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Comparison of Labor and Delivery Care Provided by Certified Nurse-Midwives and Physicians: A Systematic Review, 1990 to 2008

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A B S T R A C T

Background: Advanced practice nurses (APNs) in the United States could expand access to high-quality health care, particularly for underserved populations. Yet, there has been limited synthesis of the evidence related to their effectiveness as compared with other providers. The study reported here, part of a larger study that examined all four types of APNs, compares the labor and delivery care outcomes of certified nurse-midwives (CNMs) and physicians.
Data Sources: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Proquest (for dissertations), were searched for the years 1990 through 2008.
Study Eligibility Criteria: Only those articles where processes or outcomes of care were quantitatively compared between CNMs and physicians were included. For all APNs, 27,993 citations were reviewed. For CNMs, 21 articles representing 18 unique studies reported either infant or maternal outcomes.
Methods: The systematic review followed established procedures (replicable search of relevant databases, sequential review to identify eligible studies, abstraction by two reviewers, assessment of quality, and grading of evidence).
Results: For measures that relate to the processes of care (e.g., epidural, labor induction, episiotomy), lower use was found for CNMs. For many of the infant outcomes (e.g., low Apgar, low birth weight, neonatal intensive care unit admission), there were no differences between physicians and CNMs. Perineal lacerations were lower and breastfeeding was higher among women cared for by CNMs compared with physicians.
Limitations: The review addressed only CNMs practicing in the United States and outcomes measured during labor and delivery. The majority of study designs were observational and the models of care ranged from independent to shared, limiting the control for bias. Moreover, all reviewers were nurses.
Conclusion: Differences in practice between CNMs and MDs seem to be well documented, particularly in the use of technology. Yet, the findings provide evidence that care by CNMs is safe and effective. CNMs should be better utilized to address the projected health care workforce shortages.

Introduction

Advanced practice nurses (APNs) in the United States have the potential to expand access to high-quality health care, particularly for underserved populations. Yet, there has been limited synthesis of the evidence related to their effectiveness compared with other providers. The study reported herein, part of a larger study that examined all four types of APNs, compares the labor and delivery care outcomes of certified nurse-midwives (CNMs) and physicians (Newhouse et al., 2011).

The care of childbearing women and their newborns is the most common reason for hospitalization in the United States (Levit, Wier, Stranges, Ryan, & Elixhauser, 2009). The costs of this care are enormous with maternal and newborn estimates for

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facility charges alone of $86 billion in 2006 (Andrews, 2008). Although the majority of women and their newborns are healthy with low risk of poor outcomes, obstetrical care in the United States primarily takes place in hospitals with enhanced technology and use of invasive procedures. A 2008 report summarized the research and statistics related to maternity care in the United States (Sakala & Corry, 2008). The comprehensive review revealed gaps in evidence and wide use of practices that are appropriate for mothers and babies only in limited circumstances (e.g., fetal monitoring, erythromycin ophthalmic ointment prophylaxis). Moreover, some practices that are known to be beneficial are underused (e.g., fetal auscultation, vaginal birth after cesarean delivery).

The recent National Institutes of Health consensus conference on Vaginal Birth After Cesarean Birth (Cunningham et al., 2010) has again focused attention on the casual way in which decisions about use of invasive technologies are made during labor and delivery. Midwives view birth as a normal process and emphasize the use of nonpharmacologic approaches to manage birth. A Cochrane review of 11 non-U.S. randomized, controlled trials (RCTs) comparing midwife-led care with medical-led and shared care found that midwife care was associated with many benefits and no adverse effects (Hatem, Sandall, Devane, Soltani, & Gates, 2008). The benefits cited included a reduction in fetal loss before 24 weeks' gestation, use of analgesia, episiotomy, and instrumental births. Midwife led care also increased the chance of a woman having a spontaneous vaginal birth and breastfeeding. There were no differences in risk of fetal death or in cesarean rates. It must be noted that midwives are often the lead providers of care for women with uncomplicated pregnancies in the studies represented in the Cochrane review. This is in contrast with the United States, where medical doctors (MDs) are the primary care providers for most pregnant women.

In the United States, 7.9% of all births are attended by nurse-midwives (Martin et al., 2009). Midwifery care is provided by certified nurse-midwives (CNMs), certified midwives, or certified professional midwives. CNMs are registered nurses who obtain a graduate degree in nursing and pass a national certification examination. Certified midwives graduate from an accredited midwifery program and take the same certification examination, but have no nursing education. Certified professional midwives do not have degree requirements, but are trained primarily through apprenticeship models; they must pass a certification examination. There has been a 33% increase in midwife-attended births in hospitals between 1996 and 2006 (Martin et al., 2009), with CNMs attending the overwhelming majority of hospital births attended by midwives (94.3%). Yet, this estimate is considered low owing to underreporting of midwife-attended deliveries.

