCE: N. Roos and L. Roos, University of Manitoba, Winnipeg, Manitoba, work in progress, 1979

ninity, strength, childbearing ability, and menstruation, or effects on aging, appearance, and lowered self-esteem (2,12,25,29,32,53,61).

Raphael (64) analyzed the literature available on the development of psychological problems subsequent to hysterectomy. In her own interviews of 100 patients, she found that 60 percent of women experienced "postoperative blues" characterized by weeping, sadness, and uncontrolled distress, usually occurring about the fourth to fifth day after hysterectomy, while only 20 percent of women experienced such distress after cholecystectomy. Moore and Tolley (55) found that 32 percent of 47 patients were depressed postoperatively as assessed by a self-rating depression scale. But this postoperative incidence of depression 12 weeks after surgery was the same as preoperative incidence, as measured by the same scale 1 day prior to hysterectomy. Moore and Tolley concluded that those patients who were depressed after the operation were likely to be depressed before surgery because they had had misgivings about the operation.

Barker (7) found that 7 percent of 729 women who had undergone hysterectomy were referred to psychiatrists within a period of 4% years after their surgery. This referral rate was 2½ times the rate expected for a matched group of women in the general population. Eighty percent of the psychiatric referrals occurred within the first 2 years, and psychiatric referral was not associated with premature menopause in this series. Several factors characterized those who were referred for psychiatric care: 1) women undergoing hysterectomy in the absence of pelvic disease were referred for psychiatric care twice as often as those who had had pelvic disease; 2) women who had psychiatric care prior to hysterectomy were 10 times as susceptible to further mental illness postoperatively; and 3) women who had a history of marital disruption were 6 times as likely to be referred for psychiatric care after a hysterectomy.

Depression is a particularly common psychological disturbance following hysterectomy. Richards (66) in England surveyed 112 patients, half of whom underwent hysterectomies, the other half of whom received other operations. Data were collected between 1966 and 1969 from a four-partner group practice that included Richards. Patients were surveyed retrospective-

1 The other operations compared were cholecystectomies, appendectomies, and partial mastectomies.

Table 1 I.–Selected Diagnoses Associated With Hospital Outpatient and Emergency Room Visits and Physician Office and Home Visits in the 12 Months Before and 12 Months After Hysterectomy'

Diagnosis (ICDA-8) associated with primary indication for surgery	Number of visits: 12 months before hysterectomy	Number of visits: 12 months after hysterectomy
Uterine fibroma (218)	409	3
Benign neoplasms and those of unspecified nature (including carcinoma in situ) (219-221,234)	108	12
Salpingitis and oöphoritis (612-615)	45	3
Diseases of parametrium and pelvic peritoneum (616)	158	43
Infective and other diseases of the uterus (620-62,625)	325	202
Uterovaginal prolapse (623)	270	21
Disturbances of menstruation (626)	1,161	20
Other diseases of female genital organs (629)	185	113
Anemia (280-285,289)	226	127
Diseases of kidney and urinary tract infections (580-599,786,789)	430	523
Menopausal symptoms (627)	235	355
Neuroses, psychiatric disorders (291-307,780,790)	675	837
Infections of skin and subcutaneous tissues (680-686)	46	89
Other inflammatory conditions of skin (690-698)	140	206
Miscellaneous other diagnoses	5,304	5,354
Total visits	9,717	7,908

'See app A

SOURCE N Roos and L Roos. University of Manitoba, Winnipeg, Manitoba, work in progress, 1979

ly as to whether in the 3 years after their hysterectomies they had experienced any of a list of symptoms common for posthysterectomy patients seeking psychiatric treatment. The results showed that depression, both treated with antidepressive drugs and untreated, was more common in the hysterectomy group (70 percent) than in the control group of women who had had other surgical procedures (30 percent). The average duration of depression, both treated and untreated, was reported to be longer for the hysterectomy group (12.9 months for treated and 8.5 months for untreated patients) when compared with the controls (4.2 and 5.9 months, respectively). Six percent of the hysterectomy patients were admitted to mental hospitals. Richards also found that hysterectomy patients were more likely to have manifested preoperative depression. When he excluded all patients in both groups who had had preoperative depression, the occurrence of postoperative depression was still more frequent in hysterectomy patients (33 percent of 36 patients) than in the controls (14 percent of 44 patients).

In the Manitoba study (69), it was reported that there was an increase in overall patient visits to physicians for "neuroses and psychiatric disorders" from 675 in the year prior to hysterectomy to 837 in the following year (see table 11). Most of this increase was accounted for by women in the 20- to 39-year-old age group, particularly those who underwent oöphorectomy (removal of the ovaries) (see table 12). There was also an increase in the number of visits to psychiatrists from 103 in the year prior to surgery to 139 in the following year. (Comparable data for women undergoing cholecystectomy are being compiled; see app. A.)

To what extent are these posthysterectomy changes physiological? There is a specialized blood supply between the ovary and uterus such that the ovary can be exposed to substances leaving the uterus. To what extent ovarian function is actually influenced by uterine function is not known and has apparently been little studied. Richards (66) found that 61 percent of women under 45 years of age (19 patients) who had **a** hysterectomy, but in whom one or both ovaries were preserved, had hot flashes, 1[4] a symptom generally considered to indicate an impaired estrogen supply. Only 20 percent of the control patients under 45 years of age receiving other operations (29 patients) reported hot flashes. In the Manitoba study (69), there was a 39-percent increase in age-adjusted incidence of ambulatory visits to physicians' offices for menopausal symptoms within 1 year after abdominal hysterectomy in women whose ovaries were kept intact (see table 13). In patients who had undergone oöphorectomy at the time of hysterectomy, there was an 85-percent increase in ambulatory visits. A large part of the increase in visits for menopausal symptoms, both with and without removal of the ovaries was accounted for by women in the 20- to 39-year-old age group (see table 12).

[4]In the same series, 12 out of 17, or 71 percent, of patients losing both ovaries in the same period experienced hot flashes.

Table 12.—Visits for Neuroses and Psychiatric Disorders and for Menopausal Symptoms in the 12 Months Before and 12 Months After Hysterectomy, By Type of Operation and Age of Patient*

	Number of visits by abdominal hysterectomy patients												Number of visits by vaginal hysterectomy patients					
	With oöphorectomy						Without oöphorectomy						Without oöphorectomy					
	20-39		40-49		50+		20-39		40-49		50+		20-39		40-49		50+	
Diagnosis (ICDA-8)	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Neuroses and psychiatric disorders (291-307,760,790)	49	121	101	122	62	56	143	173	166	151	31	76	50	49	43	43	29	42
Menopausal symptoms	1	46	43	86	67	59	5	17	61	78	24	32	0	2	16	15	18	20
Number of women	99		162		138		154		192		74		59		67		120	

B =12 months before hysterectomy; A= 12 months after hysterectomy.
[a]See app. A.

SOURCE: N. Roos and L. Roos, University of Manitoba, Winnipeg, Manitoba, work in progress, 1979.

Table 13.--Age- Adjusted Rates for Visits for Menopausal Symptoms in the 12 Months Before and 12 Months After Hysterectomy

	Number of visits by abdominal hysterectomy patients		Number of visits by vaginal hysterectomy patients
	With oöphorectomy	Without oöphorectomy	Without oöphorectomy
12 months before hysterectomy	278.6	254.2	152.1
12 months after hysterectomy	515.4	352.6	161.9
Percentage increase	85%	38.7%	6.4%

[a]See app. A.

SOURCE: N. Roos and L. Roos, University of Manitoba, Winnipeg, Manitoba, work in progress, 1979.

COMPARISON OF HEALTH RISKS OF HYSTERECTOMY WITH THOSE OF TUBAL LIGATION

The alternative to hysterectomy for sterilization of a woman is tubal ligation. In 1975-76, 394,000 tubal ligations were performed at a rate of 360 per 100,000 females (57). There are three prevalent types of tubal ligations performed: 1) abdominal (most frequently by the Pomeroy technique), 2) vaginal, and 3) endoscopic (most frequently by laparoscopic techniques).[15] As can vaginal and abdominal hysterectomies, these techniques can be applied for sterilization at the time of abortion, at the time of delivery, or when the patient is not pregnant.

