**Supplemental Content**

Search terms and key words used in the literature review

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| **MeSH Terms** | **Additional Keywords** |
| advanced practice provider  midlevel provider  nurse practitioner  physician assistant  intensive care unit  intensive care unit organization & administration  critical care organization & administration  critical care standards  critical care statistics & numerical data  medical staff  hospital/organization & administration  patient care team/organization & administration  quality of health care/organization & administration  intensive care units/economics  nurse practitioners/standards United States  organizational culture  patient care team  delivery of health care/organization & administration  physician assistants/supply & distribution  practice patterns  nurse practitioners/supply & distribution  efficiency  models of care organization  personnel staffing and scheduling/organization & administration  quality of health care/standards  quality of health care/statistics & numerical data  Hospitals public/manpower  Hospitals public/organization & administration  physician assistants/organization & administration  professional practice/organization & administration  professional role | acute care nurse practitioner  critical care  critical care manpower standards  intensive care unit  outcome assessment health care  patient care team  quality of health care  **Inclusion criteria:**  NP, PA or APP care focused;  ICU or acute care setting  **Exclusion criteria:**  Did not involved NP, PA or APP care;  Primary care setting |

Supplemental Table 1: Studies Assessing Outcomes of APPs in Acute and Critical Care

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| Author(s) | Design | Measures | Outcomes Measured |
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| Bevis et al., 2008 59 | Retrospective blinded chart reviews | Comparison of tube thoracostomies performed by APPs and trauma surgeons | No difference between APPs and trauma surgeons in insertion complications, complications requiring additional interventions, hospital length of stay (HLOS), or morbidity; Significant difference in tubes directed caudad from insertion site (21% for surgeons, 2.6% for APPs) |
| Pirret 200856 | Comparative study design | Evaluation of role and effectiveness of a nurse practitioner (NP) led critical care outreach service with respect of ICU readmissions <72 hours. Time frame was 12 months pre and post NP role implementation. | There were 133 NP referrals, which resulted in 525 patient visits. The most common interventions completed by the NP during visits included ordering diagnostic tests and prescribing. Following introduction of the NP outreach service, there was a sustained reduction in ICU readmissions <72 hours. |
| Sherwood et al., 200933 | Retrospective review | Comparison of 12-month trauma admissions (N=967) and care by APP team with national trauma data bank (1,055,450 patient admissions for the same year) | Decreased length of stay (LOS) but not statistically significant; decreased mortality rate when categorized by injury severity score. |
| Mains et al. 200936 | Retrospective study | Comparison of PA care and resident physician care for trauma patients for 15,297 over a 7 year period. | No differences in mortality or mean ICU LOS. Mean unadjusted hospital length stay was lower when PAs were added to the trauma care team. |
| Holleman et al., 201042 | Cross-sectional descriptive survey | Descriptive survey 1 year after implementation of pediatric NP to pediatric neurosurgery group to practice physicians, nurses and allied staff assessing pre-post satisfaction with availability, responsiveness and patient clinical satisfaction with the addition of the NP role | Satisfaction scores in all categories, including overall satisfaction, significantly improved (p = 0.001). The number of paging calls received by the residents was reduced (91% were managed independently by NP) and there were no sentinel event reports noted. |
| Gillard et al., 201137 | Pre/Post | Comparison of trauma patient admissions, census, complications, and discharges over two distinct 13-month time periods | Reduction in HLOS and ICU-LOS, no increase in complications; reduced UTI rate; no change in DVT or major arrhythmia |
| Kawar and DiGiovine 201160 | Retrospective review | Comparison of PA care and resident team care in a medical ICU over a 3-year period with 5,346 patient admissions | No difference in HLOS, ICU LOS, hospital mortality or ICU mortality. Survival analyses showed no difference in 28-day survival between the two groups. |
