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Medical Practice Variations in Reproductive, Obstetric, and Gynaecological Care

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Abstract

In hospitals and practices that provide reproductive health services, there is still no consensus on the best way to diagnose and treat extensively studied clinical procedures. Procedures for surgery, screening, diagnostics, maternal, and newborn care vary across facilities, regions, and countries, and so do health outcomes. This chapter explores these variations. Understanding why and how clinical practices vary is a crucial step to improving reproductive health-related services.
Reproductive health encompasses all reproductive processes, functions, and systems, at all stages of life.
The definition of practice variation in reproductive health used in this chapter includes services for women's and men's reproductive health and neonatal care. Though the focus is on prostatectomies, hysterectomies, and C-section variations, this broad definition is kept in mind.
The study of medical practice variation of reproductive health started with the early work of Miller (Am J Obstet Gynecol 51:804–10, 1946) looking at hysterectomies and has progressed with the work of Wennberg and Fowler at al. exploring different gynecologic procedures and prostatectomy. Today, this field has grown significantly.
The first three sections of this chapter focus on medical practice variation for different types of services for women, men, and newborns. The last section of this chapter focuses on variation of the workforce supply and its effects on reproductive health.

Introduction

Definition of Subject Area

The reproductive system consists of the reproductive organs, associated ducts, and external genitals. Reproductive health considered in this chapter includes women's and men's reproductive health and newborn care. In this chapter particular focus lies on obstetric and gynecological care, to make the case for medical practice variation for this end of spectrum of health services.

The goal of the section is to understand the way services are distributed, determinants of such variation, and differences in their outcomes. Patients tend to demand long lists of services for themselves and their newborns, and medical practitioners offer many different treatments for a range of health conditions. Many of the medical procedures that maintain and restore reproductive health (RH) are provided in high volumes and often are of high priority because poor RH has imminent consequences on human reproduction. Variations in clinical practice in RH might be explained by differences in the individual preferences of patients and physicians, by organizational characteristics of care provision, or by systemic factors, including payment systems, insurance coverage, and the like.

Not all variations are alike: some variations may directly compromise quality of care at the patient level, resulting in the utilization of harmful procedures, ineffective care, and poor health outcome. Practice variation can also indicate that the health system is not performing well, is inefficient, or is too expensive. High-income countries' overuse and oversupply of services may contribute to this variation. In developing countries, where health-care resources and funding are scarce, undersupply and differential access to care are other major determinants of practice variation. Variation in service provision does not necessarily indicate a problem. It may address differences in the population health or differences in health-care systems. The ability to vary service to meet the needs of the system and patients, without compromising quality of care, may be an indicator that a health-care system is performing well. But neither the positive nor negative effect of a variation can be taken for granted. Studying variations in medical practice helps determine the differences in the way services are provided and also seeks to understand why variations arise by identifying specific and systemic incentives or limits, as well as areas of over- and undersupply of services.

The Historical Evolution of Practice Variation in Reproductive Health (RH)

In 1946, the first report on medical practice variation in provision of RH services, specifically hysterectomies, was published by Miller. The author asked if differences in hysterectomy rates among hospitals were the result of a "surgical racket" or a "therapeutic necessity." However, the most influential publications came later; in the 1970s, Bunker (*1970*) investigated variation in rates of surgical procedures, challenging the paradigm that treatment is always beneficial to patients. Later, Wennberg and Gittelsohn followed suit (McPherson *2008*). Vayda and Anderson's (*1975*), McCarthy and Widmer's (*1974*), and Walker and Jick's (*1979*) works on hysterectomies were also influential. In the 1980s, Jack Wennberg and Klim McPherson (McPherson et al. *1982*; Wennberg and Gittelsohn *1982*) studied variations in hysterectomy rates and related outcomes. They conducted the first small-area analysis studies, laying groundwork for Fowler et al. (*1993*) and also subsequent studies that examined different gynecologic procedures and prostatectomy. From 2001, Goodman and Thompson (Goodman et al. *2001*; Thompson et al. *2005*) went on to study medical practice variations in newborn

care. There is now a great deal of research on medical practice variation in RH services; for example, variation in C-section rates is one of the most extensively studied variations in medical practice. Certain studies have crossed international borders. McPherson, Walker, Wennberg, and Stephenson have been interested in international comparisons. Stephenson's (Stephenson et al. *1993*) work spurred the interest of major international health agencies in the study of variation, including the World Health Organization (WHO) and, later, the Organisation for Economic Co-operation and Development (OECD). In 1992, WHO's first report on international variation, with data from 1983 to 1988, was published. It analyzed variation in 12 countries (Victoria, Australia; Quebec, Canada; Czech Republic; Slovak Republic; Denmark; Finland; Greece; Hungary; Israel; the Netherlands; Slovenia; Scotia, the United Kingdom; and Washington state, USA). WHO sought to determine rates of obstetrical interventions and changes over time and to investigate C-section rates within hospitals and regions of each of the participating countries. The study also investigated determinants of variation, including population-related factors and indicators of hospital performance (Stephenson et al. *1993*). In 2011, the OECD initiated a systematic approach, documenting medical practice variations, with a focus on within-country variations. The study explored possible causes of practice variation and suggested policy options to reduce unwarranted variation and to improve resource allocation. Variation between countries is most likely rooted in differences between health systems and sociocultural factors, making it difficult to isolate specific causes of variation. Studies of variation within a country may be more useful than between countries since they usually involve a single health-care system. Furthermore, causes and outcomes of variation, including on the supply side, can be easily identified (McPherson *2008*).

Research on variation in RH services has policy implications, such as reducing the number of services provided (McPherson *2008*). However, an understanding of the policy process is required to put research into practice at the level of the health system. Clinicians, policy-makers, insurers, and other stakeholders may not agree on the value of research findings. However, researchers must cultivate good relationships with decision-makers if they wish to improve health services and see their evidence-based and applicable recommendations put into practice.

The Road Map to This Chapter

The first three sections describe variation in the provision and utilization of different RH services and their health outcomes. These sections focus on variations in medical practice among different types of services for women, men, and newborns. The last section deals with variation of workforce supply and its effects on RH.

The emphasis is primarily on geographic/regional variation studies. However, studies that examine variation at the hospital or individual levels (i.e., physicians or patients) are also presented to clarify points of importance. Since most variation studies are descriptive, causes of the variation are not identified. Certain analyses, however, control for specific factors (usually demographic and clinical) and exclude potential determinants of variation. It is possible that systemic factors at all three levels (geographic/regional, hospital, and individual) may contribute to variation and may be responsible for negative outcomes of variation. Hospital-level variation studies and studies that examine decisions at the individual level tend to capture causal relationships between determinants of variations in service provision.

