

## Nurse practitioners and physician assistants in the intensive care unit: An evidence-based review

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**Background:** Advanced practitioners including nurse practitioners and physician assistants are contributing to care for critically ill patients in the intensive care unit through their participation on the multidisciplinary team and in collaborative physician practice roles. However, the impact of nurse practitioners and physician assistants in the intensive care unit setting is not well known.

**Objectives:** To identify published literature on the role of nurse practitioners and physician assistants in acute and critical care settings; to review the literature using nonquantitative methods and provide a summary of the results to date incorporating studies assessing the impact and outcomes of nurse practitioner and physician assistant providers in the intensive care unit; and to identify implications for critical care practice.

**Methods:** We conducted a systematic search of the English-language literature of publications on nurse practitioners and physician assistants utilizing Ovid MEDLINE, PubMed, and the Cumulative Index of Nursing and Allied Health Literature databases from 1996 through August 2007.

**Interventions:** None.

**Results:** Over 145 articles were reviewed on the role of the nurse practitioner and physician assistant in acute and critical care settings. A total of 31 research studies focused on the role and impact of these practitioners in the care of acute and critically ill patients. Of those, 20 were focused on nurse practitioner care, six focused on both nurse practitioner and physician assistant care, and five were focused on physician assistant care in

acute and critical care settings. Fourteen focused on intensive care unit care, and 17 focused on acute care including emergency room, trauma, and management of patients with specific acute care conditions such as stroke, pneumonia, and congestive heart failure. Most studies used retrospective or prospective study designs and nonprobability sampling techniques. Only two randomized control trials were identified. The majority examined the impact of care on patient care management ( $n = 17$ ), six focused on comparisons of care with physician care, five examined the impact of models of care including multidisciplinary and outcomes management models, and three assessed involvement and impact on reinforcement of practice guidelines, education, research, and quality improvement.

**Conclusions:** Although existing research supports the use of nurse practitioners and physician assistants in acute and critical care settings, a low level of evidence was found with only two randomized control trials assessing the impact of nurse practitioner care. Further research that explores the impact of nurse practitioners and physician assistants in the intensive care unit setting on patient outcomes, including financial aspects of care is needed. In addition, information on successful multidisciplinary models of care is needed to promote optimal use of nurse practitioners and physician assistants in acute and critical care settings. (Crit Care Med 2008; 36:2888–2897)

**KEY WORDS:** nurse practitioner; acute care nurse practitioner; physician assistant; midlevel provider; critical care workforce; nonphysician provider; nonphysician clinician

The terms *nonphysician provider* and *midlevel practitioner* have been used to refer to advanced level practitioners including nurse practitioners (NPs), physician assistants (PAs), clinical nurse specialists, certified registered nurse anesthetists, and certified nurse midwives. In the acute and critical care setting, NPs

and PAs are most commonly used to provide care to critically ill patients as members of the medical care team. NPs and PAs have been increasingly used in the management of hospitalized patients in the intensive care unit (ICU). NPs and PAs have been identified as a solution for meeting the physician manpower shortage, caused by the implementation of Ac-

creditation Council for Graduate Medical Education regulations limiting resident physicians' hours (1, 2). Current and projected workforce requirements for care of critically ill patients project a continued shortage of intensivists (2–4). In 2000, the Committee on Manpower for the Pulmonary and Critical Care Societies identified that the shortfall of intensivists to provide care for the critically ill would be 22% of demand by the year 2020 and 35% by 2030 (4). As the projections of NPs and PAs identify a growing supply of practitioners (5) (Fig. 1), their integration into the care of ICU patients represents a strategy to meet the gap in ICU coverage (3, 6). Recommendations of the Leapfrog intensivist-physician staffing identify that a Fundamental Critical Care Support cer-

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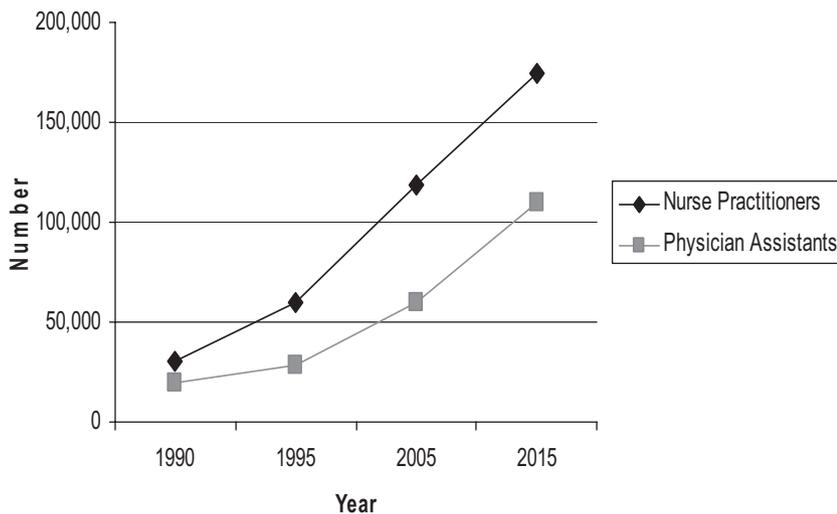
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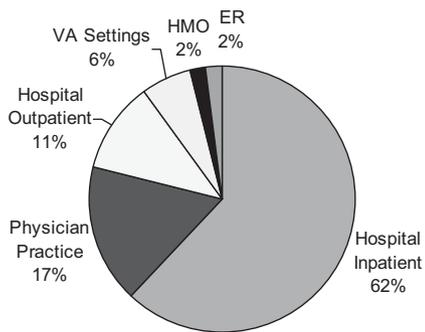
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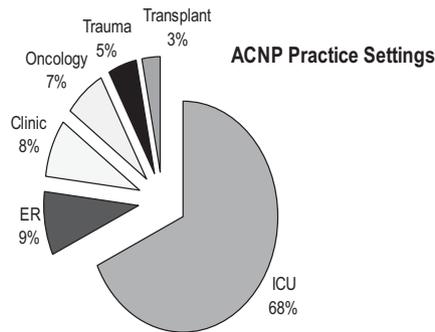
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**Figure 1.** Current and projected workforce of nonphysician clinicians demonstrating increases in the number of nurse practitioners (NP) and physician assistants (PA) over time. The projected growth in NP and PA workforce should stimulate further development of research focusing on their roles and outcomes in the care of critically ill patients. Adapted from Cooper RA et al (95).



