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Quality of primary care by advanced practice nurses: a systematic review

MELANIE SWAN, SACHA FERGUSON, ALICE CHANG, ELAINE LARSON, and ARLENE SMALDONE*

Columbia University School of Nursing, 617 West 168th Street, New York, NY 10032, USA

*Address reprint requests to: Arlene Smaldone, Columbia University School of Nursing, 617 West 168th Street, New York, NY 10032, USA. Tel: +212-342-3048; Fax: +212-305-6937; E-mail: ams130@columbia.edu

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Abstract

Purpose: To conduct a systematic review of randomized controlled trials (RCTs) of the safety and effectiveness of primary care provided by advanced practice nurses (APNs) and evaluate the potential of their deployment to help alleviate primary care shortages.
Data sources: PubMed, Medline and the Cumulative Index to Nursing and Allied Health Literature.
Study selection: RCTs and their follow-up reports that compared outcomes of care provided to adults by APNs and physicians in equivalent primary care provider roles were selected for inclusion.
Data extraction: Ten articles (seven RCTs, plus two economic evaluations and one 2-year follow-up study of included RCTs) met inclusion criteria. Data were extracted regarding study design, setting and outcomes across four common categories.
Results of data synthesis: The seven RCTs include data for 10 911 patients who presented for ongoing primary care (four RCTs) or same-day consultations for acute conditions (three RCTs) in the primary care setting. Study follow-up ranged from 1 day to 2 years. APN groups demonstrated equal or better outcomes than physician groups for physiologic measures, patient satisfaction and cost. APNs generally had longer consultations compared with physicians; however, two studies reported that APN patients required fewer consultations over time.
Conclusion: There were few differences in primary care provided by APNs and physicians; for some measures APN care was superior. While studies are needed to assess longer term outcomes, these data suggest that the APN workforce is well-positioned to provide safe and effective primary care.

Key words: primary care, advanced practice nursing, nurse practitioners, quality of healthcare

Introduction

The Declaration of Alma-Ata (1978) identified universally-accessible primary care as a fundamental component of an effective health system [1–3]. However, even in resource-rich countries such as the United States (US), this vision has yet to be realized. With an aging population and expanded access to insurance coverage under the Affordable Care Act, the shortage of primary care providers (PCPs) in the US is increasingly acute. Although estimates of the magnitude of the shortage vary, projections remain consistent that the supply of PCPs will not keep up with the growing demand for primary care services [4, 5]. The shortage stems largely from the increasing complexity of services provided in the primary care setting, coupled with financial disincentives to enter primary care practice [6]. Compared with most developed nations, access to primary care is more limited for Americans. In a 2014 comparison of eleven international healthcare systems, the Commonwealth Fund reported that while the US had one of the shortest wait times for specialist care, only 59% of American adults were able to get a same- or next-day primary care appointment when ill [7]; a related study found that family practice wait times averaged 19.5 days [8]. One proposed solution to the PCP shortage relies on increasing physician supply through programs and policies offering incentives for entry into primary care. To date this approach has not

been successful, offers no guarantee of success and, even if successful, requires considerable lead time and high cost [9].

An alternative approach is to maximize utilization of non-physician providers, including nurse practitioners (NPs) and other advanced practice nurses (APNs), physician assistants and midwives in primary care delivery. These provider types receive different training with different scopes of practice defined by state legislation. In the US, the supply of NPs is growing rapidly [5, 10] with NPs more likely to specialize in primary care than their physician counterparts. Currently more than 75% of NPs in the US practice in at least one primary care site [11]. Hence, full deployment and expanded use of NPs is one promising strategy to alleviate the primary care shortage and is consistent with the Institute of Medicine Future of Nursing Report recommendation that nurses should practice to the full extent of their education and training [12].

Previous systematic reviews examining outcomes of NP and other APN care have demonstrated favorable results; however, they are either outdated [13], not limited to the primary care setting [14–17], include studies with designs other than randomized controlled trials (RCTs) [13–19], include studies which do not compare outcomes of APNs and physicians in comparable roles [15, 18, 20] or include studies in which the APN is not in a PCP role [21]. The purpose of this systematic review is to evaluate data from RCTs regarding the cost and quality of care provided by APNs in primary care.