Death rarely occurs with tubal ligations. A mortality rate of 2 per 10,000 women (0.02 percent) was reported by CPHA for 1,592 Professional Activity Study hospitals in 1972-73 (22). Reviews of combined studies indicate mortality rates between 0.0025 percent (laparoscopic tubal ligation only) (39), and 0.02 percent (60). Thus, the risk of death from tubal ligation is substantially less than that estimated above for a healthy 35-year-old woman undergoing elective hysterectomy (0.05 to 0.10 percent). The risk of death from tubal ligation is estimated to be less than 5 to 10 percent of the risk of death from subsequent pregnancy in women 25 to 35 years old and 10 to 20 percent of the risk of death from pregnancy in women 35 to 40 years old (75).

Morbidity reportedly occurs in far fewer patients with tubal ligations than with hysterectomies. Serious complications have been reported in one study to occur in about 4.2 per-

[15]Laparoscopic tubal ligation is the technique associated with fewest medical risks overall, but this technique requires expensive equipment and specially trained gynecologists.

cent of abdominal tubal ligations and 2.6 percent of vaginal tubal ligations (62). In the same study, 8.0 percent of vaginal hysterectomies were associated with serious complications. Serious complications after laparoscopic tubal ligations were reported in another study to occur in 1.7 percent of the patients (85). Postoperative fevers persisted in only 1.5 percent of laparoscopic tubal ligation patients and 20.7 percent of abdominal tubal ligation patients, as compared with 42.7 percent of patients sterilized by vaginal hysterectomy and 45.2 percent of those sterilized by abdominal hysterectomy (45). No morbidity was recorded for 91.6 percent of laparoscopic tubal ligation patients, as compared with 47.1 percent of abdominal tubal ligation patients and 20.4 percent and 16.1 percent for vaginal and abdominal hysterectomy patients, respectively (45). Transfusions were not needed for abdominal, vaginal, or laparoscopic tubal ligations, but were administered in 13.4 percent of vaginal hysterectomies (44). The average postoperative hospital length of stay reported was 2 to 3 days for laparoscopic and vaginal tubal ligations (44,45,60). For abdominal tubal ligation, the average postoperative length of stay has been variously measured as 8.54 days (45) and 4 to 6 days (44). Average postoperative lengths of stay for vaginal and abdominal hysterectomies in the same studies were 8.52 and 10.2 days (45), and 8.6 and 8.4 days (44).

Psychological sequelae of tubal ligations have not been reported to occur as frequently or to be as severe as sequelae of hysterectomies. Regret at having been sterilized[16] was reported more often than depression, and then among only 1 to 4 percent of women (9,19,27,43,49,74). Younger patients and socioeconomically disadvantaged patients are more likely to express regret over the decision (19,43).

Despite higher risks of postoperative complications, two benefits of hysterectomy are commonly given for preferring hysterectomy over tubal ligations as a means for sterilization: 1) hysterectomies are 100-percent effective in preventing conception; and 2) they remove the chance of future uterine/cervical disease. The conception rate after tubal ligation is about 0.3 to 2 percent depending on the technique of tubal ligation (71). Furthermore, a portion of these pregnancies appear to be ectopic (out of normal position), generally necessitating further surgery (39). Gynecologic disease subsequent to tubal ligation develops in 24 to 40 percent of women in 3 to 10 years after surgery, and 13 to 19 percent result in hysterectomies in the same period (39,56). However, the original studies lacked sufficient controls to be able to determine whether or not the women had a higher incidence of gynecologic disease than would be expected. Women who have had hysterectomies can still develop certain gynecologic diseases (see Manitoba study, app. A). Nevertheless, women sterilized with tubal ligations do have a risk of pregnancy and uterine disease. Women who have undergone hysterectomy do not have these risks.

[16]The belief that sterilization by tubal ligation is potentially reversible, as opposed to sterilization by hysterectomy, may reduce the psychological impact of sterilization on **some women, and may make the increased risk of conception** more acceptable to some women.

COMPARISON OF HEALTH RISKS OF HYSTERECTOMY WITH THOSE OF FUTURE CANCER

Of all deaths in women 15 years old and over, cancer of the cervix accounts for approximately 0.72 percent; cancer of the endometrium, 0.68 percent; and cancer of the ovary, 1.24 percent (58). Removal of the normal uterus by total hysterectomy can be assumed to preclude the possibility of future cancer of the cervix or the endometrium—and the resultant average increase in life expectancy is substantial, about 2½ months for a 35-year-old woman (21). Only those 1.4 percent of women who would have later succumbed to cancer of the cervix or en-

dometrium actually receive this benefit; for them, the average increase in life expectancy is 14.3 years (or, perhaps more correctly, for them, a decrease in life expectancy of 14.3 years is prevented) (21).

In achieving these benefits, the patient takes the risks of undergoing hysterectomy. The overall mortality rate for all hysterectomies is about 0.17 percent, but in a 35-year-old woman in good physical condition, the risk of death is smaller, estimated to be somewhere between 0.05 to 0.10 percent, or the equivalent of 1 or 2 weeks of life expectancy (21). Thus, the average loss in life expectancy in a good-risk 35-year-old woman undergoing hysterectomy is smaller than the average gain. However, the women who die at the time of surgery immediately lose remaining years of life, whereas the gain in life expectancy for the women who without the elective surgery would have died of cancer occurs at some indefinite time in the future. Furthermore, for an older woman or a woman in worse physical condition, there may be a considerably increased risk in anesthesia and surgery, further lessening the apparent advantage of elective surgery (16). Whether an individual patient considers the potential gains of elective hysterectomy to be worth accepting the risks is a highly personal matter which can be resolved only by the patient herself. However, there are some data to suggest that many patients may be averse to accepting immediate risks in order to gain uncertain benefits sometime in the future (52).

In attempting to assess hysterectomy as cancer prevention, a comparison should be made with optimal, nonsurgical gynecological care rather than with no care or average care. Prompt response to early symptoms and signs of cervical and fundal malignancy, followed by appropriate treatment (hysterectomy, radiotherapy, ionization of the cervix, or a combination), is believed to result in a high cure rate, although reliable data are not available (34). It is assumed, however, that regular examination, early diagnosis, and prompt treatment can appreciably reduce the risk of death, perhaps by as much as 75 to 80 percent for fundal cancer (67). If this assumption is correct, the apparent advantage of hysterectomy in preventing cancer of the cervix or endometrium may largely disappear.

It is important to acknowledge that socioeconomically disadvantaged women, who are at high risk of developing cervical cancer, are less likely than others to seek routine medical services. Some of the added risk of cervical cancer is offset by the finding that endometrial cancer primarily affects middle- and upper-income women (21). But the combined cancer mortality risk of disadvantaged women is 1.5 to 2.0 times greater than the average for all women (21). We have noted above that some physicians consider hysterectomy the treatment of choice for disadvantaged women, because such women have a greater risk of malignancy and are less likely to seek medical care. An argument of equal or greater validity is that the routine gynecological care of such women should be improved. The relative costs of these two alternatives are explored in the next part of this case study.

Removal of normal ovaries at the time of hysterectomy prevents future cancer of the ovaries in the 1 percent of women who otherwise might have died of this disease. Combining this effect with prevention of uterine cancer by hysterectomy, elective total hysterectomy and oophorectomy in a 45-year-old woman will result in an average gain in life of 13.9 years for the 2.3 percent of women saved (21).[17] This assumes that hormonal replacement therapy does not increase the chance of developing a malignancy of any remaining organ (e.g., breast, liver).

