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Neurosurgeons Deliver Similar Quality Care Regardless of First Assistant Type: Resident Physician versus Nonphysician Surgical Assistant

Grace Y. Ng¹, Ryan S. Gallagher¹, Austin J. Borja¹, Rashad Jabarkheel¹, Jianbo Na², Scott D. McClintock³, H. Isaac Chen¹, Dmitriy Petrov¹, Brian T. Jankowitz¹, Neil R. Malhotra^{1,2}

■ **OBJECTIVE:** There are limited data evaluating the outcomes of attending neurosurgeons with different types of first assistants. This study considers a common neurosurgical procedure (single-level, posterior-only lumbar fusion surgery) and examines whether attending surgeons deliver equal patient outcomes, regardless of the type of first assistant (resident physician vs. nonphysician surgical assistant [NPSA]), among otherwise exact-matched patients.

■ **METHODS:** The authors retrospectively analyzed 3395 adult patients undergoing single-level, posterior-only lumbar fusion at a single academic medical center. Primary outcomes included readmissions, emergency department visits, reoperation, and mortality within 30 and 90 days after surgery. Secondary outcome measures included discharge disposition, length of stay, and length of surgery. Coarsened exact matching was used to match patients on key demographics and baseline characteristics known to independently affect neurosurgical outcomes.

■ **RESULTS:** Among exact-matched patients ($n = 1402$), there was no significant difference in adverse postsurgical events (readmission, emergency department visits, reoperation, or mortality) within 30 days or 90 days of the index operation between patients who had resident physicians

and those who had NPSAs as first assistants. Patients who had resident physicians as first assistants demonstrated a longer length of stay (mean: 100.0 vs. 87.4 hours, $P < 0.001$) and a shorter duration of surgery (mean: 187.4 vs. 213.8 minutes, $P < 0.001$). There was no significant difference between the two groups in the percentage of patients discharged home.

■ **CONCLUSIONS:** For single-level posterior spinal fusion, in the setting described, there are no differences in short-term patient outcomes delivered by attending surgeons assisted by resident physicians versus NPSAs.

INTRODUCTION

Since the implementation of work hour restrictions for resident physicians and as growth of the aging population continues to outpace surgeon capacity,¹ there has been increasing demand for expansion of the neurosurgical workforce, including the hiring of nonphysician practitioners as part of neurosurgical care teams.^{2,3} Some of these nonphysician practitioners act as first assistants during surgery and are hereafter referred to as nonphysician surgical assistants (NPSAs).

Key words

- Advanced practice provider
- Lumbar fusion
- Mid-level provider
- Nonphysician surgical assistant
- Registered nurse first assistant
- Spinal fusion

Abbreviations and Acronyms

- ASA:** American Society of Anesthesiologists
BMI: Body mass index
CCI: Charlson Comorbidity Index
CEM: Coarsened exact matching
CI: Confidence interval
ED: Emergency department
EVD: Extraventricular drain
MHI: Median household income
NPSA: Nonphysician surgical assistant
OR: Odds ratio

PA: Physician assistant

PGY: Postgraduate year

RNFA: Registered nurse first assistant

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NPSAs include both registered nurse first assistants (RNFAs) and physician assistants (PAs). Registered nurses and nurse practitioners may enroll in graduate programs to obtain RNFA certification,^{4,6} while PAs may complete graduate training programs to act as first assistants during surgery.⁷ These programs prepare nonphysician trainees for multiple intraoperative responsibilities, including acting as first assistants during setup and preparation, exposure, dissection, hemostasis, and closing incisions.^{3,4,8}

In preparation for surgery, patients often ask about the involvement of the surgeon's assistant during surgery; many are pleased to hear that their surgeon has an assistant but seek reassurance that the attending surgeon will be responsible for the surgical outcome and that the outcome will not vary according to the first assistant. Some studies from other surgical fields have investigated whether the identity of the first assistant is associated with changes in postoperative outcomes; these studies found no significant differences in 30-day mortality, readmission, or complication rates when the first assistant was a resident physician compared to an NPSA.⁹⁻¹³ However, these studies were limited by small sample sizes and/or investigated nonneurosurgical procedures with poor generalization to neurosurgery.

