

Production Process Substitution in Maternity Care: Issues of Cost, Quality, and Outcomes by Nurse-Midwives and Physician Providers

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Escalating health care costs have resulted in demands for cost containment in both the private and the public sectors. At the same time the public is demanding quality health care services.

One proposed method of cost control in maternity care is the substitution of certified nurse-midwives (CNM) for physicians for certain services. This article evaluates the usefulness and implications of a model of provider substitution as a basis for policy decisions or cost-containment strategies in the delivery of maternity care. In providing care to low-risk or essentially normal mothers, CNMs are a potential substitute for physicians. However, to conceptualize using CNMs as a simple substitution is to ignore the differences in care produced by the two providers.

This study first describes two potential providers of maternity care and then considers the possibility of provider substitution in the production of maternity care. Next, barriers to and potential benefits of substitution are evaluated with particular emphasis on cost, quality, and outcomes. Finally, an alternative model of production process substitution is offered and evaluated.

MATERNITY CARE PROVIDERS

Two professions, nurse-midwifery and medicine, both currently claim maternity care within the practice realms of their disciplines.

NURSE-MIDWIFERY

The practice of midwifery has two major provider groups: certified nurse-midwives, and a second group that includes lay midwives, foreign-trained midwives, apprentice-trained midwives, and others who may or may not be registered nurses (RNs). This article limits consideration to nurse-midwives certified by the American College of Nurse-Midwives (ACNM), certification that assures patients and the public that the nurse-midwife has satisfactorily acquired the competencies necessary for safe and effective practice (Conway-Welch 1986). Certification is granted to individuals (1) licensed as registered nurses in one of the United States or its territories, (2) graduated from a nurse-midwifery educational program either approved or with approval pending by the ACNM, and (3) who have achieved a passing score on the certifying examination (Foster 1986). The American College of Nurse-Midwives defines nurse-midwifery practice as "the independent management of care of essentially normal newborns and women, antepartally, intrapartally, postpartally and/or gynecologically" (Rooks and Haas 1986, p. 9).

PHYSICIANS

Within the practice of medicine both family practice physicians and obstetrician/gynecologists are obstetrical care providers. The American Academy of Family Practice Physicians (AAFP) and the American Board of Family Practice claim the care of the pregnant woman and her family in their charter philosophy:

Comprehensive medical care with particular emphasis on the family unit, in which the physician's continuing responsibility is not limited by the patient's age or by a particular organ system or disease entity. Family practice is the specialty in breadth which builds upon a core of knowledge derived from other disciplines—drawing most heavily on internal medicine, pediatrics, obstetrics and gynecology, surgery, and psychiatry—and establishes a cohesive unit combining the behavioral sciences with the traditional biological and clinical sciences. The core of knowledge encompassed by the discipline of family practice prepares the family physician for a unique role in patient management, problem solving, counseling, and as a personal physician who coordinates total health care delivery. (Feinbloom 1986, 109-110)

The American Board of Family Practice requires a residency that includes a minimum of three months in obstetrics and gynecology.

Obstetrics is defined as the art and science of caring for women and their unborn progeny during pregnancy, labor, and continuing into the immediate puerperium (Chamberlain and Turnbull 1989). Another textbook of medicine gives obstetrics a broader definition, stating that obstetrics is concerned with all of the physiologic, psychologic, and social factors that influence both the quantity and quality of human reproduction (Pritchard, MacDonald, and Gant 1985). Still a third text points out that obstetrics arose as an offshoot of midwifery and that it was not until the end of the eighteenth century that physicians became involved in the process (Merrill 1975). Gynecology arose as a surgical specialty, but as knowledge of reproduction increased, the overlap between obstetrics and gynecology became apparent and the disciplines united (Merrill 1975).

The significant similarities, as well as the differences, in the service provided by certified nurse-midwives, family practice physicians, and obstetrician/gynecologists affect their professional relationships and the potential for substituting one set of providers for another in the production of maternity care.

SUBSTITUTION IN THE PRODUCTION OF MATERNITY CARE

A production function is a relationship between inputs and outputs. The production function for maternity care can be represented by the following equation:

$$Q_{mc} = f(P_{dr}, RN, Z \dots)$$

Output quantity is defined in terms of units of maternity care (*mc*). Each unit includes mother and infant care during the antepartum, intrapartum, and postpartum periods. The provider (*P_{dr}*) could be either the obstetrician (OB) or the certified nurse-midwife (CNM). The *RN* represents some input of registered nurse time. *Z* represents everything else that enters into the process: laboratory tests, diagnostic procedures, and so forth.

The total cost of producing a specified number of units of maternity care (*TC_{mc}*) is equal to the price of the input multiplied by the quantity of the inputs used, as represented by: $TC_{mc} = (PP_{dr} * QP_{dr}) + (PRN * QRN) + (PZ * QZ)$. The current emphasis on cost containment in health care requires that we examine the quantity and price of each input used.

A production function framework permits us to focus on several interesting questions: (1) What combinations of inputs can be used to produce a given number of units of maternity care? (2) Do physicians and CNMs use the same input combinations to produce the same output? (3) What combination of inputs costs less to produce the same output?

To a large degree the answers to these questions depend on the extent to which substitution of some inputs for other inputs is possible. Specifically in the case discussed here, conditions under which CNMs can be substituted for MDs in the production of maternity care will determine the range of choice available to patients and policymakers. And the range of choice in turn provides opportunities for cost savings and quality improvement.

Several characteristics of the current health care delivery system in the United States have led policymakers to consider provider substitution for some services. Rising health care costs, limited access to certain types of care in some areas, localized physician shortages, consumer demand for more personalized care, and an increasing public interest in preventive care have all contributed to this movement. The available literature that reports CNM and nurse practitioner (NP) substitution for physicians is unclear, although it is not in conflict. This literature often

combines CNMs with nurse practitioners, and family practice physicians with obstetricians. Weiner, Steinwachs, and Williamson (1986) assert that the roles of NPs are becoming increasingly uncertain today because of the changes in the United States health care system. These authors summarize two views of the state of such alternative provider roles: One asserts that the role is limited in an era of surplus physicians, while a second view argues that the role of these providers in organized and prepaid group practice is a major organizational form of health care delivery.

A study from the Office of Technology Assessment found that the degree to which nurse-midwives can substitute for physicians is considerable (Herdman, Behney, Ruby, et al. 1986). Herdman cited an ACNM study that indicated that of 1,000 certified nurse-midwives, over 75 percent provided full-scope practice; that is, they delivered prenatal, labor, delivery, and postpartum care as well as family planning and normal gynecological services. A 1988 study of 1,735 members of the American College of Nurse-Midwives indicated that 59.9 percent of the respondents were engaged in clinical nurse-midwifery practice managing births with another 10.7 percent in clinical nurse-midwifery practice not managing births (Lehrman and Paine 1990).