This chapter focuses on prostatectomies, hysterectomies, and C-section variation because they have been extensively studied, and researchers have improved their understanding of the causes of these variations and the influence of variation on health outcomes. Existing research on prostatectomy and hysterectomy has shaped health policy discussions in England and the USA. Interest in C-section

variation is large because the procedure is increasingly common, worldwide. There are studies on other RH services, including investigations of radiation and chemotherapy for conditions related to RH, but these were not included because the focus is on elective surgery procedures, diagnostic/screening procedures, neonatal care, and physician supply of physicians. Furthermore, the chapter examines three key aspects of variation for each procedure: description of variation in geographic regions, determinants that may explain variation (especially those not based on medical need), and clinical or systemic outcomes (i.e., health expenditures).

Medical Practice Variation in RH

Medical Practice Variation in Women's RH Care

Research on medical practice variation often focuses on the practice of women's RH care. Practice variation in women's RH care is often linked to procedures that are or can be elective (i.e., C-section, lumpectomy, breast reconstruction). In such procedures, patient preferences may play a key role in the decision for health service utilization. For elective procedures, there may be trade-offs between choosing most effective treatments, with risk of complications, and those treatments that provide limited health benefits with low risk of side effects. Wennberg (*2010*) defines this as "preference-sensitive care." Physician's uncertainty regarding the best protocol to be used for specific procedures may also drive such variation, which may result in inferior effectiveness of care (Wennberg *2010*).

Breast Cancer Diagnosis and Treatment

Women are more likely to be diagnosed with breast cancer than any other cancer, and the disease kills about 460,000 women a year (OECD *2011*). Diagnosis of breast cancer begins when women self-report lumps in their breast or when lumps are detected by mammography screening. The lump is biopsied to establish a reliable diagnosis. At this stage of the disease, cancers are usually confined to the breast and have not spread to other organs, as they do in later stages. Decisions about treatment are made based on the stage of the disease at initial diagnosis. Next, services are discussed along the chain of diagnosis and treatment, including mammography, mastectomy, and reduction mammoplasty.

Mammography – Many OECD countries have developed and implemented screening programs for breast cancer. The US Preventive Services Task Force (USPSTF) recommended that every woman between 65 and 69 years old should have a mammogram at a maximum interval of 2 years (Wennberg *2010*). The European Commission guidelines target 75 % of all eligible women for inclusion in breast cancer screening programs (OECD *2011*). However, recent research has brought the need for this screening into question.

Though US health policies are designed to encourage doctors and women to depend on mammograms to screen for breast cancer, utilization rates have not met set targets and vary widely across the country. During 1995 and 1996, only 12–50 % percent of women aged 65–69 were screened with mammograms. Differences were evident across hospital referral regions (Wennberg et al. *1999*). Ten hospital referral regions in Michigan saw among the highest percentages of women who had at least one mammography within 2 years. The highest rate of screening was achieved by Kaiser Permanente South Health Maintenance Organization (HMO), which screened 82 % of women. Though screening

programs did not meet the target goals, many more women were screened in 1996 than in 1993, when the screening rate varied between hospital regions from 9 % to 35 % among women 65+ enrolled in the Medicare program (Wennberg et al. *1996*). In 1996, the coverage rate for screening was still far less than the 50 % target set by the USPSTF.

Wennberg et al. (*1999*) examined variation in mammography screening but found no association between the supply of specialists/general physicians and the number of mammograms. In 1996, Wennberg et al. suggested service provision might vary because women were given different descriptions of the procedure's importance. In some regions, higher screening levels may be due to the success of various outreach efforts (Wennberg et al. *1999*; Rosso et al. *2010*). The 2011 OECD data on obstetric care showed that there is a correlation between providing too many curative services (i.e., C-sections) and too few preventive services, as was evident in Turkey. This evidence highlights the role physicians may play in health promotion.

Policy-makers should consider the benefits of treatments provided to patients and balance those benefits against their costs. For example, early detection of cancer can be a lifesaver, and low rates of screening in some regions may place a serious burden on health. Nevertheless, there is growing evidence that screening for breast cancer is not an unmitigated good and that it may result in overdiagnosis of cancers (Welch *2009*, *2011*; McPherson *2010*; Gotzsche and Jorgensen *2013*). Screening appears to have reduced mortality but has also resulted in increased incidence and treatment of false-positive or harmless cancers (McPherson *2010*). Efficiency of screening programs is also questionable. Zackrisson et al. (*2006*) found that 10 % of breast cancers were diagnosed after screening, while Jorgensen and Gotzsche (*2009*) found that screening programs detected one-third of breast cancers. Overdiagnosis and efficiency factors call into question the utilization of mammography screening programs.

Mastectomy – Mastectomy (breast tissue is surgically removed) is the most common treatment for breast cancer. The most extensive procedure is radical mastectomy, which completely removes the breast, the skin over the breast, all of the lymph nodes underneath the arm, and the chest muscles. A modified radical mastectomy removes all the breast tissue and lymph nodes but leaves the chest muscles in place. Total mastectomy also removes the entire breast and auxiliary lymph nodes if these are present in the breast tissue. In comparison, a less extensive procedure is subcutaneous mastectomy, in which the entire breast, except the nipple and areola, is removed. Other ways to describe mastectomy relate to the procedures being more or less conservative: nonconservative mastectomy spares some glandular breast tissue, while a conservative mastectomy completely removes glandular tissue in the breast and may or may not remove skin tissue. Breast lump removal, often referred as lumpectomy, entails surgically removing specific breast cancer sites and the tissue that surround the main locus. Most of these procedures are combined with other therapeutic approaches, including radiotherapy, chemotherapy, and hormonal therapy.

The rate of radical mastectomy varies considerably among regions. In 1998, in the USA, mastectomy was the most varied procedure among 306 hospital referral regions (Wennberg et al. *1998*). Between 1994 and 1995, there were a variation of 30 % or more in 26 regions and a variation of less than 25 % in 19 regions. The rate of lumpectomies varies too. Though there seems to be little difference in survival rate among women who undergo lumpectomy (combined with radiation and chemotherapy) and those who undergo radical mastectomy, the proportion of women that receive those procedures is far from equal. Between 1992 and 1993, in the USA, more than 100,000 lumpectomies were performed on women in the Medicare program who were over 65 and had been diagnosed with cancer (Wennberg et al. *1996*). The rates of lumpectomies among 306 hospital referral regions in the USA varied from 1.4 % to 48.0 %, while the Northeast regions had the highest rate. Regions located in the South, Midwest, and Northwest had the lowest rates. Other countries have also reported variation in

mastectomy. Conservative mastectomy rates of breast cancer varied fourfold among health service areas in Spain (Ridao-Lopez et al. *2011*). Nonconservative mastectomy varied twofold regardless of the age group.