Although CNMs view birth as a normal process, the use of appropriate interventions is supported. This is embodied in the Philosophy of the American College of Nurse-midwives which states "appropriate use of interventions and technology" and "consultation, collaboration and referral with other members of the health team" are needed to provide optimal care (American College of Nurse-Midwives, 2004). Regulatory bodies may define criteria for care by nurse-midwives that exclude women at high risk for worse outcomes, although CNMs may care for women with moderate risk (Cragin & Kennedy, 2006). Indeed, most CNMs work in shared models where they care for women with uncomplicated pregnancies and births with the collaboration of physicians.

A meta-analysis compared outcomes of nurse practitioners and CNMs with physicians practicing in the United States (Brown & Grimes, 1995). Of the 15 CNM studies reviewed that controlled for patient risk, CNMs used less technology and analgesia than did physicians in intrapartum care. Neonatal outcomes were equivalent to those of physicians. Although individual studies have compared processes of care and outcomes between CNMs and physicians in the last two decades, there has been no recent systematic review. The study reported herein is unique in that it encompassed observational and experimental designs, applies the developing standards for systematic review, and is the first review since the Brown and Grimes meta-analysis.

Considering the projected inadequate supply of care providers to meet the nation's health care needs, CNMs are seen as a potential solution, particularly for the poor and underserved. The intent of this study was to provide the scientific evidence needed to make informed decisions about obstetrical care delivery and about health care workforce policies.

Review Question

This study compares processes of care and outcomes of births attended by CNMs and physicians in the United States from 1990 to 2008. It is part of a larger systematic review of four APN groups that was commissioned to summarize the findings on how APNs contribute to the safety, quality, and effectiveness of care (Newhouse et al., 2011). For CNMs, the question was specific: Compared with other providers, are CNM patient outcomes similar? Differences in labor and delivery care processes and outcomes are compared between CNMs and physicians because there were limited studies related to prenatal care outcomes. The start time of 1990 was selected as the Brown and Grimes (1995) meta-analysis was conducted in 1991 and 1992.

Review Methods

The study was undertaken using procedures adapted from the processes specified for Evidence-based Practice Centers funded by the Agency for Healthcare Research and Quality, and guided by an expert co-investigator. These steps include defining the question, searching for studies, selecting studies and collecting data, assessing risk of bias/study quality, addressing reporting bias, summarizing results and interpreting findings, and grading evidence. Whereas a Cochrane review typically seeks RCTs of a particular intervention and/or outcomes in a particular population, the intent of this review was to include all studies and outcomes where CNMs were quantitatively compared with physicians.

Defining the Question

As determined by those supporting the study, the question was intentionally broad to encompass a broad range of measures reflecting the safety, quality, and effectiveness of care. The study was restricted to CNMs rather than non-nurse midwives as the intent of the study was to examine APNs.

Searching for Studies

The search strategy was defined in collaboration with a medical librarian and study team members with relevant clinical expertise. The following databases were searched: PubMed, Cumulative Index to Nursing and Allied Health

Literature (CINAHL), and Proquest (for dissertations). Test sets were evaluated by determining if a validation set of articles were captured by the strategies. A CNM technical expert panel was formed to review the search strategy and to review the final report. The results of the searches were downloaded into ProCite version 5.0.3 (ISI ResearchSoft, Carlsbad, CA). Duplicate articles were removed resulting in a final set of 27,993 citations for all APN groups (Figure 1).

Selecting Studies and Collecting Data

The review process used web-based database software, facilitating access to electronic articles, data extraction, and management of study data through a browser interface. Only studies conducted in the United States were included because the APN model is somewhat unique to the United States. The time period was limited to studies published between 1990 and

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("Nurse Anesthetists"[Mesh] OR "nurse anesthetist"[tiab] OR "nurse anesthetists"[tiab] OR "Nurse Clinicians"[Mesh] OR "nurse clinician"[tiab] OR "nurse clinicians"[tiab] OR "clinical nurse specialist"[tiab] OR "Nurse Midwives"[Mesh] OR "nurse midwife"[tiab] OR "nurse midwives"[tiab] OR midwifery[tiab] OR "Nurse Practitioners"[Mesh] OR "nurse practitioners"[tiab] OR "nurse practitioner"[tiab] OR "advanced practice nurse"[tiab] OR "advanced practice nursing"[tiab] OR "advanced practice nurses"[tiab] OR "physician extender"[tiab] OR "nurse consultant"[tiab] OR "nurse consultants"[tiab]) AND ("apgar score"[MeSH Terms] OR Apgar[tiab] OR "pregnancy outcome"[MeSH Terms] OR outcome[tiab] OR "delivery, obstetric"[MeSH Terms] OR "mortality"[MeSH Terms] OR mortality[tiab] OR "quality of health care"[MeSH Terms] OR "quality of care"[tiab] OR "attitude of health personnel"[MeSH Terms] OR "attitude to health"[MeSH Terms] OR (attitude[tiab] AND health[tiab]) OR "malpractice"[MeSH Terms] OR Malpractice[tiab] OR "costs and cost analysis"[MeSH Terms] OR cost[tiab] OR costs[tiab] OR "risk management"[MeSH Terms] OR "risk management"[tiab] OR "patient care management"[MeSH Terms] OR "self care"[MeSH Terms] OR "self care"[tiab] OR "preventive health services"[MeSH Terms] OR Medical Errors[mh] OR Error[tiab] OR Errors[tiab] OR Hospitalization [mh] OR Admission[tiab] OR Breast Feeding[mh] OR Pain[mh] OR pain[tiab] OR Decision Making [mh] OR "decision making"[tiab] OR Pregnancy Complications[mh] OR Quality of Life[MH] OR Quality[tiab] OR prevention[tiab] OR effectiveness[tiab] OR "guideline adherence"[tiab] OR