Within the field of neurosurgery, there has been little work examining the outcomes of surgeon's assistants on surgeon's outcomes.^{14,15,16} To our knowledge, no investigations have assessed outcomes after major neurosurgical operations when the first assistant was a resident physician compared to an NPSA. This study aims to fill this knowledge gap and assesses whether attending surgeons deliver equal patient outcomes, regardless of the type of first assistant (resident physician or NPSA), after one of the most common neurosurgical procedures: single-level, posterior-only lumbar fusion. We answer this question by using coarsened exact matching (CEM) to tightly control for numerous patient characteristics that independently affect neurosurgical outcomes.

METHODS

Sample Selection

Consecutive patients undergoing single-level, posterior-only lumbar fusion across a single, multihospital academic medical center from June 7, 2013, to April 29, 2019, were retrospectively enrolled. This study was approved by the institutional review board at the present institution. The institutional review board considered this study to be of minimal risk to patients and granted a waiver of informed consent. All ethical guidelines and rules were followed to protect patient privacy.

A total of 3395 procedures were included, after exclusion criteria were applied. Procedures involving multilevel lumbar fusion ($n = 949$), anterior or anterior-posterior approach ($n = 634$), revision surgery of any kind ($n = 120$), or nonroutine operations ($n = 284$) were excluded from analysis (Figure 1). Nonroutine operations included those with unclean wounds, those not performed under general anesthesia, and those that were not scheduled inpatient operations. Of note, none of the operations in this study were performed at an ambulatory surgery center.

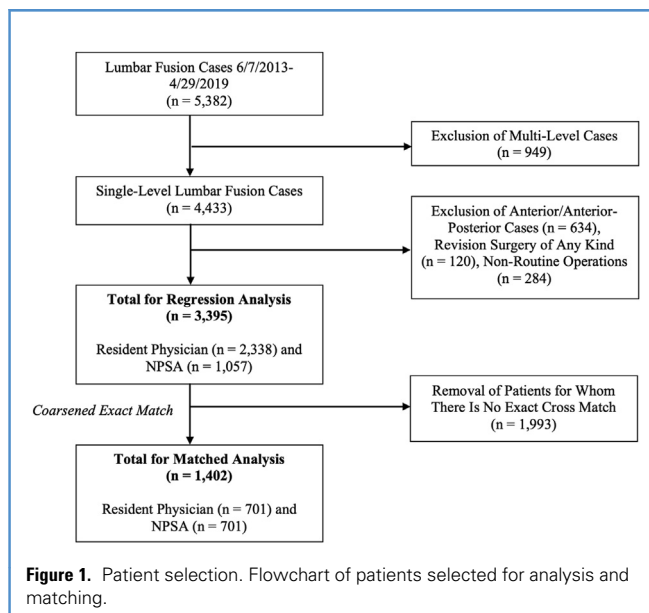


Figure 1. Patient selection. Flowchart of patients selected for analysis and matching.

Data Collection and Matching

Patient data were acquired with the EpiLog tool and subsequently extracted and pushed into defined spreadsheets. EpiLog is a nonproprietary data acquisition system created by the senior author of the paper and is layered on top of the existing electronic health record to facilitate charting, workflow, and quality improvement.¹⁷ Extracted data included patient demographic information, health information, and postoperative outcomes. Extracted data also were used to identify whether the first assistant was a resident physician or an NPSA (i.e., either RNFA or PA) across all institutions under study.

CEM was utilized to mitigate the effects of confounding variables and isolate the effect of the first assistant type (resident physician or NPSA) for analysis. With CEM, an exact match requires that the value of each covariate/matching variable be the same between the two subjects.