**Figure 2.** Practice settings as identified by 635 acute care nurse practitioners from the 2004 American Academy of Nurse Practitioners National Nurse Practitioner Sample Survey, demonstrating that the majority practiced in a hospital inpatient setting followed by physician practice in groups. Adapted from Kleinpell and Goolsby (11). VA, Veteran Affairs; HMO, health maintenance organization; ER, emergent care.



**Figure 3.** Specialty practice settings identified by 423 acute care nurse practitioners (ACNPs) in a 5-yr longitudinal study demonstrating that the majority practice in intensive care unit (ICU) settings, followed by emergent care (ER) and specialty-based practice. Adapted from Kleinpell et al (12).

tified assistant such as an NP to reach ICU patients in less than 5 mins, along with intensivist response by pager, can help to promote ICU staffing coverage (7). Yet, data on the utilization and impact of NPs and PAs in the ICU setting are essential to identify optimal use of NPs and PAs in the ICU. This article reviews the literature on the use of nonphysician providers, focusing on NP and PA roles in the acute/critical care setting. The aim of the article is to provide a summary of the results to date incorporating studies assessing the impact and outcomes of NPs and PAs in the ICU.

**Nurse Practitioners.** There are currently 115,000 practicing NPs in the United States (8). Educated at the mas-

ter's degree level, NPs were originally trained in the 1960s to provide primary care and pediatric care services. The focus on acute care practice for NPs began in the early 1990's and arose out of the need to have an advanced level practitioner to meet the needs of acute and critically ill patients in the inpatient setting. National certification for acute care nurse practitioner (ACNP) practice began in 1995 and currently, over 5000 NPs have received certification as ACNPs, (9) a role focused on providing care to acute and critically ill patients (10). The majority of ACNPs report working in inpatient settings (Fig. 2), with up to 68% (or over 2800) working in ICU settings (Fig. 3) (11, 12). Although NPs with other educational preparation such as family, adult, or gerontology also practice in hospital

settings, only ACNPs have been educated and trained to manage critically ill patients in ICU settings. A national survey of educational programs that prepare ACNPs reported that critical care skills, including chest tube insertion, arterial puncture, central line placement, endotracheal intubation, managing ventilator therapy, and hemodynamic monitoring among others, are included in most ACNP training programs, in addition to coursework in pharmacology, physiology, pathophysiology, and patient care management (13).

**Physician Assistants.** PAs also have origins since the late 1960s to address the shortage of primary care physicians (14). According the American Academy of Physician Assistants, there are over 63,000 PAs nationally. The role of the PA is focused on conducting physical exams, diagnosing and treating illnesses, ordering and interpreting tests, counseling on preventive healthcare, and assisting in surgery (14). PAs work in conjunction with a supervising physician and have autonomy in medical decision making, but roles vary with training, experience, and state law. In the United States, all states have enacted laws that authorize PA prescribing (14). PA programs were developed to augment the capabilities of primary care physicians, fill service gaps caused by physician maldistribution, and help control healthcare costs (15). The average PA program curriculum runs approximately 26 months (14). Graduation from an accredited PA program and passage of the national certifying exam are required for state licensure. Although PA training was traditionally oriented toward primary care, a number of PAs now currently work in specialty practice including critical care (16). Training for advanced responsibilities has traditionally been provided by the sponsoring physician. In addition, however, there are established post-graduate programs in specialties, such as surgery and critical care medicine.

In the critical care setting, general roles and responsibilities of NPs and PAs include patient assessment, history and physical examinations, rounding with the multidisciplinary team, and for those who are credentialed and privileged, performing invasive procedures (including suturing, central and arterial line placement), and assisting in surgery under the supervision of a physician (10, 12–14) (Table 1). A recent workforce analysis on nonphysician provider care for a department of surgery identified

Table 1. Roles of nurse practitioners and physician assistants in acute and critical care

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Patient care management
Rounding
Obtaining history and performing physical examinations
Diagnosing and treating illnesses
Ordering and interpreting tests
Initiating orders, often under protocols
Prescribing and performing diagnostic, pharmacologic, and therapeutic interventions consistent with education, practice, and state regulations
Performing procedures (as credentialed and privileged, such as arterial line insertion, suturing, and chest tube insertion)
Assessing and implementing nutrition
Collaborating and consulting with the interdisciplinary team, patient, and family
Assisting in the operating room
Education
Staff, patients, and families
Practice guideline implementation
Lead, monitor, and reinforce practice guidelines for intensive care unit patients (i.e., central line insertion procedures, infection prevention measures, stress ulcer prophylaxis, etc)
Research
Data collection
Enrollment of subjects
Research study management
Quality assurance
Lead quality assurance initiatives such as ventilator-associated pneumonia bundle, sepsis bundle, rapid response team
Communication
Promote and enhance communication with intensive care unit staff, family members, and the multidisciplinary team
Discharge planning
Transfer and referral consultations
Patient and family education regarding anticipated plan of care

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several areas of work effort for patient care activities including consultations, discharges, admissions, and routine care aspects, such as assessing patients at the bedside, ordering medications, reviewing and/or interpreting diagnostic and laboratory tests, assessing and implementing nutrition, updating families, and coordinating specialty consults (17).