Examination of determinants of variation of rates of mastectomy has shown that areas with low economic and educational levels have tended to experience low rates of conservative mastectomy (Ridao-Lopez et al. *2011*). Income level and regional policies are factors in the rate of variation (Ridao-Lopez et al. *2011*). Physicians have a strong influence in the rate of variation in deciding on which type of procedure to adopt (Wennberg *2010*).

The choice of procedures may be influenced by any potential risks and side effects, or lack thereof, of the chosen procedure. As noted above, lumpectomy and mastectomy have similar outcomes (Wennberg et al. *1998*). However, side effects from radical mastectomy (bleeding, infection, pain, swelling, hard scar tissue at the site of surgical intervention, numbness, hematoma) as well as its emotional impact are far greater than those of lumpectomy. On the other hand, lumpectomy is usually accompanied by X-ray treatments, and cancer reoccurrence tends to be more common than with mastectomy. It is not easy to choose between the two procedures, since one entails losing the breast, while the other consists of exposure to radiation. In this situation, a strong case can be made for patients to make the decision (Wennberg et al. *1998*). Women should be encouraged to provide informed consent in such circumstances.

Reduction mammoplasty – Reduction mammoplasty, or breast reduction surgery, is a typical example of an elective procedure with wide variation. It may be indicated for medical reasons after a woman has undergone breast intervention, if she wants to correct the shape of the removed breast. Or it may be performed for esthetic reasons, if women want to shape their breasts according to their preference.

Previous research suggests that reduction mammoplasty provision is variable. Gittelsohn and Powe (Gittelsohn and Powe *1995*) argue that the variation may be explained by differences in medical opinion across small areas, socioeconomic factors that influence patient preference, and other local population attributes within small areas. High use tends to be associated with high income level (Gittelsohn and Powe *1995*). However, if the procedures are not analyzed in detail, it is difficult to know if certain variations are consistent with over- or under-provision of services (Gittelsohn and Powe *1995*).

Reduction mammoplasty has similar potential side effects as other surgery (i.e., surgical wounds, effects of anesthesia, and long-term effects of the procedure, such as limitations on breastfeeding, scarring, loss of feeling in the nipple area, and poor esthetic outcomes). The cost of the procedure to the health-care system and to the patients varies, since this elective procedure is sometimes not covered or only partially covered by health insurance plans. Places where this surgery tends to be frequently performed are associated with elevated numbers of negative outcomes compared to places where it is rarely performed.

Procedures for Diagnosis and Treatment of the Uterus and Ovarian Tubes

Hysterectomy – Hysterectomy, the surgical removal of the uterus, is a common surgical procedure, and the rate at which it is performed has increased over the years. There are several types of hysterectomy. In a total hysterectomy, the body, fundus, and cervix of the uterus are removed. In a partial hysterectomy, the uterine body is removed, but the cervix is left intact. Hysterectomy is used to treat benign conditions, including abnormal uterine bleeding, endometriosis, pelvic relaxation, and preinvasive and invasive neoplasms. It is also used to treat acute conditions, including postpartum

hemorrhage or tubo-ovarian abscesses (Lefebvre et al. *2002*). In 2003, the USA overpassed other developed countries in the number of hysterectomies performed, with over 600,000 cases performed (Wu et al. *2007*). Of those, more than 90 % were for benign conditions (Wu et al. *2007*). In the Netherlands, between 1995 and 2005, the hysterectomy rate for benign cases was 1.72 per 100,000 women of all ages (Hanstede et al. *2011*). In 2008, OECD countries performed more than 350 hysterectomies per 100,000 women (McPherson et al. *2013*). According to the same source, Canada was not far behind, with 333 hysterectomies per 100,000 women, followed by Australia and Switzerland with over 200 hysterectomies per 100,000 women. Ireland had the lowest rate: just over 100 (McPherson et al. *2013*). The high rates of hysterectomy have been a source of concern among policy-makers on whether the procedure is being performed for unwarranted and unnecessary reasons. Discussions on appropriate indications, benefits, and outcomes of hysterectomy are ongoing. There is no agreement about risks and treatment alternatives that should be taken into consideration.

Rates for hysterectomy are known to vary across regions (Wennberg *2010*). Studies on surgical procedures as early as the 1980s confirmed that provision of hysterectomies varied within and among countries. In southern Norway, the rate of hysterectomies varied across seven hospital service areas (McPherson et al. *1982*). Within three New England states and in the United Kingdom, variations were not evident across service areas (McPherson et al. *1982*). According to 1985–1987 data, for the state of Maryland (USA), geographic variation of surgical procedures (including hysterectomy) was found even though this region tends to be characterized with low variation (Gittelsohn and Powe *1995*). More recent studies in the United Kingdom have also found variation of rates of surgery (including hysterectomy) (Coulter et al. *1988*). In Spain, in 26 areas of Catalonia, variation was found in hospitalization rates after hysterectomy (Jane Camacho et al. *1996*). Between 2002 and 2004, in 180 health-care areas in Spain, hysterectomy rates were found to vary also (Peiro et al. *2009*). Even in a country with the low hysterectomy rates, such as The Netherlands, variation is still found in hysterectomy rates (Hanstede et al. *2011*). An examination of women with a hysterectomy for benign gynecological conditions in the Netherlands in 1995–2005 showed variation among hysterectomy rates between 27 health-care regions within the country. Differences among regions tended to show a slight decline over the years (Hanstede et al. *2011*).

Physicians tend to influence variation when they exert preferences in clinical practices of which they are unclear (McPherson et al. *1982*). At times, they belong to a medical community that promotes a specific theoretical view and particular styles of practice (Coulter et al. *1988*; Wennberg *2010*). For example, though hysterectomy is sometimes performed to reduce bleeding and pain, and sometimes as a cancer treatment (Wennberg *2010*), these practices are not based on evidence (Wennberg *2010*). It is often the physician who makes the clinical decision based on his/her preference.

Though patients may have little direct influence in the clinical decision-making (Wennberg *2010*), they tend to accept a hysterectomy if they feel their symptoms, including loss of blood and pain, are severe enough to warrant the procedure (Coulter et al. *1988*). Ethnicity and socioeconomic status are also significantly associated with the geographic variation of this procedure (Carlisle et al. *1995*). Factors such as the presence of large health-care centers in service areas, strong economic growth, and high education levels do not seem to have an influence on the procedure (Peiro et al. *2009*). There is no evidence that practice variations in hysterectomy are associated with different health systems or to financial incentives and payment systems (McPherson et al. *1982*).

Unwarranted variation in hysterectomy rates may indicate that “clinical freedoms” exerted by clinicians do not always benefit patients (McPherson *2008*), such as in cases in which healthy organs are removed (Coulter et al. *1988*). During hysterectomies, healthy ovaries are normally removed (Oophorectomy) (Clarke et al. *2006*). For example, in 2003, in the United Kingdom, 19,000 sets of

healthy ovaries were removed in 41,000 hysterectomies (Clarke et al. *2006*). The consequences of removing healthy ovaries are discussed in a following section on oophorectomy.

