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Advanced Practice Nurse Outcomes 1990-2008: A Systematic Review

Executive Summary

- Advanced practice registered nurses have assumed an increasing role as providers in the health care system, particularly for underserved populations.
- The aim of this systematic review was to answer the following question: Compared to other providers (physicians or teams without APRNs) are APRN patient outcomes of care similar?
- This systematic review of published literature between 1990 and 2008 on care provided by APRNs indicates patient outcomes of care provided by nurse practitioners and certified nurse midwives in collaboration with physicians are similar to and in some ways better than care provided by physicians alone for the populations and in the settings included.
- Use of clinical nurse specialists in acute care settings can reduce length of stay and cost of care for hospitalized patients.
- These results extend what is known about APRN outcomes from previous reviews by assessing all types of APRNs over a span of 18 years, using a systematic process with intentionally broad inclusion of outcomes, patient populations, and settings.
- The results indicate APRNs provide effective and high-quality patient care, have an important role in improving the quality of patient care in the United States, and could help to address concerns about whether care provided by APRNs can safely augment the physician supply to support reform efforts aimed at expanding access to care.

Quality, access, and cost of health care are high-priority global concerns. In the United States, these issues are pressing due to the escalating cost of managing chronic diseases (Department of Health and Human Services, 2009), the variation in quality of care delivered (Kuehn, 2009), and the inadequate number of primary care physicians (Freed & Stockman, 2009; Kuehn, 2009; Lakhan & Laird, 2009). At this critical time, we still do not know which models of care are best, how to integrate advanced practice registered nurses (APRN) providers, or to what extent APRN providers can contribute to improved access to and quality of health care. These deficits are untenable when the health care needs of society are great and the health reform debate progresses in legislative arenas. How to expand health care services for the American public, at an affordable cost, is central to this dispute.

Advanced practice registered nurses have assumed an increasing role as providers in the health care system, particularly for underserved populations. APRNs complete specialty-specific graduate programs that include education, training, and practice experience needed to complete a national board certification examination before entry into practice. Nurses practicing in APRN roles include nurse practitioners (NPs), clinical nurse specialists (CNSs), certified nurse-midwives (CNMs), and certified registered nurse anesthetists (CRNAs). Several systematic reviews have assessed what is known about NP practice (Brown & Grimes, 1995; Horrocks, Anderson, & Salisbury, 2002; Laurant et al., 2005; Sox, 1979). Similar or better outcomes are found for patient satisfaction (Brown & Grimes, 1995; Horrocks et al., 2002; Laurant et al., 2005; Sox, 1979), patient health status (Horrocks et al., 2002; Laurant et al., 2005), functional status (Brown & Grimes, 1995), and the use of the emergency department (Brown & Grimes, 1995; Laurant et al., 2005). A Cochrane review indicated midwifery care outside the United States was associated with a reduced risk of losing a baby before 24 weeks, a reduced use of regional analgesia, fewer episiotomies or instrumental births, increased chance of a spontaneous vaginal birth, and increased initiation of breastfeeding (Hatem, Sandall, Devane, Soltani, & Gates,

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2008). No systematic reviews of CNS or CRNA outcomes have been published.

Although these reviews provide some information about the effects of APRNs on specific outcomes, an updated comprehensive review of the scientific literature on the care provided by APRNs in the United States is needed to inform educational, public, and organizational policy. This review is the most current and complete assessment of the comparability of APRNs to other providers, strengthening and extending the conclusions drawn from previous reviews by including evidence from over a span of 18 years on all types of APRNs and all outcomes, patient populations, and settings.

This systematic review compared the processes and outcomes of care delivered by APRNs to a comparison provider group, most often physicians. The intent was to consider the broad range of studies and outcome measures across these groups using a systematic, transparent, and reproducible review process.

Aim. The aim of this systematic review was to answer the following question: Compared to other providers (physicians or teams without APRNs), are APRN patient outcomes of care similar?

Methods

Design. A systematic review was conducted following processes specified for Evidence Based Practice Centers funded by the Agency for Healthcare Research and Quality, and guided by an expert co-investigator. Processes were designed to identify and select relevant studies; review, rate, and grade the individual studies; and synthesize the results for outcomes with a sufficient number of studies. Teams were developed for each of the APRN groups, led by a co-investigator. Five Technical Expert Panels (TEPs) were convened: one for each of the APRN groups and one methods panel to review the report of the overall project.

Search methods. The following databases were searched systematically: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Proquest. For each APRN group, specific search strategies were developed with the assistance of a medical librarian and four APRN role-specific TEPs. The search strategy was intentionally broad to improve search sensitivity.

Inclusion criteria were randomized controlled trial (RCT) or observational study of at least two groups of providers (e.g., APRN working alone or in a team compared to other individual providers working alone or in teams without an APRN), conducted in the United States between 1990 and 2008, and reported quantitative data on patient outcomes. Studies prior to 1990 were not included since practice and interventions have changed both in the scientific basis and the organization of health care providers. Studies were excluded if they were non-English, included no quantitative data, or contained only outcomes that could not be affected by APRNs. For example, if the intervention included free medications for one group only, the outcomes could not be attributed to the care of the APRN alone. Only U.S. studies were included because: (a) the education for and implementation of advanced practice roles and scope of practice are different in the United States compared to other countries; and (b) the health care system in the United Sates (including health care access, health insurance, and costs of care) is very different from health care systems in other countries.

Search outcome. Figure 1 depicts the summary of the literature search results and article inclu-

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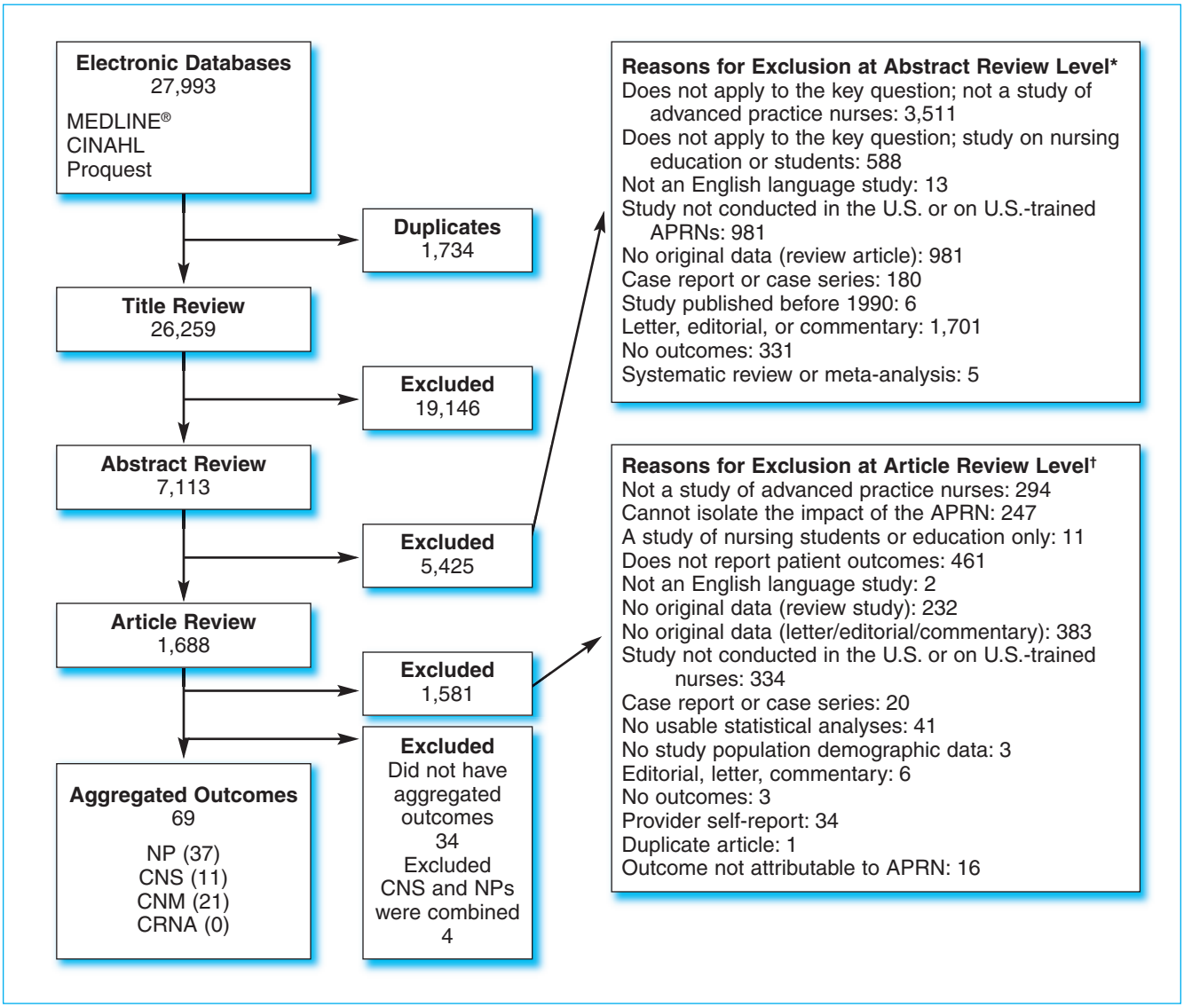
Figure 1.
Summary of Literature Search and Number of Articles