It is generally agreed that a physician shortage would increase the substitution of alternative, nonphysician providers. The recent liability insurance crisis has contributed to a shortage of obstetricians in particular. A two-year study reported the effects of medical professional liability on the delivery of obstetrical care (Rostow, Osterweis, and Bulger 1989). The study included a survey of the National Governors Association that found that 60 percent of Medicaid programs and almost 90 percent of maternal and child health programs were having trouble ensuring the participation of sufficient numbers of providers of maternity care. The rising cost of liability insurance was cited by nine out of ten programs as contributing to their problems. Data cited in that study also showed that the attrition rate among family practice physicians who provide obstetrical care was especially high, creating a shortage of services in rural areas.

In evaluating the substitution possibilities and potential of alternative providers, it is first necessary to consider several issues influencing the feasibility and desirability of the substitution. The feasibility of substitution depends on issues such as the relationship between the providers, the extent of competition in maternity care, and the status of nurse-midwifery relative to that of physicians. The desirability of substitution depends on its possible effects on quality of care, patient health outcomes, and cost.

RELATIONSHIP BETWEEN PROVIDERS

The American College of Nurse-Midwives (ACNM) specifies that their practice occurs within a health care system that provides for medical consultation, collaborative management, and referral. While the national advisory panel of the ACNM recognizes that many individual nurse-midwives enjoy happy and collegial relationships with physicians, it recommends that nurse-midwives and the ACNM establish, enlarge, and improve their relationships with groups representing consumers and/or other professions in order to collaborate on solving mutual problems and advancing common goals (Rooks and Haas 1986). In this document the advisory panel also recognized the official position of the American Academy of Family Practice Physicians, which does not refer directly to nurse-midwives but states that

“obstetrics should be practiced only by fully licensed, qualified physicians” and that “a nurse practitioner should not function as an independent health practitioner but only as part of the health care team that includes at least one physician. The nurse practitioner should be employed only as a means of providing limited care, always under the direct and responsible supervision of a practicing, licensed physician with all reimbursement for services being through the responsible, supervising physician. Although the training of nurse practitioners may extend to some degree the effectiveness of physicians now available, the ultimate solution which will provide comprehensive quality medical care to all people is the training of more family physicians.” (cited in Carr 1986, p. 70)

The ACNM calls for a concerted effort to reach an accord with the AAFP and for a jointly developed and approved statement describing an appropriate practice relationship between nurse-midwives and family practitioners.

The joint statement of practice relationships between obstetrician/gynecologists and certified nurse-midwives declares that the maternity care team should be directed by a qualified obstetrician/gynecologist (Rooks and Haas 1986). (This statement was developed and approved by both ACNM and the American College of Obstetricians and Gynecologists [ACOG].) The clinical practice relationship between the two providers calls for written medical guidelines or protocols that define the individual and shared responsibilities of each. The joint statement also explicitly states that the physical presence of the obstetrician is not implied when the nurse-midwife is giving care (Rooks and Haas 1986). The document also asserts that quality of care is enhanced by the interdependent practice of the obstetrician/gynecologist and the certified

nurse-midwife working in a relationship of mutual respect, trust, and professional responsibility.

The professional relationship between obstetricians and nurse-midwives described in the joint statement is crucial to the success of a nurse-midwifery service. In a national study of 319 nurse-midwives four of the five most important factors contributing to the success of a midwifery service involved relationships with physicians (Haas and Rooks 1986). These included: suitable physician collaboration, basic philosophical agreement, excellent or at least good interpersonal relationships among staff of the practice, and absence from constraints of state law as well as adequate access to practice settings.

Not all midwives enjoy a collegial relationship with physicians. When the same national survey asked midwives to identify the hindrances to a successful practice, 7 among the 18 rank-ordered factors had to do with CNM-physician interaction. Those factors ranked second and fourth were physicians concerned about loss of income to CNM practitioners and lack of acceptance by community physicians of nurse-midwifery as a worthwhile profession (Haas and Rooks 1986).

Issues of Provider Competition

Competition is defined as the effort of two or more parties to secure the business of a third party by the offer of the most favorable terms (Brady 1988). In a market economy, competition is generally assumed to be in the public interest since it may both improve quality and lower costs. A consideration of competition in obstetrical care is important because it simultaneously affects both production functions and costs. If constraints to competition in obstetrical care were to be removed, the potential would exist to vary the inputs to the production function and concurrently to affect costs and quality.

While some limited competition may exist, for a number of reasons the market for health care is not perfectly competitive in an economic sense. Several assumptions underlie the existence of a competitive market. First, competition assumes that the consumer has sufficient knowledge to make an informed decision in selecting a product or service. Pauly (1988) estimates that in health care this may be the case about 25 percent of the time, and that it exists in situations where a consumer uses a good or service often and routinely. The use of over-the-counter drugs or the example of a person with a chronic condition who becomes expert in managing his or her own disease illustrate situations where consumers have sufficient knowledge to make choices.

It is more likely that consumers make choices based on partial knowledge. In choosing perinatal care a woman may have little knowl-

edge or experience to guide her selection of provider, especially in the case of a first birth. CNMs acknowledged this in the national survey when they indicated that the lack of community understanding of what nurse-midwifery can provide was the number one-ranked hindrance to successful midwifery practice. Two states, Massachusetts and New York, passed legislation requiring hospitals to disclose information about rates for cesarean section and other obstetric procedures to pregnant women (Young 1989). It was hoped that this information would form the basis for decisions by pregnant women about where to give birth and would increase dialogue between physicians and patients. Pauly (1978) called for research to identify how well informed consumers are, their possible behavior with additional information, and any subsequent market changes in response.

The second assumption of a competitive market is that free entry of a good or service exists for competing providers. Given the existence of regulatory bodies, licensure examinations, and state practice acts, this is clearly not the case in health care. Nurse-midwives have a history of being denied entry to practice, most notably in the area of hospital admitting privileges (Burst 1986). These privileges are controlled by physicians who are voting members of a hospital's medical staff. The denial of hospital privileges and physician backup effectively restricts entry into practice by nurse-midwives.

A final requisite of a competitive market is the existence of price competition. Historically, costs were of little concern since third party payers fully reimbursed the providing institution without much questioning of the appropriateness of the bill. The health care market of the 1990s with its emphasis on cost containment is becoming price competitive in a limited manner. Third party payers are increasingly identifying preferred providers whose costs are lower than the cost of an alternative provider. This same price competition is slower to affect the practices of nurse-midwives and physicians. Little is known about the differences in the costs of care between CNMs and MDs (Krumlauf, Oakley, Mayes, et al. 1988). At present neither the consumer nor the third party payer is likely to have sufficient information to select a provider based on price.