In contrast to cancer of the cervix, there is no method of screening to allow early diagnosis of cancer of the ovary.[18] Prophylactic removal of normal ovaries at the time of hysterectomy might therefore seem a worthwhile life-prolonging measure. However, some or all of this advantage may be offset by the possibility that metabolic and endocrine disturbances may de-

[17] Rather than 14.3 years, 13.9 years are saved, because the operation is carried out with the patient at an older age

[18] When an ovarian mass is found or suspected, ultrasound may be effective in distinguishing large solid tumors (which are apt to be malignant) from ovarian cysts (which are usually benign). Ultrasound is not useful in detecting small, early malignancies.

velop if oöphorectomy is performed, and there is no assurance that the customary estrogen replacement would reverse these changes. As Cole has pointed out, a small increase in the incidence of atherosclerotic heart disease, which might result from loss of ovarian function, could offset any potential gain in life expectancy from cancer prevention (17).

QUANTITATIVE EVALUATION OF RISKS, COSTS, AND BENEFITS OF ELECTIVE HYSTERECTOMY

The findings of four studies that have attempted to evaluate the cost effectiveness of elective hysterectomy in prolonging life (16, 21,24,40) are summarized below. Also summarized are the initial findings of a new analysis undertaken by the authors of this case study. The model and the data that we used in that analysis are described more fully in appendix B.

The Health Risks and Costs of Hysterectomy

As discussed in the previous part of this case study, the removal of a normal uterus eliminates the risk of future endometrial and cervical cancers, but at the same time subjects the patient to the small but significant risk of surgical mortality. Cole and Berlin (21) estimated the net effect of these two factors on patient survival by the use of a simple probabilistic model. For the sake of illustration, they postulated a population of 1 million 35-year-old women for whom a policy decision was to be made: Should the entire female population undergo elective hysterectomy to prevent the development of endometrial and cervical cancers? Or should it instead receive routine gynecologic care? Under the second option, some women would eventually succumb to uterine disease.

The premise of Cole and Berlin's analysis is that the net benefits of elective hysterectomy are defined by the difference in mortality rates under the two alternatives. The authors concluded that the benefits of elective hysterectomy, in terms of patient mortality, would equal roughly 182,000 woman-years of added life for the hypothetical population. This number was translated into an economic value and compared to an estimate of the net cost of hysterectomies for 1 million women (see table **14).** From their calculations, Cole and Berlin concluded that the present value of costs of hysterectomy over benefits, discounted at **6** percent, is **$12,800** per woman-year of added life.

Table 14.—Estimated Lifetime Savings and Costs of Elective Hysterectomy for 1 Million Women
(in millions of dollars)

Savings	
Medical care for cancer[a]	$ 331
Gynecologic procedures	300
Pap smears[c]	226
Contraceptives[d]	270
Menstrual preparations	170
Down's syndrome[f]	120
Total	$1,417
costs	
1 million hysterectomies	$2,600
Related expenses[g]	300
Total	$2,900

[a] 34,800 cases prevented; 50 percent "cured" at $4.000 each; 50 percent "not cured'" at $15.000 each
[b] Lifetime gynecologic care, uterus-related, estimated at $300 Per woman
[c] Annually for 45 percent of women at $12 per smear.
[d] Oral contraceptives for 50 percent of women for 15 years at $36 per year.
[e] $10 per year per woman for 17 years.
[f] 600 affected births prevented; half the cases would be institutionalized at $8.000 per year for an average of 50 years.
[g] Wages lost for 4 weeks at $150 per week for 25 percent of women; child-care expenses estimated for 4 weeks at $75 per week for 50 percent of women.

SOURCE: P. Cole and J. Berlin, "Elective Hysterectomy," *Obstet Gynecol* 129:1 17, 1977.

The analysis presented by Cole and Berlin is subject to at least four criticisms. First, as noted by the authors themselves, the presence of competing causes of death was ignored. The authors assumed that a patient freed of the risk of one type of cancer would not be subject to a disproportionately higher risk of death from some other cause. [19] However, it is possible that eliminating one type of cancer results in an increased risk of another fatal disease, so the analysis by Cole and Berlin may have overestimated the benefits of prophylactic surgery.

[19] It should be noted that all four quantitative analyses of hysterectomy y found in the literature employ this same assumption.

A second objection to the analysis by Cole and Berlin is the subjective nature of the cost estimates. The authors provided little empirical support for the cost values they used. Taken as a whole, their estimates appear reasonable, but their estimate of $300 per woman for a lifetime of uterine-related gynecological "procedures" seems very low. Cole and Berlin estimated the savings for those who had undergone hysterectomy in terms of avoided menstrual and contraceptive costs, but did not consider costs of unwanted pregnancies, abortions, or tubal ligations should contraceptives fail. The total cost of uterine-related care foregone in hysterectomy patients was estimated to be only $1,417. By contrast, Jackson, et al. (40) reported average lifetime costs for uterine-related care for a 35-year-old woman in King County, Wash., to be $2,350 (1974 dollars, not discounted) excluding costs of contraception and pregnancy.

We question the inclusion under cost savings by Cole and Berlin of an estimated 600 children with Down's syndrome who would be born to the women not having hysterectomies at age 35. Such inclusion assumes that women who elect hysterectomies for cancer prophylaxis would have had the same birth rate as women in general. It seems reasonable to assume, to the contrary, that women who elect hysterectomies for cancer prophylaxis would be more likely than others to take advantage of tubal ligations, amniocentesis, contraceptives, and abortions, and would therefore be less likely to bear children afflicted with Down's syndrome.

Finally, the conclusions of Cole and Berlin apply to a typical woman facing the average risk of cancer by the Nation as a whole. The actual decision concerning a specific patient would be based on risks confronting that particular woman. Although Cole and Berlin address the role of elective hysterectomy for the entire female population and for an average 35-year-old woman, they do not address the role of hysterectomy for specific subgroups of women for whom the relative risks and benefits of hysterectomy might be quite different. The risks and benefits for subgroups are discussed in a separate section of this case study below.

Bunker, et al. (16) analyzed the effect of elective hysterectomy and oophorectomy on life expectancy of premenopausal women. Like Cole and Berlin, these analysts assumed that the surgical removal of the normal uterus and ovaries precluded the subsequent development of cancer at those sites and prevented the associated loss of life expectancy. Unlike Cole and Berlin, however, they adjusted the risk of surgical mortality to reflect the characteristics of the patient. Bunker, et al., concluded that the increased life expectancy with hysterectomy and oöphorectomy was small, amounting to 14 days for a 40-year-old woman in good general health. For a so-year-old woman suffering from moderately severe hypertension, elective hysterectomy was estimated to result in a loss of life expectancy of 60 days.

The Effect of Hysterectomy on Direct Costs for Medical Care

Jackson, et al. (40) reported an empirical study of the direct costs of medical care with and without elective hysterectomy. They based their findings on the actual medical care provided to women for uterine-related diseases by a comprehensive health care facility. Arguing that expenditures for such diseases could have been avoided had the woman undergone hysterectomy, they computed that the present value of savings resulting from the procedure at age 30 would amount to between $1,240 and $1,822, depending on the discount rate (see table 15). These savings were compared to the average cost of hysterectomy for 22 women, which was found to be $1,637. Thus, Jackson and his colleagues concluded that the net savings in direct costs resulting from elective hysterectomy is at most $185 per woman and decreases as the discount rate is increased. If the age of recommended elective hysterectomy is raised to 35 or above, the net dollar benefit of elective hysterectomy disappears at all discount rates.