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satisfaction[tiab]) AND English[lang] AND 1990:2008[dp] NOT (animal[mh] NOT human[mh]) NOT (review[pt] OR "meta-analysis"[pt] OR editorial[pt] OR "systematic review"[tiab] OR metaanalysis[tiab] OR "meta analysis"[tiab] OR meta-analysis[tiab])
12,941 titles (June 16, 2008)

CINAHL

((TX Nurse Anesthetists or TX Nurse Anesthetist or TX nurse clinician or TX nurse clinicians or TX clinical nurse specialist or TX clinical nurse specialists or TX Nurse Midwives or TX nurse midwife or TX midwifery or TX Nurse Practitioners or TX Nurse Practitioner or TX advanced practice nurse or TX advanced practice nursing or TX advanced practice nurses or TX physician extender or TX nurse consultant or TX nurse consultants) and (TX (attitude and health) or TX hospitalization or TX admission or TX apgar or TX "breast feeding" or TX cost or TX costs or TX "decision making" or TX (obstetric and delivery) or TX effectiveness or TX error or TX errors or TX malpractice or TX mortality or TX outcome or TX pain or TX "patient care management" or TX "pregnancy complications" or TX prevention or TX quality or TX "risk management" or TX satisfaction or TX "self care")) NOT (TX meta-analysis or TX "systematic review" or PT review or PT editorial or TX animal)

Limiters - Publication Year from: 1990-2008; Language: English

Figure 1. APN search strategy.

2008. The selected studies had to report at least one quantitative measure that related to the study question and it could not be based totally on report of providers (e.g., provider reported rating of compliance with standards). In addition, the study had to have a clear comparison group (e.g., obstetricians versus CNMs), although they may be working alone or in teams. Lastly, outcomes had to reflect actual patient outcomes not reports of simulations or training.

The research team created customized abstraction screens for each step of the sequential process of review from titles, to abstracts, and then full articles. For example, at title review, reviewers examined the title and indicated if the study met the inclusion criteria in the web-based software. The review process progressed in a stepwise fashion from title reviews, to abstract reviews, to full article review. All reviewers were nurses who were trained in the abstraction process and the use of the software. Paired reviewers independently reviewed the abstract and article titles and both reviewers had to indicate that the study was eligible. For the 1,673 articles reflecting all four APN groups that made it to the full article review, a primary reviewer abstracted the relevant data extraction and a secondary reviewer verified data. Pairs were formed for both clinical and methodological expertise. The reviews were not blinded. Differences of opinions that could not be resolved between the reviewers were resolved by consensus adjudication. Bi-weekly conference calls allowed identification of issues with review and necessary refinements were made to assure consistent decision making about inclusion and exclusion of studies, definitions, and relevant data to abstract (Figure 2).

Assessing Risk of Bias/Study Quality

The quality of each individual study, an essential component of systematic reviews, was assessed by at least two reviewers. Because many of the studies were observational rather than RCTs, the Jadad scale (Jadad et al., 1996), designed for study quality rating in RCTs, could not be used. A scale was developed to reflect design issues that are particularly relevant to observational studies, including potential sources of bias and generalizability. The scale items assigned points to the following items: Similarity of settings and patients in comparison groups, sample size, reliability and validity of measures, how well bias was controlled, and an overall judgment of how well the outcome could be attributed to the type of provider (i.e., CNM vs. physician). The summed scores ranged from 0 to 8, with 8 reflecting higher quality. To facilitate summarizing quality assessment, a dichotomous quality measure was created where a score of 5 or higher was considered to be high quality and less than 5 was considered to be low quality.

Summarizing Results

For each outcome that had at least three studies, detailed tables were created to summarize the study characteristics and to summarize the outcomes. The measures were categorized under processes of labor, processes of birth, and infant and maternal outcomes. All of the measures are considered outcomes that reflect the safety, quality, or effectiveness of care. Effect sizes and comparative proportions are not reported here; rather the significance or lack of significance reported in the study is reported.