While none of the factors identified in the national survey explicitly identifies competition as a consideration in CNM-physician relationships, one physician-author has stated that it is essential to recognize that CNMs and physicians are competing with each other (Cushner 1986). When CNMs engage in independent practice and recruit the clients that would otherwise have used physicians, competition exists. Cushner stated that the realities of competition must be faced in order to get beyond their negative implications and to gain from the positive potential competition offers.

While Rooks (1983) has stressed that the services provided by CNMs and physicians represent unique and therefore complementary professions, many others disagree. The Federal Trade Commission (FTC) advocates the benefits of competition and consumer choice in health care and has acted on behalf of midwives on this issue (Bailey 1986). In *Sweeney v. Athens Regional Medical Center* a CNM successfully charged that physicians were attempting to eliminate her "Family Birth" business since it directly competed with their own practice (*Regan Report on Nursing Law* 1989). Cushner (1986) maintains that CNMs and physicians are indeed competing with each other and that these providers need to stop pretending otherwise. He writes that a loss of practice-generated income occurs for one group, and a gain for the other.

Other authors write that while CNMs provide care that is qualitatively different from the care provided by physicians, they compete with physicians for the healthy pregnant woman as a client (Langton and Kammerer 1989). Because of a limited number of births and a projected oversupply of physicians, these authors maintain that competition can be expected to intensify. Another aspect of competition cited by Langton and Kammerer is the collaborative practice model advocated by CNMs. The authors cite views expressed by a medical director who indicated that no physician after years of training should be a consultant to a nonmedically educated person. This physician felt that ethical, malpractice, and professional issues of logic contradicted this role. A Canadian study reported that of 27 physicians who did not think midwives should be licensed, 9 physicians felt that such licensure would have a negative effect by decreasing the size of their own practice or forcing them out of obstetrics (Stewart and Beresford 1988).

One family practice physician advanced a position calling for an alliance of nurse-midwives and family practice physicians (Feinbloom 1986). In the Feinbloom model the family practice physician would function as a midwife, acquiring the skills of midwifery rather than obstetrics. Feinbloom stated that the family practice/midwife provider would avoid the use of Pitocin, analgesia, anesthesia, and forceps, and would perform cesarean section only when directly supervised by an obstetrician. Feinbloom concluded that the family practice/midwife would become a skillful childbirth educator, expert in nontechnologic approaches to the care of women in labor. A midwife response to the Feinbloom proposal countered that while the description of the role of the midwife is accurate, the family physician would be the one to benefit most from such an arrangement (Miller 1986). Miller acknowledged that the physician would gain continuity of care in family practice. She did not agree that midwives would benefit by access to families, a reduction

of professional isolation, access to consultation and referral for medical problems occurring in pregnancy, and continued involvement with the patient beyond the birth of the child. Miller pointed out that while access to families and consultation are of benefit, nurse-midwives do not need to practice with a family practice physician to assure involvement with the family beyond birth, since most CNMs continue to see women throughout their reproductive years. In addition, Miller explained that many midwives have nurse practitioner-level gynecologic and pediatric skills, which provides continuity in their practice. The expanded practice of nurse-midwifery generates potential competition beyond maternity care.

Status of Nurse-Midwifery

During the ten years spanning 1976 to 1986, the number of educational programs preparing nurse-midwives increased by 53 percent, from 17 to 26 (Raisler 1987), and to 29 in 1990 (American College of Nurse-Midwifery 1990). As of 1990, over 4,000 practicing CNMs were estimated to be practicing in the United States. The American College of Nurse-Midwifery has a membership of 3,500, which includes 653 students (Personal communication 1992). Nurse-midwifery is legal in every state in the United States, and in 17 states, as of 1991, CNMs have prescriptive authority (American College of Nurse-Midwifery 1991).

Most of the nurse-midwives report conducting deliveries in hospitals, with only 14 percent conducting home births and 12 percent using nonhospital birth centers (Adams 1984). By 1975, nurse-midwife-attended hospital births (19,686) accounted for 0.6 percent of all U.S. hospital births. By 1988, the percentage of U.S. hospital births had risen to 3.4 percent or nearly 120,000 births. This was an increase of 500 percent from 1975. By 1989, this number had again risen to 122,892 hospital births and a total of 132,286 births attended by nurse-midwives. Twelve states reported that 5 percent or more of all births in 1987 were attended by nurse-midwives (American College of Nurse-Midwifery 1990). One author described nurse-midwifery as the latest growth industry in the United States (Harsham 1983).

While 88 percent of employed nurse-midwives who responded to a 1982 survey conducted deliveries, prenatal care and family planning were the services most frequently provided. Most nurse-midwives conducted the initial prenatal examination, established the diagnosis of pregnancy, managed prenatal care, managed labor, conducted deliveries, and were responsible for the immediate care of newborns. They also reported that their practice included postpartum care, normal gynecology, and sexual counseling (Adams 1984).

Professional liability insurance is a prerequisite to the practice of nurse-midwifery. Without this insurance the profession of midwifery is jeopardized. On July 1, 1985, the group policy that covered 1,400 certified nurse-midwives was cancelled by Mutual Fire, Marine, and Inland Insurance Company. Other nurse-midwives who had previously been covered by the American Nurses Association or by the Nurses Association of the American College of Obstetricians and Gynecologists were similarly denied coverage by the companies underwriting those groups (Yates 1986). By October 1985, the ACNM began working to set up a "captive" or self-insurance program after being refused coverage by 17 insurance companies that were known to write medical malpractice insurance (Yates 1986). Nurse-midwives were told to anticipate liability insurance costs of \$3,000 to \$5,000 per year (Sinquefield 1986). Rates did increase from \$35 to \$3,500 from 1983 to 1987, a 10,000 percent increase (Patch and Holaday 1989). Bullough cited insurers who predicted rates as high as \$20,000 within the near future (cited in Patch and Holaday 1989). Malpractice insurance policies have become available to nurse-midwives through a private insurance company in 41 states.

The Federal Trade Commission (FTC) has been concerned specifically with the growth of the nurse-midwifery profession. The belief that competition in the delivery of health care is in the public interest is the basis of the commission's concern (Bailey 1986). Bailey writes that FTC activity relating to nurse-midwives focuses on hospital privileges, malpractice insurance for backup physicians, and third-party reimbursement. She has also indicated that the FTC will do everything within its power to remove the remaining barriers to professional nurse-midwifery practice.