The study by Jackson and his collaborators is an important contribution to our understanding of the role of hysterectomy in that it reported observed costs of patient care. The generalizability of the results of this study can be ques-

Table 15.—Lifetime Savings and Costs of Elective Hysterectomy

Outpatient cost data

Age	Period 1 costs (6/71-6/73) 1972 dollars	Period 1 costs (6/71-6/73) Adjusted to 1974 dollars	Period 2 costs (7/73-2/75)	Total outpatient costs	Patient years of exposure	Average annual outpatient cost per woman (in rounded dollars)
30-34	$7.363	$8,320	$4,496	$12,816	349	$37
35-39	*4,098*	*4,631*	*5,226*	*9,857*	*252*	*39*
40-44	*2,276*	*2,572*	*4,807*	*7,379*	*200*	*37*
45-49	*6,194*	*6,999*	*3,187*	10,186	230	44
50-54	4,345	4,910	2,631	7,541	191	39
55-59	1,629	1,841	1,222	3,063	139	22
60-65	707	799	696	1,495	160	9

Inpatient cost data

Age	Period 1 costs (6/71-6/73) 1972 dollars	Period 1 costs (6/71-6/73) Adjusted to 1974 dollars	Period 2 costs 7/73-2/75	Total inpatient costs	Patient years of exposure	Average annual inpatient cost per woman
30-34	$6,157	$7,142	$6,790	$13,932	349	$40
35-39	8,673	10,061	4,787	14,848	252	59
40-44	3,050	3,538	6,019	9,557	200	48
45-49, ...	13,903	16,127	4,111	20,238	230	88
50-54	2,992	3,471	1,308	4,779	191	25
55-59	3,924	4,552	283	4,835	139	35
60-65	1,887	2,189	1,778	3,967	160	25

Exposure and expenditure data from the Prepaid Health Care Project

- Age	Calculated total woman years of exposure	Annualized average expected expenditure per woman (in rounded dollars) for uterine-related diagnoses: Outpatient costs	Inpatient costs	Total costs	Total amount of projected expenditures undiscounted	Present value of total cost for each age interval at 6.5% interest	Present value of total cost for each age interval at 3% interest
30-34	349	$37	$40	$ 7 7	$ 385	$ 341	$ 363
35-39	252	39	59	98	490	317	399
40-44	200	37	48	85	425	200	299
45-49	230	44	88	132	660	227	400
50-54	191	39	25	64	320	80	167
55-59	139	22	35	57	285	52	128
60-64	160	9	25	34	170	23	66
Total projected expenditure (direct costs).					$2,735 Undiscounted	$1,240 Discounted at 6.5%	$1,822 Discounted at 3%

SOURCE: M. N. Jackson, et al., "Elective Hysterectomy: A Cost-Benefit Analysis," *Inquiry* 15:275, 1978.

tioned, however, because of the institutional characteristics of the prepaid health plan from which cost figures were derived. Costs incurred as the result of pregnancy, abortion, contraception, or associated morbidity were not included, because it was assumed that women electing hysterectomies would not plan further pregnancies, and reportedly only 17 percent of women in the United States had unplanned pregnancies after the age of 35. However, the assumption that women not undergoing hysterectomy received 100-percent" effective contraception at no cost underestimates their costs.

Furthermore, the results reported by Jackson, et al., apply to a general population of women and not to specific individuals characterized by various levels of risk. For example, a physician might be able to stratify women into groups according to the risk of uterine prolapse, one of

the uterine diseases considered in the study. If women at high risk of endometrial or cervical cancers received hysterectomies immediately, and surgery was deferred until indicated for patients in low-risk groups, savings would have been increased.

Quantitative Analysis Comparing Hysterectomy With Tubal Ligation

Deane and Ulene (24), in their analysis, compared both the expected cost (including lost earnings) and life expectancy associated with tubal ligation and hysterectomy. Deane and Ulene assumed that a woman is confronted with two alternatives: 1) hysterectomy, or 2) tubal ligation with hysterectomy deferred until medically indicated. Thus, a woman choosing tubal ligation who subsequently needs hysterectomy is exposed to the risk of uterine cancers only until the organ is removed. By adjusting the incidence of uterine cancers to reflect the chances of subsequently undergoing hysterectomy, these analysts were able to model the effect of nonmalignant uterine diseases on the relative merits of tubal ligation and elective hysterectomy.

Deane and Ulene reported unusually small differences in life expectancy for the two alternatives. A 20-year-old woman, on the average, would lose 1.88 days if she were to choose tubal ligation over hysterectomy. This loss in life expectancy decreased if future time was discounted. The direct costs for each surgical procedure included average hospital and surgical fees, but assumed no complications generating further costs. Indirect costs included an estimation of lost earnings during recovery, and the authors estimated that 53 days was an average leave of absence from work for recovery after hysterectomy and 39 days was the average time required after tubal ligation. These estimates, especially compared to likely recovery times from laparoscopic tubal ligation, are surprisingly high. A "mean daily earning" was determined as a function of age for all women 20 to 79 years of age. The author's inclusion of women over 65 in their study of women likely to be candidates for elective hysterectomy is a highly questionable maneuver, since, in practice, the age of such women alone excludes them as candidates for purely elective surgery. Furthermore, since women over 65, on the whole, are not likely to be earning wages, their inclusion dilutes the economic value of women. Deane and Ulene did not attempt to evaluate wages for housework, cooking, and childcare.

Indirect costs for tubal ligation patients included by Deane and Ulene were the estimated lost earnings resulting from menstrual irregularities developed, or surgical and hospital expenses and lost earnings from a subsequent hysterectomy if endometrial or cervical cancer developed, or if a dilatation and curretage for bleeding irregularities was needed. The hospital, surgical costs, and lost earnings of tubal ligation patients developing uterine cancer were also included as costs. Further indirect costs after tubal ligation included an adjustment based on the assumption that all pregnancies after failed tubal ligations occurred in the second year after tubal ligation and all patients received an abortion and a second, effective tubal ligation.

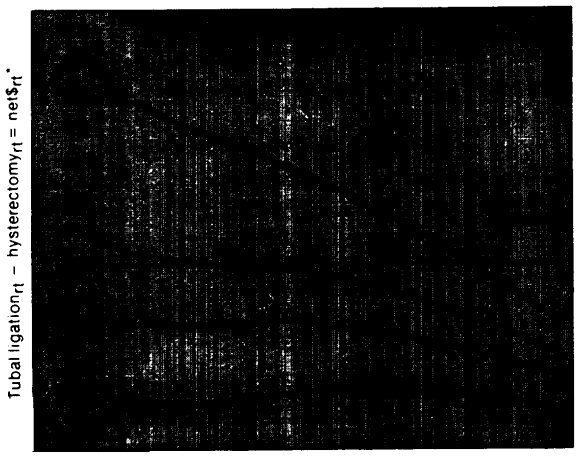
Differences in expected cost, Deane and Ulene found, ranged up to about $500, depending on the age of the woman and the discount rate (see fig. 2). In general, a comparison of cost and life expectancy indicated that hysterectomy was preferable in younger women at lower discount rates. Conversely, tubal ligation was slightly preferable at higher discount rates when the woman was older.

The quantitative results obtained by Deane and Ulene may be questioned because of the data assumptions used in their model. Nevertheless, these analysts have made a significant contribution by modeling the complex interactions involved in the comparison of hysterectomy with an alternative. Perhaps further review of the literature or future empirical studies will generate more accurate estimates for the variables used in their model.

The Role of Elective Hysterectomy in Subgroups

While differing somewhat in approach, the four studies discussed above (16, 21, 24, 40) all support similar conclusions. The consensus is that, for the average woman, elective hysterec-

Figure 2.—Net Cost Differences Between Tubal Ligation and Hysterectomy on the Basis of Mean "All Female" Earnings, By Age at Operation and Selected Discount Rates



"Present value of the cost of a hysterectomy performed at age t and discounted al rate r

SOURCE: R T Deane and A Ulene, "Hysterectomy or Tubal Ligation for Sterilization: A Cost Effectiveness Analysis," *Inquiry* 14:73,1977

tomy does not contribute importantly to either life expectancy or the cost of subsequent medical care. Therefore, the appropriateness of elective hysterectomy would appear to depend upon the other factors involved in the decision to undergo an elective hysterectomy. These factors might be referred to as the "quality of life." If it is true that the role of hysterectomy is most dependent on these less tangible risks and benefits, then the development of a good general policy to maximize benefits and minimize risks and costs is in doubt."