| Butler et al 201161 | Prospective | 3 year charge capture of APP critical care charges with use of a standardized template | 48% increase in charge capture with APP salary offset increasing from 62% to 80% |
| Sise et al 201138 | Retrospective review | Evaluation of APP impact in adult level I trauma center | Decreased ICU LOS (39.5-23.4 hours, p<.05), decreased median costs of care ($4259 to $3698, p<.05), decreased complications (20.8-14.9%, p>.05) |
| Robles et al 201147 | Pre-Post | Comparison of impact of NP role on inpatient surgery service | 50% reduction in unnecessary ER visits (25% to 13% p=0.001), increased nurse telephone communications with patients (64%, p<.0001) |
| Collins et al 201431 | Retrospective review | 12 month evaluation of impact of adding NPs to a trauma stepdown unit | Average LOS decreased (0.8 day reduction) resulting in $9,111.50 savings in hospital charges for a reduction of $27.8 million dollars in hospital charges. |
| Alexandrou et al., 201557 | Retrospective review | To review characteristics and outcomes of NP central venous catheter insertions ICU units over a 2 year period using data from the Central Line Associated Bacteraemia (CLAB) project in New South Wales Australia | 760 vascular access devices were placed by the three NP-led central venous catheter placement services in 3 hospitals. Over the study period, insertion outcomes were favourable with only 1 pneumothorax (1%), 1 arterial puncture (1%) and 1 CLAB (1%) being recorded across the three groups. The CLAB rate was lower in comparison to the aggregated CLAB data set [1.3 per 1000 catheters (95% CI = 0.03–7.3) vs. 7.2 per 1000 catheters (95% CI = 5.9–8.7)] |
| [Gershengorn et al., 2012](https://www.ncbi.nlm.nih.gov/pubmed/?term=Gershengorn%20HB%5BAuthor%5D&cauthor=true&cauthor_uid=21393397)62 | Retrospective review | Comparison of mortality, LOS, and post-hospital discharge destination of APP teams to medical housestaff teams in MICU | MICU staffing type not associated with differences in hospital mortality, MICU LOS, hospital LOS, or post-hospital discharge destination |
| Goldie et al., 201228 | Randomized study | Patients scheduled for urgent or elective coronary artery bypass and/or valvular surgery were randomly assigned to either ACNP-led (n = 22) or hospitalist-led (n = 81) postoperative care. Both ACNPs and hospitalists worked in collaboration with a cardiac surgeon. | More patients in the ACNP-led group had had surgery on an urgent basis (p ≤ 0.01) and had undergone more complicated surgical procedures (p ≤ 0.01). After discharge, more patients in the hospitalist-led group had visited their family doctor within a week (p ≤ 0.02). Measures of satisfaction relating to teaching, answering questions, listening and pain management were higher in the ACNP-led group. |
| Morris et al., 201232 | Retrospective review | Comparison of DVT, PE, SSI, pneumonia, ARF and LOS with unit-based NP model directly and resident service | Care was equivalent between NPs and residents; LOS .5 days less with NPs |
| Young and Bowling, 201230 | Retrospective review | Comparison of intracranial monitor insertion between APPs and neurosurgeons in a trauma center over a 5-year period | Of 92 monitor insertions, 22 were inserted by neurosurgeons and 70 by APP. There was one major complication (cerebrospinal fluid leak) in a monitor placed by an APP. The difference in complication rates was significantly less than 5% (1.4% vs. 0%, p = 0.0128). |
| Scherr et al 201252 | Descriptive comparative | 2 year evaluation of NP-led rapid response team (RRT) at 2 Canadian hospitals | No difference in number of cardiac arrests, unplanned ICU admissions, hospital mortality between NP-led and intensivist-led RRT. Staff nurses reported increased confidence in knowledge and skills with NP-led RRT. |
| Glotzbecker et al.,201345 | Retrospective review | Comparison of physician assistant (PA) care on patients with acute myelogenous leukemia receiving chemotherapy over a 4-year period compared with resident team care | No difference in ICU transfers or mortality rates. LOS was decreased in PA service (30.9 days) compared to resident team (36.8 days) (p=.03). The 14-day readmission rates was also decreased in the PA service (0) compared to the resident team (10.6%) (p=.03). |