Methods

Literature search

The guidelines set forth in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement [22] were followed. PubMed, Medline and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) were systematically searched with assistance from an information specialist expert in systematic review methods to identify RCTs comparing outcomes of care provided to adults by APNs and physicians in the primary care setting. Initially, broad categories of search terms were selected, including: APN, patient outcomes, primary care and RCT. Specific terms within each category were then identified (for example, the category for APN included the terms 'nurse practitioner,' 'nurse clinicians,' 'advanced practice nursing,' et cetera). Terms were entered generally and expanded to include medical subject heading (MeSH) terms where available. Similar search terms were listed using database-specific commands such as ADJ or * (wildcard) to ensure inclusion of relevant articles (for example: family NPs, patient satisfaction, family health clinic, random* stud*). All possible combinations of the terms from each category were then searched to locate target studies (see Supplementary Appendix). Additional search criteria included presence of an abstract and English language publication. No date restriction was employed.

Inclusion criteria included RCTs comparing primary care outcomes of APNs and physicians, as well as any publications stemming from these RCTs providing longer term follow-up or economic evaluation of the included RCT samples. APNs were defined as nurses who had received additional formal education and training that expanded their scope of practice to include services traditionally considered to fall under the practice of medicine, such as diagnosis and treatment of medical conditions. Exclusion criteria included review articles, non-RCT design or no original data, studies in which APN care was not the independent variable and studies with entirely pediatric samples (due to the variation in outcomes of interest between adult and pediatric patients, which would impede data aggregation). Additionally, the APN role in the study had to be that of a PCP, with an educational background allowing them to manage their own panel of patients.

After removing duplicates, reviewers screened titles to identify articles that met inclusion and exclusion criteria. Next, abstracts and full text of identified studies were independently assessed by two reviewers. Discrepancies regarding whether a study met inclusion criteria and/or whether the role of APNs was equivalent to that of a PCP were discussed among reviewers until consensus was attained. Reference lists of included articles as well as previously-published systematic reviews were hand-searched for any additional RCTs satisfying inclusion and exclusion criteria.

Quality appraisal

The Cochrane Collaboration's tool for assessing risk of bias was used to assess study quality [23]. The instrument contains seven criteria: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessor, incomplete outcome data, selective outcome reporting and other bias. Each criterion has detailed directions for making judgments about risk of bias and is rated as high, low or unclear. Two independent reviewers rated the quality of each study and discrepancies were discussed until consensus was reached among all authors.

For studies that included a cost outcome, the Quality of Health Economic Studies (QHES) instrument [24, 25] was also used, including 16 criteria scored as 'met' or 'not met'. Each criterion receives a weighted score ranging from 1 to 9 points totaling 0–100 points. Two reviewers (EL, AS) independently appraised each economic evaluation; where scores differed, agreement was achieved by consensus.

Data extraction and synthesis

Data regarding study sample and setting, design and outcomes were extracted including sample size, patient characteristics and attrition rates, number and location of practices and providers, treatment description and duration, points of data collection, outcomes measured and statistical techniques. Outcomes assessed in multiple studies were then synthesized to provide comparison across studies.

Results

Literature search

The initial search identified 784 articles. Among these, 109 were duplicates. Upon further screening, 512 articles were removed based on title review and 125 based on abstract review. Thirty were then excluded based on a review of the entire article, the most common reason for exclusion being that the study examined outcomes of care by nurses who were not acting in a PCP role. One publication, despite several requests for inter-library loan, could not be located and was excluded [26]. Two additional RCTs were identified during the hand search [27, 28] resulting in a final total of 10 articles: seven RCTs [27–33], a 2-year follow-up of the sample from the Mundinger *et al.* RCT [34] and two economic evaluations of an included RCT [35, 36]. Figure 1 summarizes the literature search.

Study characteristics

The ten included studies represent data from 10 911 subjects who participated in seven RCTs (Table 1). Five studies were conducted in Europe [27, 29–31, 33]. One study and its 2-year follow-up were conducted in the US [32, 34]. Subjects were randomized when they

