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Nurse Practitioner/Physician Assistant Staffing and Critical Care Mortality

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BACKGROUND: ICUs are increasingly staffed with nurse practitioners/physician assistants (NPs/PAs), but it is unclear how NPs/PAs influence quality of care. We examined the association between NP/PA staffing and in-hospital mortality for patients in the ICU.

METHODS: We used retrospective cohort data from the 2009 to 2010 APACHE (Acute Physiology and Chronic Health Evaluation) clinical information system and an ICU-level survey. We included patients aged ≥ 17 years admitted to one of 29 adult medical and mixed medical/surgical ICUs in 22 US hospitals. Because this survey could not assign NPs/PAs to individual patients, the primary exposure was admission to an ICU where NPs/PAs participated in patient care. The primary outcome was patient-level in-hospital mortality. We used multivariable relative risk regression to examine the effect of NPs/PAs on in-hospital mortality, accounting for differences in case mix, ICU characteristics, and clustering of patients within ICUs. We also examined this relationship in the following subgroups: patients on mechanical ventilation, patients with the highest quartile of Acute Physiology Score (> 55), and ICUs with low-intensity physician staffing and with physician trainees.

RESULTS: Twenty-one ICUs (72.4%) reported NP/PA participation in direct patient care. Patients in ICUs with NPs/PAs had lower mean Acute Physiology Scores (42.4 vs 46.7, $P < .001$) and mechanical ventilation rates (38.8% vs 44.2%, $P < .001$) than ICUs without NPs/PAs. Unadjusted and risk-adjusted mortality was similar between groups (adjusted relative risk, 1.10; 95% CI, 0.92-1.31). This result was consistent in all examined subgroups.

CONCLUSIONS: NPs/PAs appear to be a safe adjunct to the ICU team. The findings support NP/PA management of critically ill patients. CHEST 2014; 146(6):1566-1573

Given the rising demand for critical care and a shortage of trained intensivists, hospitals are searching for alternative ways to staff the ICU.[1] One model involves the use of nurse practitioners/physician assistants (NPs/PAs).[2] Since the first acute care nurse practitioner certification examination in 1995[3] and the emergence of critical care residencies for physician assistants,[4] the number of these clinicians providing complex care for patients with critical illness has grown.[5,6] In the United States, 68% of acute care nurse practitioners[6] and 24% of physician assistants[7] presently report working in ICUs.

Despite the expansion of this workforce, it remains unclear how NPs/PAs affect the quality of care in the ICU. Single-center studies examining the relationship between NP/PA staffing and outcomes either show no difference in outcomes[2,8] or demonstrate improvements on select outcomes,[9-13] and multicenter studies are lacking. To better understand how NPs/PAs affect patient outcomes, we conducted a retrospective cohort study of NP/PA use in a large cohort of US ICUs. We sought to compare organizational characteristics of ICUs with and without NP/PA staffing and to understand the association between admission to an ICU with NP/PA staffing and in-hospital mortality in adult patients in the ICU.

Materials and Methods

Study Design and Data Sources

We conducted a retrospective cohort study of NP/PA staffing and ICU outcomes from 2009 to 2010. Patient-level hospitalization data were obtained from APACHE (Acute Physiology and Chronic Health Evaluation), a nationally representative, fee-based clinical information system that provides risk-adjusted ICU outcome data to participating hospitals for benchmarking purposes.[14] These data are used for internal quality improvement and ICU outcomes research.[14-17] We linked APACHE data to an ICU-level survey of organizational practices that included in-depth information about staffing patterns. Details of the survey design were previously reported.[16,17]

Hospitals and Patients

We included ICUs that participate in the APACHE clinical information system and responded to the ICU staffing practices survey. To create a homogenous cohort with which we could adequately control for case-mix differences, we limited the analyses to medical and mixed medical/surgical ICUs. The subspecialty ICUs in this sample (ie, neuro-ICUs, cardiac ICUs) were infrequently staffed by NPs/PAs, and the surgical ICUs in this sample cared for a large number of trauma patients with various severities of illness and mortality rates than mixed medical/surgical ICUs. Limiting to mixed medical/surgical and medical ICUs allowed us to more confidently control for case mix and severity of illness across the two comparison groups. Thus, the final sample is a smaller subset of previously published work.[17]

To avoid interdependence of observations, we included only the first ICU admission for each patient. We also excluded patients aged < 17 years and those who were missing data on race (< 5% of the sample).

Variables

The primary exposure variable was admission to an ICU with NPs/PAs participating in direct patient care, defined as the response to the survey question, "Besides physician and nurses, which clinicians also routinely provide direct patient care in the ICU? (check all that apply)," with the option to select respiratory therapists, clinical pharmacists, nutritionists, and NPs/PAs. The primary outcome variable was in-hospital mortality. As in prior work, we classified patients discharged to hospice as dead upon discharge.[17]

We measured patient-level and ICU-level covariates believed a priori to be associated with both NP/PA staffing and mortality as potential confounders.[14,15] Patient-level covariates available from the APACHE dataset included age, race (grouped as black, white, and other), sex, emergency surgery before ICU admission (yes or no), presence of mechanical ventilation on day 1 of admission (yes or no), Acute Physiology Score (APS) on day 1 of ICU admission (scored from 0 to 252,

with a higher score representing higher illness severity), transferred from an outside hospital (yes or no), pre-ICU length of stay (in days), and presence of individual comorbid conditions (AIDS, myeloma, lymphoma, diabetes, metastatic cancer, cirrhosis, and liver failure [treated as indicator covariates]).

ICU-level covariates available from the APACHE dataset included annualized ICU volume[15] (treated as a continuous variable), physician trainee participation in care (categorized as either present or absent at the unit level),[18,19] and type of physician staffing model.[20] We defined physician staffing as either high intensity (ie, a mandatory intensivist physician consult or a closed unit) or low intensity (ie, an optional intensivist physician consult or the absence of available intensivists).[20]

Analysis

We assessed using χ^2 tests and t tests as appropriate the bivariate relationships between ICU and patient characteristics in ICUs with and without NPs/PAs. We assessed the multivariable relationship between NP/PA staffing and mortality using relative risk regression[21] with generalized estimating equations and robust variance estimators to account for ICU-level clustering.[22] We used relative risk regression instead of logistic regression because the incidence of the primary outcome exceeded established thresholds for which the OR approximates the relative risk.[23,24] We used generalized estimating equations (Stata command xtgee) with a normal (Gaussian) distribution and a log link. In this model, the exponentiated regression coefficients are interpreted as relative risks.[25]

We assessed the robustness of the findings by performing subgroup analyses in four groups: patients on mechanical ventilation, patients in the highest quartile of APS (> 55), patients in ICUs with low-intensity physician staffing, and patients in ICUs with physician trainees participating in direct patient care. We examined the association of NP/PA staffing among patients on mechanical ventilation and patients with the highest quartile of APS because these represent a high-severity cohort that may be most affected by NP/PA care. We examined the relationship of NP/PA staffing in ICUs with low-intensity physician staffing and ICUs with trainees because we posited that differential effects of NP/PA staffing based on the availability of physicians, trainees, or both might exist.

We also performed a sensitivity analysis in which we included patients discharged to hospice as alive upon discharge. The goal of this analysis was to assess the degree to which our definition of in-hospital mortality influenced the results.

Because the outcome variable was in-hospital mortality rather than 30-day mortality, we also assessed for potential discharge bias if patients in one group were preferentially transferred to post-acute care facilities, thereby shifting the mortality burden.[26-28] We compared discharge disposition of patients in ICUs with and without NPs/PAs using a Fisher exact test of significance. We categorized discharge disposition