Patients who underwent surgery with either resident physicians or NPSAs as first assistants were matched on the following criteria: age, gender, race, median household income (MHI) (of the patient's zip code), insurance type, body mass index (BMI), smoking status, American Society of Anesthesiologists (ASA) grade, Charlson Comorbidity Index (CCI) score, presence of any prior surgical intervention, and presence of any surgical intervention in the 30 days preceding the index operation. Age was matched according to five categories (<50, 50–59, 60–69, 70–79, or >80). Gender, race, MHI, insurance type, and smoking status were matched in a binary fashion based on being male or female, white or nonwhite, above or below the median MHI for the dataset, having private insurance or nonprivate insurance, and being a smoker or nonsmoker, respectively. BMI and CCI score were matched in a ternary fashion based on having a BMI that was <18.5, 18.5–29.9, or >30, and having a CCI score that was 1–4, 5–6, or 7–33. All other covariates were exactly matched. Unmatched patients were removed from the dataset and were not included in the matched analysis.

Statistical Analysis

Primary outcome measures were readmissions, emergency department (ED) visits, reoperation, and mortality within 30 days and within 90 days after the index operation. Secondary outcome measures were discharge disposition (home vs. all other destinations), length of stay, and total duration of surgery (from initial incision to completion of closure).

For CEM, binning of the matching variables and removal of missing values were performed using SAS version 9.4 (SAS Institute Inc., Cary, North Carolina, USA). Matching was completed using the MatchIt programming package in R Statistics (R Core Team, 2017), with subsequent analysis executed through SAS version 9.4. Significance for all analyses was set as $P < 0.05$. Univariate analysis was performed to compare all matching criteria between the groups of NPSAs and resident physicians before and after matching. Logistic regression was used to compute odds ratios (ORs) (with confidence intervals [CIs]) to compare all primary outcomes and discharge disposition between the two groups before matching. Univariate analysis was used to compare the length of stay and total duration of surgery between the two groups before matching. After matching, McNemar's test was used to compare all primary outcomes and discharge disposition between the two exact-matched groups. A nonparametric test was performed to compare the length of stay and total duration of surgery between the two exact-matched groups.

RESULTS

Patient Characteristics—Entire Sample

Patients undergoing single-level, posterior-only lumbar fusion during a 6-year period (June 2013 to April 2019) who met the inclusion criteria were included for analysis ($n = 3395$). Patients undergoing surgery with resident physicians as first assistants were younger (mean age: 60.24 vs. 62.57, $P < 0.001$), more likely to be white (84.35% vs. 70.77%, $P < 0.001$), more likely to be privately insured (50.60% vs. 46.74%, $P = 0.037$), and more likely to be smokers (14.41% vs. 11.35%, $P = 0.016$) (Table 1). They were also healthier at baseline, as evidenced by a higher CCI score ($P < 0.001$). Furthermore, patients with resident physicians as first assistants were less likely to have had lifetime prior surgeries ($P < 0.001$) or to have had any surgery in the 30 days preceding the index operation ($P = 0.002$). No significant differences were found between the two groups according to gender, MHI, BMI, or ASA grade.

Resident Training Characteristics

For the cases included in this study, the training levels of the resident physicians who acted as first assistants varied from postgraduate year (PGY) 1 to 7; 0.38% of resident physician cases had a PGY-1, 13.9% had a PGY-2, 29.98% had a PGY-3, 3.34% had a PGY-4, 2.87% had a PGY-5, 11.33% had a PGY-6, and 38.2% had a PGY-7. The average number of training years for the resident physicians involved in this study was 4.8.

Patient Characteristics—Exact-Matched Patients

After performing CEM, 701 matches ($n = 1402$ patients) were generated (match rate: 66.32% among NPSA-assisted cases). Among these exact matches, there was no significant difference in

age, gender, race, MHI, BMI, smoking status, ASA grade, CCI score, presence of any prior surgical intervention, and presence of any surgical intervention in the 30 days preceding the index operation (Table 2).

Outcomes—Entire Study Population

No significant differences were found in the whole population when comparing readmission, ED visits, reoperation, or mortality within 30 days of lumbar fusion between patients who had resident physicians and those who had NPSAs as first assistants (Figure 2). Patients who had resident physicians as first assistants were less likely to have an ED visit within 90 days of lumbar fusion (OR: 0.64, 95% CI: 0.50, 0.81). No significant difference was found when comparing readmission, reoperation, or mortality within 90 days of lumbar fusion.