In December 1980, Public Law 96-499, which provided for the reimbursement for nurse-midwifery services under Medicaid, was passed. As of September 1987, 44 states covered nurse-midwife services under the Medicaid program. At that time the Health Care Financing Administration (HCFA) indicated that it was currently working with the remaining six states (Illinois, Kansas, Missouri, Nebraska, Tennessee, Texas) to bring their plans into compliance with Medicaid requirements (Shikles 1987).

ISSUES OF QUALITY

The potential for substitution of personnel and services in medical care without a subsequent decrease in quality is substantial. Much of the research on substitution of health care providers has studied nurse practitioners, CNMs, and physician assistants (PAs) as physician substitutes. Further, this work has focused on the physician extender role

rather than on the independent practitioner role of the nurse (LeRoy and Solkowitz 1981). The role of the nurse practitioner depends to a great extent on the work setting, although LeRoy and Solkowitz acknowledged that physician assistants function primarily as physician substitutes for routine primary care. In contrast, nurse practitioners, in addition to routine primary care, offer care not usually provided by physicians; this includes teaching, counseling, and preventive care. LeRoy and Solkowitz concluded that nurse practitioners do improve access to care at reduced costs while maintaining quality. It can also be inferred from this study that nurse practitioners extend quality into areas of care not generally provided by physicians.

Another study (Herdman, Behney, Ruby, et al. 1986) operationalized quality by comparing nurse-midwife care to the care provided by physicians, examining patient satisfaction, and assessing physician acceptance of nurse-midwife care. Herdman pointed out that studies comparing nurse-midwives to physicians were biased against the CNM because these studies used the medical model, or physician care as the standard of care. While this standard may be appropriate for measuring the technical aspects of CNM practice, Herdman said that it may not be appropriate for measuring the art of care. The art of care includes teaching, counseling, and health promotion. These skills are considered essential in nursing education and are stressed in the curricula. Herdman pointed out that only psychiatrists and family practice physicians receive extensive training in interpersonal skills. Ruby's study (cited in Herdman, Behney, Ruby, et al. 1986) reported that patients have greater ease of communication with CNMs.

Herdman concluded that within nurse-midwives' areas of competence they were providing care of a quality equal to or better than that given by physicians and that they were more skillful in providing services that depended on communication and preventive actions.

Certified Nurse-Midwives retain the formal support of the American College of Obstetricians and Gynecologists as indicated in their 1982 joint statement regarding the enhancement of quality of care when both professions work in a relationship of mutual respect, trust, and professional responsibility (Rooks and Haas 1986). Despite this formal acceptance by the leading applicable professional association of physicians, CNMs have had difficulty gaining the acceptance of practicing physicians, hospital departments of pediatrics and obstetrics, companies that provide liability insurance, and nurses themselves (Herdman, Behney, Ruby, et al. 1986). Herdman concluded that a possible reason for the lack of acceptance is that competition by CNMs is threatening to the monopoly that obstetricians have enjoyed as the sole providers of specialty medical care.

ISSUES OF OUTCOMES

A second issue in considering the substitution potential of CNMs for physicians is the evaluation of outcomes of care. Multiple studies have concluded that the care provided by CNMs results in favorable outcomes, comparable to or better than those of physicians when comparison groups are used for the same clients, that is, low-risk women (Buhler, Glick, and Sheps 1988).

Some of the current literature that provides data on CNM outcomes includes methodological problems that make the conclusions somewhat tenuous. These studies are included because they are generally accepted in the CNM literature, although their shortcomings are acknowledged. One example of such a problem is the confusion of comparison groups for CNM practice. If CNMs are compared to family practice physicians and residents, the comparisons may yield distorted results. The appropriate comparison group is obstetricians, since both CNMs and obstetricians represent fully prepared practitioners in their respective clinical specialty practices. Another comparison issue is that CNM clients are screened to exclude high-risk women.

In reviewing these studies it is necessary to specify whether the outcomes of each study were taken from a birth center, hospital service, or joint CNM/MD team practice and which CNM/MD comparison groups, if any, were used. Outcomes of particular interest are maternal and infant mortality and morbidity rates, prematurity rates, birth weights, and intrapartum care. Outcome research is summarized in Table 1.

Among the earliest studies to report the outcomes of nurse-midwifery care was the study of the Frontier Nursing Service (FNS) cited in Reid and Morris (1979). A 1932 study of the first 1,000 cases found that the rate of stillbirth was one-third less than the national rate. The neonatal mortality rate was one-third less for FNS clients than the rate for whites in Kentucky, the comparison group. Reid and Morris also reported a similar study of FNS clients done 20 years later. The rates of premature birth and stillbirth were half the national rates. Still later, a study of the period from 1954 to 1974 found that the rate of stillbirth (12.2) and neonatal mortality (14.8) among FNS clients was lower compared to 14.1 and 17.8, respectively, within the overall population of Kentucky. Another study, conducted by Frontier Nursing Service of 10,000 births between 1925 and 1954, reported the rate of puerperal deaths to be 9.1 per 10,000 live births. During the study period the comparison rate for white women in the United States was 34 per 10,000 live births. The rate of fetal deaths was also lower than that shown in national statistics, as was the neonatal mortality rate (Beckwith 1958).

TABLE 1 Summary of Outcome Research

<i>Study</i>	<i>N</i>	<i>Setting</i>	<i>Groups</i>	<i>Design</i>	<i>Outcome</i>	<i>Comment</i>
Beckwith 1958	10,000	Frontier Nursing Service	Comparisons to Kentucky and national norms	Retrospective	Lower puerperal deaths, fetal deaths, and neonatal deaths than in Kentucky and nation	Clients thought to be greater than average risk due to age, parity, delivery
Levy, Wilkinson, and Marine 1971	768	Hospital	No comparisons	Before, during, and after retrospective	Favorable outcomes during 3-year CNM service; increase in unfavorable outcomes after CNM service closed	Study population served as own control; one county hospital with higher percentage of black, Mexican- American clients, and clients under 20 years old
Meglen and Burst 1974	3-year period	Not stated	No comparisons	Not a research study	Infant death rate decreased from 41.5 to 21.3 per 1,000	Focus on one Mississippi county; inference of cause and effect link
Slome, Wetherbee, Christensen, et al. 1976	438	Hospital	CNMs/House staff	Prospective	CNM clients with higher prenatal visit scores; higher rate forceps deliveries by house staff; no other significant differences	Random assignment to CNM or house staff; no significant differences between groups: age, race, marital status, gravidity, gestation at registration, initial hematocrit or systolic blood pressure