†* Reason for study exclusion can be attributable to more than one category.

sion and exclusion at each level. A multi-step process was used to conduct the review, proceeding from titles to abstracts and then the full articles. At each step, the citation was reviewed and, if judged to not meet inclusion criteria, the reasons for exclusion were documented. Web-based database software facilitated access to studies and citation management. Standardized abstract forms included in the web-based software were developed by the team specifically for this project.

Data abstraction. Titles, abstracts, and full articles were reviewed by two independent reviewers and included or excluded according to the criteria listed previously. A primary reviewer completed all of the relevant data abstraction forms. The second reviewer checked the first reviewer's data abstraction forms for completeness and accuracy. Reviewer pairs were formed to include personnel with both clinical and methodological expertise. The reviews were not blinded in terms of the articles' authors, institutions, or journal. As with article inclusion, differences of opinion that could not be resolved between the reviewers were resolved through consensus adjudication. If articles were deemed to meet inclusion criteria by both reviewers, they were included in the final data abstraction.

Quality assessment. Once a final set of studies were determined, the quality of each indi-

Table 1.
Quality Assessment Criteria

Criteria	Rating Scale
Were participants in both groups similar?	No (0) Yes (1)
Was setting of both groups similar?	No (0) Yes (1)
Was sample size in both groups adequate?	Less than 30 per group (0) 31-60 per group (1) >60 per group (2)
Were measures reliable and valid?	No (0) Yes (1)
Was bias controlled?	No (0) Yes (1)
Can the outcome be attributed to the APRN?	Yes (2) Partial (1) No (0)
Potential range	0-8

vidual study was assessed using a modified scale informed by the Jadad scale (Jadad et al., 1996). Table 1 includes the quality assessment criteria. Since the Jadad scale was designed for RCTs (e.g., use of double-blinding), additional quality criteria were constructed to account for the observational studies represented in this review (e.g., similarity of groups and settings, group sample sizes, sources of bias). The additional quality criteria included comparability of participants and settings, sample size, reliability and validity of measures, bias control, and attribution of outcome to APRN. Attribution of the outcome to the APRN was assessed by considering if the APRN (a) worked independently, as a team member, or was directly supervised; and (b) if the outcome was directly linked to APRN care.

Study quality was assessed by agreement of at least two team members using an eight-point scale. A score was assigned for each item only if the specific criterion was completely satisfied. Two reviewers independently rated the quality of each study and discussed those items on which they disagreed, and then consensus was reached. A score of ≥5 was considered high quality, and a score of ≤4 was considered low quality.

Data synthesis and analysis. A set of detailed evidence tables was created for each APRN group. Information extracted from the eligible studies was rechecked against the original articles for accuracy. If there was a discrepancy between the data abstracted and the data appearing in the article, this discrepancy was addressed by the investigator in charge of the APRN-specific data set and the data were corrected in the final evidence tables.

Outcomes were aggregated for each APRN group when there was a minimum of three studies with the same outcome. The decision to only aggregate studies with three similar outcomes was based on the rational that: (a) One or two studies do not provide adequate evidence to summarize results or assess a body of evidence; and (b) This systematic review was intentionally broad to assess all APRN outcomes, rather than a few outcomes as is common in most systematic reviews.

Grading of evidence. At the completion of the abstraction and the rating of study quality, the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) Working Group Criteria (Atkins et al., 2004) was applied to the overall evidence for each aggregated outcome.

Evidence first was classified into one of four baseline categories: high, moderate, low, or very low. A high baseline category was designated if there were at least two RCTs or one RCT and two high-quality observational studies. A moderate baseline category was designated if there was one RCT, one high-quality observational study, and one low-quality observational study or three high-quality observational studies. A low baseline category was designated if there were fewer than three high-quality observational studies.

Next, the overall grading questions in Table 2 were then applied to the body of research for each outcome. Table 3 includes the overall quality categories and definitions. An overall grade category was assigned by considering the number of studies, design, study quality, consistency of results, directness (extent to which results directly addressed the question), and likelihood of reporting bias.

The grade was decreased by one level for each question if indicated by a positive answer to each question. For example, if study results were inconsistent, outcomes with a baseline category of high would be reduced one level to moderate. The final strength-of-evidence grade was then assigned.

In grading the evidence, the direction of effects was evaluated as favoring APRNs, favoring the comparison group, or no significant difference. In many cases, showing equivalence of outcome was considered a good outcome, similar to equivalence trials where the aim is to show the therapeutic equivalence of two treatments (Jones, Jarvis, Lewis, & Ebbutt, 1996). This was the case when comparing care involving NPs, CRNAs, or CNMs with care involving only physicians.

Effect sizes were not calculated for the multiple outcomes, rather the significance or nonsignificance reported by the authors was recorded. Calculating effect sizes for these

Table 2.
Assessment of Overall Evidence

Criteria	Rating System	Definition
Based on the number of studies and numbers of patients, is this sparse?	-1	Sparse = fewer than three studies per outcome; fewer than two RCTs when RCTs are appropriate
As a body of evidence, are the study designs the strongest designs to answer the question?	-1	Determination of strongest study designs is outcome dependent. RCTs are not always feasible, and in some instances, observational studies provide better evidence (e.g., RCT for physiologic outcome such as blood pressure, lipids, glucose — RCT desirable; outcomes that are rare events, such as death, complications — observational desirable).
Is the quality of the studies acceptable?	-1	Quality refers to the study methods and execution. Quality of studies is reflected in the individual study-quality rating (0_8) and designated as low or high (≥5 = high, ≤4 = low).
Is there important inconsistency across the studies?	-1	Consistency is similar estimates of the effect. Inconsistency is demonstrated through differences in direction of effects and significances of differences across all studies. For outcomes for which equivalent nonsignificant outcomes are favorable (NP, CNM, CRNA), inconsistencies are present when the significant difference favors the comparison group.
Is there concern about the directness of the evidence?	-1	Directness is the extent to which study participants, measures, and outcomes are similar to the population of interest.
Is there a high probability of reporting bias? This includes publication bias and selective reporting of outcomes.	-1	Probability of reporting bias that would result in more significant differences in comparison groups than actually exist

Table 3.
Overall Quality Categories and Definitions

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

SOURCE: Atkins et al. (2004).

multiple broad outcomes would be problematic for several reasons. First, for many outcomes the studies represent widely varying populations, definitions, time periods, and study designs. Second, the publications did not consistently include the necessary data to calculate effect size (e.g., Ns and standard deviations for subsamples) since many of the studies were not designed specifically to make APRN comparisons to other providers.

A draft of the evidence report was reviewed by four TEPs, one for each APRN category and one methodological TEP including other stakeholders (consumer statistician and physician leader). Each TEP submitted written comments and recommendations that were addressed by the research team.