Patients who had resident physicians as first assistants were more likely to be discharged home (83.19% vs. 78.33%, $P = 0.001$; OR: 1.37, 95% CI: 1.14, 1.64) (Table 3) and to have a shorter duration of surgery (mean: 191.7 vs. 217.5 minutes, $P < 0.001$). There was no significant difference when comparing length of stay (mean: 98.6 vs. 91.3 hours, $P = 0.43$).

Outcomes—Exact-Matched Patients

No significant differences were found among exact-matched patients when comparing readmission, ED visits, reoperation, or mortality within 30 days or 90 days of lumbar fusion between patients who had resident physicians and those who had NPSAs as first assistants (Figure 3).

Patients who had resident physicians as first assistants were more likely to have a longer length of stay (mean: 100.0 vs. 87.4 hours, $P < 0.001$) and a shorter duration of surgery (mean: 187.4 vs. 213.8 minutes, $P < 0.001$) (Table 3). There was no significant difference when comparing the percentage of patients discharged home (82.17% vs. 80.31%, $P = 0.36$; OR: 1.17; 95% CI: 0.86, 1.58).

DISCUSSION

In this study of matched patients ($n = 1402$) undergoing single-level, posterior-only lumbar fusion, there were no significant differences in short-term readmissions, ED visits, reoperation, or mortality regardless of whether the first assistants were resident physicians or NPSAs.

Among secondary outcomes, otherwise matched patients with resident-assisted surgery had a shorter duration of surgery (mean: 187.4 minutes for resident physicians and 213.8 minutes for NPSAs; 12.3% reduction) and a longer length of stay (mean: 100.0 hours for resident physicians and 87.4 hours for NPSAs). Across the various hospitals (within the same institution) that were included in this study, discharge planning was performed by advance practice providers under the supervision of attending and/or resident physicians; thus, differences in staffing related to discharge planning were less likely to be a confounder for the length of stay outcome. The two groups had no significant difference in discharge disposition (home vs. nonhome).

In this study, CEM was utilized to control for the confounding influence of various patient characteristics (e.g., patient

Table 1. Prematch Patient Characteristics. Characteristics Describing the Entire Sample of Patients (n = 3395) Undergoing Single-Level, Posterior-Only Lumbar Fusion Over Six Years, with Either a Resident Physician First Assistant or Nonphysician Surgical Assistant (NPSA). Bold Values Denote Statistical Significance ($P < 0.05$)

Variable	Resident Physician (n = 2338)	NPSA (n = 1057)	P Value*
Age, mean (range)	60.2 (15–88)	62.6 (19–92)	<0.001
Gender, n (%)			0.72
Male	1033 (44.18)	460 (43.52)	
Female	1305 (55.82)	597 (56.48)	
Race, n (%)			<0.001
White	1972 (84.35)	748 (70.77)	
Nonwhite	366 (15.65)	309 (29.23)	
Median household income (USD), n (%)			0.24
Below dataset median	1166 (49.87)	494 (46.74)	
At or above dataset median	1152 (49.27)	554 (52.41)	
Insurance type, n (%)			0.037
Private insurance	1183 (50.60)	494 (46.74)	
Nonprivate insurance	1155 (49.40)	563 (53.26)	
Body mass index (kg/m ²)			0.21
<18.5	18 (0.77)	5 (0.47)	
18.5–29.9	1237 (52.91)	532 (50.33)	
>30.0	1083 (46.32)	520 (49.2)	
Smoking status, n (%)			0.016
Smoker	337 (14.41)	120 (11.35)	
Nonsmoker	2001 (85.59)	937 (88.65)	
American Society of Anesthesiologists Grade, mean (range)	2.39 (1–4)	2.42 (1–4)	0.12
Charlson Comorbidity Index score, n (%)			<0.001
Score 0–4	2019 (86.36)	838 (79.28)	
Score 5–6	233 (9.97)	146 (13.81)	
Score 7–33	86 (3.68)	73 (6.91)	
Lifetime surgical interventions prior to the index operation, n (%)			<0.001
0	1636 (69.97)	662 (62.63)	
1+	702 (30.03)	395 (37.37)	
Surgical interventions 30 days prior to the index operation, n (%)			0.002
0	2287 (97.82)	1014 (95.93)	
1+	51 (2.18)	43 (4.07)	