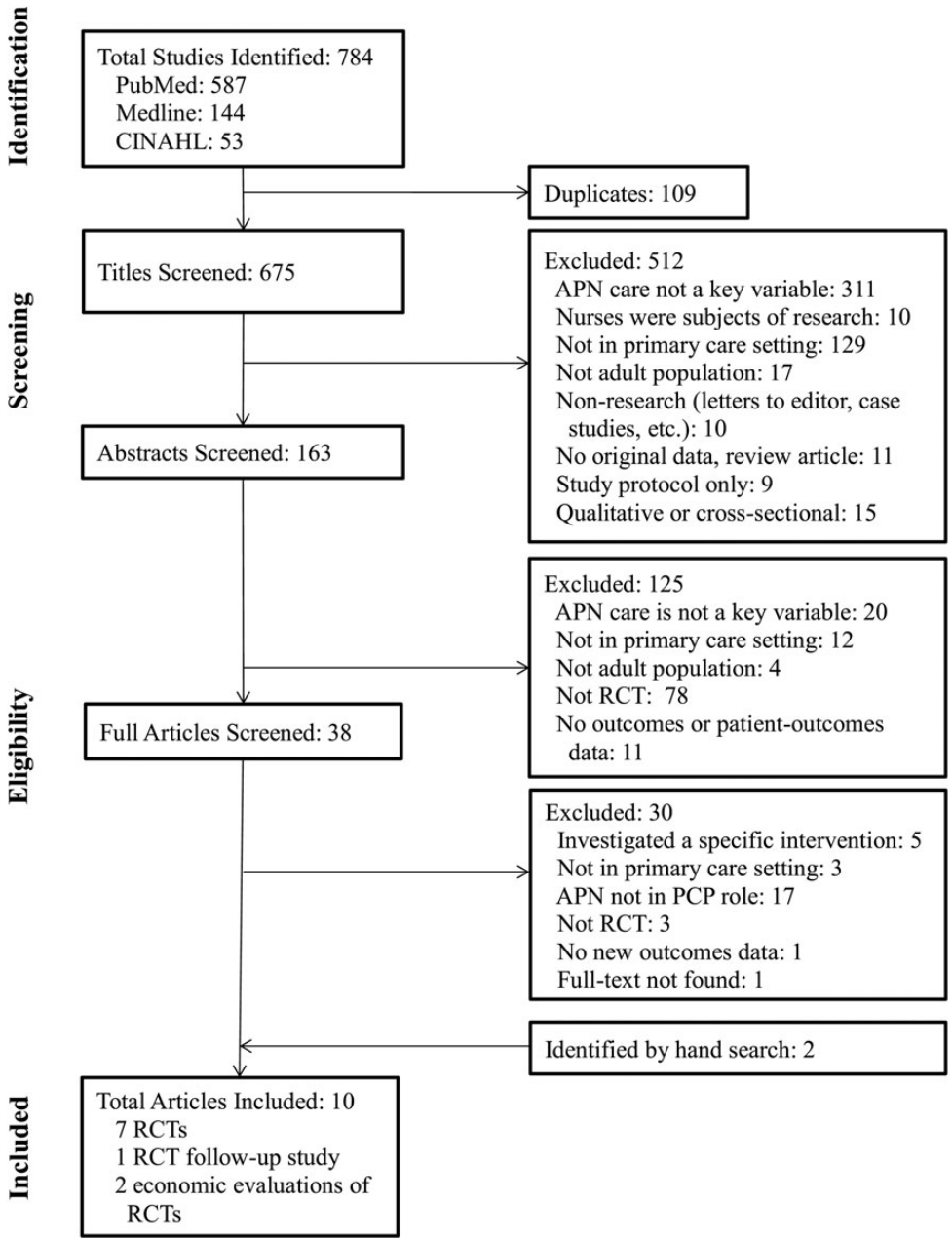

Figure 1 Flow diagram of literature search. CINAHL, Cumulative Index to Nursing and Allied Health Literature; APN, advanced practice nurse; PCP, primary care provider; RCT, randomized controlled trial.

presented for a general [28, 32] or diabetes-focused primary care visit [27, 30], or for same-day consultation for any reason [31, 33] or for a pre-defined list of conditions and/or diabetes-related care [29]. One study limited recruitment to adults without a usual source of care during an emergency room visit and targeted a high proportion with chronic conditions such as asthma, diabetes mellitus and hypertension [32].

The number of providers varied by study ranging from 2 [28, 30] to 12 [29, 31] APNs and 2 [28] to 50 [29] physicians. Two studies did not describe the number of providers [27, 33]. In two studies control group subjects saw both a physician and 'standard nurse' who provided patient education, while care to those randomized to the intervention group was provided solely by the APN [27, 28]. APN scope of practice and titles used for APNs and physicians varied across studies. Restrictions on APN practice included the requirement for APN prescriptions to be co-signed by the general practitioner [33] and APN use of a defined treatment protocol for diabetes-related care [27, 30]. One study reported that both APN and physician providers had the same resources, such as hospital admitting privileges, available to them [32]. Subject follow-up ranged from 1 day [29] to 2 years [34].