Results

Across the four APRN groups, 107 studies met inclusion criteria (NP, 49; CNS, 22; CNM, 23; CRNA, 4; and CNS and NP combined, 9). Based on the decision to focus on outcomes with at least three supporting studies, 69 studies (20 RCTs and 49 observational studies) were included in outcome aggregation. The summary of studies and overall strength of evidence grades are included for NPs

Table 4a.
Summary of Study Characteristics for Nurse Practitioners

Author, Year	Compared Groups	Disease/Condition	Patient Population	Setting	Study Quality
RCTs (n=14)					
Becker et al., 2005	NP to MD	Coronary artery disease	African Americans, 30-59 y/o, sibling of probands <60 y/o	Community	High
Büla et al., 1999	GNP + team to MD	Varied	>74 y/o, without cognitive or functional impairment	Community	High
Callahan et al., 2006	GNP + team to MD	Alzheimer's disease	In home with caregiver	Community	High
Counsell et al., 2007	NP + team to MD	Varied	>64 y/o; income <200% of federal poverty level	Community	High
Fanta et al., 2006	PNP + attending MD to resident + attending MD	Condition requiring inpatient trauma care	Children between 2 months and 17 years of age	Inpatient	Low
Krichbaum, 2007	GNP to MD	Hip fracture	>64 y/o with hip fracture repair	Inpatient	Low
Lenz et al., 2004	NP to MD	Varied	Hispanic adults with recent urgent care or ED visit	Community	High
Lenz et al., 2002	NP to MD	Diabetes	Adults; primarily Hispanic; no current health care provider	Community	High
Litaker et al., 2003	NP to MD	Hypertension and diabetes	Adults without complex medical conditions	Community	High
Mundinger et al., 2000	NP to MD	Chronic conditions	Hispanic adults with recent urgent care or ED visit	Community	High
Nelson et al., 1991	PNP to usual ED care	Infectious or emergent condition	Children <8 y/o without chronic illness	Community	High
Paez & Allen, 2006	NP to MD	Coronary artery disease	Adults undergoing revascularization procedure	Community	High
Pioro et al., 2001	NP to MD	Varied medical conditions	18-69 y/o; admitted to general medical units	Inpatient	High
Stuck et al., 1995	GNP to MD	Varied conditions	>74 y/o; living at home without preexisting functional impairment	Community	High
Observational (n=23)					
Ahern et al., 2004	NP to MD	Chronic hepatitis C	Adults	Community	Low
Aigner et al., 2004	NP to MD	Chronic diseases	Residents in eight nursing homes	Nursing home	High
Aiken et al., 1993	NP to MD	HIV/AIDS	Adults with HIV/AIDS seen in specialty clinic	Community	Low
Bissinger et al., 1997	NNP to MD	Conditions encountered in low-birthweight infants	Low-birthweight neonates between 500-1,250 grams	Inpatient	High
Borgmeyer et al., 2008	PNP to MD	Asthma	Children admitted to general units with exacerbation of asthma	Inpatient	Low
Dahle et al., 1998	NP to MD	Uncomplicated decompensated heart failure	Adults admitted to hospital	Inpatient	High

Table 4a. (continued)
Summary of Study Characteristics for Nurse Practitioners

Author, Year	Compared Groups	Disease/Condition	Patient Population	Setting	Study Quality
Observational (n=23) (continued)					
Garrard et al., 1990	NP to MD usual care	Varied	Nursing home resident	Nursing home	Low
Gracias et al., 2008	ACNP to MD	Varied postoperative	Adults admitted to surgical ICU	Inpatient	High
Hoffman et al., 2005	ACNP to MD	Varied medical conditions	Adults receiving mechanical ventilation and admitted to subacute MICU	Inpatient	High
Kane et al., 2004	NP to MD	Varied	Nursing home residents	Nursing home	Low
Karlowicz & McMurray, 2000	NNP to MD	Extremely low-birthweight infants	Newborns admitted to NICU	Inpatient	High
Kutzleb & Reiner, 2006	NP to MD	Heart failure	18-75 y/o	Community	Low
Lambing et al., 2004	NP to MD	Varied	60+ years admitted to geriatric unit or 1 of 2 general medical units	Inpatient	Low
McMullen et al., 2001	ACNP to MD	Varied	Adults admitted to medical unit	Inpatient	High
Meyer & Miers, 2005	ACNP to MD	Varied conditions associated with cardiovascular surgery	Adults undergoing cardiovascular surgery	Inpatient	High
Miller, 1997	GNP to PA	Varied inpatient medical conditions	Nursing home patients admitted to inpatient medicine unit	Inpatient	High
Paul, 2000	NP to MD	Heart failure	Adults with CHF seen in specialty clinic	Community	Low
Pinkerton & Bush, 2000	NP to MD	Diabetes and hypertension	Adults	Community	High
Rideout, 2007	PNP to MD	Cystic fibrosis	Children admitted to adolescent unit	Inpatient	Low
Ruiz et al., 2001	NP to MD	Twin pregnancy	Women diagnosed with twin pregnancy	Community	High
Russell et al., 2002	ACNP to MD	Varied neurological conditions	Adults with tracheostomy admitted to neurological unit	Inpatient	High
Schultz et al., 1994	NNP to MD	Varied neonatal conditions	Infants admitted to transitional care unit	Inpatient	High
Varughese et al., 2006	NP to MD	Varied operative conditions	Children scheduled for outpatient surgery	Ambulatory surgery	Low

Table 4b.
Summary of Study Design, Study Groups, Study Purpose, Patient Population, Outcomes, and Quality for Certified Nurse-Midwives

Author, Year	Compared Groups	Disease/Condition	Patient Population	Setting	Study Quality
RCTs (n=2)					
Chambliss et al., 1992	CNM vs. MD	Low-risk pregnant women	Admitted in one hospital to unit for physician or unit for midwifery management	Inpatient	High
Heins et al., 1990	CNM to MD	Pregnant women	Women attending 1 of 5 state-funded prenatal clinics and considered high risk for low birthweight	Prenatal-inpatient	High
Observational (n=19)					
Baruffi et al., 1990	CNM to MD	Pregnant women	Delivering in hospital with CNM care or hospital with residents and physicians	Inpatient	High
Blanchette, 1995	CNM to MD	Pregnant women	Women in single clinic cared for by CNM or by MD	Prenatal-inpatient	High
Butler et al.,1993	CNM to MD	Low-risk pregnant women	Women delivered in hospital with CNM or MD care	Inpatient	High
Cragin, 2002	CNM to MD	Moderate-risk pregnant women	Women with prenatal care at two sites	Prenatal-inpatient	High
Cragin & Kennedy, 2006	CNM to MD	Low or moderate-risk pregnant women	Women enrolled in obstetric practice who chose either CNM or MD care	Prenatal-inpatient	High
Davis et al., 1994	CNM to MD	Low-risk pregnant women	Women delivering in hospital with both CNM and MD care	Inpatient	High
DeLano et al., 1997	CNM to MD	Low to moderate-risk pregnant women.	Women delivering in hospital with both CNM and MD	Inpatient	High
Fischler & Harvey, 1995	CNM to MD	Retrospective 20-year trend study.	Women cared for in one of three care models and Medicaid, giving birth in single county	Prenatal-inpatient	Low High
Hueston & Rudy, 1993	CNM to MD	Low-income pregnant women	Women receiving care at medical center primary care group	Prenatal-inpatient	High
Jackson, Lang, Ecker et al., 2003a[§]	CNM to MD	Pregnant women	Women enrolling at study site	Prenatal-inpatient	High
Jackson, Lang, Swartz et al., 2003b[§]	CNM to MD	Low-income and low-risk pregnant women	Women enrolling at study site	Prenatal-inpatient	High
Lenaway et al.,1998	CNM to MD	Low-income and low-risk pregnant women	Women presenting to county health department where CNMs are principal providers	Prenatal-inpatient	High
Low et al., 2000[‖]	CNM to MD	Low-income pregnant women	Women voluntarily chose the CNM group practice or faculty obstetricians	Prenatal-inpatient	High
MacDorman & Singh, 1998	CNM to MD	Low-risk pregnant women	Women in linked birth/death data	Inpatient	High

Table 4b. (continued)
Summary of Study Design, Study Groups, Study Purpose, Patient Population, Outcomes, and Quality for Certified Nurse-Midwives

Author, Year	Compared Groups	Disease/Condition	Patient Population	Setting	Study Quality
Observational (n=19) (continued)					
Oakley et al., 1995[‖]	CNM to MD	Low-risk pregnant women	Women in one medical center	Inpatient	High
Oakley et al., 1996[‖]	CNM to MD	Low-risk pregnant women	Women in one medical center	Inpatient to home	High
Robinson et al., 2000	CNM to MD	Low-risk pregnant women	Women entering care at study site	Inpatient	High
Rosenblatt et al., 1997	CNM to MD	Low-risk pregnant women	Women initiated care with one of the randomly selected providers	Prenatal to inpatient	High
Sze et al., 2008	CNM to MD	Low-risk pregnant women	Women cared for in single hospital	Inpatient	High

[§] Represents same study data
[‖] Represents same study data

in Table 4a, CNMs in Table 4b, and CNSs in Table 4c. A summary of the aggregated outcomes are included for NPs in Table 5a, CNMs in Table 5b, and CNSs in Table 5c.