## METHODS

We conducted a systematic search of the English-language literature of publications on NP and PA providers using Ovid MEDLINE, Pubmed, and the Cumulative Index of Nursing and Allied Health Literature databases from 1996 through August, 2007. Search terms used included NP, ACNP, PA, nonphysician provider, midlevel provider, acute care, intensive care, and critical care. Terms were combined to search for reviews and research articles. Abstracts were reviewed and articles were obtained that seemed to have relevance to the focus area of NP and PA care in acute and critical care settings. Reference lists from identified articles were used to identify any additional studies. For inclusion in this review, studies were required to 1) address NP and/or PA roles, and 2) to use quantitative or qualitative methods to study role impact or outcomes of care. Investigations published in

a language other than English were excluded as were unpublished studies and abstracts. One of the authors (R.M.K.) reviewed all of the articles to ensure that they met the criteria for review. The obtained literature was then reviewed and sorted into categories including education and preparation, general role descriptions, descriptive and narrative reviews, and research studies. The following aspects of each study were identified, abstracted, and analyzed: study population, study design, study aims, methods, results, and relevant implications for critical care practice.

## RESULTS

Over 145 articles were reviewed on the role of the NP and PA in acute and critical care settings. The majority of the literature on NPs and PAs in acute and critical care settings focuses on role development, education and training, scope of practice, and role expansion (18–36). A total of 31 research studies were located on NP and PA care pertaining to care of acute and critically ill patients. Of those, 20 were focused on NP care, six focused on both NP and PA care, and five were focused on PA care in acute and critical care settings. Fourteen focused on ICU care, and 17 focused on acute care includ-

ing emergency room care (37–44), trauma (45–49), and management of patients with specific acute care conditions such as stroke, pneumonia, and congestive heart failure (50–52). Table 2 outlines the studies with respect to target population, outcome(s) of interest, and findings.

Studies focusing on NP and PA care in the ICU have examined several aspects of patient care outcomes including ventilatory weaning (53, 54), rates of urinary tract infection and skin breakdown (55), use of laboratory tests (56), length of stay (LOS) (45, 46, 53–55, 57), readmission rates (56, 58, 59), mortality (53, 58), costs of care (53, 54, 57, 59–62), intracranial pressure monitor placement (63), epilepsy care outcomes (64), discharge instructions (65), radiograph interpretation skills (39), and time savings for physician staff (45) (Table 3).

Of the 31 studies assessing the impact of NP and PA care in acute and critical care, the largest number have examined the impact of care on patient care management (n = 17). Six have focused on comparisons of care with physician care and five have examined the impact of models of care including multidisciplinary and outcomes management models. The smallest number of studies assessed involvement and impact on reinforcement of practice guidelines, education, research, and quality improvement (n = 3).

Studies assessing the impact of NP and PA care in acute and critical care settings have examined a variety of areas of focus including care provider comparisons, the impact of different models of care, impact on patient care management, reinforcement of clinical practice guidelines, and impact on education, research, and quality improvement initiatives. Each of these areas will be briefly outlined.

*Care Provider Comparisons.* Of the studies comparing NP and PA care with physician care, similarities with resident and fellow-based care have been identified. Rudy et al. (66) examined the daily activities of 11 ACNPs and five PAs with a matched group of resident physicians and found that residents cared for more patients, worked more hours, and spent more time in lectures and conferences, although ACNPs and PAs were more likely than the residents to discuss patients with the ICU nurses, to interact with patients' families, and spend more time in research and administrative ac-