Referral for hysterectomy – A study by Coulter et al. (*1988*) showed that general practitioners (GPs) refer patients for hysterectomy at different rates. GPs serve as gatekeepers, which gives them a lot of influence in deciding which procedures will be best for patients. GPs can be more or less knowledgeable about the conditions for which they refer patients. If they refer patients because they are unwilling to handle the patients' problem, the decision-making influence gets shifted to a specialist who is more likely to prescribe surgery. GPs tend to be less likely to be familiar with the practice style of specialists or to know the status of waiting lists. GPs may have ties to particular specialists and automatically refer patients to them.

Oophorectomy – Oophorectomy, bilateral removal of ovaries, is often performed as a prophylactic measure against ovarian cancer. This cancer is usually fatal; only about 40 % of women with ovarian cancer are still alive 5 years later (Clarke et al. *2006*) – a frightening statistic for both patients and doctors. The procedure may also be used to address other problems, including chronic pelvic pain, pelvic inflammatory disease, endometriosis, adenomyosis, uterine prolapse, fibroids, and menorrhagia (Clarke et al. *2006*). The removal of ovaries is usually justified for the following three reasons: first, doctors consider ovaries unnecessary when a woman is no longer fertile, and the ovaries may cause problems if they remain (i.e., ovarian remnant syndrome); second, if certain genetic markers are present, they increase the likelihood a woman will develop ovarian cancer; third, surgeons consider oophorectomy to be a prophylaxis measure easily performed during hysterectomy. But removing them may not be the best option for women. The ovaries produce hormones that regulate the menstrual cycle and play a role in women's metabolism. Removing the ovaries disrupts homeostasis in a woman's body and may have various effects including increasing her risk of breast cancer, cardiovascular disease, and fractures (Clarke et al. *2006*).

Obstetric Interventions

Cesarean section (C-section) – C-section is regularly utilized for women giving birth. Sometimes, it is indicated for medical reasons, but often it is an elective procedure. C-section rates have continuously increased over the past few decades in many countries (Betran et al. *2007*; MacDorman et al. *2008*). Brazil has the highest rate of C-section (47.4 %), followed by China (46.2 %), Turkey (42.7 %), and Mexico (42.0 %) (OECD *2011*). Even countries where the C-section rates are low have seen an increase. For example, in Norway 2.2 % of women had C-sections in 1970, and by 2005, this had increased to 16.4 % (Grytten et al. *2012*). In Sweden, the C-section rates doubled between 1970 and 1983 (Eckerlund and Gerdtham *1998*). This trend is similar in developing countries. In Kosovo, C-section rates increased from 7.5 % in 1999 to 20.1 % by 2009 and to 50.6 % in the private sector (Ministry of Health) (Health *2011*). This increase in C-sections may not be entirely due to improvements to patient care.

Studies of regional variation of C-section rates have been instrumental in raising concerns over the issue of C-section increases. Gittelsohn and Powe (*1995*) investigated and confirmed the variation in C-section rates in Maryland, USA, across 115 small areas of the state. Recent studies confirm the pattern of variation. Baicker et al. (*2006*) found that there was a fourfold difference in C-section rates in low- and high-use areas (Baicker et al. *2006*). In England, the rates have varied threefold among National Health Service trusts (Bragg et al. *2010*). For low birth weight deliveries, the risk adjusted rates of C-section varied from 25 % to 50 % (Baicker et al. *2006*). Looking at births in British Columbia, Canada, between 2004 and 2007, the primary cesarean delivery rates varied from 14.7 % to 27.6 % across health service delivery areas. Dystocia was the indication in 30.0 % of all cesarean

deliveries; C-section rates as a result of dystocia varied over fivefold across health service delivery areas (Hanley et al. *2010*). In England, the examination of 146 English NHS trusts confirmed an unadjusted variation of C-section rates among NHS trusts (from 13.6 % to 31.9 % of total live births) (Bragg et al. *2010*). After adjusting for population characteristics, which were not the same among NHS trusts, the variation ranged from 14.9 % to 32.1 % of the total number of births (Bragg et al. *2010*). Emergency rates varied more than elective C-sections (Bragg et al. *2010*). Also, in China, rates of C-sections varied among different regions within the country (Feng et al. *2012*).

Understanding why C-section rates vary is the first step in understanding if the procedures are appropriate, since inappropriate use may result in long-term negative consequences for the mother and child, as well as causing unnecessary expenses. The decision to perform a C-section is influenced by both medical and nonmedical factors (Eckerlund and Gerdtham *1998*). A classification exists related to three types of determinants pertaining to the mode of delivery: obstetrical medical indications, patient-related nonmedical determinants, and professional nonmedical determinants (Eckerlund and Gerdtham *1998*). There are other factors that can affect the C-section rates, including the use of technology and health-care system factors. Baicker et al. (*2006*) noted that much variation is still unexplained. Understanding the reasons for C-section variation will aid clinicians, hospitals, insurers, policy-makers, and other relevant stakeholders in their effort to improve care and reduce costs to the health-care system and prevent harm caused by surgical intervention.

Medical (obstetrical) indications for which C-sections are mandatory include complete placenta previa or placenta accreta (Tita *2012*). Necessary indications include prior C-section, breech presentation, dystocia, and fetal distress (Tita *2012*). Professionals tend to disagree on certain indications for C-section, and this divergence in the spectrum has increased over the years. Because medical differences exist, the rate of C-sections tends to vary among individual physicians and hospitals, and these differences are, in turn, reflected in the form of regional variations in C-section rates.

P **atient-related determinants** also influence C-section rates and contribute to variation. Some patients prefer C-sections, and researchers have noted that an increasing number of women ask for C-section even when it is not medically indicated (Lavender et al. *2012*). However, Kingdon et al. (*2006*) argue that the number of C-sections determined by women's preferences is not significant. Studies of women's preferences reveal an overall pooled preference of 15.6 % (Mazzoni et al. *2010*). Higher preference for C-section was also reported in women who had a prior C-section as they are more likely to prefer it (29.4 %) than women who have not had a C-section (10.1 %). Women who live in middle-income countries prefer the procedure (22.1 %) more than women who live in high-income countries (11.8 %) (Mazzoni et al. *2010*). The preference for C-section may increase in urban areas and specific regions and may depend on the level of education or employment in service sectors (Feng et al. *2012*). Maternal age can be a factor (McCloskey et al. *1992*; Zahniser et al. *1992*; Adashek et al. *1993*). Women who fear the process of childbirth may tend to prefer C-sections (Wiklund et al. *2012*). Finally, the decision on whether to undergo a C-section may be influenced by the birth weight of the newborn, a need for oxytocin, or spinal anesthesia (Adashek et al. *1993*).

