TOPICS IN TRAINING

Perceptions of the Recommended Resident Experience with Common Orthopaedic Procedures

A Survey of Program Directors and Early Practice Surgeons

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Background: U.S. orthopaedic residency training is anchored by the Accreditation Council for Graduate Medical Education (ACGME) requirements, which include minimum numbers for 15 categories of procedures. The face validity of these recommendations and expectations for exposure to other common procedures has not been rigorously investigated. The main goals of this investigation were to understand the perceptions of program directors and early practice surgeons regarding the number of cases needed in residency training and to report which of the most commonly performed procedures residents should be able to perform independently upon graduation.

Methods: We sent surveys to 157 current program directors of ACGME-approved orthopaedic surgery residency programs and to all examinees sitting for the American Board of Orthopaedic Surgery (ABOS) Part II Oral Examination in 2017, requesting that they estimate the minimum number of exposures for the 22 adult and 24 pediatric procedures that are most commonly performed during residency and the first 2 years in practice. Where applicable, we compared these with the ACGME “Minimum Numbers” and the average ACGME resident experience data from 2010 to 2012 for resident graduates. For each of the 46 procedures, participants were asked if every orthopaedic resident should be able to independently perform the procedure upon graduation. We compared the percent for independence between the early practice surgeons and the program directors.

Results: For the majority of adult and pediatric procedures, the early practitioners reported significantly higher numbers of cases needing to be performed during residency than the program directors. ACGME Minimum Numbers were always lower than the case numbers that were recommended by the early practice surgeons and the program directors. Overall we found good-to-excellent agreement for independence at graduation between program directors and early practitioners for adult cases (intraclass correlation coefficient [ICC], 0.98; 95% confidence interval [CI], 0.82 to 0.99) and moderate-to-good agreement for pediatric cases (ICC, 0.96; 95% CI, 0.74, 0.99).

continued

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Conclusions: The program directors frequently perceived the need for resident operative case exposure to common orthopaedic procedures to be lower than that estimated by the early practice surgeons. Both program directors and early practice surgeons generally agreed on which common cases residents should be able to perform independently by graduation.

Resident education in the United States is moving toward a competency-based model. Education in surgical skills and exposure to various procedures are essential components of resident training in orthopaedic surgery¹⁻⁵. The Accreditation Council for Graduate Medical Education (ACGME) establishes requirements for programs and trainees⁶⁻⁸. ACGME “Minimum Numbers” are what the Residency Review Committee (RRC) for Orthopaedic Surgery believes to be an acceptable minimal exposure, but not the achievement of competence⁶. These case categories are determined by all surgical Review Committees as procedures that are “representative of broader procedural experiences of a non-fellowship-educated surgeon in the specialty.”⁶⁻⁸ Updated in 2014, there currently are 15 case categories, 2 of which are pediatric-focused. The 2 pediatric minimums are all pediatric cases (n = 200) and percutaneous treatment of supracondylar humeral fractures (n = 5). The 13 remaining categories present minimum numbers of exposures to procedures that mostly or completely apply to adult patients. Residents must maintain a log of cases that are performed during residency as proof of their exposure.

While residents are expected to be able to independently perform core “general” orthopaedic surgery procedures at graduation, they also often are exposed to more subspecialized procedures during residency for which independence is not expected without additional fellowship training. However, there is no published list of which procedures graduating residents should be able to perform independently or what exposure residents should expect in order to reach independence by graduation. Additionally, to our knowledge, there is no literature describing the exposure that residents should have to more specialized procedures while they consider future subspecialty training.

The goal of this study was to report and compare the perceptions of current orthopaedic surgery program directors and the 2017 American Board of Orthopaedic Surgery (ABOS) Part II Oral Examination candidates (“early practice surgeons”) regarding the recommended resident operative experience. Program directors have the most thorough understanding of resident case exposure during training across disciplines and the best understanding of the balance of cases in those areas. Program directors are required to review the ACGME case log of all procedures that are performed during residency training. Based on these case logs, program directors track resident exposure to the ACGME RRC Minimum Numbers to verify that, upon graduation, residents have performed the necessary minimum number of procedures.

In early practice, orthopaedic surgeons are expected to be competent and be able to perform core “general” orthopaedic

surgery procedures. Early practitioners are ideally positioned to assess whether their residency preparation has adequately prepared them for their first years in practice. We believe that program directors and early practice surgeons represent the best 2 groups to evaluate the current state of orthopaedic operative training and the needs of our graduates for early practice.

We had 3 specific aims: (1) to report the perceptions of program directors and early practice surgeons regarding the minimum number of cases to be performed in residency training for the most commonly performed adult and pediatric orthopaedic procedures, (2) to identify the differences regarding the perceived need for exposure to procedures in residency between program directors and early practice surgeons, and (3) to report which of the most commonly performed procedures program directors and early practice surgeons expect residents to be competent to perform independently at graduation.