Table 2. Studies of NP and PA roles in acute and critical care

Authors	Target Population	Outcome(s) of Interest	Finding(s)
Spisso et al. (45)	Retrospective study of use of NPs in trauma 12 months before and after role implementation	Costs of care, LOS, documentation time, clinical wait time, time savings for house MD	Use of NPs was associated with ↓ LOS and ↓ clinic wait time, ↑ documentation of quality of care; time savings of 352 min/day for house staff MDs
Dubaydo et al. (71)	PA care in medical ICU compared with MD	ICU occupancy, mortality, quality of charting, rate of complications	Over a 2-yr period, there were no changes in occupancy, mortality rate, complications, or quality of charting
Carzoli et al. (60)	NP, PA and resident care in neonatal ICU	LOS, use of total parenteral nutrition, blood transfusions, procedure complication rate, mortality	No differences in outcomes of NPs, PAs, and resident MD staff; NP-PA care was associated with an overall cost savings in terms of annual costs and hospital charges
Mitchell-Dicenso et al. (94)	NP care and resident care in neonatal ICU	LOS, mortality rates, complication rates, parent satisfaction, quality of care, costs	No differences were found between NP and pediatric resident staff in all outcome measures
Freij et al. (39)	NP care in ER	Radiology request and interpretation	There was no significant difference in the ability of NPs and MDs in requests or interpretation of radiographs. In both groups, a radiograph was considered appropriate in 70% of patients; sensitivity of interpretation was 93% in both groups
Hooker and McCaig (40)	NP and PA care in ER compared with physician care	Type of ER patient cared for, drugs prescribed, diagnostic screening tests ordered, diagnoses made	No differences between the services of the NP and PA group and physicians
Buchanan and Powers (44)	NP care in minor ER setting	Visit time, patient satisfaction, laceration care, NP job satisfaction	Visit times for NPs were shorter in minor emergency than main emergency area: patient and NP satisfaction scores were high; laceration care audits showed appropriate care
Miller et al. (46)	PA care for trauma service patients	Injury severity scores, transfer time to OR, transfer time to ICU, LOS	PA care resulted in ↓ time to OR (43%), ↓ time to ICU transfer (by 51%) and ↓ LOS (by 33%)
Rudy et al. (66)	ACNP and PA care for 289 ICU patients	LOS, mortality, readmission, patient care activities	No difference between NP/PA and resident care quality. Residents cared for older and sicker patients, worked more hours, more active on rounds, spent more time on rounds, NP/PA more likely to discuss patients with ICU nurse and family; more time in research and administrative duties
Stetler et al. (26)	Evaluation of ACNP role in medical, neonatal, and cardiothoracic ICUs	Performance ratings by administrators, MDs, nursing staff, and patients; clinical competency, timely orders, costs of care	Positive performance ratings were given by clinicians, patients and families; ACNPs had positive impact on patient care quality and processes of care
Balgardi (73)	Interventional cardiology NP service care for 180 patients status postcardiac or percutaneous transluminal coronary angioplasty	Impact of NP on clinical practice guideline adherence	Comparison of baseline and 12-month data sets demonstrated an ↑ in lipid screening ( $p < 0.001$ ), lipid profiles ( $p < 0.001$ ), smoking cessation counseling ( $p < 0.001$ ) and ↑ use of beta-blockers and ACE inhibitors ( $p < 0.001$ ) related to NP care
Sakr et al. (38)	Randomized control trial of ER patients cared for by NP (n = 704) vs. resident MD (n = 749 patients)	Adequacy of care, history taking, examination of patient, interpretation of radiographs	There were no differences in NP and resident MDs in accuracy of exams, adequacy of treatment, planned follow-up, or requests for or interpretation of radiographs; NPs were better at recording medical history and fewer patients seen by the NP had to seek unplanned follow-up advice about their injury
Gawlinski et al. (56)	ACNP care for cardiac ICU patients using extubation protocols	Mechanical ventilation time, reintubation events, LOS	↓ mean time to extubation, ↓ rates of ventilator-associated pneumonia, shorter LOS, ↓ use of arterial blood gases were demonstrated
Sole et al. (47)	ACNP and PA care on trauma service during a 6-month period	Types of patients cared for; diagnoses; orders; patient disposition	The ACNP/PA team identified new diagnoses in 53% of patients; they were also more likely to order rehabilitation and discharge planning, bowel management, and nutrition-based orders
Van Rhee et al. (50)	PA care for acute stroke, pneumonia, CHF, MI, and GI bleeding patients	Resource use including direct costs, radiology, laboratory and total resource use, and LOS	PAs used fewer total ancillary resources for patients with pneumonia and fewer laboratory resources for patients with stroke, pneumonia, and CHF than did residents; There were no differences in LOS