Interpreting Findings/Grading of Evidence

For each outcome, the overall body of evidence was graded using an adaptation of the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) Working Group Criteria (Atkins et al., 2004). As a strength of evidence system, GRADE incorporates not only study design, but other components such as bias, quantity of evidence, directness of evidence, consistency, and precision. First, a baseline category based on the study design was determined. Outcomes were considered as having high baseline evidence if there were at least two RCTs or one RCT and two high-quality observational studies. Outcomes were considered to have moderate baseline quality if there were at least one RCT, one high-quality observational study, and one low-quality observational study or three high-quality observational studies. Outcomes were considered as having a low baseline quality if there were fewer than three high-quality observational studies.

After the baseline grade was determined, grading questions were applied that assess the other components of design (Table 1). The baseline grade was decreased by one level (i.e., from high to moderate) for each question if the body of evidence was sparse, the study was not the strongest design to answer the question, the study had poor overall quality, results were inconsistent, or there was a possibility of reporting bias. Finally, based on these adjustments, the overall evidence grade was assigned using the following ordinal categories:

- High: Further research is unlikely to change confidence in the estimate of effect.
- Moderate: Further research is likely to have an important impact on confidence in estimate of effect and may change the estimate.
- Low: Further research is very likely to have an important impact on confidence of estimate of effect and is likely to change the estimate.
- Very low: Any estimate of effect is very uncertain.

Results

The review process identified 21 articles or dissertations that provide evidence of CNMs effectiveness as compared with physicians for 13 measures of process or outcome. These reflected 18 unique studies; a few articles represented the same data. The threshold of at least three studies to include the process or outcome was not reached for any prenatal care measure. Therefore, the measures reported here represent only the process and outcomes of labor and delivery care. Furthermore, all of the studies report on deliveries in hospitals, not home births or stand-alone birthing centers. Table 2 summarizes the 21 studies. Only 2 of the 21 studies were RCTs. One RCT (Heins, Nance, McCarthy, & Efird, 1990) reflects a study with cluster randomization and took place in five regional state health department clinics that targeted women at high risk for infants with low birth weight. The other RCT (Chambliss et al., 1992) randomized women in a single hospital to a CNM managed unit or a traditional unit managed by senior residents and attending physicians with the intent of isolating the role of selection bias in comparing cesarean rates between physicians and midwives. The majority of the observational studies were retrospective cohort designs that used existing administrative databases or medical record review. For studies with prospective cohort designs, administrative data were sometimes supplemented with patient surveys or record reviews.