Materials and Methods

Survey Design and Administration

We administered online surveys to the current program directors of ACGME-approved orthopaedic surgery residency programs and to examinees sitting for the ABOS Part II Oral Examination in 2017. The institutional review board determined that this study met the criteria for exemption.

The 25 most common adult and pediatric procedures in orthopaedics that are performed during residency and during the first 2 years in practice have been previously reported⁹. In creating the survey, we combined procedures that have nearly identical descriptors, such as “single level spinal decompression (1) with or (2) without foraminotomy.” Procedures that are markedly similar but represent a step down in complexity from another procedure were removed (e.g., “diagnostic arthroscopy of the knee” was removed, but “arthroscopy of the knee with meniscectomy” was retained). This process resulted in 22 adult and 24 pediatric procedures that were used to evaluate the perceived need for independence and exposure. For both program directors and early practitioners, we created 1 adult and 1 pediatric procedure questionnaire.

Participants were asked to estimate the minimum number of exposures to each procedure that they believe is necessary during residency. The survey asked: “What is the minimum number of cases you think that orthopaedic surgery residents should be exposed to during the course of their residency? *When providing your answer, keep in mind that the average total case volume for graduating residents is approximately 1,500 operations.*” Participants were then asked: “Should every graduating orthopaedic resident be able to independently perform this procedure at graduation?”

TABLE I Survey Summary of Adult Procedures*

Procedure		Program Directors (N = 75)	ABOS Part II Examinees (N = 317)	Adjusted P Value
ORIF of bimalleolar ankle fracture	Cases†	25 (20, 30)	30 (25, 50)	<0.001
	Independence‡	100	98.7	1
Placement of intramedullary nail for femoral shaft fracture	Cases†	20 (15, 30)	30 (20, 44.5)	0.002
	Independence‡	100	98.4	1
Open fracture debridement, including skin, subcutaneous tissue, muscle fascia, and bone	Cases†	25 (17.5, 35)	30 (20, 50)	0.81
	Independence‡	98.7	99.4	1
Placement of intramedullary nail for tibial shaft fracture	Cases†	20 (15, 29)	25 (20, 40)	0.011
	Independence‡	100	97.8	1
Application of uniplanar external fixator	Cases†	15 (10, 25)	25 (15, 33)	<0.001
	Independence‡	97.3	99.7	1
Treatment of inter/per/subtrochanteric femoral fracture with intramedullary nail	Cases†	20 (15, 30)	30 (20, 50)	<0.001
	Independence‡	98.7	97.5	1
Hardware removal	Cases†	15 (10, 23)	21 (15, 30)	0.001
	Independence‡	97.3	98.7	1
Knee arthroscopy with meniscectomy	Cases†	30 (20, 50)	37 (25, 50)	1
	Independence‡	98.7	96.8	1
Femoral neck fracture ORIF or hemiarthroplasty	Cases†	20 (15, 30)	30 (20, 50)	<0.001
	Independence‡	100	95.6	1
Carpal tunnel release	Cases†	20 (15, 25)	25 (15, 31.2)	0.002
	Independence‡	97.3	95.6	1
Trigger finger release	Cases†	15 (10, 20)	20 (10, 26)	0.001
	Independence‡	97.3	91.1	1
Total knee arthroplasty	Cases†	36 (25, 50)	50 (40, 84.8)	<0.001
	Independence‡	93.2	85.1	1
ORIF of intra-articular distal radial fracture	Cases†	20 (15, 27.5)	25 (20, 40)	<0.001
	Independence‡	89.3	86.8	1
Shoulder arthroscopy with subacromial decompression	Cases†	25 (15, 30)	30 (20, 50)	0.009
	Independence‡	89.3	83.9	1
Total hip replacement	Cases†	40 (25, 50)	50 (35, 75)	<0.001
	Independence‡	93.3	75.9	0.018
Arthroscopic knee ACL reconstruction	Cases†	20 (15, 30)	25 (15, 30)	1
	Independence‡	64	46.8	0.17
Arthroscopic shoulder rotator cuff repair	Cases†	20 (12.5, 25)	25 (20, 40)	<0.001
	Independence‡	41.3	37	1
Arthroscopic shoulder debridement with capsulorrhaphy	Cases†	10 (10, 20)	20 (10, 25)	0.2
	Independence‡	40.5	26.3	0.33
Total shoulder arthroplasty	Cases†	10 (10, 20)	20 (10, 26)	<0.001
	Independence‡	21.3	13.2	1
Laminotomy with decompression of nerve root and/or excision of herniated intervertebral disc	Cases†	12.5 (10, 20)	15 (10, 25)	1
	Independence‡	16	3.5	0.005
Laminectomy with decompression of spinal cord, cauda equina, and/or nerve root	Cases†	10 (5, 20)	15 (10, 20.8)	0.13
	Independence‡	12	4.4	0.53
Single-level lumbar posterior or posterolateral spinal fusion	Cases†	10 (5, 20)	15 (10, 20)	0.11
	Independence‡	9.3	3.8	1