Table 2.—Continued

Authors	Target Population	Outcome(s) of Interest	Finding(s)
Cooper et al. (37)	Randomized trial of ER patients cared for by NP (n = 99 patients) compared with house officer MD (n = 100 patients)	Patient care, patient satisfaction, clinical documentation	Patients reported higher levels of satisfaction with NP care compared with MD care ( $p < 0.001$ ); and NP clinical documentation was rated of higher quality ( $p < 0.001$ ). There were no differences in level of symptoms, recovery times, or unplanned follow-up between the groups
Russell et al. (55)	ACNP care for neuroscience ICU patients	LOS, rates of UTI, skin breakdown, Foley catheter time, mobilization out of bed	Patients managed by ACNPs had shorter LOS ( $p = 0.03$ ), shorter ICU LOS ( $p < 0.001$ ), lower rates of UTI and skin breakdown ( $p < 0.05$ ), and shorter time to discontinuation of Foley catheter and mobilization ( $p < 0.05$ ).
Costopoulos et al. (51)	NP and PA care for cardiology and vascular medicine patients	LOS, costs of care	There were no significant differences in care given by NP/PA team and MD care with respect to LOS or costs of care
Burns et al. (54)	ACNP care for mechanically ventilated patients in ICU	Ventilator duration, ICU LOS, mortality, costs of care	An outcomes management model of ACNP care resulted in ↓ ventilator duration ( $p = 0.0001$ ), ↓ ICU LOS ( $p = 0.0008$ ), ↓ hospital LOS ( $p = 0.0001$ ), and mortality rates ( $p = 0.02$ ); >\$3,000,000 cost savings were realized
Hoffman et al. (67)	ACNP care in comparison with pulmonary critical care fellows in ICU	Activities and roles in the ICU	ACNPs and fellows spent a similar proportion of time performing required tasks. Physicians spent more time in nonunit activities such as education, although ACNPs spent more time interacting with patients and patients' families and collaborating with health team members
Garcias et al. (74)	NP care in surgical ICU for 900 patient days	Influence on compliance with clinical practice guideline use for DVT/PE, stress ulcer and anemia	Compliance was significantly higher ( $p < 0.05$ ) for NP team for all three clinical practice guidelines (DVT/PE $p < 0.001$ , stress ulcer $p < 0.001$ , and anemia $p < 0.02$ )
Oswanski et al. (48)	PA care in trauma center compared with resident care	LOS, patient mortality	↓ LOS resulted from PA care (2.54 compared 3.4 days). PAs had 100% participation in trauma care alerts compared with 51% of residents
Christmas et al. (49)	PA and NP care on trauma service	No. admissions, hospital and ICU LOS, mortality, direct cost per case, weekly resident work hours	There were statistically significant ↓ in ICU, floor and hospital LOS. Patient mortality and costs per patient were unchanged. Average number of hours worked per resident ↓ from 86 to 79 hrs/wk
Kleinpell (12)	5-yr longitudinal study of 437 ACNPs assessing role development	Role and role components	ACNPs reported spending a majority of time in direct patient care management (85% to 88%). Other aspects of the role include teaching, research, program development, quality assurance, and administrative components
Meyer and Miers (57)	ACNP care on a cardiovascular surgery team	LOS, costs of care	Care given by ACNPs on the CV team resulted in ↓ LOS by 1.91 days and ↓ costs of care by \$5,038.91 per patient
Hoffman et al. (68)	ACNP care in MICU	Comparison of ACNP and critical care fellows care for 526 patients	There were no differences in readmission rates, mortality, duration of mechanical ventilation, LOS, or disposition
Vazirani et al. (76)	2-yr review of NP care for inpatients	Perceptions of NP role by 156 MDs and 123 staff nurses	Physicians reported greater collaboration ( $p < 0.001$ ) and better communication ( $p = 0.006$ ), nurses reported better communication with NPs than with MDs ( $p < 0.001$ )
Morse et al. (86)	NP-led rapid response team calls	Codes outside the ICU, staff perceptions of the RRT, in-hospital mortality rates	An ACNP-led RRT resulted in ↓ codes outside the ICU, ↓ in-hospital mortality rates, and high satisfaction ratings from staff evaluations
Hoffman et al. (69)	ACNP care in MICU	Comparison of ACNP and critical care fellow care for 192 mechanically ventilated patients	There were no differences in LOS, days of mechanical ventilation, readmissions, discharge weaning status, or mortality
Cowan et al. (52)	ACNP and hospitalist care for 1207 acute care medical patients	LOS, hospital costs, readmission rates 4 months after discharge	Average LOS was lower in ACNP/MD co-managed patients (5 vs. 6 days, $p < 0.001$ ). Costs of care were less.
Dacey et al. (87)	PA-led rapid response team	Cardiac arrests, hospital mortality, unplanned ICU admissions	A PA-led rapid response team was associated with ↓ rates of in-hospital cardiac arrest and unplanned ICU admissions ( $p < 0.05$ )

ACNP, acute care nurse practitioner; CHF, congestive heart failure; CV, cardiovascular; DVT/PE, deep vein thrombosis/pulmonary embolus; ER, emergency room; GI, gastrointestinal; LOS, length of stay; ICU, intensive care unit; MD, medical doctor; MICU, medical ICU; MI, myocardial infarction; NP, nurse practitioner; OR, operating room; PA, physician assistant; RRT, rapid response team; UTI, urinary tract infection; ACE, angiotensin-converting enzyme.

**Table 3.** Outcomes of NP and PA care in acute and critical care have been studied in the following areas

Ventilatory weaning (53, 54) <sup>a</sup>
Pneumonia (56) <sup>a</sup>
Emergency room care (37–39, 41, 44, 45) <sup>a</sup> ; (42, 44) <sup>b</sup> ; (40) <sup>c</sup>
Use of laboratory tests (56) <sup>a</sup> ; (50) <sup>b</sup>
Trauma care (45, 49) <sup>a</sup> ; (46) <sup>b</sup> ; (47) <sup>c</sup>
Use of radiologic tests (50) <sup>b</sup>
ICU occupancy rate (71) <sup>b</sup>
Time savings for physicians (45) <sup>a</sup> ; (46) <sup>b</sup>
Associated number of resident work hours (49) <sup>a</sup> ; (46) <sup>b</sup>
Rates of urinary tract infection and skin breakdown (55) <sup>a</sup>
Length of stay (45, 49, 52–55, 57) <sup>a</sup> ; (46, 50, 71) <sup>b</sup> ; (51) <sup>c</sup>
Readmission rates (57–59) <sup>a</sup>
Implementation of quality improvement initiatives such as rapid response team (86) <sup>a</sup> ; (87) <sup>b</sup>
Compliance with practice guidelines (56, 73) <sup>a</sup>
Unplanned ICU readmissions (86) <sup>a</sup> ; (87) <sup>b</sup>
Inpatient cardiac arrests (86) <sup>a</sup> ; (87) <sup>b</sup>
Mortality (53, 58) <sup>a</sup> ; (71) <sup>b</sup>
Costs of care (49, 53, 54, 57, 59, 61, 62) <sup>a</sup> ; (46, 51) <sup>c</sup>
Discharge instructions (65) <sup>a</sup>
Communication in the ICU (76) <sup>a</sup>
Quality of charting (71) <sup>b</sup>
Intracranial pressure monitor placement (63) <sup>a</sup>
Epilepsy care outcomes (64) <sup>a</sup>
Radiograph interpretation skills (39) <sup>a</sup>

<sup>a</sup>Studies focused on NP care; <sup>b</sup>Studies focused on PA care; <sup>c</sup>Studies focused on both NP and PA care.