P **rofessional determinants** pertain to physician influences on C-section decisions. The role of physicians in medical decision-making has long been recognized (Wennberg et al. *1982*; Goyert et al. *1989*) and explained in relation to theory by Wagstaff (*1986*). Due to asymmetry of information between the supplier/agent (physician) and client (patient), there tends to be an opportunity to (mis)use the privilege of making medical decisions on behalf of the patient. Financial incentives, convenience, and professional discipline are some of examples of professional-related determinants of variation (Eckerlund and Gerdtham *1998*). Practice patterns can vary widely and are largely determined by the overall pattern of care in a particular country, physician's education, and lack of

access to evidence-based medicine (Danishevski et al. *2008*). This, in turn, could result in variation in the provision of care and the use of harmful or ineffective practices at the expense of effective treatments. The variation may well be a reflection of differences in medical decision-making approaches of physicians (Hanley et al. *2010*). Gender can play a role too. Female physicians are known to perform less C-sections compared to male physicians. However, they tend to perform increased numbers of C-sections for specific indications, such as dystocia (Tussing and Wojtowycz *1993*).

Access to technology can influence the decision to perform C-sections. Patients who have an ultrasound scan during pregnancy are more likely to have a C-section (Eckerlund and Gerdtham *1998*). In Norway, the introduction of technology (i.e., two-dimensional ultrasound, cardiotocography, ST waveform analysis, and fetal blood analysis) has reduced variation in C-section among hospitals (Grytten et al. *2012*).

The **health system** can influence C-section rates. Different health systems have different incentive structures, payment processes, regulations for delivery of service, priorities, and financing mechanisms. In Sweden, women who had no formal prenatal care were more likely to have a C-section (Eckerlund and Gerdtham *1998*). Women who received care in family planning hospitals or a general hospital had a 2.6 greater chance of having a C-section than women who received care in small township hospitals (Eckerlund and Gerdtham *1998*). Some studies have found that hospitals that act as referral centers will influence rates of C-section compared to other hospitals by increasing the rates (Stephenson et al. *1993*) or decreasing (Braveman et al. *1995*; Garcia et al. *2001*). Incentive systems (i.e., fee-for-service payment systems) tend to encourage physicians to perform C-sections (Mossialos et al. *2005*). Moreover, the practice style of hospitals may affect outcomes (Baicker et al. *2006*). Provider density, availability of medical care capacity, and pressure from malpractice law suits are all associated with variation (Baicker et al. *2006*; Yang et al. *2009*; Zwecker et al. *2011*). Zwecker et al. (*2011*) found that fear of litigation significantly increases the odds a doctor will perform a C-section but (Yang et al. *2009*) argue that, though present, this effect is not large. Hospital capacity, which includes the total number of physicians, surgeons, pediatricians, obstetricians and gynecologists, internists, and other specialists per birth, as well as neonatal intensive beds for birth, can also be factor (Baicker et al. *2006*). Variation in C-section rates may indicate inefficiency or reflect over- or underutilization (Eckerlund and Gerdtham *1998*). Developing nations may suffer from inequality of access, so that even necessary C-sections are underperformed.

Though C-sections can reduce perinatal morbidity and mortality, which has dropped significantly over the last 100 years (Eckerlund and Gerdtham *1998*), overuse of C-sections does not benefit women and children (Menacker et al. *2006*; Miesnik and Reale *2007*; Lavender et al. *2012*). In areas with high rates, C-sections may be performed without medical need. This variation does not appear to improve health outcomes of mothers and babies (Baicker et al. *2006*; Miesnik and Reale *2007*), though some researchers argue that medical evidence on benefits and harms of normal delivery and C-section delivery is still not clear (Lavender et al. *2012*). The claimed benefits of planned C-section include safety for the baby, decreased pelvic floor trauma for the mother, and avoidance of labor pain and convenience for doctor and patient (Lavender et al. *2012*). However, this may not hold true for all normal deliveries, since women who had had more children do not have less pelvic floor trauma (Ben-Meir et al. *2005*).

C-sections are associated with high maternal and infant mortality rates and high complication rates for births that follow (Gilliam *2006*; Adams-Chapman *2008*; Lee and D'Alton *2008*; O'Shea et al. *2010*; Hyde and Modi *2012*). A first pregnancy delivered by C-section is significantly associated with an increase in incidence of uterine rupture in labor, postpartum hemorrhage, postpartum infection, admission to ICU, and placenta previa in the next pregnancy (Souza et al. *2010*). C-sections that are not medically indicated tend to be associated with increased risk of adverse short-term maternal

outcomes (Souza et al. *2010*). Other disadvantages include increased risk of major morbidity or mortality for the mother, adverse psychological sequelae, problems in subsequent pregnancies, uterine scar rupture, and higher risk of stillbirth and neonatal morbidity (Lavender et al. *2012*). C-sections can also compromise the health of newborns (Lavender et al. *2012*) who may suffer problems later in life, such as asthma and sensitization to allergens (Roduit et al. *2009*). Moreover, C-sections may also cause neurological problems in newborns (Adams-Chapman *2008*).

A C-section requires more hospital resources than a normal vaginal delivery (Eckerlund and Gerdtham *1998*), so it costs more. It also increases length of stay and recovery time. The costs can be two to three times higher than normal delivery (Clark et al. *1991*; Keeler and Brodie *1993*; Eckerlund and Gerdtham *1998*; OECD *2011*). It is worth noting that some studies do not show any differences in costs between the two forms of childbirth delivery (Finkler and Wirtschafter *1991*). Welfare loss to society (i.e., money that could have been spent on other goods and services) as result of the added cost of C-sections (compared to normal delivery) can be a point for policy debate (Eckerlund and Gerdtham *1998*).

Medical Practice Variation in Male RH Care

The study of medical practice variation in male RH care is largely related to the study of medical practice variations in prostatectomy and screening and diagnostic procedures for prostate cancer. These are usually elective procedures and therefore can be categorized as preference-sensitive care. There are two main reasons for the use of such procedures: benign prostatic hyperplasia (BPH) and prostate cancer.

BPH is associated usually with difficulty in urination. The treatment options range from surgery (usually transurethral radical prostatectomy – TURP) to no treatment at all. There are also drugs (i.e., alpha-blockers, 5-alpha-reductase inhibitors, Cialis) that can relieve symptoms. The evidence shows that surgery improves the problems with urination and other symptoms (Smith and Patel *2011*). Possible side effects may include slight incontinence and retrograde ejaculation (Stanford et al. *2000*; Kirschner-Hermanns and Jakse *2002*). The effectiveness of drugs tends to be lower compared to surgery, although drugs tend to have no side effects compared to surgery (Wennberg et al. *1998*).

