The Impact of Different PostGraduate Years (PGY) in Neurosurgery Residency on 30-Day PostOperative Outcomes

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Hypothesis: Does the PGY level in the neurosurgical specialty affect postoperative outcomes?

Methods: The National Surgical Quality Improvement Program (NSQIP) was queried for adult neurosurgical cases, designated into the four major subspecialties: spine, open-vascular, cranial-other and functional. Utilizing data from 2005-2014, 30-day postoperative outcomes were compared among junior residents [PGY 1 – PGY 3], mid-level residents [PGY 4 + PGY 5], senior residents [PGY 6 + PGY 7], and attending-only. The burden of preoperative comorbidities were analyzed with Frailty Index and American Society of Anesthesiologists (ASA) Class. Multivariable regressions explored three outcomes: any wound complication (superficial surgical site infection [SSI], deep SSI, organ space infection, and/or wound dehiscence) [Table 1], Clavien-Dindo Class 4 (life-threatening complication) [Table 2], and death [Table 3].

Table 1

	Unadjusted Odds Ratio [95% Confidence Interval]	P	Adjusted Odds Ratio [95% Confidence Interval]	P
Gender, Male	0.95 [0.79 – 1.14]	0.622	0.97 [0.80 – 1.17]	0.780
Decade of Life			0.94 [0.87 – 1.01]	0.121
Level of Resident Training				
Attending-Only	REF		REF	
Junior Residents [PGY 1 – PGY 3]	0.94 [0.71 – 1.23]	0.667	0.88 [0.66 – 1.16]	0.390
Mid-Level Residents [PGY 4 + PGY 5]	1.19 [0.89 – 1.57]	0.206	1.03 [0.76 – 1.36]	0.839
Senior Residents [PGY 6 + PGY 7]	1.50 [1.18 – 1.89]	**<0.001**	1.19 [0.92 – 1.52]	0.168
Smoking	1.10 [0.90 – 1.35]	0.318	1.10 [0.88 – 1.36]	0.382
Mean Relative Value Unit	1.01 [1.00 – 1.01]	**0.014**	1.00 [0.98 – 1.02]	0.599
Body Mass Index				
Underweight [<18.5 kg/m^2]	1.10 [0.46 – 2.22]	0.804	0.93 [0.38 – 1.89]	0.862
Normal [18.5 – 24.9 kg/m^2]	REF		REF	
Overweight [25.0 – 29.9 kg/m^2]	0.89 [0.68 – 1.17]	0.420	0.91 [0.69 – 1.19]	0.508
Obese [30.0 – 39.9 kg/m^2]	1.27 [0.99 – 1.65]	0.055	1.22 [0.95 – 1.59]	0.116
Morbidly Obese [≥40 kg/m^2]	2.62 [1.90 – 3.60]	**<0.001**	2.26 [1.62 – 3.15]	**<0.001**
Bleeding disorder	1.05 [0.54 – 1.83]	0.866	0.83 [0.42 – 1.49]	0.582
Renal Failure	1.98 [0.11 – 9.42]	0.502	1.47 [0.08 – 7.53]	0.709
Wound Class				
1 – Clean	REF		REF	
2 – Clean/ Contaminated	1.92 [1.16 – 2.99]	**0.005**	1.93 [1.15 – 3.05]	**0.007**
3 – Contaminated	3.61 [1.51 – 7.27]	**0.001**	3.22 [1.33 – 6.60]	**0.003**
4 – Dirty/ Infected	2.99 [1.61 – 5.08]	**<0.001**	2.44 [1.28 – 4.26]	**0.003**
American Society of Anesthesiologists (ASA) Class	1.51 [1.32 – 1.73]	**<0.001**	1.34 [1.13 – 1.59]	**<0.001**
Frailty Index	3.14 [1.25 – 7.62]	**0.012**	1.16 [0.37 – 3.53]	0.793
Operative Time	1.00 [1.00 – 1.00]	**<0.001**	1.00 [1.00 – 1.00]	**<0.001**
Emergency Surgery	2.06 [1.42 - 2.88]	**<0.001**	1.91 [1.28 – 2.77]	**<0.001**
Case Type				
Spine	REF		REF	
Cranial	1.19 [0.96 – 1.47]	0.096	0.75 [0.54 – 1.02]	0.075
Functional	0.62 [0.32 – 1.05]	0.107	0.61 [0.32 – 1.06]	0.108
Vascular	0.67 [0.33 – 1.20]	0.225	0.31 [0.12 – 0.72]	**0.008**

Logistical regression with unadjusted OR (univariable regression) and adjusted OR (multivariable regression) for any wound disruption: sum of surgical site infection [superficial SSI, deep SSI, and/or organ space SSI] plus wound dehiscence within 30 postoperative days

