



Did a Minimum Case Requirement Improve Resident Surgical Volume for Closed Wrist and Forearm Fracture Treatment in Orthopedic Surgery?

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OBJECTIVE: The purpose of this study is to determine whether the 2013 implementation of ACGME minimum case requirements was associated with increased documented case volume of closed manipulation of forearm and wrist fractures (CMFWF) for graduating orthopedic surgery residents.

DESIGN: We reviewed ACGME case log data for CMFWF among graduating orthopedic surgery residents from 2007 to 2016. Annual national mean, and median number of CMFWF performed by residents in the 10th, 30th, 50th, and 90th case volume percentile were evaluated. Preminimum (2007-2010) data was compared to postminimum (2013-2016) values to assess the impact of ACGME minimum requirements on resident case volume.

SETTING: Review of publically available ACGME Orthopedic Surgery Residency Program case log data.

PARTICIPANTS: ACGME case log data for orthopedic surgery residents graduating between 2007 and 2016.

RESULTS: National mean number of CMFWF increased significantly pre- to postminimum requirement (30.0 ± 2.84 to 45.0 ± 3.36 , $p < 0.001$). Between 2010 and 2016 there was a 1100%, 300%, 83%, and 9% increase in the median number of CMFWF within the 10th, 30th, 50th, and 90th percentiles, respectively.

CONCLUSIONS: ACGME's 2013 case minimum requirement corresponded to an increase in case counts for

CMFWF; the greatest increase occurred in residents below the 50th percentile of case volume. Implementation of case minimum requirements may allow for more accurate depiction of resident experience and program strengths with regards to procedural exposure. However, the current case log system measures only case quantity, which may inaccurately depict mastery of given procedures. Future work should focus not only on improving case counts in underperforming residents and training sites, but also on refining metrics that ensure accurate assessment of resident skill for essential orthopedic procedures prior to graduation. (J Surg Ed 76:1153–1160. © 2019 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Case minimums, ACGME, orthopedics, resident, case volume

COMPETENCIES: Patient Care

ABBREVIATIONS: ACGME, Accreditation Council for Graduate Medical Education; CMFWF, Closed manipulation of forearm and wrist fractures

INTRODUCTION

With increased emphasis on competency-based education, a priority for residents and program directors is determining whether residents gain sufficient knowledge and experience in training to become safe, independent orthopedic practitioners.¹⁻⁶ Such a determination requires an accurate and objective assessment of residents' clinical judgment and technical skill, which in part are acquired through sufficient case volume to allow mastery of skills that will theoretically translate into optimal patient outcomes.⁷⁻⁹

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Fractures of the forearm and wrist are one of the most common injuries encountered by orthopedic surgeons in both young and elderly individuals.¹⁰⁻¹² Forearm fractures are the most common long bone fracture in children, which comprise nearly 40% of all pediatric fractures.¹³ Distal radius fractures are the dominant injury within this category, accounting for approximately 25% of all pediatric fractures and up to 18% of fractures in older adults.^{11,12,14} Data over the past several decades show an increasing incidence of distal radius fractures in both adult and pediatric patients.^{12,14} The common nature of these injuries emphasizes the importance of orthopedic residents becoming adept at managing fractures about the wrist and forearm.

Closed manipulation of forearm and wrist fracture (CMFWF) is 1 of 15 procedures with a minimum caseload requirement mandated by the Accreditation Council for Gradual Medical Education (ACGME).¹⁵ Distal radius fracture management has also been identified by the ACGME as a required topic for evaluating resident performance and educational progress in the Orthopedic Surgery Milestone Project.¹⁶ Since the 2013 graduation year, the ACGME has required residents to perform a minimum of 20 CMFWF during orthopedic residency training.¹⁵ The ACGME Orthopedic Surgery Residency Review Committee began development of minimum requirements in 2010 based on review of case log data from orthopedic residents graduating in 2008, 2009, and 2010. This information was published in 2011, along with an announcement that minimum requirements would go into effect at the start of the 2012-2013 academic year. Citations for lack of compliance in minimum case requirements were first issued for residents graduating in 2013.¹⁵

CMFWF is the only nonoperative procedure with a case minimum requirement for orthopedic surgery residents.¹⁵ Multiple studies have demonstrated disparity in case volumes logged by orthopedic residents, and greater inconsistency in resident case logging practices for nonoperative

procedures has additionally been described in the literature.¹⁷⁻²³ The purpose of this study is to determine whether the 2013 implementation of ACGME minimum case requirements was associated with an increase in documented case counts of CMFWF for graduating orthopedic surgery residents. Our hypothesis is that the number of CMFWF cases per resident increased after implementation of the ACGME case minimum requirement, particularly among underperforming residents who failed to meet the minimum requirement prior to 2013.