NP, nurse practitioner; PA, physician assistant; ICU, intensive care unit.

activities (Fig. 4). Outcomes did not differ for patients treated by either group with respect to LOS, in-hospital mortality or readmission rates (66).

Hoffman et al. (67) performed 500 observations of ACNP and pulmonary and critical fellows in a medical ICU and found that ACNPs spent more time in activities related to coordination of care (45% vs. 18%;  $p < 0.001$ ), less time in nonunit activities such as attending conferences, reading, and teaching (15% vs. 37%;  $p < 0.001$ ), and more time ( $p < 0.05$ ) in interactions with the nursing and medical staff and with patients and family members (67). In a study exploring the outcomes of care managed by ACNP and attending physician team compared with an attending physician and/or critical care/pulmonary fellows for 526 patients in a medical ICU, there were no significant differences in readmission rates, duration of mechanical ventilation, weaning status, or patient disposition (68). Of note, these early studies were conducted before implementation of the 80-hr work restrictions for medical residency. Other studies focusing on care-provider comparisons are outlined in Table 2.

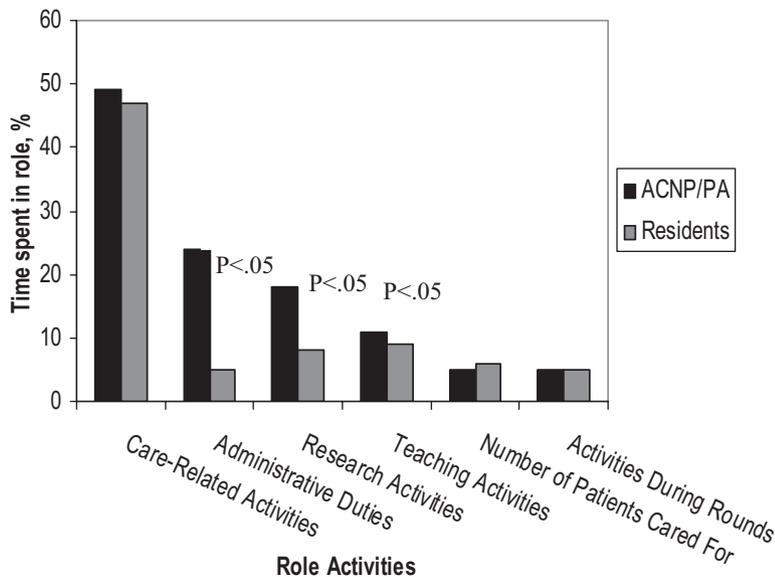
**Models of Care.** Several studies have focused on models of care using NPs and PAs. ACNP care for neuroscience ICU patients comparing 402 patients prospectively with 122 patients cared for by ACNPs in a multidisciplinary model of

care delivery found that patients managed by ACNPs had significantly shorter ICU LOS ( $p < 0.001$ ), lower rates of urinary tract infection and skin breakdown ( $p < 0.5$ ), and shorter time to mobilization and discontinuation of Foley catheter ( $p < 0.05$ ) (Fig. 5) (55). In addition, the ACNP managed group was hospitalized 2306 fewer days than the baseline group, demonstrating a cost savings of \$2,467,328 (55).

Assessment of the impact of PA care on a trauma service over a 2-yr period was found to result in decreased transfer times from the emergency room to the operating room by 43%, to trauma ICU by 51%, and to the floor by 20%, with a time savings of 4–5 hrs/day reported by all eight trauma surgeons because of the integration of PA care on the service (46). In another study focusing on trauma service care, the addition of NPs was found to be associated with a decrease in LOS and clinic wait times, and an increase in documentation quality (45).

Other studies focusing on care models using NPs and PAs have found comparable LOS and costs of care for vascular medicine patients managed by an NP and PA group, and resident and MD groups (51), and comparable ICU LOS, days of mechanical ventilation, discharge weaning status, and number of ICU readmissions for ACNP care given in collaboration with attending physicians for medical ICU patients requiring prolonged mechanical ventilation (69).

**Impact on Patient Care Management.** The majority of studies on NPs and PAs in acute and critical care settings have focused on the impact on patient care management. Among these studies, NP and PA care was associated with improved clinical and financial outcomes for mechanically ventilated patients including ventilator duration, LOS, mortality and cost savings (53, 54), reduction in floor, ICU and overall LOS for trauma care patients (46–49), improved management of patients with chronic heart failure (56), reduction in LOS and costs of care for cardiac surgery patients (57), reduction in LOS for vascular medicine patients (51), patient satisfaction with emergency room care (37), and proficiency in skills such as intracranial pressure monitor placement (63), surgical assistant skills (70), invasive procedures including arterial lines, central venous catheters, pleural taps, lumbar puncture and thoracentesis (71), and diagnostic cardiac catheterization (72).



**Figure 4.** Care activities of residents, acute care nurse practitioners (ACNPs) and physician assistants (PA) at two tertiary care facilities. Comparison of care activities and patient outcomes of 16 ACNPs and PAs and a matched group of resident physicians during a 14-month period demonstrating no differences in care-related activities, number of patients cared for, or activities during rounds. The ACNP/PA group spent more time in administrative duties, research, and teaching activities. Adapted from Rudy et al (66).