*ABOS = American Board of Orthopaedic Surgery, ORIF = open reduction and internal fixation, and ACL = anterior cruciate ligament. †Cases reported as average number (minimum, maximum) recommended. ‡Independence = % of respondents who believe that residents should be independent at graduation.

TABLE II Survey Summary of Pediatric Procedures *

Procedures		Program Directors (N = 73)	ABOS Part II Examinees (N = 270)	Adjusted P Value
I&D of open fracture; debridement of bone, muscle, fascia, soft tissue, and skin	Cases†	10 (5, 15)	10 (5, 15)	1
	Independence‡	100	96.3	1
Hardware removal	Cases†	10 (8.8, 20)	10 (9, 20)	1
	Independence‡	94.5	94	1
Percutaneous fixation of supracondylar humeral fracture	Cases†	13 (10, 20)	20 (10, 25)	<0.001
	Independence‡	95.8	91.9	1
Percutaneous fixation of distal radial fracture	Cases†	5 (5, 10)	10 (5, 20)	<0.001
	Independence‡	90.4	88.5	1
Knee arthroscopic I&D	Cases†	5 (2, 6)	5 (3, 10)	0.51
	Independence‡	86.3	81	1
ORIF radial and ulnar shaft fractures	Cases†	5 (5, 10)	10 (5, 19)	0.005
	Independence‡	86.3	80.7	1
ORIF lateral malleolar fracture	Cases†	5 (2, 8.5)	5 (3, 10)	0.21
	Independence‡	81.9	82	1
Closed pinning of SCFE	Cases†	5 (5, 10)	10 (5, 15)	0.005
	Independence‡	76.7	64.7	1
Achilles tenotomy or lengthening, or gastrocnemius recession	Cases†	5 (3.2, 10)	5 (5, 10)	0.25
	Independence‡	71.2	58.6	1
Percutaneous fixation of phalangeal shaft fracture	Cases†	5 (0, 10)	5 (4, 10)	0.029
	Independence‡	61.6	58.1	1
Wrist ganglion-cyst excision	Cases†	2 (0, 5)	5 (2, 7)	0.002
	Independence‡	56.9	54.6	1
ORIF clavicular fracture	Cases†	0 (0, 5)	5 (1, 9)	<0.001
	Independence‡	48.6	54.1	1
ORIF intra-articular distal tibial fracture	Cases†	5 (2.5, 5)	5 (4, 10)	0.12
	Independence‡	60.3	37.5	0.012
ORIF of medial or lateral humeral condyle fracture	Cases†	5 (3, 6.8)	10 (5, 12)	<0.001
	Independence‡	49.3	46.6	1
Trigger-finger thumb release	Cases†	5 (2, 5)	5 (3, 10)	0.004
	Independence‡	46.6	48.9	1
ORIF elbow epicondylar fracture	Cases†	3 (1, 5)	5 (4, 10)	<0.001
	Independence‡	50.7	40.7	1
Arthroscopic meniscectomy meniscal repair	Cases†	5 (5, 10)	10 (5, 15)	0.87
	Independence‡	48.6	42	1
Hip adductor tenotomy or lengthening	Cases†	5 (2, 5.2)	5 (3, 10)	0.75
	Independence‡	49.3	33.2	0.27
Shoulder arthroscopy	Cases†	3 (0, 5)	5 (2, 10)	0.28
	Independence‡	28.2	28.5	1
Femoral intertrochanteric or subtrochanteric osteotomy	Cases†	5 (3, 5)	5 (3, 10)	0.9
	Independence‡	24.7	9.4	0.012
Femoral shaft or supracondylar osteotomy	Cases†	3 (1, 5)	5 (2, 10)	0.18
	Independence‡	21.9	8.2	0.023
Calcaneal osteotomy	Cases†	3 (0, 5)	5 (2, 7.2)	0.09
	Independence‡	16.7	3	0.002
Arthroscopic ACL reconstruction	Cases†	5 (2, 8.5)	5 (3, 10)	1
	Independence‡	6.8	3.7	1
Posterior spinal instrumentation and fusion	Cases†	5 (5, 10)	10 (5, 15)	0.1
	Independence‡	1.4	1.5	1

*ABOS = American Board of Orthopaedic Surgery, I&D = irrigation and debridement, ORIF = open reduction and internal fixation, SCFE = slipped capital femoral epiphysis, and ACL = anterior cruciate ligament. †Cases are reported as average number (minimum, maximum) recommended. ‡Independence = % of respondents who believe that residents should be independent at graduation.