Prostate cancer is one of the most common causes of morbidity among men in developed countries (Damber and Aus *2008*). The incidence has increased during the last two decades, and this may be a result of an introduction of prostate cancer screening. There is a good indication that prostate cancer will rarely progress to an aggressive form of cancer and, in most cases, the surviving patient tends to not be threatened by it (Damber and Aus *2008*). This type of cancer can be diagnosed by physical examination or screening for PSA antigen. Treatment options range from simple patient surveillance to radical prostatectomy (Damber and Aus *2008*). According to Wennberg et al. (*1999*), there are three main options for taking care of early-stage prostate cancer. The first option entails watchful waiting and careful observation to determine whether the cancer progresses in a way that could affect the patient's quality of life or life itself. Many prostate cancers never progress but some do; therefore, it is important to observe these patients. In many cases, the patients die from other causes before the cancer has played any role in the termination of life. The second option is to use radiation therapy. This therapy will eliminate or, at least, reduce the cancer. Disadvantages are side effects from radiation. Prostatectomy entails the removal of risks from cancer but has serious potential side effects such as urine incontinence and impotence that tend to reduce quality of life. According to recent evidence, there is uncertainty as to which treatment works best (Alibhai and Klotz *2004*; Wilt et al. *2008*; Bannuru et al. *2011*), while the complication rates after surgery are well documented.

Prostatectomy – Prostatectomy entails the partial or complete removal of the prostate gland. There are three kinds of prostatectomy: transurethral radical prostatectomy (TURP), open prostatectomy, and endoscopic prostatectomy. Complete removal is known as radical prostatectomy.

Studies have shown significant variation for general prostatectomy among regions (Wennberg *2010*). An assessment of radical prostatectomy in 50 states and the District of Columbia in the USA, within a national sample (20 %) of male Medicare beneficiaries aged 65 years or older, revealed a substantial geographic variation from 1988 through 1990 (Lu-Yao et al. *1994*). During 1992–1993, approximately 65,000 prostatectomies were preformed among men over 65 years old who had been enrolled in Medicare. The number of prostatectomies varied between 0.6 and 7.0 per 1,000 for all Medicare enrollees. The highest rates of prostatectomies were found in the Northwest and upper Midwest regions (Wennberg et al. *1996*). During 1994–1995, 60 (out of 306) regions experienced 30 % or higher variation. In contrast, 70 (out of 306) regions had been marked with a 25 % variation or variations below the national average (Wennberg et al. *1999*). Similarly, New Zealand and Spain mirrored such high geographic variations between regions (Jane Camacho et al. *1996*; Derrett et al. *2009*). In particular, TURP mirrors the high variations found for overall prostatectomy. During 1992–1993, TURP varied between 6.5 per 1,000 Medicare enrollees and 23.7 per 1,000 (Wennberg et al. *1996*). The Midwest experienced the highest rates of variation with other high rates of variation also found in the Southeast and Northwest of the USA. During 1994–1995, 27 (out of 306) regions were found to have 30 % or higher variation, while 30 (out of 306) regions experienced 25 % variation or variations below national average rates (Wennberg et al. *1999*). These geographic variations in TURP rates were confirmed by another study conducted in Los Angeles County (Carlisle et al. *1995*).

Recent studies confirm that variation of prostatectomy rates has been found to be due to the influence of supply factors such as physician or hospital capacity, population-related determinants, and policy measures that regulate delivery of care (Jane Camacho et al. *1996*; Peiro et al. *2009*; Wennberg *2010*).

Supply factors are known to influence rates of prostatectomy (Jane Camacho et al. *1996*). Supply of physicians tends to influence the quantity of services provided. For example, living close to large cities (Peiro et al. *2009*), where there are more health-care resources, influences the odds of having a prostatectomy. In the USA, despite little variation in the supply of urologists, a large variation is found in prostate surgery variation (Wennberg et al. *1998*). Therefore, differences in practice variation appear to influence surgery variation, rather than supply of specialists. In the USA, variation in prostatectomy is believed to be attributable to a lack of evidence on the benefits of surgical procedures or to differences in interpretation by physicians (Wennberg et al. *1999*). Specialists tend to lean toward prescription of specific therapies in the absence of evidence (Wasson et al. *1998*) with emphasis on aggressive treatment (Wennberg et al. *1996*; Fowler et al. *1998*). Physician social networks, as indicated by Pollack et al. (*2011*), can influence such circumstances and, hence, contribute toward variation in prostate cancer treatment.

There are also **population-related factors** that affect the rate of variation in prostatectomy. Geographic variation in the utilization of prostatectomy may be related to ethnicity (Carlisle et al. *1995*), socioeconomic status (Carlisle et al. *1995*; Peiro et al. *2009*), and education levels (Peiro et al. *2009*).

In addition, **policy measures** and standards of care may have an effect on variation patterns. For example, the rate of surgery (TURP) has been found to drop by 40 % after the implementation of shared medical decision-making (Wennberg et al. *1999*). The introduction of a two-tier system in New Zealand, on the other hand, did not appear to have an impact in variation (Derrett et al. *2009*).

Surgery outcomes are important in the discussion of the use of prostatectomy as a treatment option. Surgery (prostatectomy) can be beneficial in improving complaints compared to presurgery. However, complications can surface after surgery, such as persistent incontinence and impotence (Fowler et al.

1988). The risk of mortality and rate of complications after prostatectomy, which in turn may require further surgical intervention, are underreported (Wennberg et al. *1988*). The main benefit from prostatectomy has been reported to be improvement in the quality of life, which is related to the relief of symptoms (Wennberg *2010*). Therefore, patients' preferences should play an important role in the decision for such a procedure (Wennberg et al. *1988*). However, the role of patients in decision-making has been marginal (Wennberg *2010*).

Prostate-specific antigen screening – Prostate-specific antigen (PSA) screening measures the blood level of prostate-specific antigen and is used for diagnosis of prostate cancer. There are concerns about the use of this procedure as it seems it is leading to overdiagnosis. Wide variation has been found, ranging from 2 % to 38 % in men aged 80 and older among fee-for-service Medicare patients, compared to national averages at 17.2 % (Bynum et al. *2010*). Elevated levels of PSA screening have been shown to be present in regions with high expenditures, availability of intensive care at the end of life, and a large number of physicians (Bynum et al. *2010*).

The amount of variation in PSA screening has not been attributed to differences in comorbidities among patients (Wennberg et al. *1999*). After adjusting for comorbidities, differences in PSA screening among hospital referral regions have been found (Wennberg et al. *1999*). In principle, the screening for the presence of a specific disease aims to decrease incidence and mortality as well as improve quality of life (Ilic et al. *2013*). However, considerable variability has been found in the screening for prostate cancer with differences in guidelines among professional communities and among different countries (Ilic et al. *2013*). Rates for PSA screening have been found to be low in places with a large ratio of primary care physicians to specialists (Bynum et al. *2010*). Variability in providing information to patients about the potential harms and benefits of PSA screening may be present in locales with low utilization of primary care services (Bynum et al. *2010*). In contrast, primary care physicians have tended to prefer PSA testing compared to specialists (urologists) (Fowler et al. *1998*). This trend may be reflected in an early positive attitude toward PSA screening among primary care physicians when PSA screening was first introduced, compared to recent times when outcomes may be questionable.