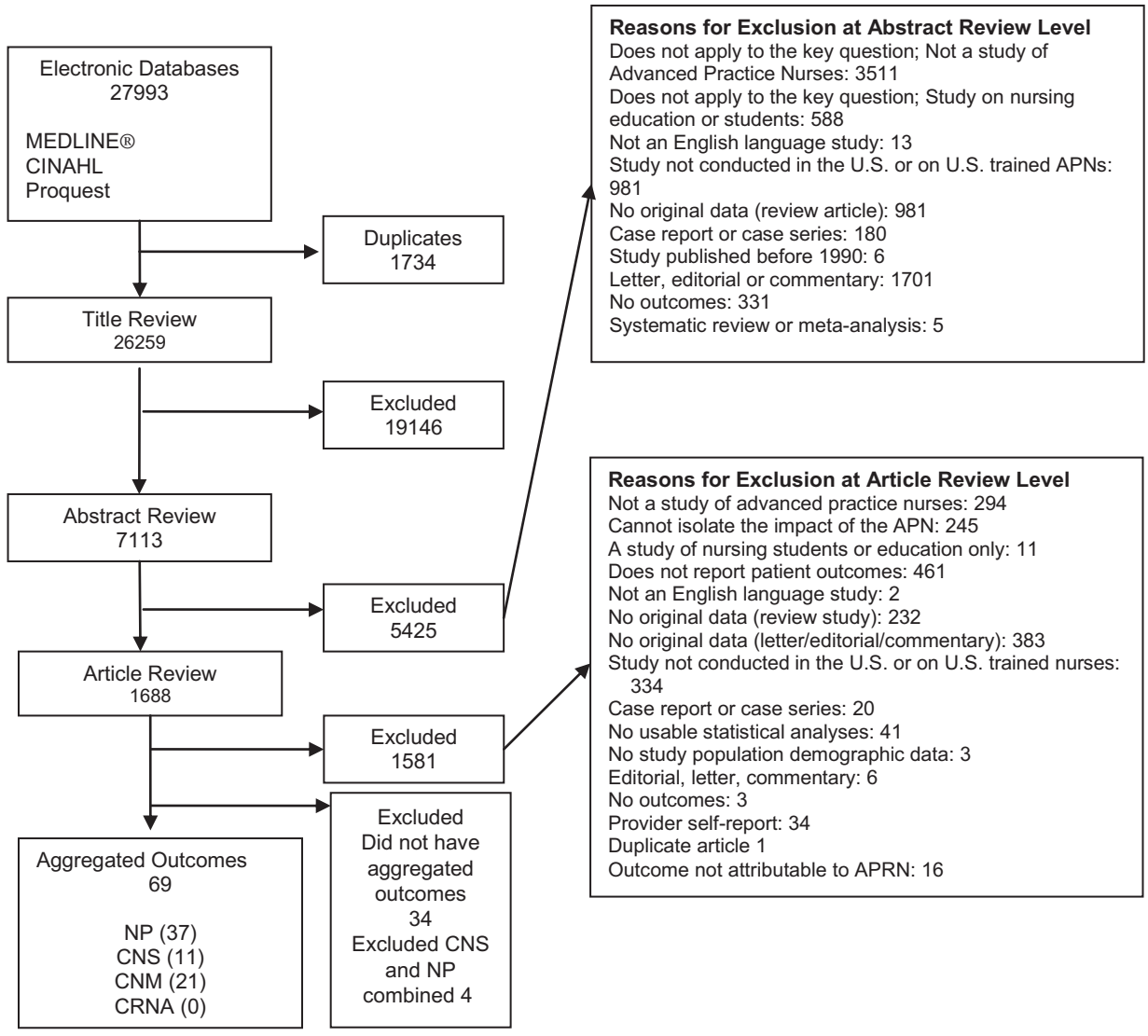

Figure 2. Summary of citation review for all APN groups (number of articles).

The heterogeneity of the patient populations being compared for CNMs and physicians was of particular concern. Many of the studies used strict criteria for inclusion that reflect the low risk criteria that must be met for delivery by CNMs (e.g., singleton birth, no serious medical complications). However, potential issues of selection bias must be acknowledged. Some studies attempted to control for differences in patient populations by using very specific sample inclusion/exclusion criteria or through use of multivariate control. However, several studies reported unadjusted differences. These issues were taken into consideration in rating the quality of studies. As summarized in the study summaries (Table 2), study quality ranged from 3 to 7 out of a possible 8, with the most frequent quality score being 6. Compared with other advanced practice groups examined in the larger study, the observational studies comparing outcomes for CNMs and MDs often have large sample sizes and use established measures. Only 2 of the 21 studies were rated as low quality using the dichotomized measure (quality score < 5).

Table 3 summarizes the outcome measures with 3 or more studies. The outcomes are organized into 3 categories: Process of labor, process of birth, and post birth infant and maternal outcomes. Use of epidural analgesia by CNMs compared with MDs is the most frequent labor process measure found in the review (10 studies), followed by labor augmentation, labor induction, and labor analgesia. The majority of studies reported differences between CNMs and MDs that favored CNMs in that they used fewer pharmacological interventions. The evidence grades were moderate to high.

The four measures related to the process of birth have similar findings that favor the CNMs in the use of fewer cesarean deliveries, operative vaginal deliveries (forceps or vacuum), and episiotomy; and more vaginal births after cesarean delivery.

Table 1
Criteria Used to Downgrade Each Outcome after Assignment of Baseline Category

Criteria	Decrease from Baseline Level	Definition
1: Based on the number of studies and numbers of patients, is this sparse?	−1	Sparse reflects <3 studies per outcome; <2 RCTs when RCTs are appropriate
2: As a body of evidence, are the study designs the strongest o answer the question?	−1	Strong study designs may be dependent on outcome studied; RCTs are not always feasible.
3: Is the quality of the studies acceptable?	−1	Refers to the study methods and execution and is reflected in the individual study quality ratings.
4: Are there important inconsistencies across the studies?	−1	Refers to similar estimates of the effect. Inconsistency is demonstrated through differences in directions of effect and significance.
5: Is there concern about the directness of the evidence?	−1	The extent to which study participants, measures, and outcomes are similar to the population of interest.
6: Is there a high probability of reporting bias?	−1	Refers to other publication bias and selective reporting bias that would result in more significant differences in comparison groups.

Source: Atkins et al. (2004).

These differences are often attributed to selection bias in that women who "need" operative births are more likely to be attended by physicians—and women who desire fewer interventions are more likely to be cared for by a CNM. Some of the studies paid particular attention to ensure that their study sample had the same risk profiles and/or used statistical controls in testing differences. For example, Chambliss et al. (1992) found no difference in cesarean rates in their RCT, although the rates were extremely low for both CNMs and MDs.

The five infant and maternal outcomes after birth might be of greatest interest in comparing CNMs with MDs. In some of these measures, a study finding no difference in outcomes is considered good, because CNMs may be achieving equivalent outcomes with fewer interventions. Low Apgar scores was the outcome with the most studies ($n = 11$), followed by low birth weight, perineal lacerations, neonatal intensive care unit (NICU) admission, and breastfeeding. For Apgar, only 1 of the 11 studies reported a difference in scores between CNMs and MDs and that one favored the CNMs. A similar finding is seen for low birth weight and NICU admission. These differences may be attributable to differences in risk for poor outcomes between the CNM and MDs. However, the one RCT that compared low Apgar scores between CNMs and MDs (Chambliss et al., 1992) found no differences. All five studies reporting third- or fourth-degree perineal lacerations favored the CNM, including the one RCT. Likewise, breastfeeding initiation favored the CNMs, although there were only three observational studies. Unfortunately, there were no measures of duration of breastfeeding.