What has not been adequately explained is whether subgroups of women might clearly benefit from either elective hysterectomy or its alternatives. As previously noted, low socioeconomic background has been observed to be a risk factor for cervical cancer. Furthermore, low-income women tend to have less access to regular medical care, implying that when cancer develops in these women, it is likely to be detected at later stages with lower survival rates. For these reasons, it has been suggested that hysterectomy has additional benefits as a means of sterilization for low-income women.

[20]Department of Health and Human Services regulations of sterilization practices prohibit payment for hysterectomy as a means of sterilization.

Conversely, women who undergo routine gynecological care are likely to have potential malignancies detected at stages when response to therapy is apt to be favorable. It might follow, therefore, that this group of women would benefit more from tubal ligation and less from elective hysterectomy.

In order to examine the assertion that certain subgroups of women will clearly benefit either from hysterectomy or one of its alternatives, the authors of this case study undertook an analysis of their own. In the remainder of this section, we will discuss the general features of the approach that we used and the conclusions that we reached. The model and the data it incorporated are described more fully in appendix B.

The following scenario was used as a vehicle for our analysis. A 35-year-old woman in good health and without any apparent uterine malignancy desires sterilization. Two alternatives are available: 1) hysterectomy, or 2) tubal ligation by the Pomeroy technique. If a pregnancy occurs subsequent to tubal ligation, then the woman will undergo abortion and a repeat of the same sterilization procedure. If any uterine cancer, including cervical cancer in situ, is detected later in life, then the woman will undergo hysterectomy as part of her therapy. The woman will also undergo hysterectomy if indicated for nonmalignant conditions such as uterine prolapse. The incidence of these indications for hysterectomy will be equal to their incidence in women of similar age.

Clearly, alternatives to hysterectomy other than tubal ligation are available to the woman who desires sterilization. For the purposes of this analysis, however, we felt that tubal ligation most closely matched hysterectomy. Admittedly, not every aspect of our scenario is completely representative. Some women might object to abortion in the event of pregnancy. Laparoscopic tubal ligation is becoming more commonplace, with lower mortality risks. Furthermore, hysterectomy is not always the preferred treatment of uterine cancers. Nevertheless, omission of these alternatives was found to contribute little to the final conclusions; at the same time, it greatly reduced the complexity of the analysis.

Given a specific scenario such as that outlined above, it is possible to estimate the probability of death at a particular age for either of the two alternatives. In the event of elective hysterectomy, it was assumed that the woman would either die immediately as a result of the procedure, or that her survival would match the national average for women, excluding death from uterine diseases. Estimating the survival function for women undergoing tubal ligation was far more complex. The analysis incorporated the age-specific incidence for various stages of uterine cancers, survival after diagnosis for each stage of cancer,[21] the frequency of hysterectomy for nonmalignant uterine diseases, and the age-specific incidence for nonuterine-related causes of death.

The model estimated that for the average 35-year-old woman, hysterectomy would result in an increase of life expectancy of 0.3 year over tubal ligation. It also estimated that the expected direct medical costs for a woman undergoing hysterectomy would be $84 less than the costs for tubal ligation. This cost difference is in agreement with the estimates by Deane and Ulene (24). The survival difference is considerably larger than that reported by Deane and Ulene, but agrees quite closely with the values reported by the other three studies cited above (16,21,40).

We do not believe that giving equal weight to costs and life in the future and to costs and life today (as we do in the previous paragraph) properly reflects the perception of differences between the alternatives. Given the real interest rate (monetary interest rate minus inflation rate), it is clear that future monetary costs should be discounted to their present values. A similar argument can be applied to future years of life. A rational individual will pay a price to avoid a risk of death. If the risk is small, then the maximum price an individual would pay to avoid the risk would also be small. If the risk is large, then the maximum price would also be large. Therefore, a risk of death in the future can be approximated by an equivalent future monetary cost. Since it can also be argued that a rational individual will decrease the amount she is willing to pay to avoid death depending on how remote in time the chance of death is, it follows that life expectancy should be computed by discounting future years.

The difference in life expectancy and direct costs for various interest rates are as follows:

Hysterectomy minus *tubal ligation*

Real interest rate	*Life expectancy*	*Direct cost*
0%	0.3 year	–$ 84
1	0.2 year	– 41
2	0.2 year	4
3	0.1 year	46
4	0.1 year	82
5	0.1 year	114

The trend is expected. Hysterectomy involves a higher initial cost than tubal ligation, but offers the potential of savings in the future. Therefore, as the rate at which the future is discounted increases, the cost given hysterectomy increases relative to the cost given tubal ligation. Conversely, hysterectomy implies a high risk initially with a reduction in risk later in life. Therefore, life expectancy with hysterectomy decreases relative to life expectancy with tubal ligation, as the discount rate increases.

The goal of our analysis was to determine if, women with different risks of developing uterine cancers or with varying levels of access to care would alter the comparison of hysterectomy and tubal ligation. We focused on cervical cancer, although our analysis could be varied to include endometrial cancer. We asked what is the relative risk of high-risk women compared to low-risk women in regard to cervical cancer? Barron and Richart (11) identified relative risk ratios of 2.0 for subsets of women in their study population. Therefore, in order to approximate the age-specific incidence for a high-risk woman, we doubled the values used in the initial calculations. Admittedly, this approximation ignored any shift to lower age groups for cancer in high-risk women. At a real interest rate of 2 percent, the result of this higher cancer risk was to decrease the life expectancy of patients undergoing tubal ligation by 0.2 year and to increase the expected cost by $80. Therefore, our analysis predicted that a high-risk woman who underwent hysterectomy at age 35 would

[21] This term was not included in any of the previously published analyses.

increase her life expectancy by 0.4 year and decrease the expected cost for her medical care by $76. Our analysis assumed that any increase in noncancer risk associated with an increase in cervical cancer risk would balance between the two alternatives.

Finally, the effect of intensive screening on the comparison was approximated by assuming that half of the cancer currently detected in late stages would be detected in stage I by more frequent testing. Otherwise, the age-specific incidence was left equal to the rates observed in the general population. It **was** assumed that the intensive screening added $20 per year to a woman's gynecologic care (prior to undergoing hysterectomy). Our analysis predicted that hysterectomy would still increase life expectancy by 0.2 year. Hysterectomy would increase expected cost by about $19. Again these values were computed by discounting the future at 2 percent per year.

The conclusion that can be drawn from our analysis is that changes in the risk of cancer or access to care probably do not change the comparison of hysterectomy and tubal ligation appreciably. For example, the higher risk of cancer increases the life expectancy differences; however, the change was approximately the same as differences between hysterectomy and tubal ligation at more typical cancer risks. The shifts in expected costs were as expected; however, the magnitudes were probably smaller than the errors in the analysis. Thus, if hysterectomy and tubal ligation were equivalent methods of sterilization for the population as a whole, the same equivalence would apply to an identifiable subpopulation as well.

CONCLUSIONS AND RECOMMENDATIONS

Evidence has been cited previously that an estimated 30 percent of hysterectomies currently being performed in the United States today can be considered "elective," in the sense that sterilization or prevention of endometrial and cervical cancers or other nonmedical indications dominate the decision for a woman to undergo a hysterectomy. In view of the costs in morbidity &d mortality that are associated with hysterectomy, such utilization practices are worthy of careful scrutiny. Furthermore, with the goals of lowering the dollar costs of health care to both society and the individual, elective hysterectomies could be discouraged without lowering the quality of health care. For these reasons, cost analyses of the risks and benefits of elective hysterectomies are important. Such analyses, as described above, have been undertaken by four different groups (16, 21,24, 40).

None of the quantitative analyses of risks, costs, and benefits of hysterectomies has found hysterectomies to be cost effective for sterilization or prevention of uterine cancer. The cost and risk differences between elective hysterectomy and tubal ligation are so small that the cost-effective decision depends on factors not entered into the analyses. This finding results largely because the majority of costs and mortality and morbidity risks of hysterectomy occur in the present, whereas the majority of savings and benefits occur when uterine diseases are avoided in the relatively distant future. If risks and savings are discounted, even at very low rates of 2 to 3 percent, any monetary savings or increased life expectancy achieved by hysterectomy becomes offset by the monetary costs and immediate health risks of the operation.