Nurse Practitioner Outcomes

Thirty-seven studies (14 RCTs and 23 observational studies) examined patient outcomes of care by NPs (NP care group) compared with care managed exclusively by physicians (attending physicians with or without interns, residents, and/or fellows) in all but one study. Eleven patient outcomes were summarized: patient satisfaction with provider/care, patient self-assessment of perceived health status, functional status, blood glucose, serum lipids, blood pressure, emergency department visits, hospitalization, duration of ventilation, length of stay, and mortality. The number and type of studies for each outcome will be described.

Patient satisfaction. Six studies (four RCTs) reported patient satisfaction with the provider. Studies were conducted in primary care settings with adults, and from parents of children who had undergone outpatient surgery or been admitted to the hospital after a traumatic injury. When comparing NP and MD care, there is a high level of evidence to support equivalent levels of patient satisfaction.

Self-reported perceived health. Seven studies (five RCTs) examined self-reported perceived health. The instrument used in the studies included the SF-12 or SF-36 physical and mental function scales to rate self-reported perception of health. Studies were conducted with samples of adults cared for in a primary care setting, specialty clinic, or home care in a community setting, and patients hospitalized with general medical conditions. When comparing NP and MD care, there is a high level of evidence to support equivalent levels of self-reported patient perception of health.

Functional status. Ten studies (six RCTs) reported activities of daily living (ADL), instrumental activities of daily living (IADL), 6-minute walk test, or patient self-report.

Studies were conducted with samples of community-dwelling elders who were recently discharged from hospitals and receiving either home care or inpatient rehabilitation, adults hospitalized for general medical problems, and ambulatory patients diagnosed with HIV/AIDS. When comparing NP and MD groups, there is a high level of evidence to support equivalent patient functional status outcomes.

Glucose control. Five studies (RCTs) reported glucose control (glycosolated hemoglobin, serum glucose). Studies were conducted with samples of adults in ambulatory primary care settings. When comparing NP and MD care, there is a high level of evidence to support equivalent levels of patient glucose control.

Lipid control. Three studies (RCTs) reported lipid control. Studies were conducted with samples of adults in primary care settings. When comparing NP and MD groups, there is a high level of evidence to support better

Table 4c.
Summary of Study Design, Study Groups, Study Purpose, Patient Population, Outcomes, and Quality for Clinical Nurse Specialists

Author, Year	Compared Groups	Disease/Condition	Patient Population	Setting	Study Quality
RCTs (n=4)					
Allen et al., 2002	CNS to usual care	Stroke and transient ischemic attack	Adults discharged to home from hospital or rehabilitation	Community	High
Duffy-Durnin & Campbell-Heider, 1994	CNS to usual care	Medical-surgical admission	>70 y/o	Hospital	High
Swindle et al., 2003	CNS to usual care	Depression	Adult veterans	Community	High
York et al., 1997	CNS to usual care	High-risk pregnancy	Women recruited during first hospital admission	Community	High
Observational (n=7)					
Ahrens et al., 2003	CNS to standard care	End-of-life care	Patients at high risk of dying	Inpatient	High
Hanneman et al., 1993	CNS to usual care	Varied conditions	Adults admitted to critical care units	Inpatient	High
Koch & Smith, 1994	CNS to usual care	Radical prostatectomy	Men undergoing retropubic prostatectomy	Inpatient	Low
Lombness, 1994	CNS to PA	Coronary bypass graft	Adults for elective surgery	Inpatient	High
Micheels et al., 1995	CNS to usual care	Colon resection	Adults	Inpatient	Low
Sherman & Johnson, 1994	CNS to usual care	Oncology conditions	Adult oncology patients	Inpatient	Low
Wheeler, 2000	CNS to usual care	Total knee replacement	Adults	Inpatient	High

management of patient serum lipid levels by NPs.

Blood pressure. Four studies (RCTs) reported blood pressure control. Studies were conducted with samples of adults in primary care settings. When comparing NP and MD groups, there is a high level of evidence to support equivalent levels of BP control.

Emergency department (ED) or urgent care visits. Five studies (three RCTs) reported utilization outcomes through ED or urgent care visits. Studies were conducted with samples of ambulatory patients with diabetes, hypertension, dyslipidemia, asthma, and heart failure; community-dwelling elders; nursing home residents; and otherwise healthy children who had recently been seen in the ED for an emergent condition. When comparing NP and MD groups, there is a high level of evidence to support equivalent rates of ED visits.

Hospitalization. Eleven studies (three RCTs) reported the utilization outcome hospitalization. Studies were conducted with samples of adult patients with heart failure managed in ambulatory care settings, older adults receiving care in nursing homes, or patients discharged home after acute care hospitalizations (premature infants, children with asthma, adults with heart failure, and older adults with general medical conditions). When comparing NP and MD groups, there is a high level of evidence to support equivalent rates of hospitalization.

Duration of mechanical ventilation. Three studies (0 RCTs) reported duration of mechanical ventilation. Studies were conducted with samples in acute care settings with adults or low-birthweight neonates. When comparing NP and MD groups, there is a low level of evidence to support equivalent duration of mechanical ventilation.

Length of stay (LOS). Sixteen studies (two RCTs) reported patient LOS. Studies were conducted with samples in high-risk neonates, children (admitted for exacerbation of asthma, pulmonary complications of cystic fibrosis, or non-thoracic or CNS traumatic injuries), critically ill adults (requiring endotracheal intubation or tracheostomy and mechanical ventilation for respiratory failure), adults (admitted with general medical problems or for cardiovascular surgery), and older adults (admitted from home or a nursing home with general medical problems). When comparing NP and MD groups, there is a moderate level of evidence to support equivalent LOS.