| Skinner et al., 201363 | Retrospective review | Evaluation of mortality rates, surgical trainee attendance in theatre, after-hour calls by NPs to doctors, and cost after adding NPs as first-line care in an ICU | No significant differences in mortality; Surgical trainee attendance in theater increased from 68% to 80% (P < 0.001); Annual cost of staffing the junior doctor and NP program before the change was £933 344 and £764 691 after; 57% of the after-hour calls, advice sufficed. 73% required attendance of the doctor. |
| Sawatzky et al 201325 | Prospective RCT | Impact of NP managed cardiac surgery follow up for 200 patients randomly assigned to NP model of care | Decreased ED visits, decreased rehospitalizations (19 vs 15, nonsignificant), decreased patient reported symptoms (p=0.002), increased patient satisfaction (p=0.001) |
| Alexandrou et al., 201464 | Observational study | Evaluation of APP central venous catheter, peripherally inserted central catheter, high-flow dialysis catheter or midline catheter insertions for adult patients from critical care and general wards between November 1996 and December 2009. | A total of 4,560 catheters were placed in 3,447 patients. The most common catheters inserted were single-lumen peripherally inserted central catheters (n = 1,653; 36.3%) and single-lumen central venous catheters (n = 1,233; 27.0%). A small proportion of high-flow dialysis catheters were also inserted over the reporting period (n = 150; 3.5%). The overall catheter-related bloodstream infection rate was 0.2 per 1,000 catheter days. The prevalence rate of pneumothorax recorded was 0.4%, and accidental arterial puncture (simple puncture—with no dilation or cannulation) was 1.3% using the subclavian vein. |
| Costa et al., 201465 | Retrospective cohort analysis | Examined effect of NPs/PAs on in-hospital mortality for patients on mechanical ventilation, patients with the highest quartile of Acute Physiology Score (> 55), and ICUs with physician staffing and trainees | Unadjusted and risk-adjusted mortality was similar between groups. |
| Kapu et al., 201466 | Retrospective, secondary analysis | Examined billing, LOS, quality metrics of NPs added to inpatient care teams | Gross collections compared with expenses for 4 NP-led teams for 2-year time periods were 62%, 36%, and 47%, and +32%.; Average risk-adjusted LOS for the 5 time periods after adding NPs decreased and charges decreased, thus demonstrating less resource use; Clinical outcomes improved beyond pre-project baselines. |
| Rayo et al., 201467 | Observational | Comparison of handover communication between attending physicians, resident physicians, and NPs in 3 medical ICUs over a 12-month period | A total of 133 patient handovers were analyzed. Higher levels of training were associated with fewer interjections, and a higher proportion of interactive questioning to detect erroneous assessments and actions by the incoming provider. All groups were observed to use the least assertive level of a collaborative cross-check, which could contribute to misunderstandings. |
| Kapu, Wheeler and Lee 201453 | Retrospective review | 12 month pilot evaluation of adding NPs to medical and surgical rapid response teams | NPs responded to 898 RRT calls, (66.7% of all calls). Majority of patients remained in same location; 360 were transferred to the ICU. 35% of calls resulted in ICU billing. Charge nurses were surveyed (n=24), with 96% expressing high satisfaction associated with enhanced service and quality. |
| Sirleaf et al., 201468 | Retrospective review | Comparison of complication rates from (arterial lines, central venous lines, bronchoalveolar lavage, thoracostomy tubes, percutaneous endoscopic gastrostomy, and tracheostomies performed by ICU resident physicians (RPs) and advanced clinical practitioners (ACPs) | No difference in procedural complication rates, mortality, or the mean ± SE ICU LOS and HLOS |
| David et al., 201527 | Retrospective 2 group comparative design | Comparison of medical team with acute care NP to medical team alone for patients admitted to a cardiovascular ICU for heart failure or myocardial infarction over a 2-year period | Patients receiving care from medical team with NP (n=109, intervention group) were re-hospitalized 50% less compared to those receiving care from medical team (n=76). 30-day hospital readmission (p=.011) and 30 day return rates to the ED (p=.021) were significantly lower in the intervention group. |
| Hiza et al., 201535 | Retrospective Review | Evaluation of impact of NP role 1-year pre and post role introduction on trauma patients (pre=713 patients; post = 871 patients) | LOS decreased significantly (13.56 compared with 7.02 days, P = 0.001). The number of patients discharged to a rehabilitation facility (10.84 compared with 8.31 days, P = 0.002), patients discharged on antibiotics/wound VAC therapy (15.16 compared with 11.24 days, P = 0.017) and length of time to surgery all decreased (1.48 compared with 1.31 days, P = 0.37). |