Quality appraisal

Randomized controlled trials

The majority of studies fell in the low risk of bias category across five of the seven criteria. For allocation concealment, risk of bias was low

Table 1 Characteristics of included studies

Author, year, country	Sample, setting	Provider type (number), intervention description	Data collection time points, attrition rate	Main outcomes
Dierick-van Daele, 2009, 2010[a] The Netherlands	APN group $N = 817$; physician group $N = 684$ Age (years): 42.8 ± 16.5 APN group, 46.1 ± 16.6 physician group Race/ethnicity: NR 15 general practices	NP ($n = 12$) vs. general practitioner ($n = 50$) Single consultation for pre-defined list of problems; any follow-up over 2 week duration	Data collection: • Baseline • Immediately after visit Attrition 32.8% at 2 weeks for follow-up questionnaire data, 6.9% for medical data	Effectiveness of consultation (health status) Patient satisfaction Direct costs[a] Productivity loss[a] Healthcare resource utilization Adherence to guidelines
Houweling, 2009 The Netherlands	APN group $N = 50$; physician group $N = 43$ Age (years): 63.1 ± 10.6 APN group, 59.6 ± 10.6 physician group Race/ethnicity: NR 2 hospital associated diabetes outpatient clinics	Nurse specialized in diabetes ($n = $ NR) vs. internist ($n = $ NR) All diabetes care, including blood pressure and lipid management, over 12 month duration	Data collection: • Baseline • 6 months • 12 months Attrition 9.7% at 12 months	Physiologic measures (hemoglobin A1c, blood pressure, lipid profile, BMI) Quality of life, symptoms Patient satisfaction Healthcare costs Healthcare resource utilization
Houweling, 2011 The Netherlands	APN group $N = 116$; physician group $N = 114$ Age (years): 67.1 ± 11.0 APN group, 69.5 ± 10.6 physician group Race/ethnicity: NR Single group practice	Practice nurse ($n = 2$) vs. general practitioner ($n = 2$) All diabetes care, including blood pressure and lipid management, over 14 month duration	Data collection: • Baseline • 14 months Attrition 10.4% at 14 months	Physiologic measures (hemoglobin A1c, blood pressure, lipid profile, BMI) Quality of life, symptoms Patient satisfaction Process indicators (appropriate preventive care, therapy intensification)
Kinnersley, 2000 England and Wales	APN group $N = $ NR; physician group $N = $ NR; total $N = 1465$ Age ≥16 years: 62% APN group, 68% physician group Race/ethnicity: NR 10 general practices	NP ($n = 10$) vs. general practitioner ($n = $ NR) Same-day consultation; any follow-up over 4 week duration	Data collection: • Baseline • Immediately after initial visit • 2 weeks • 4 weeks (audit data) Attrition 25% at 2 weeks for questionnaire data, 11% at 4 weeks for audit data	Symptom resolution Patient satisfaction Healthcare resource utilization Patient education Patient intentions for future care
Mundinger, 2000 and Lenz, 2004[b] United States	APN group $N = 1181$ (222[b]); physician group $N = 800$ (184[b]) Age (years): 45.5 ± NR APN group, 46.7 ± NR physician group Race/ethnicity: 90.3% Hispanic 5 primary care clinics at an urban academic medical center	NP ($n = 7$) vs. physician ($n = 17$) All primary care services over 1 year duration	Data collection: • Baseline • Immediately after initial visit • 6 months • 1 year • 2 years[b] Attrition 0.05% at 6 months for medical data; 21% at 6 months for interview data	Physiologic measures (glycosylated hemoglobin, blood pressure, peak flow) Health status Patient satisfaction Healthcare resource utilization

Table continued

Table 1 Continued

Author, year, country	Sample, setting	Provider type (number), intervention description	Data collection time points, attrition rate	Main outcomes
Spitzer, 1974, 1976[a] Canada	APN group $N = 1529$; physician group $N = 2796$ (selected for interview cohort: APN group $N = 340$; physician group $N = 614$) Age >15 years: 80% Race/ethnicity: NR Large suburban primary care practice	NP ($n = 2$) vs. family physician ($n = 2$) All primary care services over 1 year duration	Data collection: • Baseline • 1 year Attrition: NR	Physiologic measures (mortality, physical function, social and emotional function) Patient satisfaction Cost of care, financial performance[a] Healthcare resource utilization[a] Quality of care, adherence to guidelines
Venning, 2000 England and Wales	APN group $N = 651$; physician group $N = 665$ Age >16 years: 67% Race/ethnicity: NR 20 general practices	NP (n = NR) vs. general practitioner (n = NR) Same-day consultation plus any follow-up within 2 week duration	Data collection: • Baseline • 2 weeks Attrition 24% at 2 weeks	Health status Patient satisfaction Cost of care Healthcare resource utilization