Today, overdiagnosis and overtreatment associated with screening are found (Ilic et al. *2013*). As a result of PSA screening, patients at low risk can be exposed to aggressive local therapy (Shao et al. *2010*). Elevated rates of prostate surgery and surgical variation can be intensified with the use of diagnostic/screening procedures, such as PSA (Wennberg et al. *1999*). From 1984 to 1995 in the USA, the use of radical prostatectomy among Medicare beneficiaries after the introduction of prostate-specific antigen testing increased rapidly and reached its peak in 1992 (Lu-Yao et al. *1997*). There was a marginal patient benefit. Men diagnosed with prostate cancer whose life expectancy was less than 10–15 years were highly unlikely to benefit from the screening (Ilic et al. *2013*). There is also evidence that screening for prostate cancer does not contribute to decreased prostate cancer-specific mortality (Ilic et al. *2013*). Patients ought to be informed about any adverse events as they face the decision on whether to undertake (prostate cancer) screening (Ilic et al. *2013*).

Prostate biopsy – Prostate biopsy constitutes another method for diagnosis of prostate cancer. Prostate biopsy is performed by taking parts of tissue from the prostate gland, using a needle, and then the sample is analyzed with a microscope, in search for cancer tissue and cells. The use of biopsies in the USA during the 1980s and 1990s increased rapidly. For example, in 1993, at least one prostate biopsy had been performed on 2.5 % of the male population over the age of 65. There were also marked variations among regions. The rates among hospital referral regions varied between 0.7 % and 4.9 % (Wennberg et al. *1996*) with no particular geographic distribution pattern among hospital referral regions (Wennberg et al. *1996*). Variation in prostate biopsy may reflect supplier or physician preferences, often without consideration of patients' preferences (Wennberg et al. *1996*). Primary care

physicians tend to lean toward biopsy referrals compared to specialists (urologists) (Fowler et al. *1998*). The differences in biopsy rates may also be a consequence of the variation in utilization of PSA screening (Wennberg et al. *1996*). Variation in the rates of biopsy is also likely to lead to overdiagnosis and overtreatment (Welch et al. *2007*).

Medical Practice Variation in Newborn Care

The study of variation for newborn care is characterized with the study of newborn care treatment and diagnostic procedures as well as outcomes of newborn care. Neonatal care is an emerging field of clinical medicine that has grown rapidly over the past few decades. Much of today's practice is driven primarily by uncertainty, rather than by evidence. This, most likely, could have a serious impact on the variation of provision of services as well as health outcomes. In this section, several examples of variation of newborn care are presented and discussed in order to illustrate the variation for this type of clinical care and potential outcomes.

Low birth weight variation – Regional variation in rates of low birth weight (LBW) infants is an example of variation in newborn outcomes. A study by Thompson et al. (*2005*) identified regions with LBW rates by looking at a 1998 cohort of births across the USA. LBW was analyzed across 246 neonatal referral regions. The variation in LBW among regions varied between 3.8 % and 10.6 % of total births. After adjusting for known maternal risk factors, the variation in LBW was threefold (Thompson et al. *2005*). Similarly, in Canada, Crosse et al. (*1997*) found large variations in LBW infants across geographic locations (Crosse et al. *1997*), varying between 4.0 % and 11.1 % of total live births, with rates increasing from the West to the East Coast (Crosse et al. *1997*).

The variation in LBW rates cannot be explained entirely by the socioeconomic characteristics of the areas under study (Crosse et al. *1997*) or mother risk factors (Gorman *1999*). Studies have shown that variation can be explained partially by individual (mothers) and regional (place of birth) characteristics and health system factors. High rates of LBW were associated with **individual risk factors,** such as race (higher LBW for babies delivered by mothers who were black), age of mother, and consumption of alcohol and tobacco (Thompson et al. *2005*). Variation in low birth weight can also be a related to **characteristics (contextual factors) of the county** where the mother resides (Gorman *1999*). Lower household income level and regions with higher density of providers (i.e., more providers) were associated with higher LWB rates (Thompson et al. *2005*). Different welfare systems that influence the health of mothers and birth outcomes can constitute other determinants of regional variation (Thompson et al. *2005*). Similarly, **health system characteristics** may be of influence. Differences in LBW can be related to organizational issues and health-care system performance within a region (Thompson et al. *2005*) or to the place in which infants receive care, such as private practices or academic centers (Kiefer et al. *2009*).

Neonatal intensive care unit admission – Studies have documented variation in neonatal intensive care unit (NICU) admission of infants. According to Barfield et al. (*2010*), in 2006 in the USA, rates of admission of infants with very low birth weight (VLBW) varied from 63.7 % in California to 93.4 % in North Dakota (Barfield et al. *2010*).

The variation was associated with hospital and patient characteristics (Horbar et al. *1997*). The variation in NICU admission could be a result of policies for newborn management in different practices (Roblin et al. *2000*). Factors related to birth can be of influence too. Studies have found a positive association between preterm delivery, multiple births, cesarean delivery, and prevalence of NICU admission (Kiefer et al. *2009*). The variation could not explain different reimbursement systems in the hospital units (Roblin et al. *2000*). Although casual association was not found, these

data provide sufficient information to warrant further exploration that may be helpful to researchers and decision-makers alike.

Appropriate and early admission is important for adequate care of newborns, as it can reduce the risk of mortality in children with VLBW (Barfield et al. *2010*). No hospital admission, in specific situations, may lead to unwanted health outcomes for newborns.

Perinatal and infant mortality rates – Several studies have investigated perinatal and infant mortality rates and causes to variation across regions. In the United Kingdom, variation was found in perinatal mortality rates across primary care trusts in England. The rates varied from 3.5 to 12.6 per 1,000 births among different primary care trusts (NHS *2012*). Authors suggested that high rates of perinatal mortality could be associated with socioeconomic status (NHS *2012*). Regional variations in infant mortality, as a result of perinatal conditions, were found also in the Netherlands between 1984 and 1994 (Treurniet et al. *2000*). The relative risk of mortality varied from 0.70 to 1.28 from 1984 to 1986 and from 0.72 to 1.26 from 1992 to 1994 (Treurniet et al. *2000*). This variation could not be explained by health-care system characteristics, such as place or supervision of delivery or the availability of specialized neonatal care (Treurniet et al. *2000*).