Reid and Morris 1979	1,000 cases	Frontier Nursing Service	Comparisons to Kentucky and national norms	Retrospective	Stillbirth and neonatal mortality rates of nurse-midwives less than state and national rates	Clients thought to be greater than average risk due to age, parity, delivery
Haire 1981	2,608 (83% delivered by midwives)	Hospital	No comparisons	Not research design	88% normal spontaneous vaginal deliveries; neonatal mortality rate of infants 1,000g and greater 4.2 per 1,000; 93% of infants greater than 1,000g with an Apgar score of 7 or greater at 1 minute	30% incidence of high-risk mothers; clients primarily black and Hispanic
Mann 1981	1,000 over 5 years	Hospital with alternative birth center	CNMs/hospital, city, state	Retrospective	Perinatal mortality rate 9 per 1,000; 999 live births out of 1,005 total births	Comparison between obstetrical department outcomes for this hospital and city, state statistics; if risk factors developed during pregnancy, joint management CNM-MD
Schorfheide 1982	2,301 (68% delivered by CNMs)	Hospital	Team practice	Retrospective	Anecdotal report of intangible outcomes of client satisfaction, increased nursing support, improved physician services;	Equal white and nonwhite client mix; report of CNM-MD joint practice; results not broken down by provider

Continued

TABLE 1 Continued

Study	N	Setting	Groups	Design	Outcome	Comment
Schorfheid, continued					decreased low-birth-weight infants (7.40%–4.72%); decreased perinatal deaths (2.92%–1.80%)	Small sample size; Family practice training varied: some had specialist training in family medicine and OB/GYN
Stewart and Clark 1982	2,050 (80% attended by nurse- midwives)	In-hospital birth center	Birth center, Georgia, United States	Concurrent	Neonatal mortality rate 3–5% < state level; perinatal mortality rate 7–9% < U.S. rate	Site: in-hospital birthing center; population is all private patients with average of 2 years of college; 40% primigravidas
Schreier 1983	838	Hospital	Nurse- midwives	Retrospective	Six infant deaths; 99% of 825 live births with Apgar score of 7–10 at 5 minutes; 86% spontaneous vaginal deliveries	33% of population teenagers; 50% of population nulliparas; majority of clients with ten or more prenatal visits
Nichols 1985	175	Hospital	CNMs/National statistics	Retrospective	Low medical interventions intrapartum; maternal morbidity = 0; neonatal mortality = 2 per 2,000	Faculty practice; clients middle-class, insured or self-paying, married, planned pregnancy

Buhler, Glick, and Sheps 1988	132 Total = 44 CNM/88 FP	Hospital	CNMs/Family physicians	Retrospective	CNM rating of superior care 2.3 times higher than FP; rate of omissions that indicated inadequate score 4.5 times higher among FPs	Data abstraction done by nurse without knowledge of study objectives and hypotheses
Rooks 1989	11,814	Freestanding birth centers	Women in center/All women giving birth; five U.S. in-hospital birth centers	Prospective	No maternal deaths; overall intrapartum and neonatal mortality rate 1.3 per 1,000 births; average of 11.3 prenatal visits; cesarean section rate = 4.4%	Site: 84 freestanding birth centers in the United States
Cavero, Fullerton, and Bartlome 1991	1,000	In-hospital	Comparison to U.S., CA, County norms	Retrospective	CNMs with lower rates of low birthweight and perinatal deaths than three comparisons	Comparison group includes high-risk women; some cases collaboratively managed with MDs

In 1963, the outcomes of nurse-midwifery care were documented by Levy, Wilkinson, and Marine (1971) in a retrospective study of the period July 1960 through June 1963. Following the introduction of nurse-midwives in a California hospital that served mainly the medically indigent in an agricultural county, significant improvements included: more prenatal care given to a larger proportion of pregnant women, a higher proportion of six-week postpartum examinations, a decrease in the prematurity rate, and a decrease in the neonatal mortality rate. At the end of the initial demonstration period, the Council of the California Medical Association refused to support a permanent change in the state law that would have enabled the nurse-midwives to continue to practice as they had during the study period. The program was discontinued. The same authors then studied the period January 1964 to June 1966, during which no nurse-midwives practiced. Prematurity rates rose from 6.6 percent to 9.8 percent ($p < .02$); fetal deaths rose from 22.2 to 27.3 per 1,000 total births; neonatal deaths increased from 10.3 to 32.1 per 1,000 live births ($p < .005$). Interestingly, while prematurity and neonatal mortality rates rose among mothers having county hospital births after the cessation of the program, prenatal care for mothers being delivered there decreased. Almost twice as many women received no known prenatal care after the program ceased and the number of women having six or more prenatal visits also decreased significantly. Other possible explanations for the postprogram changes, such as unusual events like nursery epidemics or a decrease in the number of physicians, were examined but not found to account for the results.

Meglen and Burst (1974) reported findings from the introduction of a nurse-midwifery service in Mississippi where the infant mortality and morbidity rates had been among the nation's highest. In 1965, the infant death rate was 41.5 per 1,000 live births compared to 24.2 nationally. In less than three years after introduction of a nurse-midwifery service (1968-1971), the infant death rate was reduced to 21.3 per 1,000 live births in one target Mississippi county. Unfortunately, no comparison group was used, making it impossible to determine whether or not historical trends might have played a part in this reduction.

Another Mississippi study of 438 low-risk maternity patients in a university hospital clinic setting indicated that with two exceptions, no differences occurred in the prenatal, labor and delivery, and early infancy outcomes between women and infants cared for by house staff physicians and those cared for by nurse-midwives (Slome, Wetherbee, Christensen, et al. 1976). The two exceptions were the higher use of forceps by physicians and the higher rate of kept appointments by nurse-midwife clients. Of the CNM clients, 86 percent had spontaneous deliveries compared to house staff spontaneous deliveries of 66.1 per-

cent ($p < .00001$). Only 9.1 percent of CNM clients had either a low- or mid-forceps delivery compared to 29.5 percent of house staff clients ($p < .00001$). There were no significant differences between the two groups with respect to gestational age, newborn condition, or infant length. Nurse-midwifery clients kept an average of 94 percent of prenatal visits; house staff clients kept 80 percent. This result was not explained by differences in health status between the two groups.

Another study reviewed 2,608 births at North Central Bronx Hospital in 1979 (Haire 1981). This population had a 30 percent incidence of high-risk mothers who received the same care as low-risk mothers unless there was a specific medical indication for intervention. Nurse-midwives delivered 83 percent of the total population and 88 percent (2,295) of the deliveries were normal, spontaneous births. Of the infants born weighing over 1,000 grams, 98.3 percent had Apgar scores of 7 or above at five minutes. The incidence of instrumental delivery was 2.3 percent. Analgesia and anesthesia was used less than 30 percent of the time; episiotomy was used in 26 percent of births. The neonatal mortality rate was 4.2 percent per 1,000 for infants 1,000 grams or over; 7.6 percent per 1,000 for infants 750 grams or over. The overall cesarean section rate was 9 percent. Uterine stimulants (such as oxytocin) were used on only 3 percent of labors and only for a medical indication. There were no elective inductions. Having reviewed these statistics Haire concluded that the nurse-midwives in this study demonstrated that even high-risk mothers and their babies benefit from a policy of nonintervention unless there is a clear medical indication for intervention.