TABLE III Recommended Minimum Number of Cases to Perform During Residency (Adult Procedures) *

ACGME Category (No. of Cases Recommended)	Procedures	ACGME Performed†	Directors (Median No. of Cases)	Examinees (Median No. of Cases)	Average (Median No. of Cases)	Total‡
Total hip arthroplasty (30)	Total hip replacement	67.3	40	50	45	45
Total knee arthroplasty (30)	Total knee arthroplasty	97.9	36	50	43	43
Knee arthroscopy (30)	Knee arthroscopy with meniscectomy	35.3	30	37	34	34
Shoulder arthroscopy (20)	Shoulder arthroscopy with subacromial decompression	37.8	25	30	28	
	Arthroscopic shoulder rotator cuff repair	26.5	20	25	23	
	Arthroscopic shoulder debridement with capsulorrhaphy	10.6	10	20	15	66
Hip fractures (30)	Femoral neck fracture ORIF or hemiarthroplasty	14.4	20	30	25	
	Treatment of inter/per/subtrochanteric femoral fracture with intramedullary nail	21.2	20	30	25	50
Operative treatment of femoral and tibial shaft fractures (25)	Placement of intramedullary nail for femoral shaft fracture	20.3	20	30	25	
	Placement of intramedullary nail for tibial shaft fracture	20.3	20	25	23	48
Carpal tunnel release (10)	Carpal tunnel release	32.8	20	25	23	23
ACL reconstruction (10)	Arthroscopic knee ACL reconstruction	25.5	20	25	23	23
Ankle fracture fixation (15)	ORIF of bimalleolar ankle fracture	18.2	25	30	28	28
Spine decompression/posterior spine fusion (15)	Laminotomy with decompression of nerve root and/or excision of herniated intervertebral	7.1	12.5	15	14	
	Laminectomy with decompression of spinal cord, cauda equina, and/or nerve root	10.1	10	15	13	
	Single-level lumbar posterior or posterolateral spinal fusion	14	10	15	13	40
	Open fracture debridement, including skin, subcutaneous tissue, muscle fascia, and bone	31.7	25	30	28	28
	ORIF of intra-articular distal radius fracture	10.2	20	25	23	23
	Application of uniplanar external fixator	12.6	15	25	20	20
	Hardware removal	40.6	15	21	18	18
	Trigger finger release	17.4	15	20	18	18
	Total shoulder arthroplasty	11.3	10	20	15	15

*ACGME = Accreditation Council for Graduate Medical Education, ORIF = open reduction and internal fixation, and ACL = anterior cruciate ligament. †Average number performed during residency by 2010-2012 graduating U.S. residents. ‡Total column is the total of the averages for all cases recommended within each ACGME category, where applicable.

The questionnaires were constructed and administered online to 157 of the 166 program directors for whom the ABOS had e-mail addresses and to all 725 ABOS 2017 Part II Oral Examination candidates who had taken the Part I Examination in 2013 or later (“early practitioners”). In June 2017, the survey

of adult procedures was sent to a random sample of 79 of the 157 program directors and to a random sample of 363 of the 725 early practitioners. The pediatric survey was sent to the remaining program directors and Part II candidates. After the first survey (adult or pediatric) had been completed, the second

TABLE IV Recommended Minimum Number of Cases to Perform During Residency (Pediatric Procedures) *

Procedures	ACGME Performed†	Directors (Median No. of Cases)	Examinees (Median No. of Cases)	Average (Median No. of Cases)
Percutaneous fixation of supracondylar humeral fracture	12.1	13	20	17
I&D of open fracture; debridement of bone, muscle, fascia, soft tissue, and skin	4.3	10	10	10
Hardware removal	14	10	10	10
ORIF radial and ulnar shaft fractures	2.5	5	10	8
Closed pinning of SCFE	3.2	5	10	8
Percutaneous fixation of distal radial fracture	2.2	5	10	8
ORIF lateral malleolar fracture	1.6	5	5	5
Knee arthroscopic I&D	2.2	5	5	5
Arthroscopic meniscectomy meniscal repair	3.4	5	10	8
ORIF of medial or lateral humeral condylar fracture	2.8	5	10	8
Percutaneous fixation of phalangeal shaft fracture	1.8	5	5	5
ORIF intra-articular distal tibial fracture	1.9	5	5	5
Trigger-finger thumb release	2.8	5	5	5
Achilles tenotomy or lengthening, or gastrocnemius recession	6	5	5	5
Hip adductor tenotomy or lengthening	4	5	5	5
Wrist ganglion-cyst excision	1.6	2	5	4
ORIF elbow epicondylar fracture	1.8	3	5	4
ORIF clavicular fracture	1.4	0	5	3
Posterior spinal instrumentation and fusion	4.8	5	10	8
Femoral intertrochanteric or subtrochanteric osteotomy	3.8	5	5	5
Arthroscopic ACL reconstruction	4.6	5	5	5
Calcaneal osteotomy	6.1	3	5	4
Femoral shaft or supracondylar osteotomy	3	3	5	4
Shoulder arthroscopy	1.8	3	5	4