Table 5a.
Summary of Outcomes and Evidence for Nurse Practitioners

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
Patient satisfaction	6 (4 RCTs)	Lenz et al., 2004 (6)* Fanta et al., 2006 (3)* Litaker et al., 2003 (8)*† Mundinger et al., 2000 (8)* Pinkerton & Bush, 2000 (7) Varughese et al., 2006 (2)	Six studies reported patient satisfaction with the provider. Four of the studies were of high quality (Lenz et al., 2004; Litaker et al., 2003; Mundinger et al., 2000; Pinkerton & Bush, 2000). Five studies were conducted in primary care settings with adults (Lenz et al., 2004; Litaker et al., 2003; Mundinger et al., 2000; Pinkerton & Bush, 2000). The other two studies collected data from parents of children who had undergone outpatient surgery or been admitted to the hospital after a traumatic injury (Fanta et al., 2006; Varughese et al., 2006). When comparing NP and MD care, there is a high level of evidence to support equivalent levels of patient satisfaction.	High: Satisfaction is equivalent in NP and MD comparison groups.
Self-reported perceived health	7 (5 RCTs)	Counsell et al., 2007 (7)*† Litaker et al., 2003 (8)* Lenz et al., 2002 (6)* Pioro et al., 2001 (5)* Mundinger et al., 2000 (8)* Ahern et al., 2004 (3) McMullen et al., 2001 (4)†	All used the SF-12 or SF-36 physical and mental function scales to rate self-reported perception of health. Five were judged high-quality RCTs (Counsell et al., 2007; Litaker et al., 2003; Lenz et al., 2002; Mundinger et al., 2000; Pioro et al., 2001). Four of the studies were conducted with adults cared for in a primary care setting (Lenz et al., 2002; Litaker et al., 2003; Mundinger et al., 2000) and one used a sample of adults diagnosed with hepatitis C managed in a specialty clinic (Ahern et al., 2004). A sixth study collected data from older adults receiving home care in a community setting (Counsell et al., 2007). The last two studies reported on results obtained from adults hospitalized with general medical conditions (McMullen et al., 2001; Pioro et al., 2001). One RCT (Counsell et al., 2007) found higher health status in patients cared for by NPs as part of a comprehensive care management team, and the rest of the studies did not find any difference in health status depending on provider type, though two were powered to do so. When comparing NP and MD care, there is a high level of evidence to support equivalent levels of self-reported patient perception of health status.	High: Self-assessed health status is equivalent in NP and MD comparison groups.
Functional Status ADL/IADL	10 (6 RCTs)	Counsell et al., 2007 (7)* Krichbaum, 2007 (3)* Callahan et al., 2006 (5)* Pioro et al., 2001 (5)* Büla et al., 1999 (5)*† Stuck et al., 1995 (8)*† Kutzleb & Reiner, 2006 (2) Aiken et al., 1993 (2) Ahern et al., 2004 (3) Garrard et al., 1990 (3)	Ten studies evaluated the impact of provider (NP vs. MD) on patient functional status in terms of scores on measures of ADL or IADL, 6-minute walk test, or patient self-report. Five of the studies were high quality (Büla et al., 1999; Callahan et al., 2006; Counsell et al., 2007; Pioro et al., 2001; Stuck et al., 1995) and two found NP care was associated with higher functional status (Büla et al., 1999; Stuck et al., 1995). Community-dwelling elders who were recently discharged from hospitals and receiving either home care or inpatient rehabilitation were the focus of five of these studies (Büla et al., 1999; Callahan et al., 2006; Counsell et al., 2007; Krichbaum, 2007; Stuck et al., 1995). One study included adults hospitalized for general medical problems (Pioro et al., 2001) and another included ambulatory patients diagnosed with HIV/AIDS (Aiken et al., 1993). When comparing NP and MD groups, there is a high level of evidence to support equivalent levels of patient functional status.	High: Functional status measured as ADL/IADL is equivalent in NP and MD comparison groups.
Glucose control	5 (5 RCTs)	Becker et al., 2005 (5)*† Lenz et al., 2004 (6)* Litaker et al., 2003 (8)*† Lenz et al., 2002 (6)* Mundinger et al., 2000 (8)*	Blood glucose control (glycosolated hemoglobin, serum glucose) was an outcome in four studies, all high-quality RCTs. All of the studies were conducted in ambulatory primary care settings using samples of adults (Lenz et al., 2004; Lenz et al., 2002; Litaker et al., 2003; Mundinger et al., 2000). When comparing NP and MD care, there is a high level of evidence to support equivalent levels of patient glucose control.	High: Blood glucose levels/control among patients cared for by NPs was comparable or better than that of patients cared for by other providers.

Table 5a. (continued)
Summary of Outcomes and Evidence for Nurse Practitioners

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
Lipid control	3 (3 RCTs)	Paez & Allen, 2006 (8)*† Becker et al., 2005 (5)*† Litaker et al., 2003 (8)*†	Three studies examined the effect of provider on serum lipids. All of the studies were conducted in ambulatory primary care settings using samples of adults (Becker et al., 2005; Litaker et al., 2003; Paez & Allen, 2006). The three RCTs were high quality and also provided evidence NP care was associated with better lipid control compared to care from other providers (Paez & Allen, 2006). When comparing NP and MD groups, there is a high level of evidence to support better management of patient serum lipid levels by NPs (Becker et al., 2005; Litaker et al., 2003).	High: Serum lipid levels/control among patients cared for by NP group was better than the MD comparison group.
Blood Pressure	4 (4 RCTs)	Becker et al., 2005 (5)*† Lenz et al., 2004 (5)* Litaker et al., 2003 (8)* Mundinger et al., 2000 (8)*†	Blood pressure control was an outcome of four RCTs. All of the studies were conducted in ambulatory primary care settings using samples of adults. All four RCTs were high quality, and two of those RCTs found patients cared for by the NP had better-controlled BP than patients cared for by other providers (Becker et al., 2005). When comparing NP and MD groups, there is a high level of evidence to support equivalent levels of BP control.	High: Blood pressure levels/control among patients is equivalent in NP and MD comparison groups.
ED or urgent care visits	5 (3 RCTs)	Counsell et al., 2007 (7)*† Lenz et al., 2002 (6)* Nelson et al., 1991(7)* Aigner et al., 2004 (4) Paul, 2000 (3)	Five studies reported rates of ED visits. All three RCTs were judged to be high quality (Counsell et al., 2007; Lenz et al., 2002; Nelson et al. 1991). Study samples included ambulatory patients with diabetes, hypertension, dyslipidemia, asthma, and heart failure (Lenz et al., 2002; Paul, 2000); community-dwelling elders and nursing home residents (Aigner et al., 2004; Counsell et al., 2007); and otherwise healthy children who had recently been seen in the ED for an emergent condition (Nelson et al., 1991). When comparing NP and MD groups, there is a high level of evidence to support equivalent rates of ED visits.	High: Rates of ED or urgent care visits are equivalent in NP and MD comparison groups.
Hospitalization	11 (3 RCTs)	Counsell et al., 2007 (7)* Stuck et al., 1995 (8)* Lenz et al., 2002 (6)* Schultz et al., 1994 (6) Lambing et al., 2004 (4) Kane, 2004 (4)† Aigner et al., 2004 (5) Paul, 2000 (4)† Dahle et al., 1998 (5) Garrard et al., 1990 (3)† Borgmeyer et al., 2008 (4)	Eleven studies reported rates of hospitalization. Adult patients with heart failure, managed in ambulatory care settings, were the focus of one study (Paul, 2000). Three studies evaluated older adults receiving care in nursing homes (Aigner et al., 2004; Garrard et al., 1990; Kane et al., 2004). The remaining five studies collected data from a variety of individuals discharged home after acute care hospitalizations (premature infants, children with asthma, adults with heart failure, and older adults with general medical conditions) (Borgmeyer et al., 2008; Dahle et al., 1998; Lambing et al., 2004; Schultz et al., 1994). When comparing NP and MD groups, there is a high level of evidence to support equivalent rates of hospitalization.	High: Rates of hospitalization/ rehospitalization are equivalent in NP and MD comparison groups.
Duration of ventilation	3 (0 RCTs)	Hoffman et al., 2005 (7) Russell et al., 2002 (5) Bissinger et al., 1997 (5)	Duration of ventilation was an outcome in three studies. Two found the substitution of an NP for pulmonary fellows and neurosurgical house staff had no deleterious effect on patient duration of ventilation (Hoffman et al., 2005; Russell et al., 2002). Low-birthweight neonates whose care was provided by a neonatal NP or medical residents spent similar lengths of time supported by mechanical ventilation (Bissinger et al., 1997). When comparing NP and MD groups, there is a low level of evidence to support equivalent duration of mechanical ventilation.	Low: Duration of ventilation is comparable among patients cared for by NPs in collaboration with attending MDs compared to duration of ventilation in patients cared for by house-staff MDs in collaboration with attending MDs.