A California study from 1975 to 1979 in a hospital-based nurse-midwifery service reported outcomes for 999 live births (Mann 1981). In this study women at high risk for complications were excluded at the initial screening, but if they developed risk factors during pregnancy they were jointly managed by the CNM and the physician, and they were included in the study statistics. Analgesic medication was available to all women but used by only 29 percent. The perinatal mortality rate of the nurse-midwifery service was 9 per 1,000 compared to 13 per 1,000 for the hospital, 18 per 1,000 for the city, and 24 per 1,000 for the state. Interpretation of these differences is difficult, however, because high-risk births were included in all comparison groups except the nurse-midwifery service outcomes.

Another study reports outcomes of the first five years of a CNM-physician hospital practice. Two CNMs entered joint practice with two obstetricians. The study included data from 2,301 births. Of those, 1,406 or 66 percent were assisted by nurse-midwives (Schorfheide 1982). For each year of the study the number of low-birthweight babies and perinatal deaths declined except during year four, an outcome that the author

could not explain. There were 101 (4.3 percent) cesarean sections. Schorfheide reports anecdotally that the introduction of CNMs into the practice resulted in increased family and client satisfaction and that it improved physician services to clients since more time was now available for the practice of high-risk obstetrics.

A study of 2,050 births in an in-hospital birthing center, about 80 percent of which were delivered by nurse-midwives, showed both perinatal and neonatal mortality rates below the level of the state in which the study was conducted, as well as below United States levels for a four-year period (Stewart and Clark 1982). There was a 9.4 percent cesarean section rate and an 85.6 percent rate of spontaneous vaginal deliveries. Maternal outcomes reflected low use of analgesia, anesthesia, episiotomy, and cesarean section.

In a study of approximately 838 clients followed to delivery, almost one-third of whom were teenagers, the Tucson, Arizona nurse-midwifery service reported 86 percent spontaneous deliveries by nurse-midwives; 37 percent of nurse-midwife clients had no episiotomies or lacerations while 31 percent had episiotomies (Schreier 1983). This compares with national figures of 80-90 percent for primigravidas and 50 percent for multiparas. The cesarean section rate was 5 percent and usually was indicated by failure to progress or cephalopelvic disproportion. Apgar scores were in the 7-10 range for an estimated 99 percent of 825 live births at five minutes. Six deaths occurred among the babies of the clients whom the nurse-midwives followed to delivery; only one baby who died was actually delivered by a midwife, and this baby had multiple congenital anomalies.

Nichols (1985) reported the results of a faculty-based nurse-midwifery practice. A retrospective chart review of 175 client deliveries, 76.4 percent of which were conducted by CNMs, indicated that maternal morbidity was 0 and neonatal mortality was 2 per 1,000. In this study 79.5 percent of the clients received no analgesia or anesthesia, 57 percent of the clients had episiotomies, and 5.1 percent had cesarean sections. The use of Pitocin in labor was 29 percent and electronic fetal monitoring was used with 43 percent of the women. Maternal mortality was 0 and neonatal mortality was 2 per 1,000.

The National Birth Center Study included 11,814 women in 84 freestanding birth centers in the United States (Rooks, Weatherby, Ernst, et al. 1989). Certified nurse-midwives and their students provided care during 78.6 percent of the labors and 80.6 percent of the births. Of the women in this study, 70.7 percent had only minor complications, 7.9 percent had serious emergencies such as thick meconium or severe shoulder dystocia. Of the study sample 15.8 percent were transferred to a hospital; 2.4 percent were emergency transfers. There were

no maternal deaths. Of the women who gave birth in the centers, 99.4 percent had spontaneous vaginal deliveries with forceps used in 0.2 percent. The overall cesarean section rate was 4.4 percent; the most common reason was failure to progress. The Rooks study used Apgar scores and mortality rates as measures of final outcome. Of 11,814 babies, 0.6 percent had five-minute Apgar scores below 7. Of 11,826 births, a total of 15 intrapartum infant deaths occurred, 7 of which were due to congenital anomalies. The overall mortality rate was 1.3 percent per 1,000 births. Of the 75.7 percent of the women who completed patient satisfaction surveys, 98.8 percent stated that they would recommend the birth center to friends and 94 percent said that they would use it again themselves. Rooks, Weatherby, Ernst, et al. (1989) also reported that the combination of good outcomes and low cesarean section rate found in this study has also been found in studies of hospital-based nurse-midwifery care.

A final study summarized the process and outcomes of the first 1,000 births of a California nurse-midwifery service (Cavero, Fullerton, and Bartlòme 1991). All of the women in this study were evaluated as low risk in order to be admitted to the nurse-midwifery care. Data were collected retrospectively from chart audit. Eighty-seven percent of the clients had spontaneous vaginal births. The cesarean section rate was less than half the rate of the other obstetrical clients in the same hospital. There were 5.9 percent low birthweight infants. Nine hundred thirty-six infants were judged to be at term, 22 were postmature, and 29 were premature. Ninety-three percent of the infants had an Apgar score of 7 or better at one minute of age. There were 41 cases of postpartum hemorrhage, 12 cases of endometritis, and 21 instances of significant anemia. One maternal death occurred, due to cerebral aneurysm in the postpartum period. The authors of the study then compared the CNM service results to those of the United States, California, and Fresno County. The CNM low-birthweight rate of 5.4 percent was compared to rates of 6.8 percent (United States), 6.2 percent (California), and 6.5 percent (Fresno County). The CNM perinatal death rate (which includes fetal deaths at more than 20 weeks and neonatal deaths at less than 28 days) of 7.0 percent was compared to rates of 17.5 percent (United States), 14.6 percent (California), and 13.6 percent (Fresno County).

The research studies reviewed conclude uniformly that nurse-midwifery practice maintains both quality and safe outcomes of care. Although many design issues can be cited within the comparison studies, the weight of the evidence is such that CNM care appears to be as safe and effective as physician care.

ISSUES OF COSTS

The economic analysis of physician and nurse-midwife comparisons has had limited documentation in the literature. Much of the discussion either is not research based or is limited to very small studies. Perhaps because the majority of maternity care has been covered by third party reimbursement for many years, little emphasis has been given to gathering such data and drawing policy conclusions. Five relevant studies are found in the literature dealing with the cost issues of alternative providers. These studies are summarized in Table 2.