Published studies of costs, risks, and benefits of hysterectomy share a number of limitations. For instance, all of the studies have used mortality and morbidity costs measured or estimated from studies of ***all*** hysterectomies. Data are needed on actual risks of hysterectomy in the absence of serious uterine disease or clear medical indication. Of special concern is the apparent increase in frequency of psychological sequelae following hysterectomy. (In one study of psychiatric complications after hysterectomy, women with no prior pelvic disease were referred for psychiatric care twice as often as women with pelvic disease.

The cost analyses of published studies have also lacked reliable data on postoperative recovery, e.g., how long a period of time is needed to return to the workplace or domiciliary duties. Furthermore, no study of costs of hysterectomy has attempted to deal with the special considerations of the value of women's lives in respect to lost earnings for work done in the home and in the care of children.

None of the published studies has included costs of surgical complications, except insofar as average surgical fees for hysterectomy, average daily hospital charges, and estimated average recovery time reflect costs of complications. Such complications may require, for example, additional surgical repair procedures, treatment of urinary tract infections, and psychiatric counseling, all entailing additional costs. All of the studies mention such complications, but none of the studies attempted a cost adjustment for such longer term complications for some women.

Furthermore, none of the studies has accounted for the fact that women at higher than average risk of developing uterine cancers in the future might obtain sufficiently greater benefits by electing hysterectomy over tubal ligation as a means of sterilization. However, our own analysis presented in this case study found that at a twofold increased risk of developing cervical cancer, discounting future benefits at 2 percent, a woman undergoing hysterectomy at age 35 would increase her life expectancy by only 0.4 year and decrease the expected cost for her medical care by only $76. Thus, it does not appear that under these conditions a woman would obtain significant savings or benefits.

The process of analysis of risks, costs, and benefits of elective hysterectomy has shown how the majority of risks and costs are immediate, whereas the majority of benefits are realized in the future. On balance, the net benefits and cost savings are small. The average increase in life expectancy is less than 2½ months, and the average cost savings are approximately $200, but the increase in life expectancy and savings disappear at discount rates as low as 2 to 3 percent. Thus, the ultimate decision as to whether or not to undergo hysterectomy for sterilization or for cancer prophylaxis can largely be determined by perceived benefits that are not quantifiable in the present analysis. Such perceived benefits include the strong desire to avoid pregnancy in a woman who maintains a firm moral objection to abortion.

To lessen the abuse of major surgery for minor benefits to the patient (e.g., relief of relatively minor menstrual difficulties) or for the economic advantage of the physician, elective hysterectomy policy should be directed towards implementation of the current standards of care as developed by the PSRO program and the reimbursement policy of the Department of Health and Human Services. The PSRO medical indications for hysterectomy specifically state that sterilization by vaginal or abdominal hysterectomy is acceptable only in the presence of concomitant uterine disease; and the medicare law specifically excludes reimbursement of hysterectomy for sterilization. Implementing these standards and policies will not be easy. Although some modest successes have been achieved in limiting the numbers of elective hysterectomies by medical audit and peer review in individual institutions, implementing a program to audit hysterectomies on a continuous basis at the national level would be a formidable task. Furthermore, under present conditions of reimbursement incentives, the effort would not be likely to succeed—indeed, to disapprove indications for hysterectomy such as sterilization could be expected to encourage further misrepresentation of diagnoses. If reimbursement patterns are restructured, perhaps along the lines of competing health maintenance organizations (31), however, problems of overutilization of elective hysterectomy could be controlled.

APPENDIX A: THE MANITOBA STUDY*

The Manitoba Health Care System and Claims Data

In carrying out this research, claims data were used from records of the Manitoba Health Services Commission (MHSC), which operates the Manitoba health insurance program. **The entire population of Manitoba (in** 1973, 1,027,866 **people) is covered by health insurance. The program includes virtually universal coverage (including visits to chiropractors) for residents wherever their care is rendered. There is no fee associated with physician visits or hospital usage, and there are few coverage limits. Cosmetic surgery is excluded as is routine dental care. There are also limits on certain types of services. Only one eye examination a year is covered unless medical conditions indicate otherwise. Similarly, there is an upper limit on the amount of chiropractic services covered (in 1979, the limits were *$70* per single person, *$140* for a family of three or less, etc). A small number of physicians have opted out of the Provincial insurance scheme. In such cases, the Province pays the patient rather than the physician for services delivered, and the physician may charge the patient the difference between the MHSC benefit and his or her posted fee.**

Physicians are paid on a fee-for-service basis, and in order to be paid, they must submit a claim identifying services rendered to their patients. These claims contain identifying information on the patient, the physician, and the diagnosis (coded at MHSC by ICDA-8). Every discharge from Manitoba hospitals also results in a claim that will contain information on the attending physician and surgeon as well as the patient, up to three diagnoses, and up to three surgical procedures. Each of these files is maintained separately, with no routine record integration. However, since patient numbers and physician numbers are unique across files, it is possible to build files on individuals (all instances of care received from various physicians and in various hospitals over time).

The Hysterectomy Research

For our research on hysterectomy **in Manitoba, a sample of hospital discharges in 1973 which included hysterectomy (ICDA procedure codes 69.1-69.7) as the first, second, or third surgical procedure was abstracted for further analysis. Exactly 1,148 cases meeting this initial criterion were selected. Given this all inclusive definition, hysterectomy rates in Manitoba are as follows: *4.37/1,000* females aged 15 to *20; 4,87/1,000* females aged 21 to 39; 15.82/1,000 females aged 40 to 49; 5.80/1,000 females aged 50 and over. Seventy-two percent of the surgery was done by gynecologists, 14 percent by general practitioners, and 13 percent by general surgeons. Forty-three percent was done in Winnipeg teaching hospitals, 33 percent in Winnipeg nonteaching hospitals, 6 percent in rural hospitals with** 125 **beds or more, and 18 percent in smaller rural hospitals. Approximately half of Manitoba's and 79 percent of the active physicians (above a minimum earning level) practice in Winnipeg, the Provincial capital and site of the medical school.**

After examination of the diagnoses and the additional surgical procedures which these women had undergone, we decided to exclude all women who had had as a first, second, or third diagnosis a malignancy (ICDA 140-209). Seventy-two women **were excluded from the study on this basis. One additional woman who had had a complete abdominal hysterectomy combined with a cesarean section was excluded from the study. Subsequent analysis of hysterectomy patients has since been restricted to the *1,075* women remaining. These include only women who have had an abdominal hysterectomy (partial, subtotal, or complete, ICDA** 69.1-69.2) **or a vaginal hysterectomy (total and subtotal, ICDA *69.4),***

For these *1,075* women, we abstracted all discharges from hospitals which occurred in the 12 months following hysterectomy as well as the 12 months prior to hysterectomy. For each of these discharges, it was possible to examine up to three associated diagnoses and up to three operative procedures. In addition, for the 12 months before and the 12 months after hysterectomy, all claims for visits to emergency room or outpatient clinics were abstracted (including one diagnosis and one operative procedure if performed). Finally, all out-of-hospital physician visits (whether they occurred at home or in the physician's office) for the 12 months before and the 12 months after hysterectomy were abstracted. These claims included one diagnosis. For a woman who had a hysterectomy in January 1973, the periods of claims examined would be as follows: 1) for the 12 months before, claims from January *1972* through December 1972 would be pulled; and 2) for the 12

*Sources N P. Roos, et al., A New Audit Procedure Applied to an Old Question Is the Frequency of T & A Justified? *Med Care* 15(1): 1, 1977; and L. Roos, Jr, et al. Using Administrative Data Banks for Research and Evaluation A Case Study, *Evaluation Quarterly* 3(2 I 236, 1979

months after period, claims from February 1973 through January 1974 would be examined.