Discussion

Based on this systematic review, there is moderate to high evidence that CNMs rely less on technology during labor and delivery than do physicians and achieve similar or better outcomes. Many may view the findings as expected. CNMs and physicians practice differently. Considering that only 5 of the 21 studies were published since 2000, the usefulness of such descriptive studies seems to have been exhausted. Yet, where are the next studies that help us to understand how and why these differences influence the cost and quality of care? How do care patterns vary by organizational characteristics and culture? What CNM-led and shared models reflect best practices in labor and delivery? Even with the increasing emphasis on evidence-based practice, there are limited studies examining the influence of different models of obstetrical care, practice guidelines, and performance measurement on processes and outcomes of care. More studies such as those by Hodnett et al. (2002; 2008), which focus on the effectiveness of supportive care during labor, are needed.

The challenges raised by this systematic review and other recent reports relate to how maternity care can be changed in the United States. The "Blueprint for action: Steps toward a high-quality, high-value maternity care system" proposes actionable strategies in 11 critical areas (Transforming Maternity Care Symposium Steering Committee, 2010). Research is needed to understand how these strategies are translated to care settings and linked with patient outcomes. Little is understood about the full content and context of care provided during labor. Evidence must be developed to understand the circumstances under which more invasive interventions are indicated. These studies require strong methods and good measures. Unfortunately, the existing obstetrical data systems are limited and the majority of information is provided in a flow sheet format. Data systems that better support monitoring of practice and research must be developed.

Several limitations of this study must be acknowledged. The majority of studies were observational and it was not always clear how women were selected for care by CNMs versus MDs. Women having a midwife-attended delivery by definition have, in the aggregate, lower risk for poor outcomes. Some studies employed more stringent methods to achieve comparable groups. In addition, women cared for CNMs may have been transferred to physician care when more invasive interventions were needed. The reliance on secondary data is also a limitation. Definitions could not be clarified and documentation practices may be influenced by reimbursement and performance measurement monitoring. On the other hand, many of the measures reported are reliably recorded although for some the definitions did differ. For example, Apgar was measured differently across studies (<8, 7, and 6 at 5 minutes) and definitions of induction were not always clearly defined. Organizational and contextual variables that might have influenced the comparisons were not consistently examined. The time period covered in this review (1990–2008) was long and obstetrical care changed considerably. For example, cesarean rates were decreasing in the early 1990s but then increased. However, comparisons are still valid; they were made for the same time periods.

Another limitation relates to the procedures for review. Although the team was multidisciplinary with expertise in such reviews, the reviewers were all nurses, which may have influenced decisions and abstraction of data. Last, conclusions are based on the significance reported by the study, not on calculated effect sizes and meta-analyses. Some studies did not provide essential data for effect size calculation (e.g., Ns, standard deviations) nor were care delivery models explained in adequate