Lubic (1981) reported a fiscal audit for 1976/1977 of the Childbearing Center, an out-of-hospital maternity care facility where nurse-midwives provide most of the care. The audit was conducted by Blue Cross/Blue Shield of Greater New York. The report indicated that, barring complications, charges for Childbearing Center care were 37.6 percent of in-hospital care charges. This report was anecdotal, with no discussion of how the figures were derived.

Reid and Morris (1979) described expenditures for prenatal care in four rural Georgia counties after the introduction of a nurse-midwifery service. The program of care was undertaken when the number of women who arrived at the hospital for delivery after little or no prenatal care was recognized as a serious problem. The target group was defined as women of low to moderate income who had no private physician. Agreement was made to establish a nurse-midwifery service and two nurse-midwives were hired in 1979. Estimates of total expenditures for each of the four target counties were established by categorizing both services (physician, nurse-midwife and public health nurse, and hospital) and types of recipients (target group and private). Hospital expenditures were estimated by determining an average cost per day for deliveries by dividing the average cost per delivery by the length of stay. This figure was multiplied by the average length of stay for either target group or private patients and then by the number of patients of each type. Hospital expenditures included costs and supplies but did not include fees for physician services. Expenditures for physician services were estimated to be the income received by obstetricians for normal prenatal care and delivery. Additional charges for complications or neonatal care were not included. Expenditures for nurse-midwives and public health nurses were derived from estimates of expenditures for prenatal care and delivery. Costs of prenatal visits were estimated from data supplied by the health department and were based on the salary of a public health nurse. Other (laboratory) expenses were included also. Delivery expenditures were estimated based on the salaries and fringe benefits of the two nurse-midwives. Estimates of total perinatal care

TABLE 2 Summary of Charge Research

<i>Study</i>	<i>Sample</i>	<i>Design</i>	<i>Charge Variable</i>	<i>Outcomes</i>	<i>Comments</i>
Reid and Morris 1979	Four target counties in Georgia	Before and after groups	Estimated MD, CNM/PHN, and patient expenditures	Decrease in total perinatal care expenditures	Authors cite questionable reliability of retrospective data based on financial records; estimated costs
Lubic 1980	Childbearing Center	Fiscal year audit by Blue Cross/Blue Shield in Greater New York City	Charges	Childbearing Center's charges 37.6% of in-hospital care	Insufficient data to evaluate
Cherry and Foster 1982	48 CNM clients matched to 45 MD clients	Matching on relevant criteria; hospital deliveries	Charges from hospital billing records	Mean hospital bill for CNM clients \$114 less than for MD clients	Small sample
Stewart and Clark 1982	2,050 births	Retrospective; in-hospital birth center	Estimated costs for normal uncomplicated vaginal deliveries	Costs in birth center \$150 to \$750 less than in area hospitals	Insufficient data to evaluate
Krumlauf, Oakley, Mayes, et al. 1988	29 matched pairs of clients of CNMs and MDs	Matching on relevant criteria; hospital-based CNM practice	Charges from hospital billing records	Professional service charges same for both groups; total hospital charges \$402 more for MD clients than for CNM clients	Small sample; no cesareans included

expenditures were shown to decrease over the course of the program for the four-county area. Increases in expenditures were seen for the target group, but these were offset by the decreases in the expenditures of the private group. Savings were realized primarily due to both a shortened length of stay following delivery and the use of less expensive personnel.

Stewart and Clark (1982) describe a nurse-midwifery practice in an in-hospital birthing center. The estimated cost of obstetrical care for a normal uncomplicated vaginal delivery in this center was from \$150 to \$750 less than at eight other hospitals in the west Atlanta area. These data are based on a survey of eight other hospitals in the metropolitan area where the birthing center was established. This study did not reveal how costs were calculated.

Another study found that the mean hospital bill for a maternity stay for CNM patients was \$114 less than the hospital bill for patients of physician providers (Cherry and Foster 1982). In this study 48 CNM clients were matched with 45 physician clients. Subjects were matched according to date of delivery, parity, maternal age, spontaneous or forceps delivery, medication used for delivery, infant weight and Apgar scores, lack of complications, and place of birth. Total charges were calculated from hospital billing records. The lower CNM charges were due primarily to the shorter mean length of stay for the CNMs and to their increased use of the less expensive birthing room during the postpartum period. The birthing room was used by 56 percent of CNM patients and 29 percent of MD patients. There was also a significant difference in the mean charges for intravenous use between the patients of the two providers. CNM patients (54 percent) were charged a mean amount of \$14.71; physician patients (84 percent) had a mean charge of \$25.05. Although both groups had an almost equal number of spontaneous deliveries, only 37 percent of CNM patients received anesthesia compared to 78 percent of physician patients.

In another study of matched pairs of 29 clients each of CNMs and obstetricians, Krumlauf, Oakley, Mayes, et al. (1988) found that the average charges for the 58 clients in the study were \$3,843 per woman. The mean total charges to MD clients were \$4,117 and to CNM clients \$3,569. These differences approached statistical significance. This study was also the first to consider the professional charges of provider groups. It showed that the professional service charges of both of the provider groups was essentially the same but that significant differences were noted in the total hospital charges: obstetrician charges were \$402 more per client than CNM charges. Physicians tended to use more electronic fetal monitoring, anesthesia, and regular delivery rooms than did CNMs. The mean charge of electronic fetal monitors was \$38 (CNM)

compared to \$69 (MD). The mean charge of anesthesia was \$7 (CNM) compared to \$97 (MD). The mean value of normal delivery room charges was \$139 (CNM) compared to \$559 (MD). The differences between each of these three interventions by provider group was significant.

Only a limited number of research studies deal with the cost issues of provider substitution, and the available studies have some conceptual or measurement problems. Not all of these five studies include an analysis of complications as a factor contributing to differences in costs. Some of these studies fail to define measures of charges while others make the implicit assumption that charges equal costs. All of the current studies are small in sample size and cover a very limited time period. Only one study considers professional service fees as a part of charges (Krumlauf, Oakley, Mayes, et al. 1988).

INADEQUACY OF THE PROVIDER SUBSTITUTION MODEL

Despite some methodology problems, all of the studies cited explicitly or implicitly conclude that no lessening of quality of care or outcomes occurs when maternity care is provided by CNMs. Having established that physicians and CNMs have equal outcomes and quality of care, the one-for-one substitution of CNM for physician is still not perfect in the economic interpretation of the term. That is, if all other things are equal, one cannot substitute a CNM, generally thought to be a less costly provider, for a physician and conclude that the same output will be produced at less cost. One reason is that some proportion of low-risk women will have complications requiring medical management. For this reason, CNMs always work with physicians in some manner.