*Continuous variables were compared via nonparametric tests, while discrete variables were compared by χ^2 or Fisher's exact tests.

demographics and baseline health characteristics) known to independently affect neurosurgical outcomes. We chose to utilize CEM over other matching methods (such as propensity score matching) to ensure that each individual risk-associated covariate was adequately balanced and controlled. By comparison, propensity score matching summarizes all covariates into a single propensity score and thus may result in larger standard mean differences (signifying poor balance) for some individual

covariates compared to CEM.^{18–20} In this study, CEM was applied to control for selection bias, and it effectively balanced baseline characteristics between the two study groups. Before matching, the groups were significantly different across many characteristics, but after matching, these intergroup differences were eliminated.

This study compares the postoperative outcomes delivered by attending surgeons when they selected a first assistant resident physician (across all levels of training) with those of the NPSA

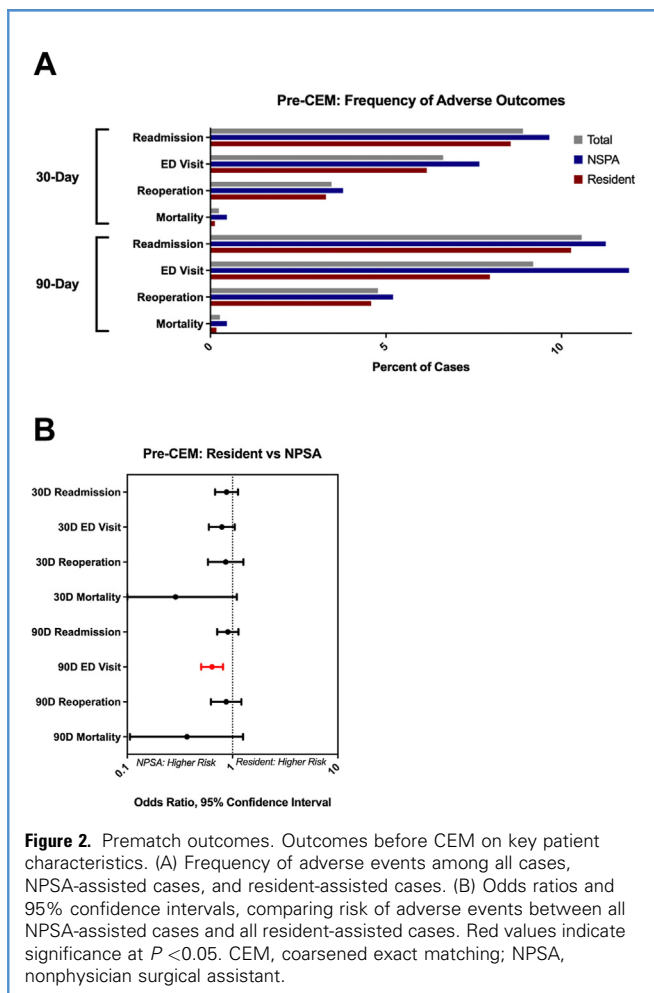
Table 2. Postmatch Patient Characteristics. Characteristics Describing the Exact-Matched Patients (n = 1402) Undergoing Single-Level, Posterior-Only Lumbar Fusion Over Six Years, with Either a Resident Physician First Assistant or Nonphysician Surgical Assistant (NPSA)