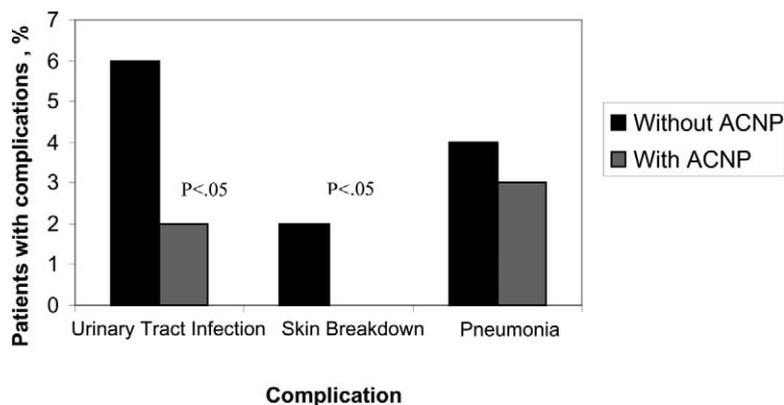


Figure 5. Impact of acute care nurse practitioner (ACNP) care for neuroscience patients in the intensive care unit demonstrating a decrease in urinary tract infections, skin breakdown, and pneumonia with ACNP oversight of care. Adapted from Russell et al (55).

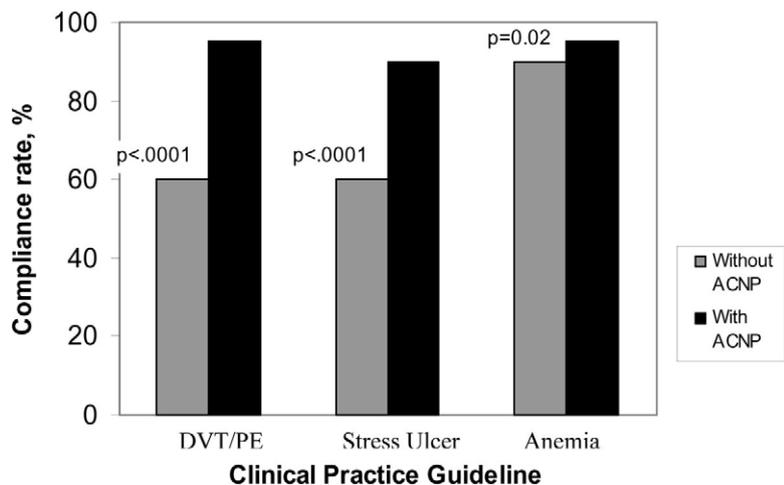


Figure 6. Impact of acute care nurse practitioners (ACNPs) in improving compliance with clinical practice guidelines for deep vein thrombosis/pulmonary embolus (DVT/PE) prophylaxis, stress ulcer prophylaxis, and anemia in a surgical intensive care, in %. Adapted from Garcias et al (74).

Two randomized clinical trials assessed the impact of NP care in emergency room settings. In a large randomized trial of NP care for 704 patients compared with 749 patients cared for by resident MDs, there were no differences found in accuracy of exams, adequacy of treatment, planned follow-up, or requests for interpretation of x-rays. NPs were found to record more medical histories, and fewer patients seen by the NP had to seek unplanned follow-up advice about their injury (38). A second randomized trial compared NP-led care for 99 patients with senior house officer care for 100 patients and found no differences in recovery times, levels of symptoms, time off work, or unplanned follow-up between groups (37). Patients reported higher levels of satisfaction with NP care compared with MD care ( $p < 0.001$ ) and NP clinical documentation was rated of higher quality ( $p < 0.001$ ).

**Clinical Practice Guideline Use.** Several studies have focused on the impact of NP care on improving compliance with clinical practice guidelines and have demonstrated increased adherence with lipid management, smoking cessation counseling, nutrition and diet recommendations, physical activity, and control of blood pressure for cardiac patients (56, 73), increased compliance with deep vein thrombosis/pulmonary embolus prophylaxis, stress ulcer prophylaxis and anemia clinical practice guidelines (74) (Fig. 6), and decreased incidence of ventilator-associated pneumonia, decreased intubation time, and decreased use of arterial blood gas measurements for ICU patients (56).

**Education, Research and Quality Initiatives.** Research on the ACNP role has demonstrated that in addition to providing direct care management, ACNPs contribute to patient care through discharge

planning, education of patients, families and nursing staff, and patient and family satisfaction. In a 5-yr longitudinal study of 437 ACNPs assessing role development, the most frequently identified aspects of care included discussing care with the family, ordering and interpreting lab tests and radiographs, initiating specialty consultations, and initiating discharge planning, all elements of the integrative aspect of the role in promoting continuity of care (12). Additional outcomes of ACNP care include allocation of time to physician collaborators, surgical or other billable procedures, practice management team productivity, and oversight of clinical programs (75).

## DISCUSSION

Overall, a limited number of studies have focused on the impact of NP and PA care in acute and critical care settings, and they are limited in their generalizability because of small sample sizes, use of selected settings, limited populations of interest, and short duration of outcome assessment. However, the existing research on NPs and PAs demonstrates that their integration in the ICU positively impacts patient care. NP and PA care has been demonstrated to enhance patient care flow and resident work hours without altering patient outcomes or direct hospital costs (49) and that tasks, activities, and outcomes are similar to resident physicians (66–69). Other studies have demonstrated additional areas of influence such as improved clinical and financial outcomes for mechanically ventilated patients including ventilator duration, LOS, mortality and cost savings (53, 54), reduction in floor, ICU and overall hospital LOS for trauma care patients (46–49), improved management of patients with chronic heart failure (56), reduction in LOS for vascular medicine patients (51), patient satisfaction (37), enhanced collaboration and communication in the ICU (76), and increased compliance with clinical practice guidelines (56, 73, 74). As the implementation and adherence to guidelines in the ICU has been identified as challenging, NPs and PAs can help to provide leadership and serve as champions to promote support for guideline uptake and use (77).