Results: Compared to junior resident (n=3785), mid-level resident (n=2810), and senior resident (n=3746) cases, the attending-only cases (n=12517) experienced statistically significantly lower percentages of wound complications (p<0.001) [Table 1], Clavien-Dindo Class IV complications (p<0.001) [Table 2], and death (p<0.001) [Table 3]. However, following a multivariable regression, only the junior resident category, as compared to attending-only, incurred statistically significantly higher incidences of life-threatening complications (OR 1.41, p=0.007). Moreover, ASA Class, Frailty Index, operative time, and/or emergency status consistently produced stronger prognostic factors of all three outcome measures. Lastly, compared to spinal cases, cranial cases predicted higher life-threatening complications (OR 2.47, p<0.001) and death (OR 2.17, p<0.001), and open-vascular cases predicted lower wound complications (OR 0.31, p=0.008) and higher life-threatening complications (OR 2.45, p=0.002).

Table 2

	Unadjusted Odds Ratio [95% Confidence Interval]	P	Adjusted Odds Ratio [95% Confidence Interval]	P
Gender, Male	1.18 [1.00 – 1.39]	**0.042**	1.22 [1.02 – 1.46]	**0.029**
Decade of Life			1.17 [1.10 – 1.26]	**<0.001**
Level of Resident Training				
Attending-Only	REF		REF	
Junior Residents [PGY 1 – PGY 3]	1.73 [1.37 – 2.18]	**<0.001**	1.41 [1.09 – 1.81]	**0.007**
Mid-Level Residents [PGY 4 + PGY 5]	1.97 [1.53 – 2.51]	**<0.001**	1.03 [0.84 – 1.44]	0.477
Senior Residents [PGY 6 + PGY 7]	2.72 [2.21 – 3.33]	**<0.001**	1.21 [0.96 – 1.52]	0.112
Smoking	0.89 [0.73 – 1.08]	0.252	0.98 [0.79 – 1.21]	0.848
Mean Relative Value Unit	1.05 [1.05 – 1.06]	**<0.001**	1.01 [1.00 – 1.03]	**0.030**
Body Mass Index				
Underweight [<18.5 kg/m^2]	1.51 [0.84 – 2.51]	0.135	1.09 [0.58 – 1.91]	0.783
Normal [18.5 – 24.9 kg/m^2]	REF		REF	
Overweight [25.0 – 29.9 kg/m^2]	0.87 [0.70 – 1.08]	0.227	0.95 [0.75 – 1.20]	0.652
Obese [30.0 – 39.9 kg/m^2]	0.83 [0.67 – 1.04]	0.110	0.90 [0.71 – 1.45]	0.403
Morbidly Obese [≥40 kg/m^2]	1.16 [0.82 – 1.60]	0.376	1.19 [0.82 – 1.70]	0.341
Bleeding disorder	4.58 [3.36 – 6.12]	**<0.001**	1.40 [0.98 – 1.96]	0.060
Renal Failure	5.14 [1.21 – 14.88]	**0.007**	1.73 [0.37 – 5.88]	0.423
Wound Class				
1 – Clean	REF		REF	
2 – Clean/ Contaminated	1.60 [0.98 – 2.45]	**0.042**	1.28 [0.77 – 2.02]	0.321
3 – Contaminated	1.98 [0.69 – 4.42]	0.135	0.96 [0.32 – 2.27]	0.928
4 – Dirty/ Infected	4.37 [2.74 – 6.64]	**<0.001**	3.00 [1.80 – 4.77]	**<0.001**
American Society of Anesthesiologists (ASA) Class	4.35 [3.83 – 4.95]	**<0.001**	1.87 [1.60 – 2.19]	**<0.001**
Frailty Index	1079.77 [572.41 – 2030.65]	**<0.001**	49.78 [22.00 – 112.33]	**<0.001**
Operative Time	1.00 [1.00 – 1.01]	**<0.001**	1.00 [1.00 – 1.01]	**<0.001**
Emergency Surgery	8.00 [6.48 – 9.83]	**<0.001**	2.96 [2.29 – 3.80]	**<0.001**
Case Type				
Spine	REF		REF	
Cranial	5.82 [4.85 – 7.00]	**<0.001**	2.47 [1.89 – 3.22]	**<0.001**
Functional	0.99 [0.50 – 1.74]	0.984	1.08 [0.54 – 1.94]	0.806
Vascular	10.32 [7.81 – 13.52]	**<0.001**	2.45 [1.38 – 4.30]	**0.002**