Variable	Resident Physician (n = 701)	NPSA (n = 701)	P Value*
Age, mean (range)	61.6 (17–88)	61.8 (19–90)	0.97
Gender, n (%)			1.00
Male	298 (42.51)	298 (42.51)	
Female	403 (57.49)	403 (57.49)	
Race, n (%)			1.00
White	567 (80.88)	567 (80.88)	
Nonwhite	134 (19.12)	134 (19.12)	
Median household income (USD), n (%)			1.00
Below dataset median	309 (44.08)	309 (44.08)	
At or above dataset median	392 (55.92)	392 (55.92)	
Insurance type, n (%)			1.00
Private insurance	347 (49.5)	347 (49.5)	
Nonprivate insurance	354 (50.5)	354 (50.5)	
Body mass index (kg/m ²), mean			1.00
<18.5	0 (0.00)	0 (0.00)	
18.5–29.9	382 (54.49)	382 (54.49)	
>30.0	319 (45.51)	319 (45.51)	
Smoking status, n (%)			1.00
Smoker	56 (7.99)	56 (7.99)	
Nonsmoker	645 (92.01)	645 (92.01)	
American Society of Anesthesiologists Grade, mean (range)	2.38 (1–3)	2.38 (1–3)	1.00
Charlson Comorbidity Index score, n (%)			1.00
Score 0–4	615 (87.73)	615 (87.73)	
Score 5–6	63 (8.99)	63 (8.99)	
Score 7–33	23 (3.28)	23 (3.28)	
Lifetime surgical interventions prior to the index operation, n (%)			1.00
0	486 (69.33)	486 (69.33)	
1+	215 (30.67)	215 (30.67)	
Surgical interventions 30 days prior to the index operation, n (%)			1.00
0	695 (99.14)	695 (99.14)	
1+	6 (0.86)	6 (0.86)	

*Continuous variables were compared via nonparametric tests, while discrete variables were compared by χ^2 or Fisher's exact tests.

(across all levels of experience). In the face of this variability in the training and experience of first assistants, attending surgeons exercise discretion to determine the role of the first assistant during surgery, and the outcomes of surgery are ultimately the responsibility of the attending surgeon. Thus, our study assesses attending surgeons' ability to select and manage first assistants in order to achieve optimal outcomes, regardless of the type of first assistant. We include resident physicians and NPSAs with varying

degrees of experience, training, and operative involvement to reflect real-world variability in the backgrounds of first assistants. Specifically, resident physicians from all postgraduate levels (PGY 1–7) were included in this study. This study design reflected the mix of resident levels involved in neurosurgical patient care at most residency programs, and the literature does not show differences in neurosurgical outcomes depending on level of resident training.^{21–23} NPSAs with differing training backgrounds were also



included in this study; registered nurses and nurse practitioners complete a graduate-level RNFA program to obtain certification,⁴⁻⁶ while PAs are trained through different graduate-level programs.⁷ Similar to resident physicians, NPSAs may be involved in the operating room and the perioperative management of inpatients. By including NPSAs with a variety of operative and patient care roles in this study, this study captures real-world variability

among NPSAs, with the aim of evaluating attending surgeons' ability to achieve equal outcomes and manage decisions related to the use of first assistants.

Of note, for all cases included in this dataset, the attending surgeon was present for all the critical steps of lumbar fusion (as defined by institutional standards), including in cases of overlapping surgery.²⁴ Prior work showed that overlapping surgery is not associated with differences in postoperative outcomes,²⁴ and thus overlapping cases were not excluded from this study. This study's findings suggest that attending surgeons effectively manage first assistants, both in cases of overlapping and nonoverlapping surgery, to deliver consistent outcomes.

The results from this study corroborate limited findings from other surgical fields (studies from the fields of urology,¹² bariatric surgery,¹³ and cardiac surgery⁹⁻¹¹), showing no difference in outcomes (such as 30-day mortality, readmission, or complication rates) when the first assistant was a resident physician compared to a nonphysician practitioner. However, within the field of neurosurgery, studies comparing resident physicians and NPSAs have been limited to bedside procedures.¹⁴⁻¹⁶ Our work fills an important gap in the neurosurgical literature and contributes to the broader surgical literature by showing no difference in attending surgeons' outcomes after a common neurosurgical operation, when the first assistant was a resident physician or an NPSA.