By using the unique family registration number combined with sex and birth year, it was possible to build histories for individual women.

Validity and Reliability of Claims Data

We have been doing health services research using claims data from the Manitoba insurance system for the past 5 years. An important part of this research effort has been devoted to examining the validity and reliability of the claims as a data source. Two articles have been published (68,70) and report some of the extensive analysis which we have done on the validity and reliability of claims information in conjunction with our research on tonsillectomy. We have found that the data-transcription error rate from physician's written diagnosis to claims ICDA-coded diagnosis is less than 3 percent. The interobserver and intraobserver reliability of diagnosis recorded on the claims compares favorably with published studies in clinical settings. Reliability is higher when diagnoses are grouped than when any single diagnosis is examined. The diagnoses are valid in the sense that surgeons performed operations consistent with previous diagnoses recorded for the patient.

We have conducted reliability checks comparing diagnoses recorded on medical and hospital claims with diagnoses recorded in hospital and physician records. The overall correspondence between diagnoses in these two sources is reasonably good. (Disagreements range from 10 to 30 percent, depending on how fine the distinctions being made are.) We have also made comparisons between diagnoses recorded on hospital claims and diagnoses recorded in *Vital Statistics.* These comparisons suggest a very close correspondence between diagnostic information contained in *Vita/ Statistics* and the diagnostic information contained on a hospital claim during the admission when a patient died.

In a special study of validity of claims as they relate to hysterectomies, the procedures billed for by surgeons and anesthetists were compared with the procedures recorded in the hospital file when a hysterectomy was coded. The reverse comparison was also made; that is, the procedures recorded in the hospital file were compared with those for which the surgeon and/or anesthetist had billed for hysterectomy. In both comparisons, 94 percent of the records were an identical match. Where there were discrepancies, the discrepancy was almost always due to a date discrepancy or to the surgeon's billing for a more extensive procedure associated with an abdominal malignancy to which the hysterectomy would have been incidental. In all these cases, the more extensive procedure was also recorded in the hospital claims.

APPENDIX B: AN ANALYSIS OF ELECTIVE HYSTERECTOMY AND TUBAL LIGATION

Introduction

The purpose of this analysis is to compare the length of life and direct medical expenditures for a woman undergoing either elective hysterectomy or tubal ligation on her 35th birthday. This comparison is based on the estimation of the probability that the woman's lifetime equals a specific length and the probability that direct medical expenses equals a specific amount, given her choice of sterilization procedure. These estimates are based on an analysis that incorporates the influence of controlled events (e.g., elective surgery) and uncontrolled events (e.g., the development of cancer) on life expectancy.

In order to simplify the analysis, it will be assumed that all events significant occur on the patient's birthday. Therefore, at precisely 12-month intervals, the woman undergoes surgery, is diagnosed and treated for disease, and risks dying from the various causes of death to which she is exposed. This assumption reduces the field of interest to a finite number of points in the woman's life. The other assumptions incorporated in the analysis are described in the next section below.

Given the complete history of events that actually do occur on a woman's birthdays, it is possible to determine the total direct cost of her gynecologic care. Thus, the analysis computes the probability that direct costs equal a particular value by surveying the probability of all possible histories that correspond to that level of cost. Future costs are discounted according to a fixed estimate for the real interest rate.

Assumptions

A response to future events in one's life can vary from one individual to another. Furthermore, when several alternatives are available, it is often difficult to state with certainty in advance of the actual decision which alternative will be chosen. However, for the sake of simplicity, it will be assumed that the following decisions are made conditional on corresponding events.

If a woman becomes pregnant after tubal ligation, she will undergo abortion and repeat sterilization. It will be assumed that any pregnancies after tubal ligation occur 1 year after the procedure. It will also be assumed that subsequent tubal ligations do not fail.

If any uterine cancer develops in a woman after tubal ligation, then she will undergo hysterectomy as part of her therapy. Admittedly, many cancers are often treated without surgery, particularly cervical cancers detected in situ. Nevertheless, so as to simplify the analysis, it will be assumed that surgery is indicated in the treatment of uterine cancer. Sensitivity analysis indicates that this assumption does not affect the comparison. Furthermore, it is not unreasonable to expect that a woman who has previously undergone a sterilization procedure will undergo hysterectomy after the subsequent detection of cancer.

Finally, it will be assumed that causes of death are independent. Therefore, reducing the chance of death from one cause does not disproportionately increase the chance of death from another cause. This independence assumption can be expressed mathematically as follows. Suppose that all possible causes of death have been lumped together into "n" groups. For example, the jth group might be all uterine related causes of death. Let "P(i,j)" denote the probability that a woman dies on her ith birthday from the jth cause (actually, a cause from the jth group). Then "P(38,j)" would denote the probability of death from uterine disease on a woman's 38th birthday. The independence assumption is then:

$$\text{Probability of death at ith birthday from jth cause given did not die from kth cause} = \frac{P(i,j)}{1 - P(i,k)}$$

In general, this independence assumption does not always hold—e.g., consider a very risky surgical procedure which is only performed for a disease that is always fatal if not cured. Let death from the surgical procedure denote one cause of death and death from the disease another. If the surgery is always attempted as a final effort to save the patient's life, then few patients would actually die from the disease itself. On the other hand, eliminating one cause of death by either discontinuing the surgery or else preventing the disease by some other approach will disproportionately alter the probability of the other cause of death. Therefore, these two causes of death are dependent.

This analysis will consider the following groupings of causes of death:

- uterine cancers,
- complications during hysterectomy,
- complications during tubal ligation,
- complications during abortion,
- complications during dilatation and curettage, and
- all other causes of death.

Dependencies between the first and second causes of deaths are eliminated in the analysis by combining

deaths due to uterine cancer with deaths during therapeutic hysterectomy.

The Woman Undergoing Hysterectomy

The woman who undergoes elective hysterectomy faces only two causes of death from the list above: 1) death as a result of the procedure, or 2) death from the "other" causes (which exclude gynecologic causes). The age-specific risk of death during hysterectomy was obtained from The National *Halothane* Study (18). The overall death rate for low-risk surgical operations was observed to be *23* deaths per 10,000 procedures, which equaled the weighted average for mortality rates in 12 studies (24). Thus, it was assumed that the age-specific death rate for death from hysterectomy matched that for all low-risk procedures.

Age-specific surgical mortality rates for hysterectomy

Age	*Deaths/10,000*
30	8.9
40	14.5
50	33.9
60	54.1
70	116.5
80	281.8
90	500.0
100	500.0

The age-specific mortality rates for nongynecologic death was determined from the *Vital Statistics of the United States* for 1976 (58).

Age-specific nongynecologic annual death rates

Age	*Deaths/100,000*
30	68
35	93
40	146
45	244
50	381
55	586
60	931
65	1,336
70	2,095
75	3,678
80	6,125
100	15,932

Let the following symbols denote the probability for the respective events on the 35-year-old woman's ith birthday:

Symbol	*Event*
A	Alive at start of birthday
L	Death during birthday
R	Risk from hysterectomy
M	Nongynecologic mortality rate

then:

$$A(i) = A(i-1) - L(i-1), \text{ with } A(35) = 1$$

That is, the probability of being alive on her ith birthday equals the probability of being alive on her i-lst birthday minus the probability of dying on her i-1st birthday. If the woman undergoes elective hysterectomy, then:

$$L(35) = R(35) + M(35)$$

Therefore, during subsequent years the probability of death on a particular birthday can be computed from the following equation:

$$L(i) = A(i) \times M(i)$$

The Woman Undergoing Tubal Ligation

Lower mortality rates are observed for tubal ligation than for elective hysterectomy. Deane and Ulene (24) reported that the weighted average tubal ligation mortality rate for 13 studies was 12 deaths per 10,000 patients. This is approximately half of the weighted average hysterectomy mortality rate. Therefore, the age-specific mortality rate for tubal ligation was estimated by halving the rates reported by The *National Halothane Study* for low-risk procedures (18).