Table 5a. (continued)
Summary of Outcomes and Evidence for Nurse Practitioners

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
LOS	16 (2 RCTs)	Fanta et al., 2006 (3)*† Pioro et al., 2001 (5)* Rideout, 2007 (3) Meyer & Miers, 2005 (6)† Hoffman et al., 2005 (7) Ruiz, 2001 (5)† Karlowicz & McMurray, 2000 (5) Miller, 1997 (5)† Schultz et al., 1994 (6)† Borgmeyer et al., 2008 (4) Lambing et al., 2004 (4)‡ Aigner et al., 2004 (5) Russell et al., 2002 (5)† Paul, 2000 (4) Dahle et al., 1998 (5) Bissinger et al., 1997 (5)	High-risk neonates, children (admitted for exacerbation of asthma, pulmonary complications of cystic fibrosis, or non-thoracic or CNS traumatic injuries), adults (admitted with general medical problems or for cardiovascular surgery), and older adults (admitted from home or a nursing home with general medical problems) were included in these studies. In addition, two studies examined outcomes in critically ill adults requiring endotracheal intubation or tracheostomy and mechanical ventilation for respiratory failure. One study was conducted in a neonatal critical care unit with high-risk newborns (excluding those with congenital malformations). Ten were judged high quality. Results of five of the studies favored the NP (Fanta et al., 2006; Miller, 1997; Ruiz et al., 2001; Russell et al., 2002; Schultz et al., 1994) but one low-quality study favored MDs (Lambing et al., 2004). However, the elderly patients cared for by the NPs in that study had higher acuity scores than patients in the MD group. This difference in acuity may have influenced the subsequent patient LOS. Studies in which NP patients had lower LOS included neurosurgical patients, elders, pediatric trauma patients, and low-birthweight and twin neonates. Ten studies found no difference in LOS depending on the provider (NP outcome comparable to physicians). These studies included adults and elderly patients hospitalized in a subacute MICU, cardiovascular surgical patients, and adults diagnosed with a variety of diagnoses, including heart failure, in addition to low-birthweight neonates and children with acute exacerbations of asthma and cystic fibrosis. When comparing NP and MD groups, there is a moderate level of evidence to support equivalent LOS.	Moderate: LOS is equivalent in NP and MD comparison groups.
Mortality	8 (1 RCT)	Pioro et al., 2001 (5)* Hoffman et al., 2005 (7) Ruiz, 2001 (5) Karlowicz & McMurray, 2000 (5) Gracias et al., 2008 (7)† Kane, 2004 (4) Russell et al., 2002 (5) Bissinger et al., 1997 (5)	Samples included high-risk infants (twins, pre-term, or low birthweight) (Bissinger et al., 1997; Karlowicz & McMurray, 2000; Ruiz et al., 2001), adults with acute and chronic medical conditions (Pioro et al., 2001), older adult residents of nursing homes (Kane et al., 2004), and critically ill adults (diagnosed with respiratory failure, multiple-cause critical illnesses, and after complex neurosurgery) (Gracias et al., 2008; Hoffman et al., 2005; Russell et al., 2002). Seven of the studies were judged high quality (Bissinger et al., 1997; Gracias et al., 2008; Hoffman et al., 2005; Karlowicz & McMurray, 2000; Pioro et al., 2001; Ruiz et al., 2001; Russell et al., 2002). A high-quality quasi-experimental study found mortality rates were lower in patients cared for by NPs (Gracias et al., 2008). The remaining seven studies found no differences in mortality rates. When comparing NP and MD groups, there is a high level of evidence to support equivalent mortality rates.	High: Mortality is equivalent in NP and MD comparison groups.

* RCT
† Favors APRN
‡ Favors comparison group

Mortality. Eight studies (one RCT) reported patient mortality. Studies were conducted with samples of high-risk infants (twins, pre-term, or low birthweight), adults with acute and chronic medical conditions, older adult residents of nursing homes, and critically ill adults (diagnosed with respiratory failure, multiple-cause critical illnesses, and after complex neurosurgery). When comparing NP and MD groups, there is a high level of evidence to support equivalent mortality rates.

Certified Nurse-Midwife Outcomes

Outcomes from 21 studies (two RCTs and 19 observational studies) were aggregated for 13 outcomes of care managed by

Table 5b.
Summary of Outcomes for Certified Nurse-Midwives

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
Cesarean	15 (1 RCT)	Baruffi et al., 1990 (6)† Blanchette, 1995 (5)† Butler et al., 1993 (6)† Chambliss et al., 1992 (7)* Cragin, 2002 (6)† Cragin et al., 2006 (5)† Davis et al., 1994 (6)† DeLano et al., 1997 (5)† Fischler & Harvey, 1995 (4)† Hueston & Rudy, 1993 (7)† Jackson, Lang, Ecker et al., 2003 (5) Jackson, Lang, Swartz et al., 2003 (5)† Lenaway et al., 1998 (5) Oakley et al., 1995 (6)† Rosenblatt et al., 1997 (7)	The only RCT did not show a significant difference. The purpose was to determine if the differences in cesarean rates between the CNMs and obstetricians were due to selection bias. However, it should be noted the baseline cesarean section rates were very low: 2% for CNMs and 9% for obstetricians. Thirteen of the 14 observational studies were high quality. Thirteen of the 15 studies favor CNMs, and the others are equivalent. There is a high level of evidence that CNM patients have lower rates of cesarean sections compared to MD patients.	High: Lower rates of cesarean sections for CNMs than other providers.
Low Apgar score	11 (1 RCT)	Blanchette, 1995 (5) Butler et al., 1993 (6) Chambliss et al., 1992 (7)* Davis et al., 1994 (6) Fischler & Harvey, 1995 (4) Hueston & Rudy, 1993 (7) Jackson, Lang, Ecker et al., 2003 (7) Jackson, Lang, Swartz et al., 2003 (5) Lenaway et al., 1998 (5)† Oakley et al., 1996 (6) Rosenblatt et al., 1997 (7)	The majority of studies measured as Apgar <7. One of these was a RCT (Chambliss et al., 1992) with a quality rating of 7. For the observational studies, nine were high quality and one was low quality. Since equivalent Apgar scores are desirable, having 10 of the 11 studies with non-significant differences and the remaining study favoring the CNM group was considered acceptable. However, it should be noted several studies included deliveries that might be at risk for low Apgar, while others do not, and there was inconsistent use of statistical control. A high level of evidence indicates CNM and MD Apgar scores are comparable.	High: Comparable rates of low Apgar scores between CNM and other provider groups in all studies but one.
Epidural	10 (0 RCTs)	Blanchette, 1995 (5)† Butler et al., 1993 (6) Cragin, 2006 (5)† Davis et al., 1994 (6)† Hueston & Rudy, 1993 (7) Jackson, Lang, Swartz et al., 2003 (7)† Oakley et al., 1995 (6)† Robinson et al., 2000 (6)† Rosenblatt, 1997 (7)† Sze et al., 2008 (6)†	Nine of the 10 observational studies showed CNMs used less epidural anesthesia. For births in hospitals, women do have access to regional anesthesia (epidural) during labor even when attended by a CNM. Regional anesthesia may not be available in birthing centers. While there was consistency of findings, there were no RCTs, so the evidence of lower or comparable epidural use was graded as moderate.	Moderate: Less epidural use by CNMs than other providers.
Labor augmentation	9 (1 RCT)	Blanchette,1995 (5)† Chambliss et al.,1992 (7)*† Davis et al., 1994 (6)† Hueston & Rudy, 1993 (7)† Jackson, Lang, Swartz et al., 2003 (7)† Lenaway et al., 1998 (5)‡ Oakley et al., 1995 (6) Robinson et al., 2000(6)† Rosenblatt et al., 1997(7)†	One observational study that did not favor the CNM (Oakley et al., 1995) was from a single institution. One study comparing a county-level CNM intervention to two control counties favored the women in the control counties (Lenaway et al., 1998). The authors noted this was contrary to published reports and suggested it may be related to differences in risk or differences in obstetrical practices in institutions. Considering the inclusion of an RCT and the consistency of evidence, the evidence of lower rates of labor augmentation for CNM was graded as high.	High: Lower or comparable use of labor augmentation between CNM and other providers.
Labor induction	9 (0 RCTs)	Blanchette, 1995 (5)† Davis et al., 1994 (6)† Hueston & Rudy, 1993 (7)† Jackson, Lang, Swartz et al., 2003 (7)† Lenaway et al., 1998 (5)‡ Oakley et al., 1995 (6) Robinson et al., 2000 (6)† Rosenblatt et al., 1997 (7)† Sze et al., 2008 (6)	One of the nine studies showed no significant difference. Seven favored the CNM, while one favored the women in the control counties (Lenaway et al., 1998) similar to labor augmentation. Based on the lack of an RCT study and the inconsistency of the findings, the evidence of lower rates of labor induction for CNM was graded as moderate.	Moderate: Comparable or lower rates of labor induction compared to other providers.