This study provides a much-needed assessment of the quality of care provided by neurosurgical operative teams with NPSAs. Our findings suggest that, in settings where resident physician coverage is limited, nonphysician practitioners can be managed as surgical first assistants without a difference in the attending surgeon's postoperative outcomes. This study provides evidence that attending surgeons can be effective both at selecting and managing their first assistants, with achievement of consistent patient outcomes. With appropriate supervision, NPSAs can alleviate the workload of other medical staff, including resident physicians, attending neurosurgeons, and floor nurses.^{2,4,25} In settings with limited to no resident neurosurgeon coverage, such as some rural areas or low-resource settings in the United States and globally,²⁶ NPSAs extend the ability of attending neurosurgeons to provide much-needed care for greater numbers of patients. Our study findings provide important evidence for decision-making by spine neurosurgeons aiming to expand neurosurgical services in the United States and globally.

Table 3. Secondary Outcomes. Comparison of Secondary Outcomes Between Single-Level, Posterior-Only Lumbar Fusion Cases with Either a Resident Physician First Assistant or Nonphysician Surgical Assistant (NPSA). Bolded Values Denote Significance at $P < 0.05$

Outcome	Pre-CEM			Post-CEM		
	Resident (n = 2338)	NPSA (n = 1057)	P Value	Resident (n = 701)	NPSA (n = 701)	P Value
Discharge to home, n (%)	1945 (83.19%)	828 (78.33%)	0.001	576 (82.17%)	563 (80.31%)	0.36
Length of stay, hours, mean (range)	98.6 (9–1070)	91.3 (12–349)	0.43	100.0 (24–705)	87.4 (12–273)	<0.001
Total duration of surgery, minutes, mean (range)	191.7 (22–697)	217.5 (6–561)	<0.001	187.4 (22–697)	213.8 (6–561)	<0.001

CEM, coarsened exact matching.

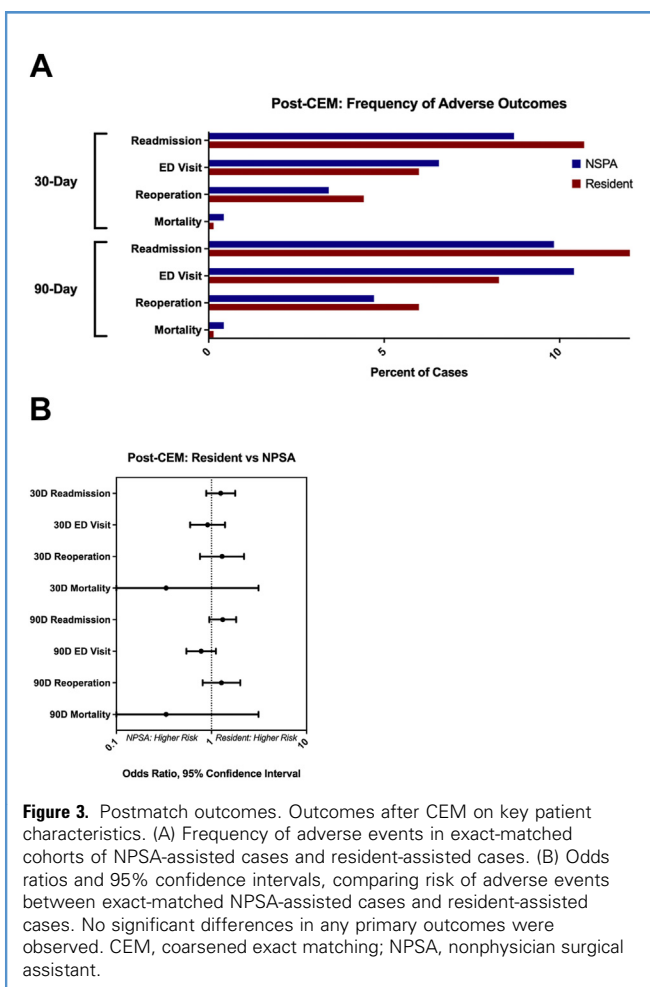


Figure 3. Postmatch outcomes. Outcomes after CEM on key patient characteristics. (A) Frequency of adverse events in exact-matched cohorts of NPSA-assisted cases and resident-assisted cases. (B) Odds ratios and 95% confidence intervals, comparing risk of adverse events between exact-matched NPSA-assisted cases and resident-assisted cases. No significant differences in any primary outcomes were observed. CEM, coarsened exact matching; NPSA, nonphysician surgical assistant.