METHODS

ACMGE case log data for orthopedic residents graduating in 2007-2016 were analyzed for this descriptive study. The ACGME tracks the total number of cases performed throughout residency for each graduating orthopedic surgery resident in an ACGME-accredited orthopedic surgery residency program. Although the ACGME maintains individual resident case counts for all procedures logged, only national summary data and statistics are publically available.²⁴

Our analysis focused on the subset of closed manipulations performed for adult and pediatric forearm/wrist injuries as identified by any of 9 specific CPT codes, which collectively count toward the case minimum requirement for CMFWF (Table 1). Resident case log data, including the year of graduation, the annual national mean and standard deviation of CMFWF procedures performed per resident, and the median national number of CMFWF procedures performed per resident within the 10th, 30th, 50th, and 90th resident percentiles were analyzed. The mean number of CMFWF cases as both total number (combined adult and pediatric) as well as adult and pediatric cases separately were evaluated. Median number of CMFWF (combined adult and pediatric) performed within the 10th, 30th, 50th, and

TABLE 1. CPT Codes and Procedures Included in the ACGME Minimum Requirement for the Category "Closed Manipulation of Forearm and Wrist Fractures"

CPT Code	Procedure Description
25505	Closed treatment of radial shaft fracture; with manipulation
25520	Closed treatment of radial shaft fracture and closed treatment of dislocation of distal radioulnar joint (Galeazzi fracture/dislocation)
25535	Closed treatment of ulnar shaft fracture; with manipulation
25565	Closed treatment of radial and ulnar shaft fractures, with manipulation
25605	Closed treatment of distal radius fracture (i.e., Colles or Smith type) or epiphyseal separation, includes closed treatment of fracture of ulnar styloid, when performed; with manipulation
25624	Closed treatment of carpal scaphoid (navicular) fracture, with manipulation
25675	Closed treatment of distal radioulnar dislocation with manipulation
25680	Closed treatment of trans-scaphoperilunar type of fracture dislocation, with manipulation
25690	Closed treatment of lunate dislocations, with manipulation

90th resident percentiles were reviewed. The national total number of orthopedic surgery residents and ACGME-accredited orthopedic residency programs were also recorded.

The primary outcome of this study is the change in CMFWF case volume for 2 groups: orthopedic residents who graduated in 2007-2010 before the ACGME announcement and implementation of minimum case requirements (preminimum group), compared with residents graduating between 2013 and 2016 after implementation of minimum case requirements (postminimum group). Transition graduation years of 2011 and 2012 were not included in this 2-group comparison because the plan for minimum requirements was announced by ACGME in 2011.²⁵ Although not implemented until the 2013 graduation year, the 2011 announcement may have altered resident and/or program behavior during this time period. This study specifically evaluated the change in the annual mean number of CMFWF performed per resident as well as the change in median number of cases performed by “low case volume” residents within the 10th, 30th, and 50th percentiles. The change in median number of cases performed by residents in the 90th percentile was included as a reference point for residents meeting and exceeding the minimum requirement.

We compared the means of the 4-year periods, preminimum versus the postminimum group, using a Student *t* test, with *p* < 0.05 considered significant. Statistical analyses were performed in SAS 9.1.3 (SAS Institute Inc., Cary, NC). Median case volume within the 10th, 30th, 50th and 90th percentiles for years 2010, 2013, and 2016 are reported as absolute and percent changes in table and graphical format.

RESULTS

Between graduation years of 2007 and 2016, the total number of ACGME-accredited orthopedic surgery

residency programs increased slightly from 149 to 153. The total number of orthopedic residents within these accredited programs also increased from 616 to 705. The average number of residents per program remained consistent at approximately 4 during this period (Table 2).

From 2007 to 2016, there was an increase in the national average number of CMFWF performed by residents in both pediatric and adult patients (Fig. 1). There was a statistically significant increase in the national average number of CMFWF in all patients precompared with postminimum requirement implementation. Average number of CMFWF increased from 30.0 ± 2.8 (2007-2010) to 45.0 ± 3.4 (2013-2016, *p* < 0.001, Table 3).

The median number of CMFWF performed by residents within the 10th, 30th, and 50th volume percentiles increased after 2013, with the greatest increase in the lowest 10th percentile of residents (Fig. 2). The median number of CMFWF for the 10th percentile of residents increased from 2 in 2010 (preminimum) to 24 in 2016 (postminimum), representing a 1100% (12-fold) increase in case volume within this subset of residents (Table 4). The median number of CMFWF performed by residents in the 30th and 50th percentiles also increased but to a lesser degree (300% and 83.3% respectively, Table 4). In comparison, the median number of reductions performed by residents in the 90th percentile increased minimally from 78 in 2010 to 85 in 2016, a 9% increase within this top group of residents.