Table 5b. (continued)
Summary of Outcomes for Certified Nurse-Midwives

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
Episiotomy	8 (1 RCT)	Blanchette, 1995 (5)† Chambliss et al., 1992 (7)*† Hueston & Rudy, 1993 (7)† Jackson, Lang, Swartz et al., 2003 (7)† Low et al., 2000 (6)† Oakley et al., 1995 (6)† Robinson et al., 2000 (6)† Rosenblatt et al., 1997 (7)†	All studies were rated as high quality and all favored CNMs. Overall, it was concluded there is a high level of evidence to support that episiotomy rates are lower for CNMs than MDs.	High: Episiotomy rates are lower for CNMs than other providers in all studies.
Low birthweight (<2,500 g)	8 (1 RCT)	Blanchette, 1995 (5) Fischler & Fischler, 1995 (4) Heins et al., 1990 (6)* Jackson, Lang, Swartz et al., 2003 (7) Lenaway et al., 1998 (5) MacDorman & Singh, 1998 (6)† Oakley et al., 1996 (6) Sze et al., 2008 (6)†	The common measure was proportion with low birthweight (<2,500 GMs). All remaining observational studies were rated as high quality. While six of the studies reported no significant differences in low-birthweight rates, the other two favored CNMs. There is a high level of evidence that there are comparable rates of low birthweight between CNMs and other providers.	High: Comparable rates of low birthweight between CNMs and other providers.
Vaginal operative delivery (forceps, vacuum, or both)	8 (1 RCT)	Blanchette, 1995 (5) Butler et al., 1993 (6)† Chambliss et al., 1992 (7)* Cragin, 2002 (6)† Davis et al., 1994 (6)† DeLano et al., 1997 (5) Oakley et al., 1995 (6)† Rosenblatt et al., 1997 (7)†	Eight high-quality studies reported vaginal operative delivery use, including forceps use, vacuum use, or both. The RCT (Chambliss et al., 1992) showed no significant difference in forceps use but was significant for vacuum use. It should be noted the RCT excluded cases with significant maternal or fetal complications. Five of the remaining seven observational studies favored the CNM. The evidence of lower or comparable vaginal operative deliveries among CNMs was graded as high.	High: Lower or comparable vaginal operative deliveries between CNMs and other providers.
Labor analgesia	6 (1 RCT)	Blanchette, 1995 (5) Chambliss et al., 1992 (7)*† Davis et al., 1994 (6)† Hueston & Rudy, 1993 (7) Jackson et al., 2003 (7)† Oakley et al., 1995 (6)†	Analgesia (narcotic) use during labor was reported in six studies, one of which was an RCT (Chambliss et al., 1992). The RCT and five of the six observational studies favored the CNM. The studies were all rated as high quality. All women have access to analgesia during labor, but some women prefer to use non-pharmacologic approaches to manage pain. There is a high level of evidence there is less analgesia use by CNMs than MDs.	High: Less analgesia use by CNMs than other providers.
Perineal lacerations	5 (1 RCT)	Chambliss et al., 1992 (7)*† Hueston & Rudy, 1993 (7)† Low et al., 2000 (6)† Oakley et al., 1996 (6)† Robinson et al., 2000 (6)†	All studies favored the CNM. Perineal lacerations are associated with episiotomy use. A Cochrane review comparing routine versus restricted use of episiotomy found restricted use was associated with less-severe perineal trauma, less suturing, and fewer healing complications (Carroli & Belizan, 1999). Overall, it was concluded there is a high level of evidence rates of third and fourth-degree perineal lacerations are lower for CNMs than MDs.	High: Rates of third and fourth-degree perineal lacerations are lower for CNMs than other providers.
Vaginal birth after cesarean (VBAC)	5 (0 RCTs)	Blanchette, 1995 (5)† Cragin, 2002 (6)† Davis et al., 1994 (6)† DeLano et al., 1997 (5)† Lenaway et al., 1998 (5)	Four of the five studies favored CNMs. The one study that showed no difference (Lenaway et al., 1998) did have a higher proportion but it was not significant in random-effects testing. Not all of the studies excluded women who may not be eligible for VBAC, and there were no RCTs. A moderate level of evidence supports comparable or higher rates of VBAC for CNMs compared to MDs.	Moderate: Comparable or higher rates of VBAC for CNMs compared to other providers.

Table 5b. (continued)
Summary of Outcomes for Certified Nurse-Midwives

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
NICU admission	5 (0 RCTs)	Butler et al., 1993 (6)† Fischler & Harvey, 1995 (4) Hueston & Rudy, 1993 (7) Jackson, Lang, Swartz et al., 2003 (7) Oakley et al., 1996 (6)†	Two of the studies (Butler et al., 1993; Oakley et al., 1996) reported lower admission for the CNM group. One of these (Butler et al., 1993) used statistical control for age, race, year of delivery, infant size, and parity. Based on the lack of RCTs and inconsistent results, the evidence supporting lower NICU admission was considered moderate.	Moderate: Comparable or lower rates of NICU admission for CNM compared to other providers.
Breastfeeding	3 (0 RCTs)	Cragin, 2002 (6)† Jackson, Lang, Swartz et al., 2003 (7)† Oakley et al., 1996 (6)†	Three observational studies reported differences in initiation of breastfeeding. All were rated as high quality and favored CNMs. There is a moderate level of evidence CNM patients have higher breastfeeding rates than MDs.	Moderate: CNM patients have higher breastfeeding rates than other providers.

* RCT
† Favors APRN
‡ Favors comparison group

CNMs compared to outcomes of care managed exclusively by physicians. Infant outcomes reported in the studies included Apgar score, birthweight less than 2,500 grams, admission to neonatal intensive care, and breastfeeding. Maternal outcomes reflected both invasive interventions (cesarean section, epidural anesthesia, labor induction/augmentation, episiotomy, forceps, vacuum use, perineal lacerations) and less-invasive interventions thought to be underused (non-pharmacologic pain relief, vaginal birth after cesarean [VBAC]. The number and type of studies for each outcome will be further described.

Cesarean. Fifteen studies (one RCT) reported differences in cesarean rates between the CNMs and MD patients. When comparing CNM and MD care, there is a high level of evidence CNM groups have lower rates of cesarean sections.

Low APGAR score. Eleven studies (one RCT) reported low infant APGAR scores. When comparing CNM and MD care, CNM have similar infant APGAR scores.

Epidural. Ten studies (0 RCTs) report epidural use. When comparing CNM and MD care, there is a moderate level of evidence CNM groups have lower rates of epidural use.

Labor augmentation. Nine studies (one RCT) reported labor augmentation. When comparing CNM and MD care, there is a high level of evidence to support equivalent levels of labor augmentation.

Labor induction. Nine studies (0 RCTs) reported labor augmentation. When comparing CNM and MD care, there is a moderate level of evidence to support equivalent or lower levels of labor induction of CNM the group.

Episiotomy. Eight studies (one RCT) reported episiotomy rates. When comparing CNM and MD care, there is a high level of evidence to support lower rates of episiotomy for the CNM group.

Low birthweight (<2500 g). Eight studies (one RCT) reported low birthweight infants. When comparing CNM and MD care, there is a high level of evidence to support equivalent levels of low birthweight infants.

Vaginal operative delivery (forceps, vacuum, or both). Eight studies (one RCT) reported vaginal operative delivery. When comparing CNM and MD care, there is a high level of evidence to support comparable levels or lower levels in the CNM group of vaginal operative delivery.

Labor analgesia. Six studies (one RCT) reported labor analgesia. When comparing CNM and MD care, there is a high level of evidence to support lower levels of labor analgesia in the CNM group.

Perineal lacerations. Five studies (one RCT) reported perineal laceration outcomes. When comparing CNM and MD care, there is a high level of evidence to support lower levels of third and fourth-degree perineal laceration rates for the CNM group.