APN, advanced practice nurse; NR, not reported; BMI, body mass index.
[a]Economic evaluation of randomized control trial.
[b]Two-year follow-up of 406 subjects.

or unclear risk, and for random sequence generation the majority of studies demonstrated unclear risk (Fig. 2).

Four studies were unclear regarding the methods used for random sequence generation [28, 30–32], two showed low risk [29, 33] and one demonstrated high risk of inadequate random sequence generation [27]. Four studies reported their method of allocation concealment [29, 31–33]. Study personnel [27–29, 32] and outcome assessors [27, 28, 30–33] were blinded in the majority of studies. Four studies had low risk of incomplete outcomes data [27, 28, 30, 32] while three had high risk due to high attrition rates [29, 31, 33]. Six studies had a low risk of selective outcome reporting [27–30, 32, 33]. No significant risk of bias was identified in the 'other bias' category for any of the RCTs.

Economic evaluations

Two economic evaluations [35, 36] were conducted alongside the RCTs [28, 29] with scores of 51 (9 criteria met) [36] and 86 (13 criteria met) [35]. Both studies provided adequate description of their methodology for measuring and/or estimating cost and clearly described primary outcome measures. One [35] stated the perspective from which the study was completed, conducted a sensitivity analysis of the cost estimate under varying assumptions and measured health outcomes using valid and reliable scales.

Outcomes results

Table 2 summarizes select physiologic, patient satisfaction, cost and resource use outcomes for each study. In three studies, outcome monitoring ended no more than 4 weeks from the time of the initial study visit [29, 31, 33]; in one study subject follow-up was limited to 1 day [29]. A single study reported long-term outcomes of patients retained in care at 2 years [34].

Physiologic measures

Three RCTs [27, 30, 32] and one follow-up study [34] assessed blood pressure and glucose outcomes, and two [27, 30] reported lipid outcomes. Between-group differences were generally not significant, with the exception of the cholesterol/high-density lipoprotein (HDL) ratio [27] and the diastolic blood pressure at 6 months [32] with both favoring the APN group. Additional physiologic measures were investigated in single studies with no differences between APN and physician groups for mortality [28], change in body mass index (BMI) [27, 30], change in LDL [27] or peak expiratory flow rate [32, 34].

All studies investigated subjective health status; instruments used included the Medical Outcomes Short Form 36 (SF-36) [32–34], burden of illness and the EQ5-D [29], measures of disability or impaired activities of daily living and emotional and social functioning [28] and measures of symptoms and symptom resolution [27, 30, 31] with no differences between groups.

Patient satisfaction

All studies examined patient satisfaction. Four RCTs [27, 30, 31, 33] and one follow-up study [34] used existing validated instruments, two [29, 32] adapted existing instruments and one [28] did not specify the tool used to measure satisfaction. Three studies demonstrated higher patient satisfaction among patients who received care from APNs [27, 30, 33], and one study reported higher satisfaction among patients who received care from APNs at three of their ten study sites [31].