*ACGME = Accreditation Council for Graduate Medical Education, I&D = irrigation and debridement, SCFE = slipped capital femoral epiphysis, ORIF = open reduction and internal fixation, and ACL = anterior cruciate ligament. †Average number performed during residency by 2010-2012 graduating U.S. residents⁹.

survey (adult or pediatric) was sent to each potential participant, regardless of whether they had filled out the first survey. Three reminder e-mails were sent to nonrespondents; survey collection was closed in August 2017.

As mentioned previously, ACGME Minimum Numbers are what the RRC believes to be an acceptable minimal exposure, but not the achievement of competence⁶. In this report, for the adult categories, we compared those minimums to the previously reported average ACGME resident experience data⁹ from 2010 to 2012 for resident graduates and to the perceived minimum numbers that are needed for residents to be independently competent according to residency directors, ABOS Part II examinees, and the combined average of the directors and the examinees.

Data Analysis

Results were summarized as median and interquartile range (IQR) for number of cases, because of a notable distribution

skew, and percent for independence. Comparisons between directors and early practitioners were made using a Wilcoxon rank-sum test for number of cases and a chi-square or Fisher exact test (if any expected cell counts were <5) for procedure independence. Multiple comparisons were adjusted using the Bonferroni method within each survey (22 tests for the adult procedures and 24 tests for the pediatric procedures).

We constructed overall summaries for case numbers and percent for independence for each case type by averaging the median number of cases for program directors and early practitioners and by averaging the percent of independent cases for each group. As a result, we gave the contributions of directors and early practitioners equal weight in spite of their differing response numbers. We obtained 95% confidence intervals (CIs) for the median number of cases recommended by directors and examinees by bootstrapping with 10,000 replicates.

Fig. 1

Group 1 adult procedures: numbers performed and recommended. ORIF = open reduction and internal fixation.

Procedures were classified into tertiles indicating combined recommendations for percent for independence from highest to lowest: group 1, >66.7%; group 2, 33.3 to 66.7%; and group 3: <33.3%. We chose tertiles to define and discuss the following groups of procedures: group 1 consists of procedures that are essential to perform independently by graduation, group 2 consists of procedures in the middle ground (i.e., procedures that residents should be familiar with but may not be able to perform independently), and group 3 consists of procedures that are nonessential to perform independently by graduation.

We used the intraclass correlation coefficient (ICC) with a 2-way random-effects model to formally evaluate agreement among the averaged percent of independent measures between program directors and early practitioners. The ICC is used to measure reliability among raters for continuous measures, and high values indicate both correlation and agreement among values¹⁰. Studying the lower bound of the 95% CI of an ICC estimate, the range 0.5 to 0.75 is considered moderate, >0.75 to 0.9 is considered good, and values >0.9 are considered excellent^{11,12}.

Results

For the adult procedure survey, the program director response rate was 47.8% (75 of 157), and the early practitioner response rate was 43.7% (317 of 725). For the pediatric procedure survey, the program director response rate was 46.5% (73 of 157), and the early practitioner response rate was 37.2% (270 of 725). Fifty-eight program directors and 208 Part II candidates completed both surveys (see Appendix).

For the majority of adult and pediatric procedures, the early practitioners reported the need for significantly higher numbers of cases to be performed during residency than the program directors. We found general concordance regarding the need for independence for specific adult procedures. For the adult procedures, there were 2 of 22 procedures for which there was a significant difference between early practitioners and program directors on the question of resident independence. In both cases, program directors perceived a greater need for independence in these procedures than early practitioners: “total hip replacement” (93% versus 76%, respectively, $p = 0.018$) and “laminotomy with decompression of nerve root

Fig. 2

Group 1 pediatric procedures: numbers performed and recommended. I&D = irrigation and debridement, SCFE = slipped capital femoral epiphysis, and ORIF = open reduction and internal fixation.