Table 2
Summary of Studies, Comparisons, Patient Population, and Study Quality

Author (Year)	Comparisons	Patient Population	Study Quality
RCTs ($n = 2$)			
Heins et al. (1990)	Multicomponent prenatal intervention administered by CNM ($n = 667$) compared with care from obstetricians ($n = 679$) according to local standards.	Pregnant women attending state-funded prenatal clinics and considered high risk for low birthweight.	6/High
Chambliss et al. (1992)	Compared women randomly assigned to unit for normal birth managed by CNM ($n = 234$) with those managed by senior residents ($n = 253$) on a separate floor.	Pregnant, low-risk women.	7/High
Observational ($n = 19$)			
Baruffi et al. (1990)	Compared women at a women's hospital where care was provided by CNM ($n = 788$) with women in a teaching hospital where care was by residents and attending physicians ($n = 761$).	Pregnant women delivering in 1977–1978 at 1 hospital; excluded previous Cesarean.	6/High
Blanchette (1995)	Compared women in a primary care access clinic staffed by CNMs ($n = 496$) with the same clinic's private patients cared for by the obstetricians ($n = 611$).	Pregnant women giving birth August 1991–March 1994 at single practice; excluded those with medical problems.	4/Low
Butler et al. (1993)	Compared women cared for by CNMs providing personal labor support ($n = 1,056$) with those cared for physicians ($n = 3,551$).	Pregnant women delivering January 1981–June 1988; considered low risk for poor outcomes.	6/High
Cragin (2002)	Compared total population of women who enrolled for prenatal care with either CNM ($n = 822$) or obstetrician ($n = 351$) at 2 sites.	Pregnant women receiving care at 2 sites and considered moderate risk.	6/High
Cragin & Kennedy (2006)	Compared sample of women who chose CNM ($n = 196$) with those who chose physician ($n = 179$) care.	Pregnant women giving birth at single urban hospital and considered low or moderate risk.	5/High
Davis et al. (1994)	Compared medical interventions and outcomes for women managed by CNM ($n = 529$) with those managed by obstetricians ($n = 8,266$).	Pregnant, low-risk women delivered between January 1, 1987 and December 31, 1990. Low-risk women given the option of CNM service or traditional care by MDs.	6/High
Delano et al. (1997)	Compared 20-year trends in births in CNM service ($n = 3,123$) with births by physicians ($n = 4,597$) in the same hospital.	Pregnant women; excluded cesarean, multiple birth, and <35 weeks gestation.	5/High
Fischler & Harvey (1995)	Compared 3 different models of prenatal care delivery in relation to pregnancy outcomes (CNM–clinic, $n = 309$; CNM–private, $n = 111$; physician–private, $n = 297$).	Pregnant, low-income, women giving birth between January 1, 1989 and June 30, 1990. Groups varied at baseline in demographic and risk factors.	3/Low
Hueston & Rudy (1993)	Compared labor and delivery management of patients admitted in labor to either a CNM ($n = 400$) or family physician practice ($n = 450$).	Random sample of pregnant women receiving care at medical center primary care group between January 1990 and December 1991.	7/High
Jackson et al. (2003a)*	Compared outcomes for women in collaborative care (CNM-MD, $n = 1413$) with women in traditional MD-only ($n = 783$) model.	Pregnant, low-income women enrolling for prenatal care at study site from February 1994–November 1996; judged to be at low risk at first prenatal visit, and spontaneous delivery of singleton fetus in vertex position.	6/High
Jackson et al. (2003b)*	Compared outcomes for women in collaborative care (CNM-MD, $n = 1,808$) with traditional MD-only ($n = 1,149$) model.	Pregnant, low-income women enrolling for prenatal care at study site from February 1994–November 1996; judged to be at low risk at first prenatal visit, and spontaneous delivery or singleton fetus in vertex position.	6/High
Lenaway et al. (1998)	Compared the outcomes of women in a public–private, CNM-led program ($n = 692$) with women in 2 nonintervention counties cared for by physicians ($n = 1,399$).	Pregnant, low-income women presenting to single county health department September 1989–December 1990; comparison group drawn from 2 other counties.	5/High
Low et al. (2000)†	Compared outcomes for women who chose care by CNM group to women who chose care by one of faculty obstetricians (total $n = 865$). Secondary analysis of larger study.	Pregnant women receiving care from 1987 to 1992 at a tertiary medical center; eligible for midwifery care; had normal spontaneous vaginal birth of single, liveborn infant in the vertex position.	6/High
MacDorman& Singh (1998)	Compared differences in birth outcomes for women delivered by CNMs ($n = 153,194$) versus MDs/doctors of osteopathy ($n = 2,634,550$).	Pregnant women with vertex, vaginal, ≥35–43 weeks, singleton, liveborn from 1991 national linked birth/death data.	6/High
Oakley et al. (1995)†	Compared care processes of women who chose care by CNM ($n = 471$) with those who chose care by obstetricians ($n = 710$).	Pregnant women receiving care from 1988 to 1992 at a tertiary medical center; eligible for midwifery care.	6/High
Oakley et al. (1996)†	Compared care processes of women who choose care by CNM ($n = 471$) with those who chose care by obstetricians ($n = 710$).	Pregnant women receiving care from 1988 to 1992 at a tertiary medical center; eligible for midwifery care.	6/High
Robinson et al. (2000)	Compared women delivered by CNM ($n = 565$) with those delivered by faculty obstetricians ($n = 192$) and those delivered by private obstetricians ($n = 819$).	Pregnant women entering care between December 1994 and July 1995; nulliparas, singleton, spontaneous vaginal delivery after 36 weeks, and nondiabetic.	6/High
Rosenblatt et al. (1997)	Compared differences in patterns of care from a random sample of obstetricians ($n = 54$), family physicians ($n = 54$), and CNMs ($n = 43$), using a random sample of their low-risk patients.	Pregnant women who initiated care with one of the randomly selected providers between September 1988 and August 1989; considered low risk.	7/High
Sze et al. (2008)	Compared outcomes for women delivered by CNMs ($n = 3,219$), residents ($n = 2,001$), or obstetricians ($n = 3,703$).	Pregnant women with singleton, cephalic vaginal delivery that occurred between 2000 and 2004 at tertiary medical center; ≤37 weeks gestation; using forceps or vacuum were excluded.	6/High

* Represents the same study data.
† Represents the same study data.