| Jones et al., 201558 | Pre-post comparison | Evaluation of NP led proactive sepsis screening initiative over a 4-year intervention period. Twice-daily screening of patients on targeted units was conducted by bedside nurses; nurse practitioners initiated definitive treatment as indicated. Evaluation focused on extent of implementation, trends in inpatient mortality, and, for Medicare beneficiaries, a before-after (2008–2011) comparison of outcomes and costs. | The program was associated with a decrease in hospital mortality and costs of care. By year 3, 33% of inpatients were screened (56,190 screens in 9,718 unique patients), up from 10% in year 1. Inpatient sepsis-associated death rates decreased from 29.7% in the 2-year pre-implementation period to 21.1% after implementation. Death rates and hospital costs for Medicare beneficiaries decreased from pre-implementation levels without a compensatory increase in discharges to post-acute care. |
| Elliott et al 201569 | Quasi-experimental study | Comparison of ED LOS, MICU LOS, and overall hospital LOS before and after an MICU Alert Team (MAT) intervention, consisting of a  MICU nurse and PA, with oversight by a MICU attending physician for ED patients awaiting ICU transfer. | ED LOS was reduced by 30% (2.6 hours) from  baseline (*p* < .001). Time series analysis identified a 1.5-hour drop in ED LOS (*p* = .02) for patients transferred from the MICU immediately following intervention implementation and was sustained over time. |
| Althausen PL et al., 201648 | Retrospective review | Evaluation of impact of PA care over a 12-month period for of 1, 104 trauma patients with orthopaedic injuries | Patients seen in ED 205 minutes faster (p=0.006), total ER time decreased 175 minutes (p=0.001), time to surgery improved 360 minutes (P<0.03); postoperative DVT prophylaxis increased by a mean of 6.73% (p=0.03) average length of stay decreased by 0.61 days (p=0.27). |
| Gershengorn et al., 201655 | Retrospective study of two cohorts | Assessment of clinical and process outcomes when critical care medicine trained physician assistants (CCM-PA) are added to a critical care outreach team (CCOT) | Reduction in the time-to-transfer to ICU associated with adding the CCM-PA to the CCOT; No difference in hospital mortality or LOS |
| Landsperger et al., 201624 | Prospective cohort study | Comparison of 90-day survival, ICU LOS, HLOS and mortality rates of ACNP teams to resident teams in MICU | No difference in 90-day survival for patients cared for by ACNP or resident teams; ICU mortality lower for patients cared for by ACNPs; hospital mortality was not different; ICU LOS was similar between teams; HLOS was shorter for patients cared for by ACNPs. |
| Moran et al., 201629 | Retrospective study | Review of tPA utilization, door-to-needle (DTN) time, imaging-to-needle (ITN) time, and ambulation at hospital discharge were compared when NP 24/7 stroke code coverage was added. | While tPA rates were similar, decreases noted in median DTN time and median ITN time. |
| Matsushima et al., 201634 | Retrospective review | Evaluation of impact of APP night coverage in trauma ICU compared to resident physician care | APP and resident physicians transfused patients requiring massive transfusion with a similar blood product ratio (packed red blood cell, fresh frozen plasma) (2.1:1 vs 1.7:1; P = .32). In a multiple logistic regression analysis, APP coverage was not associated with any clinical outcome differences. |
| Scherzer et al., 201770 | Retrospective chart review | Comparison of usage patterns, ICU LOS, HLOS and mortality rates of a MICU staffed by NPs and a MICU staffed by physicians | Patients in the NP-staffed MICU had a significantly shorter LOS than those in the resident-staffed physician MICU; Post-hospital discharge to non-home location was higher in the NP-ICU. No difference in mortality between a NP–staffed MICU and a resident-staffed physician MICU |
| Holliday et al 201739 | Retrospective review | Two year outcome analysis of NP care on acute care trauma service | Decreased hospital LOS, decreased ICU LOS, decreased time to place rehabilitation consultation and increased discharge orders by noon. A significant decreased in complications including pneumonia and DVT was also noted. |