Vaginal birth after cesarean section. Five studies (0 RCTs) reported rates of vaginal birth after cesarean sections. When comparing CNM and MD care, there is a

Table 5c.
Summary of Outcomes for Clinical Nurse Specialists

Outcome	Number of Studies	Author, Year (Study Quality Rating), Significance	Synthesis of Studies	Evidence Grade
Satisfaction	3 (2 RCTs)	Johnson & Sherman, 1994 (4)† Swindle et al., 2003 (7)* York et al., 1997 (7)*	Only one low-quality observational study found a significant difference favoring the CNS group in satisfaction with care in a pre-test post-test inpatient oncology CNS case-management study (Johnson & Sherman, 1994). A high level of evidence supports comparable satisfaction scores, indicating that the CNS may not have a direct effect on patient satisfaction.	High: Satisfaction among patients on units with a CNS was similar to comparison group.
Length of stay	7 (2 RCTs)	Ahrens et al., 2003 (6)† Duffy-Durnin & Campell-Heider, 1994 (5)* Koch & Smith, 1994 (3)† Lombness, 1994 (6)† Micheels et al., 1995 (4) Wheeler, 2000 (8)† York et al., 1997 (7)*	Four of the five observational studies demonstrated lower LOS for patients on units with CNS-enhanced care for populations of post-coronary bypass surgery, patients in end-of-life care, patients undergoing radical prostatectomy, and patients who had a total knee replacement. Two RCTs found no significance difference in LOS when the CNS was involved in the care. However, one of those studies (York et al., 1997) explored CNS in postpartum care, and postpartum LOS is generally fixed, resulting in non-significance. Three high- and one low-quality observational studies demonstrated a difference favoring the CNS group.	High: LOS is comparable or better than patients cared for by a CNS as compared to non-CNS.
Cost	4 (2 RCTs)	Ahrens, 2003 (6)† Koch & Smith, 1994 (3)† Swindle et al., 2003 (7)* York et al., 1997 (7)*†	Three of the studies reported a significantly lower cost; however, the comparisons in each of the three studies were different. The comparisons were between CNS postpartum care and standard care (York et al., 1997) CNS and MD, with MDs in a population of patients at risk to die (Ahrens et al. 2003) and pre-post CNS with guideline implementation (Koch et al., 1994). One RCT reported no difference in the cost of care when utilizing a MD/CNS intervention for patients with major depression in an ambulatory setting (Swindle et al. 2003). A high level of evidence supports utilization of the CNS role decreases costs of care.	High: Cost is lower in CNS group care.
Complications	3 (1 RCT)	Allen et al., 2002 (6)*† Hanneman et al., 1993 (6) (Medical†) Hanneman et al., 1993 (6) (Surgical) Lombness, 1994 (6)	In the RCT of post-discharge care management by a team with a CNS, stroke and transient ischemic attack patients experienced lower complications than usual care. (Allen et al., 2002). In one observational study, patients in a surgical intensive care experienced less endotracheal tube malposition and inadvertent extubation (Hanneman et al. 1993). In two observational studies, no difference in complication rates were found for postoperative cardiac surgery patients managed by a PA or CNS (Lombness, 1994), and in pre- and post-surgical patient pulmonary complications (Hanneman et al. 1993). Because of the predominance of the pretest post-test design and inconsistency in results, a moderate level of evidence supports that CNSs affect lower complication rates.	Moderate: Complications are lower or comparable when CNS is involved in care as compared to non-CNS staff.

* RCT
† Favors APRN
‡ Favors comparison group

moderate level of evidence to support comparable levels or higher rates of vaginal births after cesarean sections in the CNM group.

Neonatal intensive care unit (NICU) admission. Five studies (0 RCTs) reported NICU admission. When comparing CNM and MD care, there is a moderate level of evidence to support comparable levels or lower rates of infant NICU admission in the CNM group.

Breastfeeding. Three studies (0 RCTs) reported maternal breastfeeding post delivery. When comparing CNM and MD care, there is a moderate level of evidence to support higher rates of breastfeeding in the CNM group.

Clinical Nurse Specialist Outcomes

Outcomes from 11 studies (four RCTs and seven observational) were aggregated for four outcomes: satisfaction, hospital length of stay, hospital costs, and complications. The number and type of studies for each outcome are described.

Satisfaction. Three studies (two

RCTs) reported satisfaction. Studies were conducted with samples in inpatient oncology or community settings. When comparing CNS and non-CNS groups, a high level of evidence supports equivalent group satisfaction scores, indicating the CNS does not have a direct effect on patient satisfaction.

Length of stay. Seven studies (two RCTs) reported patient LOS. Studies were conducted with inpatient samples of patients post-coronary bypass surgery, in end-of-life care, undergoing radical prostatectomy, and post total knee replacement. When comparing CNS and non-CNS groups, there is a high level of evidence to support equivalent or lower LOS for patients cared for in the CNS group.

Cost. Four studies (two RCTs) reported cost outcomes. Studies were conducted with samples of CNS postpartum care, a population of patients at risk to die, and guideline implementation for patients with radical prostatectomy. When comparing CNS and non-CNS groups, there is a high level of evidence to support that the CNS group has lower cost of care.

Complications. Three studies (one RCT) reported patient complications. Studies were conducted with samples of patients discharged with a diagnosis of stroke and transient ischemic attack, a surgical intensive care unit, post-operative cardiac surgery, and a pregnancy wellness program. When comparing CNS and non-CNS groups, there is a moderate level of evidence to support that the CNS decreases complication rates.

Certified Registered Nurse Anesthetists

For studies of CRNAs, no outcomes met the criteria for aggregation. Although numerous studies have reported on CRNA clinical interventions, very few studies have compared the outcomes of care involving CRNAs with other providers. Sparse data from single observational studies of low quality suggest equivalent complication rates and mortality when comparing care involving CRNAs with care involving only physicians.

Discussion

This systematic review of published literature between 1990 and 2008 on care provided by APRNs indicates patient outcomes of care provided by NPs and CNMs in collaboration with physicians are similar to and in some ways better than care provided by physicians alone for the populations and in the settings included. Use of CNSs in acute care settings can reduce length of stay and cost of care for hospitalized patients.

These results extend what is known about APRN outcomes from previous reviews by assessing all types of APRNs over a span of 18 years, using a systematic process with intentionally broad inclusion of outcomes, patient populations, and settings. The results indicate APRNs provide effective and high-quality patient care, have an important role in improving the quality of patient care in the United States, and could help address concerns about whether care provided by APRNs can safely augment the physician supply to support reform efforts aimed at expanding access to care.

The results of this systematic review should be interpreted while considering limitations in the bodies of research reviewed. Limitations include the heterogeneity of study designs and measures, multiple time points for measuring outcomes, the limited number of randomized designs, inadequate statistical data for calculating effect sizes, failure to describe the nature of the APRN and physician roles and the responsibilities or relationships of team members, including collaboration with physicians. Attribution of the APRN to specific outcomes was often difficult because of the complexity of the intervention, which sometimes included several components and multiple providers. In addition, attribution was also clouded by the fact APRNs often practice as part of a team or in collaboration with other providers. Despite these limitations, the aim of the review was to summarize the evidence for a broad range of outcomes. The quality assessment and score included transparent, systematic methods to strengthen the process, including assessment of differences in comparison groups, settings, participants, and attribution to address some of these limitations.

The results of this systematic review indicate APRNs can have an expanded role in health care systems, and should be incorporated to the fullest extent possible. One major professional organization, the American College of Physicians (2009), supports appropriate use of NPs as part of its commitment to promote teams of care. APRNs and other providers can use these results to spark interdisciplinary conversations to better understand one another's roles and capabilities. A collaborative effort will ultimately lead to higher quality health care and better health care systems.

There are many policy implications to these results (Newhouse, 2011). Research to test models of care involving APRNs should be expanded to additional settings and populations based on the needs of priority populations and health policy goals. Restrictions on APRN practice and reimbursement must be modified to allow new models of care to be tested. Health care reform initiatives should include APRNs as providers who are used to the full extent of their scope of practice. Billing data need to indicate the actual provider of care (NP, CNM, CNS, CRNA, or physician). Pay-for-performance initiatives should make provision for incorporating

APRNs and other health care providers in the development of initiatives, indicators, and participation for direct and equitable reimbursement.

Conclusion

The ideal health system comprises multiple providers who communicate with and are accountable to each other to deliver coordinated care (Shih & Fund, 2008). This systematic review supports a high level of evidence that APRNs provide safe, effective, quality care to a number of specific populations in a variety of settings. APRNs, in partnership with physicians and other providers, have a significant role in the promotion of health. American health care professionals will need to move forward with evidence-based and more collaborative models of care delivery to promote national unified health goals. **$**

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