Table 3
Summary of Outcomes Where CNMs are Compared with MDs

Author (Year)	Study Quality Rating	Outcomes (Number of Studies)			
Process of Labor		**Epidural (10)**	**Labor augmentation (9)**	**Labor Induction (9)**	**Labor analgesia (6)**
Blanchette (1995)	4	Favors CNM	Favors CNM	Favors CNM	NS
Butler et al. (1993)	6	NS	–	–	–
Chambliss et al. (1992)	7	–	Favors CNM	–	Favors CNM
Cragin & Kennedy (2006)	5	Favors CNM	–	–	–
Davis et al. (1994)	6	Favors CNM	Favors CNM	Favors CNM	Favors CNM
Hueston & Rudy (1993)	7	NS	Favors CNM	Favors CNM	NS
Jackson et al. (2003b)	7	Favors CNM	–	Favors CNM	Favors CNM
Lenaway et al. (1998)	5	–	Favors MD	Favors MD	–
Oakley et al. (1995)	6	Favors CNM	NS	NS	Favors CNM
Robinson et al. (2000)	6	Favors CNM	Favors CNM	Favors CNM	–
Rosenblatt et al. (1997)	7	Favors CNM	Favors CNM	Favors CNM	–
Sze et al. (2008)	6	Favors CNM	NS	NS	–
Evidence grade		Moderate	High	Moderate	High
Process of Birth		**Cesarean (15)**	**Vaginal operative (8)**	**Episiotomy (8)**	**VBAC (5)**
Baruffi et al. (1990)	6	Favors CNM	–	–	–
Blanchette (1995)	4	Favors CNM	NS	Favors CNM	Favors CNM
Butler et al. (1993)	6	Favors CNM	Favors CNM	–	–
Chambliss et al. (1992)	7	NS	Favors CNM	Favors CNM	–
Cragin (2002)	6	Favors CNM	Favors CNM	–	Favors CNM
Cragin & Kennedy (2006)	5	Favors CNM	–	–	–
Davis et al. (1994)	6	Favors CNM	Favors CNM	–	Favors CNM
DeLano et al. (1997)	5	Favors CNM	NS	–	Favors CNM
Fischler & Harvey (1995)	3	Favors CNM	–	–	–
Hueston & Rudy (1993)	7	Favors CNM	–	Favors CNM	–
Jackson et al. (2003b)*	5	Favors CNM	–	Favors CNM	–
Jackson et al. (2003a)*	5	Favors CNM	–	–	–
Lenaway et al. (1998)	5	–	–	–	NS
Low et al. (2000)†	6	NS	–	Favors CNM	–
Oakley et al. (1995)†	6	Favors CNM	Favors CNM	Favors CNM	–
Robinson et al. (2000)	6	–	–	Favors CNM	–
Rosenblatt et al. (1997)	7	NS	Favors CNM	Favors CNM	–
Evidence grade		High	High	High	Moderate
Infant outcome		**Low Apgar (11)**	**Low Birthweight (8)**	**NICU admission (5)**	**Breastfeeding (3)**
Blanchette (1995)	4	NS	NS	–	–
Butler et al. (1993)	6	NS	–	Favors CNM	–
Chambliss et al. (1992)	7	NS	–	–	–
Cragin (2002)†	6	–	–	–	Favors CNM
Davis et al. (1994)	6	NS	–	–	–
Fischler & Harvey (1995)	3	NS	NS	NS	–
Heins et al. (1990)	6	–	NS	–	–
Hueston & Rudy (1993)	7	NS	–	–	–
Jackson et al. (2003b)*	7	NS	NS	NS	Favors CNM
Jackson et al. (2003a)*	5	NS	–	–	–
Lenaway et al. (1998)	5	Favors CNM	NS	–	–
MacDorman & Singh (1998)	6	–	Favors CNM	–	–
Oakley et al. (1996)	6	NS	NS	Favors CNM	Favors CNM
Rosenblatt et al. (1997)	7	NS	–	–	–
Sze et al. (2008)	6	–	Favors CNM	–	–
Evidence grade		High	High	Moderate	Moderate
Maternal outcome		**Perineal lacerations (5)**			
Chambliss et al. (1992)†	7	Favors CNM			
Hueston & Rudy (1993)†	7	Favors CNM			
Low et al. (2000)†	6	Favors CNM			
Oakley et al. (1996)†	6	Favors CNM			
Robinson et al. (2000)†	6	Favors CNM			
Evidence grade		High			

VBAC, vaginal birth after cesarean.
* Represents the same study data.
† Represents same study data.

detail. Furthermore, variations in study designs would make it difficult to statistically explore sources of bias, even if the design details were adequately reported.

Care by CNMs has been shown to be safe and effective. Based on CNMs' conceptualization of birth as a natural process and the increasing scrutiny of using invasive interventions, CNMs are well-positioned to influence maternity care practices that can optimize maternal and neonatal outcomes. Moreover, they should be better utilized to address the projected health care workforce shortages.

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