TABLE V Respondents Who Think Residents Should Independently Perform the Procedure Divided into Tertiles (Adult Procedures)*

Procedures	Directors (%)	Examinees (%)	Average (%)	Tertile†
ORIF of bimalleolar ankle fracture	100	98.7	99.4	1
Placement of intramedullary nail for femoral shaft fracture	100	98.4	99.2	1
Open fracture debridement, including skin, subcutaneous tissue, muscle fascia, and bone	98.7	99.4	99	1
Placement of intramedullary nail for tibial shaft fracture	100	97.8	98.9	1
Application of uniplanar external fixator	97.3	99.7	98.5	1
Treatment of inter/per/subtrochanteric femoral fracture with intramedullary nail	98.7	97.5	98.1	1
Hardware removal	97.3	98.7	98	1
Knee arthroscopy with meniscectomy	98.7	96.8	97.8	1
Femoral neck fracture ORIF or hemiarthroplasty	100	95.6	97.8	1
Carpal tunnel release	97.3	95.6	96.4	1
Trigger finger release	97.3	91.1	94.2	1
Total knee arthroplasty	93.2	85.1	89.2	1
ORIF of intra-articular distal radial fracture	89.3	86.8	88	1
Shoulder arthroscopy with subacromial decompression	89.3	83.9	86.6	1
Total hip replacement	93.3	75.9	84.6	1
Arthroscopic knee ACL reconstruction	64	46.8	55.4	2
Arthroscopic shoulder rotator cuff repair	41.3	37	39.2	2
Arthroscopic shoulder debridement with capsulorrhaphy	40.5	26.3	33.4	2
Total shoulder arthroplasty	21.3	13.2	17.3	3
Laminotomy with decompression of nerve root and/or excision of herniated intervertebral disc	16	3.5	9.7	3
Laminectomy with decompression of spinal cord, cauda equina, and/or nerve root	12	4.4	8.2	3
Single-level lumbar posterior or posterolateral spinal fusion	9.3	3.8	6.6	3

*ORIF = open reduction internal fixation, and ACL = anterior cruciate ligament. †Group 1 consists of procedures that are essential to perform independently by graduation, group 2 consists of procedures with needed familiarity, and group 3 consists of procedures that are nonessential to perform independently by graduation.

and/or excision of herniated intervertebral disc” (16% versus 4%, respectively, $p = 0.005$) (Table I).

Similarly, we found general concordance regarding the need for independence for pediatric procedures, with 4 of 24 procedures having a significant difference in perceived need for independence reported by early practitioners versus program directors. For all 4 procedures, program directors perceived a higher percent of need for independence than early practitioners: “ORIF [open reduction and internal fixation] intra-articular distal tibial fracture” (60% versus 38%, respectively), “femoral intertrochanteric or subtrochanteric osteotomy” (25% versus 9%, respectively), “femoral shaft or supracondylar osteotomy” (22% versus 8%, respectively), and “calcaneal osteotomy” (17% versus 3%, respectively) ($p < 0.05$ for all, Table II).

Table III provides the data for the adult procedures, including (1) the ACGME recommended minimum number of cases in residency, (2) the ACGME-reported mean number of cases performed by residents who graduated from 2010 to

2012, (3) the median number of cases recommended by program directors, (4) the median number of cases recommended by early practice surgeons, (5) the average of the median number of cases recommended by program directors and early practice surgeons with each group weighted equally, and (6) the total number of procedures within the ACGME-recommended case category. Table IV provides the same information for pediatric procedures, with the exception of the total number of cases for ACGME-recommended minimum numbers because the ACGME recommends 200 total pediatric cases without further specification.

Figures 1 and 2 graphically display the key findings from Tables III and IV. Figure 1 contains data from columns 2 to 5 of Table III for the 15 adult cases in the top tertile for independence (group 1). It shows that the number of resident-performed cases generally exceeded or was similar to the number of cases that were recommended by the directors and early practitioners. There were 6 exceptions with the performed number of cases falling below the average recommendation of directors and

TABLE VI Respondents Who Think Residents Should Independently Perform the Procedure Divided into Tertiles (Pediatric Procedures)*