Logistical regression with unadjusted odds ratio (univariable regression) and adjusted odds ratio (multivariable regression) for any Clavien-Dindo Grade IV complication within 30 postoperative days

Table 3

	Unadjusted Odds Ratio [95% Confidence Interval]	P	Adjusted Odds Ratio [95% Confidence Interval]	P
Gender, Male	1.51 [1.17 – 1.96]	0.002	1.38 [1.04 – 1.83]	**0.022**
Decade of Life			1.40 [1.25 – 1.57]	**<0.001**
Level of Resident Training				
Attending-Only	REF		REF	
Junior Residents [PGY 1 – PGY 3]	1.21 [0.83 – 1.75]	0.292	1.20 [0.80 – 1.77]	0.351
Mid-Level Residents [PGY 4 + PGY 5]	1.47 [0.99 – 2.14]	**0.047**	1.06 [0.69 – 1.60]	0.757
Senior Residents [PGY 6 + PGY 7]	2.06 [1.50 – 2.81]	**<0.001**	1.31 [0.92 – 1.85]	0.126
Smoking	0.62 [0.44 – 0.85]	**0.005**	0.85 [0.58 – 1.21]	0.385
Mean Relative Value Unit	1.05 [1.04 – 1.06]	**<0.001**	1.04 [1.02 – 1.06]	**<0.001**
Body Mass Index				
Underweight [<18.5 kg/m^2]	2.33 [1.20 – 4.17]	**0.007**	1.40 [0.67 – 2.68]	0.334
Normal [18.5 – 24.9 kg/m^2]	REF		REF	
Overweight [25.0 – 29.9 kg/m^2]	0.70 [0.51 – 0.96]	**0.025**	0.75 [0.53 – 1.05]	0.093
Obese [30.0 – 39.9 kg/m^2]	0.56 [0.40 – 0.78]	**0.001**	0.64 [0.45 – 0.92]	**0.016**
Morbidly Obese [≥40 kg/m^2]	0.41 [0.19 – 0.78]	**0.012**	0.44 [0.20 – 0.88]	**0.031**
Bleeding disorder	8.06 [5.51 – 11.46]	**<0.001**	1.56 [1.00 – 2.37]	**0.039**
Renal Failure	12.72 [3.00 – 37.04]	**<0.001**	3.44 [0.73 – 11.85]	0.072
Wound Class				
1 – Clean	REF		REF	
2 – Clean/ Contaminated	2.17 [1.11 – 3.82]	**0.012**	2.08 [1.02 – 3.82]	**0.027**
3 – Contaminated	3.96 [1.21 – 9.56]	**0.007**	1.47 [0.40 – 4.03]	0.501
4 – Dirty/ Infected	4.50 [2.21 – 8.17]	**<0.001**	2.64 [1.22 – 5.17]	**0.007**
American Society of Anesthesiologists (ASA) Class	7.51 [6.16 – 9.19]	**<0.001**	2.88 [2.26 – 3.67]	**<0.001**
Frailty Index	8225.67 [3369.88 – 20072.09]	**<0.001**	62.40 [20.26 – 191.14]	**<0.001**
Operative Time	1.00 [1.00 – 1.00]	**0.003**	1.00 [0.99 – 1.00]	0.129
Emergency Surgery	9.49 [7.03 – 12.66]	**<0.001**	1.74 [1.20 – 2.49]	**0.002**
Case Type				
Spine	REF		REF	
Cranial	8.20 [6.18 – 11.00]	**<0.001**	2.17 [1.41 – 3.33]	**<0.001**
Functional	1.03 [0.31 – 2.50]	0.953	0.99 [0.29 – 2.51]	0.991
Vascular	5.47 [3.05 – 9.25]	**<0.001**	0.56 [0.20 – 1.57]	0.283

Logistical regression with unadjusted odds ratio (univariable regression) and adjusted odds ratio (multivariable regression) for death within 30 postoperative days

Conclusions: While patients in the junior resident and attending-only cohorts demonstrated equivalent preoperative profiles, senior residents operated on patients with a higher comorbidity burden as well as performed more complex procedures (higher RVUs), experienced longer operative times, and handled more emergent cases. Of all three primary outcome measures, level of residency training in neurosurgery did not predict wound infection or death; however, junior resident participation, as compared to the attending-only group, statistically significantly increased the odds of Clavien-Dindo Class IV complications by 41%. Thus, when a healthy patient does sustain an adverse event, the implications are far greater than the same scenario in a high frailty patient undergoing surgery with a senior resident assistant. Compared to spinal cases, cranial cases predicted a higher incidence of life-threatening complications and death, and open-vascular cases predicted a lower incidence of wound complications and a higher incidence of life-threatening complications.