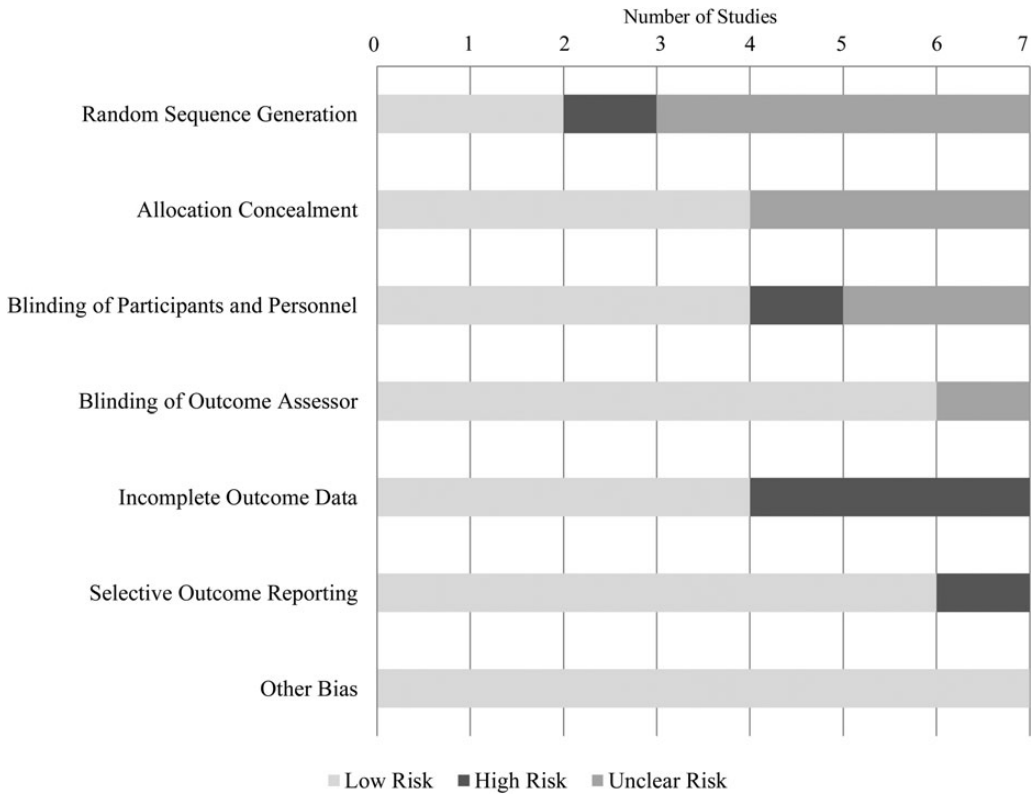

Figure 2 Summary of quality appraisal of RCTs.

Cost of care

Four studies (two RCTs [27, 33] and two economic evaluations [35, 36]) examined differences in costs of care. Three studies estimated cost using provider salary; of these, two [27, 35] found that APN care was less expensive compared with physician provided care. One study examined annual laboratory and monthly medication costs; while APN care was less expensive for laboratory services (64.9 ± 34.5 versus 91.5 ± 36.7 euros, $P = 0.001$), there were no differences in monthly medication costs [27]. Spitzer *et al.*, 1976, examined cost of care by developing a Utilization and Financial Index in which provider salary was aggregated with laboratory, radiology, hospital costs and out of pocket expenditures; no differences were observed between care provided by APNs and physicians [36].

Healthcare resource utilization

All studies reported healthcare resource utilization outcomes. Four studies [27, 29, 31, 33] examined consultation length; of these, three found that APN consultations were 3.0 [29] to 4.3 [33] minutes longer than those provided by physicians [29, 31, 33]. Two RCTs and one follow-up study examined total number of primary care visits with conflicting findings at 1 year [27, 32] but fewer visits among APN patients at 2 years [34]. One RCT [32] and its follow-up study [34] examined hospitalization and emergency department or urgent care visits with no significant differences between groups.

Three studies [29, 31, 33] examined the number of referrals made and two [32, 34] investigated the number of specialty care visits; both found no differences between APNs and physicians. Of three studies that examined follow-up adherence [29, 31, 33], two [29, 33] reported that APNs more frequently requested a return visit and their patients were more likely to keep the appointment. Three studies examined the prescription patterns for medications and diagnostic tests [29, 31, 33]; one [33] reported that APNs more frequently ordered diagnostic tests with no differences in medication prescriptive practices.

Process measures

Four studies examined other clinical process measures. Three [28–30] assessed clinician guideline adherence; one found that APNs had higher rates of providing disease-appropriate care across five of six indicators examined [30].

Kinnersley *et al.*, reported that patients assigned to the physician group were less likely to report having been told the cause of their illness (odds ratio [OR] 0.58, 95% confidence interval [CI] 0.44–0.76), how to relieve symptoms (OR 0.32, 95% CI 0.24–0.43) and what to do if the problem persisted (OR 0.61, 95% CI 0.41–0.90) [31]. There were no differences regarding the proportion reporting that they were advised of the likely duration of their illness and how to reduce the chances of recurrence.