Procedures	Directors (%)	Examinees (%)	Average (%)	Tertile†
I&D of open fracture; debridement of bone, muscle, fascia, soft tissue, and skin	100	96.3	98.1	1
Hardware removal	94.5	94	94.3	1
Percutaneous fixation of supracondylar humeral fracture	95.8	91.9	93.8	1
Percutaneous fixation of distal radial fracture	90.4	88.5	89.5	1
Knee arthroscopic I&D	86.3	81	83.7	1
ORIF radial and ulnar shaft fractures	86.3	80.7	83.5	1
ORIF lateral malleolar fracture	81.9	82	81.9	1
Closed pinning of SCFE	76.7	64.7	70.7	1
Achilles tenotomy or lengthening, or gastrocnemius recession	71.2	58.6	64.9	2
Percutaneous fixation of phalangeal shaft fracture	61.6	58.1	59.9	2
Wrist ganglion-cyst excision	56.9	54.6	55.8	2
ORIF clavicular fracture	48.6	54.1	51.4	2
ORIF intra-articular distal tibial fracture	60.3	37.5	48.9	2
ORIF of medial or lateral humeral condylar fracture	49.3	46.6	48	2
Trigger-finger thumb release	46.6	48.9	47.7	2
ORIF elbow epicondylar fracture	50.7	40.7	45.7	2
Arthroscopic meniscectomy meniscal repair	48.6	42	45.3	2
Hip adductor tenotomy or lengthening	49.3	33.2	41.3	2
Shoulder arthroscopy	28.2	28.5	28.3	3
Femoral intertrochanteric or subtrochanteric osteotomy	24.7	9.4	17	3
Femoral shaft or supracondylar osteotomy	21.9	8.2	15.1	3
Calcaneal osteotomy	16.7	3	9.8	3
Arthroscopic ACL reconstruction	6.8	3.7	5.3	3
Posterior spinal instrumentation and fusion	1.4	1.5	1.4	3

*I&D = irrigation and debridement, SCFE = slipped capital femoral epiphysis, ORIF = open reduction internal fixation, and ACL = anterior cruciate ligament. †Group 1 consists of procedures that are essential to perform independently by graduation, group 2 consists of procedures with needed familiarity, and group 3 consists of procedures that are nonessential to perform independently by graduation.

early practitioners: “application of uniplanar external fixator,” “femoral neck fracture ORIF or hemiarthroplasty,” “treatment of inter/per/subtrochanteric femoral fracture with intramedullary nail,” “placement of intramedullary nail for femoral shaft fracture,” “ORIF of intra-articular distal radial fracture,” and “ORIF of bimalleolar ankle fracture.” Figure 1 also shows that directors and examinees frequently recommended similar or higher numbers of cases than the ACGME Minimum Numbers. Likewise, Table IV and Figure 2 correspond to the pediatric procedures, but the table does not indicate an ACGME-recommended minimum number of cases because of the paucity of formal ACGME minimums for specific pediatric procedures.

Tables V and VI show groupings of the adult and pediatric cases into tertiles based on the perceived need for independence at residency graduation. Fifteen adult and 8 pediatric procedures were classified as essential procedures (group 1). For adult and pediatric procedures, the procedures in the top tertile ranged from 84.6% to 99.4% and 70.7% to 98.1%,

respectively, independent; the middle tertile ranged from 33.4% to 55.4% and 41.3% to 64.9%, respectively; and the bottom tertile ranged from 6.6% to 17.3% and 1.4% to 28.3%, respectively. Across all adult and pediatric procedures, there was good-to-excellent and moderate-to-good agreement between program directors and early practice surgeons on estimates of percent of independence for residents upon graduation (an ICC of 0.98 and a 95% CI, 0.82 to 0.99 in adult procedures and an ICC of 0.96 and a 95% CI, 0.74 to 0.99 in pediatric procedures).

Discussion

In this study of perceptions of program directors and early practice surgeons of the number of cases that should be performed in residency training for the most commonly performed adult and pediatric orthopaedic procedures, we found that early practice surgeons generally perceived a greater need for more exposure to the core procedures than program directors. Additionally, we found that there was broad agreement between

program directors and early practice surgeons as to which of these most commonly performed procedures residents should be competent to perform independently by graduation.

A tertile stratification approach was used to group the responses of early practitioners and program directors in terms of whether graduating orthopaedic residents should be able to perform procedures independently. This approach was used to help clarify which procedures are perceived as truly essential versus familiar versus nonessential, with the upper tertile representing the procedures that are considered essential for residents to be able to perform independently by graduation. Our results suggest that all residents should be able to independently perform 15 of the 22 most common adult procedures and 8 of the 24 most common pediatric procedures upon graduation. We also found that 4 of the 22 most commonly performed adult procedures and 6 of the 24 most commonly performed pediatric procedures during residency are generally perceived by both early practitioners and program directors as not needing surgical independence by graduation.

For several group-1 procedures (those that we term *essential*), we found that residents received less exposure than both directors and examinees perceived to be necessary during residency. During a U.S. residency that was completed between 2010 and 2012, on average, for 8 of the 15 adult procedures in group 1, residents were exposed to less than the average-combined minimum number of cases suggested by early practitioners and program directors. For pediatric procedures, graduating residents from 2010 to 2012 were exposed to 7 of the 8 group-1 procedures less frequently than the average-combined minimum number of cases recommended by early practitioners and program directors. These results suggest that for 15 of the 23 essential adult and pediatric procedures, residents, on average, may not actually be receiving the exposure perceived by the survey respondents as the minimum necessary during residency.