| McLaughlin et al. 201850 | Retrospective review | Comparison of care outcomes of aneurysmal subarachnoid hemorrhage patients after implementation of a nocturnist APP model of care. | Compared to patients managed previously by overnight neurocritical care coverage with general critical care physicians and neurology residents, the nocturnist APP model was associated with an approximately 10% reduction in SAH mortality (P = .54). |
| O’Mahoney et al 201751 | Retrospective review | Evaluation of the association between the use of a palliative care consultation service program utilizing APPs and hospital costs at two academic medical centers over a 2 year duration. | Hospital costs were significantly lower for patients with palliative care compared with those who did not receive palliative care at one site (US$5756). Although not significant, median direct hospital costs were US$4274 lower for patients seen after implementation of proactive rounding by a palliative care NP at the second site. |
| Jefferson and King 201871 | Quality improvement initiative | Comparison of lab test use for ICU patients before and after introduction of NP on rounds. | Eighty-one patients were enrolled in the project, 41 in the comparison and 40 in the intervention group. A reduction in patient cost was observed for the number of tests ordered. Although there was an increase in tests ordered for the intervention group, the increase was brought about by an increase in specific individual tests rather than an increase in panels of laboratory tests. |
| Craswell et al. 201849 | Retrospective review | Evaluation of impact of new NP model of care for heart failure (HF) patients. | A cost comparison was undertaken to determine the cost effectiveness of an NP-led heart failure service for a 12 month period. The cost per NP HF patient was $123 less than that of a patient attending usual care and the cost per visit was $164 less. |
| Haskell et al 201843 | Quality improvement initiative | Evaluation of 2,657 rounding encounters in a pediatric ICU to assess the proportion of interrupted encounters during family-centered rounds when utilizing a PA as part of team. | The presence of a PA during PICU rounds was  significantly associated (*P* < .001) with a 35.4% lower likelihood of an interruption. |
| Gracias et al 200873 | Prospective study | Evaluation of impact of NPs on guideline compliance in surgical ICU | Guideline compliance for anemia management, DVT prophylaxis and stress ulcer prophylaxis was higher (P<.05) in NP managed patients. |
| Tsai et al 201074 | Secondary data analysis | Comparison of care provided for 4029 ED visits for asthma care from 63 EDs in 23 states. 3622 (90%) were seen by physicians only, 319 (8%) by APPs supervised by physicians, and 88 (2%) by APPs not supervised by physicians. | Patients cared for by unsupervised APPs had a shorter ED length of stay and were less likely to be admitted but were less likely to be prescribed inhaled β-agonists and systemic corticosteroids. |

Supplemental Table 2: Outcome Measures Used to Evaluate Impact of APPs in the ICU

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| **Length of Stay**  Gillard et al. 201140  Gershengorn et al. 201172  Landsperger et al. 201624  Gershengorn et al. 201655  Kapu et al. 201466  Althausen et al 201648  Scherzer et al. 201770  Kapu et al. 53  Glotzbecker et al 201345  Morris et. al 201232  Kawar and DiGiovine 201160  Sise et al 201138  Hiza EA et. al. 201535  Sherwood et al 200933  Sirleaf et al 201468  Matsushima et al 201634  Collins et al 201431  Sawatzky et al 201325 |
| **Deep Vein Thrombosis**  Gillard et al. 201137  Althusen PL et al 2016 48  Morris et al 201232  **DVT Prophylaxis**  Morris et. al. 201232  Althausen et al 201648 |
| **Major Arrhythmia**  Gillard et al. 201137  **Post operative emergency room visits**  Robles et al 201147 |
| **Urinary Tract Infection**  Gillard, et al. 201137 |
| **Mortality**  Gershengorn et al. 201172  Landsperger et al. 201624  Gershengorn et al. 201655  Gillard et al 201137  Kawar and DiGiovine 201160  Costa et al. 201465  Scherzer et al. 201770  Skinner et. al. 201363  Althausen et al 201648  Glotzbecker et al 201345  Jones et al 201558  Sherwood et. al 200933  McLaughlin et al 201850  Sirleaf et al 201468  Matsushima et al 201634  Sawatzky et al 201325 |
| **Improving Discharge Time**  Gershengorn et al. 201172  Goldie et. al. 201228  Scherzer et al. 201770  Kawar E, DiGiovine B. 201160  Hiza EA et. al. 201535  **Impact on Resident/Fellow Education**  Joffe et al 20149  Gokani et al 201677  Kahn et al 201578  Holleman et al 201042  Skinner et al 201380  Buch et al 200879 |