Discussion

Findings of this systematic review suggest that APNs in primary care settings perform as well as physicians in terms of clinical outcomes and patient satisfaction. Results were mixed across studies regarding whether APNs ordered more diagnostic tests, and some evidence suggested APNs more frequently asked patients to return to the clinic after a consultation. APN consultations took slightly longer than physician consultations, but did not translate to overall increased costs. There was also evidence suggesting that APN patients required fewer total

Table 2 Selected outcomes results

Author, year	Outcomes: APN group vs. physician group			
	Physiologic	Patient satisfaction (Instrument)	Cost	Healthcare resource utilization
Dierick-van Daele, 2009, 2010[a]	N/A	8.2 ± 1.2 vs. 8.2 ± 1.3 (Investigator-developed instrument)	Direct cost per consultation based on salary (euros): 31.9 ± 36.3 vs. 40.2 ± 49.9[a]**	Consultation duration (min): 12.2 vs. 9.2* Referrals (percent of consultations): 12.0 vs. 14.2% Number of prescriptions per consultation: • 1: 55.0 vs. 54.2% • 2: 16.9 vs. 19.5% • ≥3: 8.8 vs. 7.8%
Houweling, 2009	Change (95% CI) over 12 months: • Systolic BP: −8.6 (−2.6, −14.7) vs. −4.0 (0.9, −8.9) mmHg • Diastolic BP: −1.4 (1.4, −4.1) vs. −2.4 (0.8, −4.9) mmHg • Total cholesterol: −0.4 (−0.2, −0.6) vs. −0.9 (−0.5, −1.3) mmol/l • Cholesterol/HDL ratio: −0.4 (0.1, −0.6) vs. −0.9 (−0.5, −1.4)*** • HbA1c: −1.5 (−1.0, −1.9) vs. −0.9 (−0.5, −1.3)%	73.9 vs. 53.3%* [Patients' Evaluation of the Quality of Diabetes Care (PEQD)]	Total salary costs over 12 months (euros): 114.6 ± 50.4 vs. 138.3 ± 48.3***	Consultation duration over 12 months (min): 272.0 ± 120.5 vs. 249.2 ± 110.7 Primary care visits over 12 months: 7.4 ± 3.0 vs. 9.8 ± 3.8**
Houweling, 2011	Change (95% CI) over 14 months: • Systolic BP: −7.4 (−3.8, −10.9) vs. −5.6 (−2.3, −8.8) mmHg • Diastolic BP: −3.2 (−1.3, −5.2) vs. −1.0 (−0.8, −2.8) mmHg • Total Cholesterol: −0.1 (−0.3, 0.1) vs. −0.05 (−0.2, 0.1) mmol/l • Cholesterol/HDL ratio: 0.03 (−0.1, 0.2) vs. 0.07 (−0.1, 0.2) • HbA1c: −0.09 (−0.3, 0.1) vs. 0.03 (−0.2, 0.3)%	66.4 vs. 51.7% (PEQD)	N/A	N/A
Kinnersley, 2000	N/A	Mean score range across practice sites: 72.9–79.5 vs. 68.7–79.5% [Consultation Satisfaction Questionnaire (CSQ)]	N/A	Consultation duration: 10 vs. 6 min (statistically significant) Referrals (percent of consultations): 5 vs. 5% Prescription issued (percent of consultations): 63 vs. 63%
Mundinger, 2000 Lenz, 2004[b]	Value at 6 months: • Systolic BP: 137 vs.139 mmHg • Diastolic BP: 82 vs. 85 mmHg*** • Glycosylated hemoglobin: 9.5 vs. 9.4% Value at 2 years: • Systolic BP: 139.0 vs. 141.9 mmHg[b] • Diastolic BP: 85.9 vs. 88.1 mmHg[b] • Glycosylated hemoglobin: 8.9 vs. 10.3%[b]	Initial consultation: 4.59 vs. 4.60 At 6 months: 4.45 vs. 4.46 (Investigator-developed instrument based on Medical Outcomes Study) At 2 years: mean score range across categories 65.4–90.8 vs. 67.6–94.4%[b] [Patient Care Assessment Survey (PCAS)]	N/A	Primary care visits at 1 year: • 0: 18.0 vs. 19.1% • 1–4: 51.8 vs. 47.1% • ≥5 visits: 30.4 vs. 33.8% Primary care visits (subgroup) • Year 1: 3.6 vs. 4.2[b] • Year 2: 1.8 vs. 2.5[b]*** ≥1 Hospitalization at 1 year: 8.5 vs. 9.8% ≥1 Hospitalization (subgroup): • First year: 4.5 vs. 7.6%[b] • Second year: 4.5 vs. 8.2%[b] ≥1 ED/urgent care visits at 1 year: 34.2 vs. 33.8% ≥1 ED/urgent care visits (subgroup): • First year: 28.4 vs. 32.6%[b] • Second year: 30.3 vs. 33.2%[b]