As part of the multidisciplinary ICU team, NPs have also been identified as impacting care through interactions and education of the nursing staff and through clinical research (12, 75, 78).

The value of NPs in leading research and quality improvement initiatives, monitoring data collection, and ensuring adherence to research protocols is demonstrated in a number of published studies (79–85). Involvement of ACNPs and PAs in leading quality improvement initiatives such as implementation of a rapid response team has also been demonstrated (86, 87).

It has been suggested that expanded reliance on NPs and PAs could help to serve as a viable complement to traditional care models (51), to ensure patient care continuity during off hours of residents (48) and with work hour restrictions of residents (49), and to meet the gap in ICU coverage (4, 88). NPs and PAs have also been cited to be a valuable adjunct in improving quality of patient care, as unlike residents or fellows, they do not rotate off service (48) and can provide greater continuity of care (47). This aspect of their role makes them well suited for helping to evaluate readiness for transfer, or for detecting subtle changes in patient condition such as delirium, vital sign trend changes, or signs of clinical deterioration. In addition, NP and PA continuity of care can facilitate implementation and adherence to protocols and guidelines, including sedation and mechanical ventilation weaning, infection prevention measures, and ventilator-acquired pneumonia and sepsis bundles (77, 89, 90).

Practice guidelines from the American College of Critical Care Medicine Task Force on Models of Critical Care Delivery identify that a multidisciplinary approach to the management of critical care patients, including the use of nonphysician providers, enhances the quality of care provided in the ICU (91). This team model for the delivery of ICU care has been advocated for improving ICU care and reducing ICU and overall hospital LOS, and costs of care (92).

Based on the results of this review, the following areas need to be further explored in a systematic fashion to further advance knowledge on the use of NPs and PAs in acute and critical care settings:

1. Dissemination of practice models: ICU teams are effectively incorporating ACNPs and PAs, yet a limited number of publications share strategies for role implementation and development. Information on successful multidisciplinary models of care, is needed

to promote optimal use of NPs and PAs in the ICU setting.

2. Additional research on the use of NPs and PAs: Further research that explores the impact of NPs and PAs in the ICU setting on patient outcomes, including financial aspects of care, is needed. A proposed research agenda includes the following areas: outcomes of specific role functions of NPs and PAs including impact on patient care; patient and family education and satisfaction; effect on staff education and job satisfaction; influence on increasing adherence to clinical practice guidelines; and effect on quality improvement measures, such as infection prevention or sepsis identification and management. Research on alternative models of ICU organization and coverage that incorporates NPs and PAs is also needed. Other areas of focus requiring further exploration include the use of NPs and PAs to extend coverage hours, or in different settings, provide care for a majority of patients in conjunction with a supervising physician. Research on models of care incorporating NPs and PAs in the new era of medical resident work hour restrictions is also needed. Other areas for additional research include the value of using the NP and PA as a proceduralist, the optimum NP- and PA-to-patient ratios, and best practice models, for example, unit-based or practice-based.

With respect to research designs, although the randomized clinical trials remains the gold standard, it is doubtful the study of NPs and PAs impact on ICU care can be explored with the use of a randomized clinical trials, especially given the complexity of issues related to multidisciplinary ICU care models. Alternative designs such as prospective before and after studies may be the best research design to further explore the impact of NP and PA care in the ICU, including alternative models of ICU organization.

3. Addressing supply and demand staffing needs in the ICU: Estimates of the intensivist workforce have identified that while there are over 10,240 critical care and pulmonary specialists in intensivist roles, a shortfall will occur equivalent to 22% of demand by 2020 and 35% by 2030 (2). Despite the fact that there are over 115,000 NPs and 63,000 PAs nationally, only a small

percentage (4%–6%) are acute care trained. Strategies for educating and training NPs and PAs to meet workforce needs for acute and critically ill patients are needed (93). Options might include providing structured ICU residencies for NPs and PAs, tuition reimbursement for advanced education, and promoting NP and PA preparation as career options for senior nurses and other healthcare personnel with an interest in and the potential for advanced practitioner roles.

4. Billing and reimbursement of NP and PA services: Although NPs and PAs can work under a true supervisory model (like a resident), they can also be independent billing practitioners who work with a physician in a collaborative practice model. Independent billing requires that the NP work in collaboration with a physician and that PA services are furnished under the general supervision of a physician, depending on state laws (75). Physician practice groups and hospitals are using NPs and PAs and billing for their services; however, information is lacking in the literature on successful practice arrangements and billing strategies.

## CONCLUSIONS

In reviewing the literature and identifying and critiquing 31 existing studies examining the use of NPs and PAs in acute and critical care settings, support was found for their involvement in patient care management, reinforcement of practice guidelines, education of patients, families and ICU staff, and research and quality initiatives. It becomes essential that reports of successful models of integrating NP and PAs are disseminated to help to promote their efficient use in team-based care to optimize outcomes for critically ill patients in the ICU and in acute, urgent, and subacute care settings.

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