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| **Quality Indicators (Tube Thoractomy, Blood Transfusion)**  Bevis et. al. 200859 |
| **Lab Test Use in ICU**  Jefferson and King, 201871  **Palliative Care Consultations**  O’Mahoney et al 201751  **Hand Over Communication**  Rayo et al. 201467 |
| **Time-to-Transfer**  Gershengorn et al. 201655 |
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| **Mechanical Ventilation Rates**  Costa et al. 201465 |
| **Financial Impact/Costs**  Kapu et. al 201466  Jefferson and King 201871  McLauglin et al 201850  Craswell et al 201849  Collins et al 201431  Gershengorn et al 201655  Scherzer et al 201670  Sise et al 201138  Skinner et al 201363  Hellervick e al 201154  Althausen et al 201648 |
| **Resource usage**  Kapu et al 201466  Jefferson and King 201871 |
| Sawatzky et al 201325  **Transfer rate/time**  Althausen et al 201648  Glotzbecker BE et al 201345 |
| **Readmission rate**  Pirret 200856  Glotzbecker et al 201345  David et. al 201527 |
| **Staff Perception of APP**  Joffe et al 201476  Kahn et al 201578  Gokani et al 201677  Buch et al 200979  Dalton 201383  Holleman et al 201042  Scherr et al 201252 |
| **Blood Transfusion**  Matsushima et. al. 201634 |
| **Complications related to procedural care**  Alexandrou et.al. 201464  Sirleaf et al 201468  Bevis et al 200859  Young PJ & Bowling WM 201230 |
| **Neuro tPA treatment rates, imaging and door to needle time** -  Moran et al. 201629  **Staffing**  Holleman et al. 201042 |
| **Staffing Cost**  Skinner et. al. 201363 |
| **Quality of Care (Acute Asthma Care Measures)** -  Tsai et. al. 201074 |
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| **Patient Flow**  Althausen et al 201648 |
| **Patient Satisfaction**  Goldie et. al 201228  Sawatzky et al 201325 |

**Additional Supplemental Content: Ideas from the Bedside: Abstracts presenting efforts to effectively use APPs to improve the quality of care in the ICU and acute care setting**

In addition to published articles concerning the value of critical care APPs, multiple abstracts have presented at professional conferences describing the positive aspects of this model. Most have not been advanced to publication as an article, but these abstracts provide insight into the “grassroots” ideas and concerns of these providers in daily practice.

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| **Abstract Title** | **Author(s) and Reference** | | **Summary** |
| Staffing the mobile stroke unit: Nurse practitioners measure up to physician-led care | [Alexandrov A.](https://www.embase.com/search/results), [Dusenbury W.](https://www.embase.com/search/results), [Swatzell V.](https://www.embase.com/search/results), [Tsivgoulis G.](https://www.embase.com/search/results),  *[International Journal of Stroke](https://www.embase.com/search/results" \o "Search for publications by this author)*[; 2017 12:2 Supplement 1 (22)](https://www.embase.com/search/results" \o "Search for publications by this author) | | Assessment of diagnostic accuracy, treatment safety, and time to diagnosis and treatment delivery of an APP-led mobile stroke team. |
| Nurses' perception of resident and APP critical care teams | [Lunn J.](https://www.embase.com/search/results), [Sandor P.](https://www.embase.com/search/results), [Lavender Z.](https://www.embase.com/search/results), [Roy C.](https://www.embase.com/search/results), [Grover P.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2016 44:12 Supplement 1 (365) | | Study to assess RN's perception of the inter-professional team dynamics between APP and resident teams in the Medical Surgical ICU |
| Outcomes comparison of medical intensive care units staffed by acute care nurse practitioners/physician assistants versus medical residents | [Chen J.-T.](https://www.embase.com/search/results), [Wahab R.](https://www.embase.com/search/results), [Connolly K.](https://www.embase.com/search/results), [Yip N.H.](https://www.embase.com/search/results), [Boerem P.](https://www.embase.com/search/results), [Brodie D.](https://www.embase.com/search/results)  *American Journal of Respiratory and Critical Care Medicine;* 2014 189 | | Review of admissions, ICU LOS and mortality between 2 MICUs, one staffed by NPs and PAs and the other by medical residents |
| A recipe for success: Advanced Practice Professionals decrease trauma readmissions | [Smith G.](https://www.embase.com/search/results), [Waibel B.](https://www.embase.com/search/results), [Evans P.](https://www.embase.com/search/results), [Goettler C.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2013 41:12 SUPPL. 1 (A149) | | Evaluated impact on LOS, and disposition when APPs were added to a Trauma service |