Physician Supply Variation

Physician supply variation is an important aspect of medical practice variations. The oversupply of physicians is known to be associated with overprovision of services (Zweifel and Breyer *1997*; Thompson et al. *2002*; Wennberg *2010*), resulting in high health-care expenditures, inefficient utilization of health-care services (Baicker and Chandra *2004*), and increased adverse events (Wennberg *2010*). Physician supply is often considered and examined as a determinant of the level of provision of specialized services. In this section, we examine the studies/cases in which physician supply variation was examined and outline some of the outcomes of such variation in service provision and outcomes.

The interaction between personnel supply and health-care system outcomes is one of most important aspects of the study of workforce variation. An efficient management of workforce supply resources is likely to result in reduced costs and care of patients' needs. Settings with elevated number of primary physicians are known to have lowered the costs and provision of high quality of care (Baicker and Chandra *2004*). An emphasis on prenatal care compared to intensive care has resulted in improved outcomes across different countries (Thompson et al. *2002*). These are just a few examples to illustrate how useful it is to study workforce variation to enable a thorough understanding of health-care performance system issues and to inform policy for addressing potential gaps in service provision.

Studies in different countries have revealed considerable variation in physician supply among and within countries and have tried to understand the effects of such supply in the provision of health-care services and in health outcomes of mothers, men, and newborns. In this section, we examine the variation in supply of gynecologists, obstetricians, neonatologists, and urologists.

Obstetricians and gynecologists – The supply of gynecologists and obstetricians has increased over the years in most countries (OECD *2011*). In OECD countries, from 2000 to 2009, there has been an average annual increase of 1.5 % (OECD *2011*) in the supply of gynecologists/obstetricians. In the USA, the number of active obstetricians/gynecologists in the health sector has increased by 94 % from 1970 to 1993 (Wennberg et al. *1996*). While it can be partially argued that these increases may be in response to increased demand for services, the variation in service provision of obstetric and gynecologic services (as a result of workforce supply) may question the positive effects of such market response to demand for services.

Variation in the distribution of gynecologists and obstetricians was a significant among hospital referral regions in the USA. The number of obstetricians/gynecologists ranged from 5.4 to more than 25 per 100,000 women (Wennberg et al. *1996*). An interesting finding was that hospitals' referral regions with small populations had a reduced per capita supply of obstetricians/gynecologists (Wennberg et al. *1996*) indicating that the increase in supply may be in response to a rise in demand. Other hospital referral regions that provided care to over a million inhabitants experienced an undersupply of physicians compared to the national average (Wennberg et al. *1996*). The oversupply of obstetricians/gynecologists has tended to focus in the East and West coasts of the USA, while regions with reduced supply were located in Midwest (Wennberg et al. *1996*).

An important point in this supply variation is consideration of cost implications. The gynecologists and obstetricians tend to provide most of the health-care services to women in countries/systems where the approach to services is "medicalized" (approach that encouraged provision of clinical services and medication compared to prevention and advisory services) (OECD *2011*). In other countries, with less "medicalization" of service, the nurses and midwifes tend to play major roles in the provision of health-care services (OECD *2011*). This difference in health-care systems has cost repercussions because of the different payment levels for midwifes versus gynecologists and obstetricians. The higher pay for gynecologists and obstetricians does not necessarily translate into high quality care (Baicker and Chandra *2004*; OECD *2011*).

Neonatal workforce – Several studies have investigated the geographic variation of the neonatal workforce. These studies have confirmed this variation and documented potential effects of such variation. In the USA, the number of neonatologists has increased over the past 30 years, while the number of births has remained the same (Goodman et al. *2001*). This increase in the number of neonatologists has resulted in the development of neonatal intensive care as an important dimension in the care of newborns and in an improvement in infant health outcomes (Goodman et al. *2001*). Authors have reported a drastic variation of specialists among 246 neonatal intensive care regions in the USA. The supply of neonatologists varied from 1.2 to 25.6 neonatologists per 10,000 live births (i.e., greater than 20-fold variation) (Goodman et al. *2001*). Interestingly, the study showed that regions with low cases of LBW (under 2,500 g) experienced an increased supply of neonatologists and vice versa (Goodman et al. *2001*). An earlier study, based on 1983 data, had shown that the distribution of neonatologists had been sufficient across the country (USA), while recognizing that specific areas of expertise in neonatology may had been short (Merenstein et al. *1985*).

A phenomenon of low number of LBW newborns in areas of oversupply may lead to an ineffective use of resources and unmet needs (Goodman et al. *2001*). The fact that this specialized workforce is costly to educate makes a case for an inefficient use of resources (Goodman et al. *2001*) (i.e., market failure: supplier induced demand). An increased level of supply as found in the USA has not been shown to contribute to improved perinatal outcomes as compared to Australia, Canada, and the United Kingdom (Thompson et al. *2002*). In a comparison between the USA, Australia, Canada, and the United Kingdom, Thompson et al. (*2002*) showed that the USA had 3.3 neonatal intensive care beds per 10,000 live births, while Australia and Canada had 2.6 and, in contrast, the United Kingdom had 0.67 neonatal intensive care beds per 10,000 live births (Thompson et al. *2002*). The USA had 6.6 neonatologists per 10,000 live births, while Australia had 3.7, 3.3 for Canada, and 2.7 for the United Kingdom (Thompson et al. *2002*). In the case of the USA, the health-care system offered more intensive care while offering less prenatal and preconceptive care. The latter may be more important for better outcomes of pregnancies (i.e., lower rates of low birth weight infants) (Thompson et al. *2002*).

Urologists – The variation in supply of urologists represents another example of workforce variation. The number of urologists active in the health sector in the USA has increased by 74 % from 1970 to

1993. There were 4,745 active urologists in the USA in 1970, and this number has increased to 8,246 active urologists in 1993 (Wennberg et al. *1996*). Wennberg et al. (*1996*) have shown that there was a significant variation among hospital referral regions in the USA. The number of urologists ranged from 1.6 to 5.4 per 100,000 patients (Wennberg et al. *1996*). Analogous to the supply of obstetricians/gynecologists, referral regions in the Midwest had a lower number of urologists, while the Northeast, Mid-Atlantic, Southeast, and West Coast regions had higher numbers compared to the national average (Wennberg et al. *1996*). As with other specialties, this variation in supply tends to influence the supply of services and, in turn, tends to influence variation in services, provision, and health outcomes.

Conclusion

This chapter introduces some of key issues related to medical practice variation of procedures that are provided to diagnose and treat specific RH conditions, the variation of newborn care, and variation in the supply of specialists that provide RH care. It discusses the determinants of such variations as well as outcomes related to such variations. It aims to clarify the fact that there are several system-related determinants that can influence the rates of specific procedures, be that in form of the presence of uncertainty on what is in the best interest of patients and physicians or in terms of policies that favor specific physician/hospital behaviors (i.e., payment systems for physician or in hospitals). Once one identifies the causes of variation, policy measures could be undertaken to address such variations.

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