Table continued

Table 2 Continued

Author, year	Outcomes: APN group vs. physician group			
	Physiologic	Patient satisfaction (Instrument)	Cost	Healthcare resource utilization
Spitzer, 1974, 1976[a]	N/A	96 vs. 97% (Instrument not specified)	Total UF-index: 297.0 vs. 285.7[a]	N/A
Venning, 2000	N/A	4.40 ± 0.46 vs. 4.24 ± 0.52)*** (Medical Interview Satisfaction Scale (MISS))	Total salary cost for initial and return consultation (pounds): 18.1 ± 33.4 vs. 20.7 ± 33.4	Consultation duration (min): 11.6 ± 5.8 vs. 7.3 ± 4.8* Referred to hospital (percent of consultations): 1.7 vs. 3.8% Prescription issued (percent of consultations): 61.0 vs. 64.7%

APN, advanced practice nurse; N/A, not applicable or not measured; BP, blood pressure; HDL, high-density lipoprotein; CI, confidence interval; UF-index, utilization-financial index.

[a]Economic evaluation of randomized control trial.

[b]Two-year follow-up of 406 subjects.

*$P < 0.001$; **$P < 0.01$; ***$P < 0.05$.

primary care visits, and that APNs demonstrated similar guideline adherence to physicians and provided more thorough patient education. Overall, APNs in these studies provided care that was in some ways different from care provided by physicians, but with comparable quality and at equal or lower cost.

Prior systematic reviews have also examined primary care provided by APNs but had limitations that we attempted to address such as variations in study design. For example, one review of studies published between 1990 and 2008 included data from observational studies and studies conducted in a wide range of settings [16]. Similarly, a review published in 2013 also included observational studies and studies in which the APN and physician were in non-equivalent or team-based roles [17], and a 2014 review investigated outcomes of nurse prescribing but included non-RCTs and a variety of care settings and specializations [14]. One recent review was limited to RCTs conducted in primary care settings but included a wide variety of nurse roles not specific to APN scope of practice [21].

The results of this systematic review are generally consistent with the conclusions of earlier reviews [14, 16, 17, 21]. However by limiting our search to RCTs in which APNs were compared directly to physicians in a PCP role, we have reduced the amount of heterogeneity present in the aggregated data to provide a higher level of evidence.

One limitation of this systematic review was our decision to limit the search to the English language. The results of the review are further limited by the small body of rigorous published research; surprisingly, assessment of primary care provided by APNs was the focus of only seven RCTs. Our decision to narrowly focus only on APNs in a PCP role and to aim for a higher level of evidence by limiting our review to RCTs led to inclusion of a smaller number of studies than previous reviews. Among the seven included RCTs, only four assessed outcomes for longer than 1 month, with one study examining outcomes of only a single consultation. Sample sizes were often small, resulting in high risk for type II errors, and outcome and process measures were assessed in different ways. These limitations preclude conclusions about long-term outcomes of care by APNs. Additionally, only one study was conducted in the US. Rigorous studies with longer observation periods are clearly needed.

Future studies should focus on additional outcomes that are absent in the current body of research. The physiologic outcomes addressed in current research focused on changes in parameters such as blood pressure; a more meaningful outcome would be the proportion of subjects attaining disease control over time. Future studies should also examine rates of preventable hospitalizations and appropriate preventive care, such as vaccines and disease screening. Finally, studies with longer follow-up periods will allow for assessment of rates of retention in care.

In 2010 the Institute of Medicine recommended that barriers be removed to allow nurses to practice to the full extent of their education and training to help meet the needs of a changing health care system [12]. This recommendation has been met with some resistance, largely from physician groups that frequently reference concerns over patient safety [9], despite research that suggests improved patient safety when a cooperative team-based approach is implemented [37]. In the US scope of practice laws in 30 states still limit NP autonomy by requiring NPs to have practice agreements with a collaborating or supervising physician [38]. Although studies with longer follow-up are needed, the research summarized in this systematic review adds to the body of evidence that there are few differences in primary care provided by APNs and physicians, and in some areas APN care may be superior. Removing barriers that prevent APNs from practicing to the full extent of their training therefore appears to be a safe, logical and effective approach to addressing the primary care shortage.

Supplementary material

Supplementary material is available at *INTQHC* online.

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