| Financial impact of adding nurse practitioners (NPS) to critical care teams | [Kapu A.](https://www.embase.com/search/results), [Jones P.](https://www.embase.com/search/results), [Parmley C.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2013 41:12 SUPPL. 1 (A19) | | Assessment of return on investment in adding NPs to 4 ICU teams. |
| Resident cardiac ICU nurse practitioners make a non-resident junior doctor rotation feasible | [Skinner H.](https://www.embase.com/search/results), [Skoyles J.](https://www.embase.com/search/results), [Redfearn S.](https://www.embase.com/search/results), [Jutley R.](https://www.embase.com/search/results), [Mitchell I.](https://www.embase.com/search/results), [Richens D.](https://www.embase.com/search/results)  *Anaesthesia;* 2012 67:3 (314) | | Demonstrated a safe and viable alternative to traditional staffing models in the cardiac ICU |
| An ICU provider staffing model utilizing acute care nurse practitioners improves access to high quality critical care services | [Rosenthal L.](https://www.embase.com/search/results), [Tseng G.](https://www.embase.com/search/results), [Beyatte M.](https://www.embase.com/search/results), [Havenar M.](https://www.embase.com/search/results), [Backes N.](https://www.embase.com/search/results), [Cage A.](https://www.embase.com/search/results), [Hess C.](https://www.embase.com/search/results), [French A.](https://www.embase.com/search/results), [Neunaber K.](https://www.embase.com/search/results), [Boyle W.](https://www.embase.com/search/results)  *Critical Care Medicine;* 2011 39 SUPPL. 12 (28) | | Compared ICU patient flow and outcomes in an 8-bed critical care area (CCA) when staffed 24 hours with ACNPs |
| ICU nurse practitioner and physician assistant utilization and in-hospital mortality | [Kelly D.M.](https://www.embase.com/search/results), [Wallace D.J.](https://www.embase.com/search/results), [Barnato A.E.](https://www.embase.com/search/results), [Kahn J.M.](https://www.embase.com/search/results)  *American Journal of Respiratory and Critical Care* Medicine; 2013 187 | | NPs/Pas appear to be a safe adjunct to physicians-in-training in academic hospitals and may yield lower odds of death for critically ill patients in nonacademic ICUs. |
| Implementation of a surgical critical care nurse practitioner service | [Warrington C.](https://www.embase.com/search/results), [Weinstein M.](https://www.embase.com/search/results), [Miller P.](https://www.embase.com/search/results), [McMenemy C.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2012 40:12 SUPPL. 1 (34) | | The addition of a 11a to 11p ACNP can improve patient care and multidisciplinary shift to shift communication during the busiest time on the unit |
| Improved quality outcomes utilizing a nurse practitioner service line | [Okuhara C.](https://www.embase.com/search/results), [Rodgers J.](https://www.embase.com/search/results), [Koh J.](https://www.embase.com/search/results), [Sanchez-Pinto N.](https://www.embase.com/search/results), [Nelson L.](https://www.embase.com/search/results), [Amirnovin R.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2016 44:12 Supplement 1 (380) | Comparison of protocol compliance, length of opioid exposure, HLOS, and withdrawal assessment tool scores between NP model in a cardiac intensive care unit (CICU) and a pediatric ICU (PICU) model staffed by attendings, fellows, and rotating residents | |
| Three year outcomes of a medical intensive care unit acute care nurse practitioner (ACNP) service | [Landsperger J.](https://www.embase.com/search/results), [Rice T.](https://www.embase.com/search/results), [Wheeler A.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2014 42:12 SUPPL. 1 (A1551) | Comparison of productivity, patient characteristics, and mortality between an MICU ACNP and two resident teams | |
| Patient-care time allocation by nurse practitioners and physician assistants in the intensive care unit. | Carpenter DL, Gregg SR, Owens DS, Buchman TG, Coopersmith CM.  *Critical Care;* 2012;16(1):R27 | Approximately two thirds of an affiliate's shift is spent providing billable services to patients. Greater than 20% of each shift is spent providing equally important but not reimbursable patient care. Understanding how affiliates spend their time and what proportion of time is spent in billable activities can be used to plan the financial impact of staffing ICUs with affiliates. | |