However, the major inadequacy of the substitution model is that it ignores differences in the "market basket" constituting the care of each provider. This omission leads to the need to consider *comparability of care* as a third factor in determining the substitution potential of CNMs for MDs.

ISSUES OF COMPARABLE CARE

Some studies have documented differences in the care processes of these two providers. The differences can be classified into two types: differences in the use of technical interventions and differences in the psychosocial aspects of care.

Differences in Technical Interventions. Some research is available to show that CNMs are less likely to use technical interventions and

more likely to use hands-on, time-consuming procedures. Petersen (cited in George 1990, 100) described nurse-midwives' approach as "low tech, high touch."

Feldman and Hurst (1987) reported a study of two retrospectively matched groups of low-risk women. One group had care delivered by CNMs with delivery at an out-of-hospital birth center; a second group had prenatal care provided by obstetricians, with in-hospital delivery where care was provided by nurses, obstetric residents and fellows, and private physicians. The two groups varied very little, although the birth center clients were somewhat better educated, more likely to be non-Hispanic white, and often nulliparous. When outcomes between the two groups were compared, the use of the following were found to be significantly more frequent in the hospital group: Pitocin augmentation, amniotomy, electronic fetal monitoring, intravenous use, analgesia and anesthesia, episiotomy, and forceps. Cesarean rates were twice as high in the hospital group but the difference was not statistically significant. Forceps deliveries were also more likely in the hospital group. The comparisons of indications of possible complications were mixed. The incidence of meconium staining was similar in both groups, but the thick meconium staining was three times higher (18 percent versus 5 percent) in the hospital group. The birth center recorded 5 percent fetal heart rate abnormalities compared to almost 25 percent in the hospital group. Infant outcomes were not significantly different between groups. Three hospital babies were transferred to neonatal intensive care for respiratory distress. No neonatal or maternal mortality occurred in either group. The authors concluded that this study showed evidence that out-of-hospital birth centers are as safe as hospital settings, and that the birth center studied was providing comparable safety with less intervention.

A study undertaken to document the differences in care given between CNMs and obstetricians to comparable groups of low-risk women found very different distributions in the percentage of women experiencing key components of care (Mayes, Oakley, Wranesh, et al. 1987). This was a pilot study in which a case-comparison design was used. A total of 58 subjects, 29 in each group, were matched for time of delivery, parity, mother's age, and infant weight. All subjects met the low-risk criteria of the CNM service. Although this was a pilot study with a small sample, the results did identify care differences. While only 34 percent of the CNMs used any form of electronic fetal monitoring, 100 percent of the obstetricians used it. Intravenous fluids were administered to 38 percent of the CNM clients and to 72 percent of the physician clients. Pitocin was used for 22 percent of CNM clients and 56 percent of physician clients. There was also a significant difference in the place of

birth. Eighty-nine percent of physician clients gave birth in a delivery room, while only 30 percent of CNM clients used a delivery room. Seventy percent of CNM clients gave birth in either a labor room or a birthing room. Analgesics or sedatives were used during labor by 10 percent of the CNM clients and 45 percent of the MD clients. Twenty-four percent of the CNM clients had episiotomies compared to 76 percent of the physician group.

Differences in Psychosocial Aspects of Care

In a recent study, researchers identified differences in care between obstetricians and CNMs in a hospital-based practice from reports of these providers (Yankou et al. 1992). CNMs reported scheduling significantly more time for both first visits and return visits than obstetricians. These self-reports were corroborated by a random check of provider schedules. The self-reports of CNMs also indicated that they did most of their own teaching compared to physicians' reliance on other staff members. The areas on which CNMs reported teaching were: nutrition, infant feeding, exercise, parenting, and minor maternal illnesses. These were areas that tend to represent nonmedical, psychosocial aspects of care—giving further support to the argument that care differences exist between the two providers.

A study designed to describe the effect of the introduction of certified nurse-midwives into a prepaid group practice found care differences in the anecdotal reports of clients (Record and Cohen 1972). Clients stated that they asked a midwife things they "wouldn't bother their doctor with," such as a rooming-in option. The authors summarized by saying that the CNM may not only be substituting for a physician in the lesser medical skills but also providing a service that the doctor cannot provide.

PRODUCTION PROCESS SUBSTITUTION MODEL

Because differences exist in both the technical and psychosocial aspects of care provided by physicians and CNMs, a single production function permitting simple provider substitution does not adequately describe the relationship between the care produced and the inputs used to produce it.

The simple production function, $Q_{mc} = f(P_{dr}, RN, Z)$ presented earlier does in fact represent two highly complex production processes by which maternity care is produced. One process uses the obstetrician as the primary provider; the second uses the CNM as the primary pro-

vider. Each provider then selects a multitude of other inputs such as anesthesia, location for delivery, laboratory testing, teaching, counseling, and so on. Differences between the two providers and differences in the other production inputs that each provider selects are the components of the production processes that affect both the cost and the output of maternity care. Because the two providers select different inputs to produce maternity care, a single production function model does not accurately reflect the differences in the two providers and thus does not allow for empirical testing of the model and comparisons between providers.

A more appropriate model would be to posit two production processes:

$$Q_{mcCNM} = f(P_{drCNM}, Z_{CNM})$$

and

$$Q_{mcOB} = f(P_{drOB}, Z_{OB}).$$

In this model the quantity of maternity care produced by the CNM is a function of the specific provider and the inputs selected by that provider. These equations also suggest that the output of each provider is qualitatively different. The maternity care produced by an obstetrician is not the same as that produced by a CNM. Obstetricians, for example, use electronic fetal monitoring more frequently than do CNMs. Conversely, CNMs use more time to teach nutrition to clients. These are examples of differences in inputs selected by a provider. Other research has been cited earlier to support this qualitative difference in care.

IMPLICATIONS FOR POLICY RESEARCH

The simplest way to think about the cost-saving possibilities of providing maternity care by nurse-midwives is to envision a direct substitution of midwife time for physician time. This article has argued that shifting care from physicians to nurse-midwives amounts to a fundamental change in the production process of maternity care, a change affecting ways in which other production inputs are used and, indeed, a change influencing the qualitative nature of the care provided.

If this argument has merit, studies of the costliness of care by nurse-midwives and physicians should examine all aspects of the production process associated with the two provider types. In particular, care should be taken to understand the differences in the use of production inputs between physicians and nurse-midwives. Special attention

must be devoted to controlling for outcomes, quality of care, and risk status of the client.

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