Age-specific surgical mortality rates for tubal ligation

Age	*Deaths/10,000*
30	4.5
40	7.2
50	16.9

Therefore, since it is assumed that the woman has no gynecologic diseases, the probability of death during her 35th birthday can be computed as follows:

$$L(35) = T(35) + M(35),$$

where T(i) is the mortality rate for tubal ligation at age i.

During the following year, the tubal ligation may fail. McElin, et al. (51) reported a subsequent pregnancy in 5 of *902* patients sterilized by the Pomeroy technique. Therefore, a failure rate of 5 per 1,000 was used in the analysis. It was assumed that pregnancy, if it occurred, did so in the year following the procedure. The unsuccessful tubal ligation was followed by a repeat of the procedure together with a dilatation and curettage. The age-specific risk of death for this combined procedure was approximated to be the same mortality rate assumed for tubal ligation.

Women choosing tubal ligation are subjected to a variety of other risks besides subsequent pregnancy. The risk of death on any particular birthday is computed by adding the risk of death from each particular cause. The nongynecologic causes comprise one group of risks. As before, the risk from nongynecologic causes is estimated by multiplying the probability of being alive by the age-specific mortality rate:

$$\text{Risk of death from nongynecologic causes} = A(i) \times M(i)$$

In order to be exposed to a gynecologic cause of death, a woman must not have previously undergone hysterectomy. Let H(i) denote the probability of un-

dergoing hysterectomy on ith birthday for an indication, and let B(i) denote the probability of living until the start of ith birthday without previously undergoing hysterectomy. Then:

$$B(i) = B(i-1) - H(i-1)\,[1-R(i-1)] - L(i-1),$$

where R is the age-specific risk from hysterectomy and L is the probability of death on the ith birthday. In other words, the probability of being alive with a uterus still intact on one's ith birthday equals the probability of being alive with a uterus intact at the previous birthday minus the probability of death or hysterectomy during the previous birthday.

In this analysis, the indications for hysterectomy are divided into two groups: cancer and noncancer. The age-specific incidence of noncancer hysterectomies was determined from unpublished data from the National Hospital Discharge Survey (57) and the findings reported by Ledger and Child (47) from their study of *12,026* hysterectomies.

Age-specific hysterectomy rate for causes other than cancer

Age	*Procedures/10,000*
30	94
40	177
50	124
60	49
80	26
100	0

Recall that the analysis assumed that hysterectomy was performed for all women in whom uterine cancer is diagnosed. Therefore, the rate of hysterectomy for cancer equals the age-specific incidence of the disease. The analysis aggregated the various stages and sites for uterine cancer into three groups: 1) localized cancer of the cervix uteri, 2) invasive cancer of the cervix uteri, and 3) cancer of the corpus uteri. Age-specific rates reported by Kim, et al. (42) were used:

Age-specific incidence for *uterine cancers*

Age	*Localized cervical*	*Invasive cervical*	*Corpus*
30	126.2	11.6	1.5
35	72.3	10.8	6.2
40	50.3	16.8	14.4
45	19.2	24.0	32.4
50	19.6	35.3	53.6
55	10.2	21.9	45.2
60	11.6	21.6	73.1
65	12.5	22.9	74.9
'70	10.0	14.8	91.6
75	6.1	15.2	61.0
		15.2	61.0

If $I_1(i)$, $I_2(i)$, and $I_3(i)$ denote the incidence of localized cervical, invasive cervical, and corpus uteri cancer, respectively, then the probability that a woman undergoes hysterectomy on her ith birthday is:

$$H(i) = B(i) \times [U(i) + I_1(i) + I_2(i) + I_3(i)],$$

where U(i) is the incidence of hysterectomy for non-malignant diseases. This includes elective procedures.

The risk of death on a woman's ith birthday can then be computed as follows:

Probability of death from hysterectomy on ith birthday = H(i) x R(i)

A woman who has not undergone hysterectomy may also develop excessive bleeding that warrants dilatation and curettage, which implies a small risk. Rates for dilatation and curettage were determined from Deane and Ulene (24):

Age-specific frequency of undergoing dilatation and curettage

Age	*Procedures/10,000*
<50	16
>50	4

Age-specific death rates from this procedure were approximated by the risks during abortion. Therefore, if G(i) denotes the age-specific risk during abortions and J(i) the age-specific frequency, then:

Probability of death from dilatation and curettage = B(i) x J(i) x G(i)

Finally, some of the women who choose tubal ligation will die from uterine cancer. The survival of these patients after diagnosis depends upon the location and extent of their disease. In this analysis, these survival rates were estimated from data reported in *Recent Trends in Survival of Cancer Patients (5)* for the years 1960 to 1971.

Probability of death from uterine cancer after various numbers of years

Years	*Localized cervical*	*Invasive cervical*	*Corpus*
1	*0.06*	*0.19*	0.11
3	0.05	0.09	0.05
5	0.02	0.05	0.03
10	0.01	0.01	0.02

It was assumed that if a patient died from uterine cancer, then the death occurred within 10 years of the initial diagnosis.

The probability of death from a particular type of cancer diagnosed k years earlier equals the probability that the cancer was discovered at that time, times the probability that the patient survived the initial therapy and subsequent risk, times the probability of death from that cancer k years after it is diagnosed. The probability of death from all cancers on a particular birthday then equals the sum of all three cancers for the previous 10 years.

Cost of Gynecologic Care

The analysis used the following estimates of the direct cost for gynecologic care. These values were obtained from Deane and Ulene (24).

Cost of elective hysterectomy $1,545
Cost of hysterectomy for cervical cancer. *2,400*

Cost of hysterectomy for corpus cancer. 3,200
Annual cost of uncured cervical cancer 800
Annual cost of uncured corpus cancer 800
Annual cost of uterine care premenopause. 20
Annual cost of uterine care postmenopause. 10
Cost of abortion 645
Cost of therapeutic dilatation and curretage 415
Cost of tubal ligation. 1,100

It is felt that these figures are perhaps lower than the actual values; however, the reduction appears to be uniform. In addition to the above cost for medical care, it was assumed that a woman incurs a $10,000 expense during the last months of her life. This expense represents the "cost of dying" but not the "cost of death" (i. e., the value of life) which would be considerably larger.

Basic Result

The analysis estimated the probabilities for death for each year after the initial sterilization procedure. The value of these estimates is listed below for every 10th birthday.

Probability of death on selected birthdays

Age on birthday	*Hysterectomy*	*Tubal ligation*
35	0.00111	0.00055
45	0.00221	0.00256
55	0.00519	0.00552
65	0.01099	0.01122
75	0.02411	0.02405
85	0.03322	0.03280
95	0.01799	0.01766

Notice that the woman sterilized by hysterectomy is more likely than the woman undergoing tubal ligation to die at the time of the procedure (age 35). This increase in operative deaths corresponds to a slight improvement in subsequent survival in that the age at death is shifted to the later years. For example, the probability of death at age 75 is approximately the same for both procedures. On the other hand, death at age 95 is more likely when the woman undergoes hysterectomy. Thus, overall, the life expectancy is 81.3 years, as opposed to 81.0 years with tubal ligation.

The probability for different ranges of total expected costs is listed below. Future costs *were* discounted at 2 percent per year.

Probability distribution for direct cost (2-percent discount rate)

Range	*Hysterectomy*	*Tubal ligation*
_< *$5,000*	*0.158*	*0.226*
_< *6,000*	*0.578*	*0.568*
_< 7,000	0.826	0.806
_< 8,000	0.921	0.913
_< 9,000	0.965	0.958
_< 10,000	0.986	0.982
_< 11,000	0.996	0.994
_< 12,000	1.000	0.997
_< 13,000	1.000	0.998
_< 18,000	1.000	1.000

The expected direct costs are $6,048 and $6,052 for hysterectomy and tubal ligation, respectively. Although the difference is not large, the higher average cost is associated with tubal ligation because of the chance of expensive cancer therapy and early death.

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