Limitations

This study has a retrospective cohort design and thus may be vulnerable to biases from data omission errors and confounding variables. However, patients had long duration of follow-up (mean: 1140 and 754 days with resident physicians first assistants and NPSAs, respectively), and encounters at outside hospital systems were ascertained at each outpatient office visit. We also controlled for a large number of patient demographic variables and baseline characteristics by employing CEM. The matching characteristics were carefully selected based on supporting literature demonstrating that race,²⁷ smoking status,²⁸ BMI,²⁹ CCI score,³⁰ and ASA grade³¹ independently predict morbidity following surgery. Thus, we expect that the effects of confounding variables have been sufficiently mitigated to protect the validity of the study findings.

This study enrolled patients undergoing single-level lumbar fusion at a single, multihospital academic medical center, which included hospitals of varying sizes in urban and suburban contexts, but no cases were performed at ambulatory surgical centers. The single-center design of this study limits its generalizability to other practice settings. It is important to note that, within this

medical center, some surgeons operate mostly or exclusively with NPSAs; the results of this study may be biased if surgeons that operate exclusively with NPSAs tend to select healthier patients or less complex cases (e.g., in smaller hospitals within the medical center). To mitigate this selection bias, we match patients on many covariates that describe health status (as described above), and we selected a specific procedure type (single-level, posterior-only lumbar fusion) that encompasses surgeries of similar levels of complexity. Follow-up studies should examine larger datasets with higher numbers of attending surgeons and cases so that the attending surgeon can be included as a matching covariate, thus mitigating selection bias related to the attending surgeon. Future studies should also examine the role of NPSAs in a variety of other procedure types and practice settings.

The present study assessed outcomes such as 30- and 90-day readmission, ED visits, reoperation, mortality, and home discharge. These outcomes are of particular interest in the context of bundled payments, where all services within 90 days of the index hospitalization (including the index surgery, postacute care or home health services, and any readmissions and ED visits) are bundled together and reimbursed with a single payment.³²⁻³⁵ Future work should consider additional outcomes such as patient-reported outcome measures.

CONCLUSION

This study showed no difference in short-term patient outcomes (30- and 90-day readmission, ED visits, reoperation, or mortality) delivered by the attending surgeons assisted by resident physicians vs. NPSAs after single-level, posterior-only lumbar fusion. Among the secondary outcomes, patients with resident physicians as first assistants had a shorter duration of surgery and a longer length of stay but no significant difference in discharge homes versus to rehab. These findings suggest that attending surgeons effectively select and manage first assistants in order to achieve similar outcomes, regardless of the type of first assistant.

CRedit AUTHOR STATEMENT

Grace Ng: Conceptualization, Methodology, Writing (original draft), Writing (review and editing), Visualization, Software, Formal Analysis, Data Curation. Ryan S. Gallagher: Writing (review and editing). Austin J. Borja: Writing (review and editing), Visualization, Software, Formal Analysis, Data Curation. Rashad Jabarkheel: Writing (review and editing). Jianbo Na: Methodology, Software, Formal Analysis, Data Curation, Writing (review and editing). Scott D. McClintock: Writing (review and editing). H. Isaac Chen: Writing (review and editing). Dmitriy Petrov: Writing (review and editing). Brian T. Jankowitz: Writing (review and editing). Neil R. Malhotra: Conceptualization, Methodology, Software, Validation, Investigation, Resources, Data Curation, Writing (original draft), Writing (editing and review), Supervision, Project Administration, Funding Acquisition.

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