The ACGME Minimum Numbers apply to code categories ranging from the “carpal tunnel release” category, which includes 2 Current Procedural Terminology (CPT) codes, to “knee arthroscopy,” which includes 23 CPT codes. We did not specifically survey the ACGME’s groupings of CPT codes, but rather focused on the most common procedures that are performed in residency with narrower definitions (e.g., “intramedullary nailing of tibial fracture” and “intramedullary nailing of femoral fracture” were queried separately), unlike the ACGME Minimum Numbers category “operative treatment of femoral and tibial shaft fractures.” Despite the ACGME case categories generally being more inclusive of related procedures, we found the ACGME Minimum Numbers to be consistently lower than those recommended by the program directors and early practice surgeons.

A recent related study defined multiple discrepancies between case exposure during residency and actual procedures performed in early practice⁹. The current study shows that there are significant differences between the perceptions of program directors and early practice surgeons about the minimum number of cases that should be performed in residency

and the case minimums that are set by the ACGME RRC for Orthopaedic Surgery for some procedures. When our cases are grouped together into the applicable minimum categories, the average response of program directors and early practice surgeons is that higher numbers of cases should be performed during residency than are presently required by the ACGME for all of the case minimum categories that were queried. Similar results were found for procedures for which independence was considered unnecessary at graduation. These data may be used by the ACGME RRC for reevaluation of the case minimum requirements and, at a program level, could prompt curricular changes to ensure that the minimum number of exposures is being met.

Overall, we found concordance between early practice surgeons and program directors regarding the level of independence for the most commonly performed adult and pediatric procedures. However, there were 2 adult and 4 pediatric types of cases that showed a significant discrepancy; in each case, program directors had higher expectations for independence than early practitioners. This raises the question of whether the program directors’ expectations for independence are meeting the reality experienced by early practice surgeons for these procedures.

Although the focus of this specific study was to generate information on perceptions of the number of cases that should be performed in residency training for the most commonly performed adult and pediatric orthopaedic procedures and to begin to understand which of these procedures truly require independence at graduation, we strongly believe that these data inform only part of what is needed to have a strong residency education. The goal of residency is to help develop a technically competent surgeon who is committed to a life of learning, practice improvement, and professionalism. All trainees learn from a broad exposure to surgical methods, anatomy, problem-solving, and patient management. These exposures allow residents to experience advanced procedures in a subspecialty for which they may ultimately undergo fellowship training or provide “crossover” skill acquisition, concepts, and principles that apply from other subspecialty areas, even if independence in those advanced skills is not expected at graduation. Mastery of specific techniques, although critical for clinical practice, is only part of the essential framework for the core education of an excellent independent orthopaedic surgeon. Trainees learn at different rates and have individual innate capabilities such that the minimum number of procedures that are needed to achieve independence varies. Ideally, safe and competent independence should not be linked to a set minimum number of surgical exposures but should be evaluated directly using prespecified performance criteria. This is not as straightforward as the current emphasis on minimum case numbers that is used in program certification.

Limitations of this study include the inherent limitations of survey data, such as potential response bias. We cannot account for individual biases of the respondents based on their practice profile (academic versus private practice and/or generalist versus subspecialist), geography (quaternary center

versus rural practice), professional experiences, or personal characteristics. In addition, program directors may be more likely to be familiar with the published ACGME Minimum Numbers than early practice surgeons. Aside from simple summaries of survey responses, our statistical analysis was limited to the extent of response differences and agreement between program directors and ABOS Part II examinees. We feel that it is interesting to highlight the differences in opinions between these 2 groups; however, it is intuitive that these groups would differ on many aspects of curricular needs since ABOS Part II examinees are likely viewing training from their own practice perspective, while program directors are viewing broader resident-training needs in the context of the practical constraints of what can be offered at their institution and system patient profiles. We separated our survey into adult and pediatric procedures because many clinical scenarios that residents are exposed to may be characterized as adult or pediatric. However, many procedure codes have substantial overlap when the teenage population is considered and may represent a source of confusion when presented with a strictly adult or pediatric list.

The results identify the volume of commonly performed procedures that are judged by residency program directors and early practice orthopaedic surgeons as essential to orthopaedic resident education and those procedures that residents should be competent to perform independently at graduation. This information may inform the determination of the core procedures that should be taught and the number of procedures that should be performed as part of competency-based residency training in orthopaedic surgery.

Appendix

Supporting material provided by the authors is posted with the online version of this article as a data supplement at [jbjs.org \(http://links.lww.com/JBJS/F281\)](http://links.lww.com/JBJS/F281). ■

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