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| ICU outcomes of physician assistants and acute care Nurse practitioners compared to resident teams | [Keller J.](https://www.embase.com/search/results), [Reed H.](https://www.embase.com/search/results), [Wang X.](https://www.embase.com/search/results), [Guzman J.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2014 42:12 SUPPL. 1 (A1380-A1381 | A PA/ACNP medical ICU team can reduce ICU and hospital mortality when compared to a traditional resident physician model. These findings suggest the partnership of PAs and ACNPs with pulmonary/critical care physicians and fellows can improve outcomes in a Medical ICU and help alleviate the projected shortage of bedside intensivists. |
| Pediatric ICU nurses evaluate (APPs) and residents: High marks for APPs. | McGee TI, Nitu ME, Rabi FA, Rigby MR.  *Critical Care Medicine;* 2012 40:12 SUPPL. 1 (227) | An APP program can be successfully implemented while maintaining bedside nurse satisfaction and confidence. |
| Comparison of NP/PA Residency-Trained Graduates. | [Xu K.](https://www.embase.com/search/results), [Gregg S.](https://www.embase.com/search/results), [Carpenter D.](https://www.embase.com/search/results), [Grabenkort R.](https://www.embase.com/search/results), [Meissen H.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2016, 44: (12):105 | Study to compare billing data of residency trained advanced practice providers (APPs) to on-the-job trained (OJT) APPs |
| Implementation of a Critical Care Ultrasonography Workshop for Advanced Practice Providers. | Bailey B, Cook C,  Kapu A  *Critical Care Medicine*; Dec 2016; 44(12):178 | Study to ascertain knowledge acquisition (pre and post tests and confidence rating) related to critical care ultrasound course |
| Effect of adding an acute care nurse practitioner to a staff nurse led rapid response team (RRT) in a University Medical Center | [Hellervik S.M.](https://www.embase.com/search/results), [Chassan C.B.](https://www.embase.com/search/results), [Landsperger J.S.](https://www.embase.com/search/results), [Wheeler A.P.](https://www.embase.com/search/results)  *Critical Care Medicine;* 2011 39 SUPPL. 12 (171) | Comparison of interventions and outcomes from RRT calls led by staff nurses with RRT calls led by ACNPs |
| Survival in a pediatric intensive care unit (PICU) with physician extenders as providers | [Kypuros K.](https://www.embase.com/search/results), [Taylor R.](https://www.embase.com/search/results), [Son M.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2011 39 SUPPL. 12 (156) | Comparison of survival rates and LOS between physician hospitalists and physician extender models over two time periods |
| Reduced cost and decreased length of stay associated with acute ischemic stroke care provided by NPs : A single primary stroke center experience | Roering L., Peterson M., Miran M.S., Freese M., Shea K., Suri M.F.K.  *Stroke*; 2017 48 Supplement 1 | Comparison of LOS and cost before and after implementation of NPs as primary medical providers in a community based stroke center |
| Appropriate transfusions in the ICU: Can APPs help improve compliance? | [Sengupta R.](https://www.embase.com/search/results), [Small B.L.](https://www.embase.com/search/results), [Smoot T.](https://www.embase.com/search/results), [Lopez-Plaza I.](https://www.embase.com/search/results), [DiGiovine B.](https://www.embase.com/search/results)  *American Journal of Respiratory and Critical Care Medicine* 2015 191 | Compliance of appropriateness of blood transfusions between MICU residents and PAs |
| Financial viability of physician assistants in an academic trauma/surgical critical care model | [Sherry S.](https://www.embase.com/search/results), [Kiraly K.](https://www.embase.com/search/results), [Schreiber M.](https://www.embase.com/search/results)  *Critical Care Medicine*; 2013 41:12 SUPPL. 1 (A18-A19) | Division productivity and clinical revenue increased. The addition of PAs enabled faculty to perform other clinical activities thus generating additional revenue, a “force multiplier” effect |
| A comparison of outcomes in a medical step down unit using a nonphysician provider model. | Amin S., Koukoularis O., Aliotta J  *American Thoracic Society* 2017 International Conference B51 Critical Care: Managing an ICU – Who Comes in and preventing complications | Comparison of ICU and HLOS, 24 hour readmission to ICU, transfer to another ICU, post-hospital discharge location, and mortality between patients cared for by a MD-trained hospitalist or non-physician provider (NPP) in a medical ICU step down unit |

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