DISCUSSION

The 2013 implementation of case minimum requirements for CMFWF corresponded to an increase in the annual number of cases logged by all orthopedic surgery residents for this procedure category. This positive effect was noted both in the national average number of CMFWF performed in pediatric and adult patients, as well

TABLE 2. Orthopedic Surgery Program Demographics From ACGME Case Log Reporting 2007 to 2016

Graduation Year	Number of Orthopedic Programs	Number of Graduating Residents	Average Number of Residents per Program
2007	149	616	4.13
2008	148	621	4.20
2009	148	635	4.29
2010	147	653	4.44
2011	148	650	4.39
2012	149	675	4.53
2013	150	678	4.52
2014	151	684	4.53
2015	151	699	4.63
2016	153	705	4.61

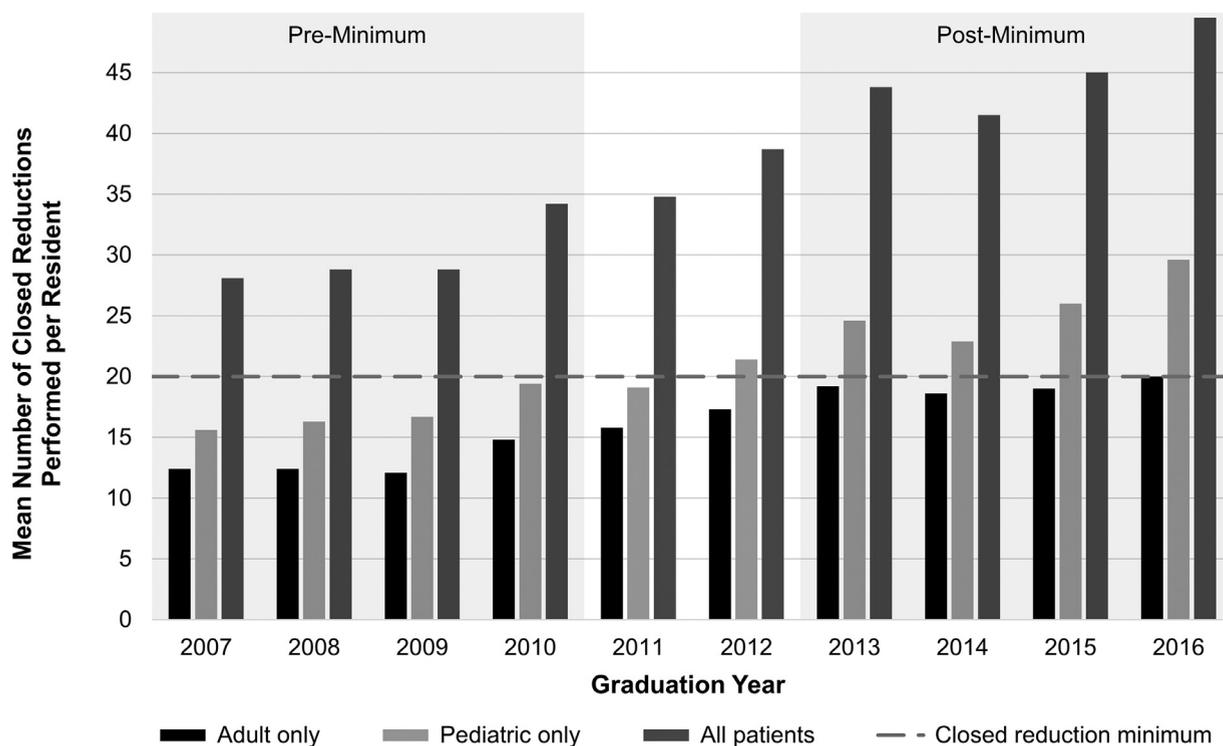


FIGURE 1. National average total number of closed manipulations of forearm and wrist fractures performed per resident in adult and pediatric patients. Horizontal dashed line represents the required ACGME minimum number of 20 closed reductions (includes both adult and pediatric cases) to be performed per resident by the end of orthopedic residency training.

TABLE 3. National Summary Statistics of Closed Manipulation of Forearm and Wrist Fractures From ACGME Case Log Data for Graduating Orthopedic Residents, 2007 to 2016*

Period	Graduation Year	Mean CMFWF/ Resident	Standard Deviation	Median CMFWF/ Resident	Mean CMFWF per Resident for Period
Pre-ACGME case minimum	2007	28.1	33	17	30.0
	2008	28.8	36	18	
	2009	28.8	29	19	
	2010	34.2	37	24	
Transition	2011	34.8	32	27	36.8
	2012	38.7	31	32	
Post-ACGME case minimum	2013	43.8	29	35	45.0
	2014	41.5	26	33	
	2015	45.0	24	39	
	2016	49.5	25	44	

*Includes adult and pediatric patients.

as in the median number of cases performed by residents in the 10th, 30th, and 50th case volume percentiles.

Given that a primary purpose of implementing minimum requirements is to improve the clinical experience of underperforming residents and programs, the 2013 minimum requirements were associated with a dramatic improvement in the documented number of CMFWF performed by residents in the bottom half of

resident case volumes, particularly in residents with the lowest percentile case volumes. Implementing case minimum requirements, in this setting, achieved its desired goal of increasing case volumes for all residents.

Surgical case volume data can provide residency programs with objective information on overall resident experience, and offers insights into a program's

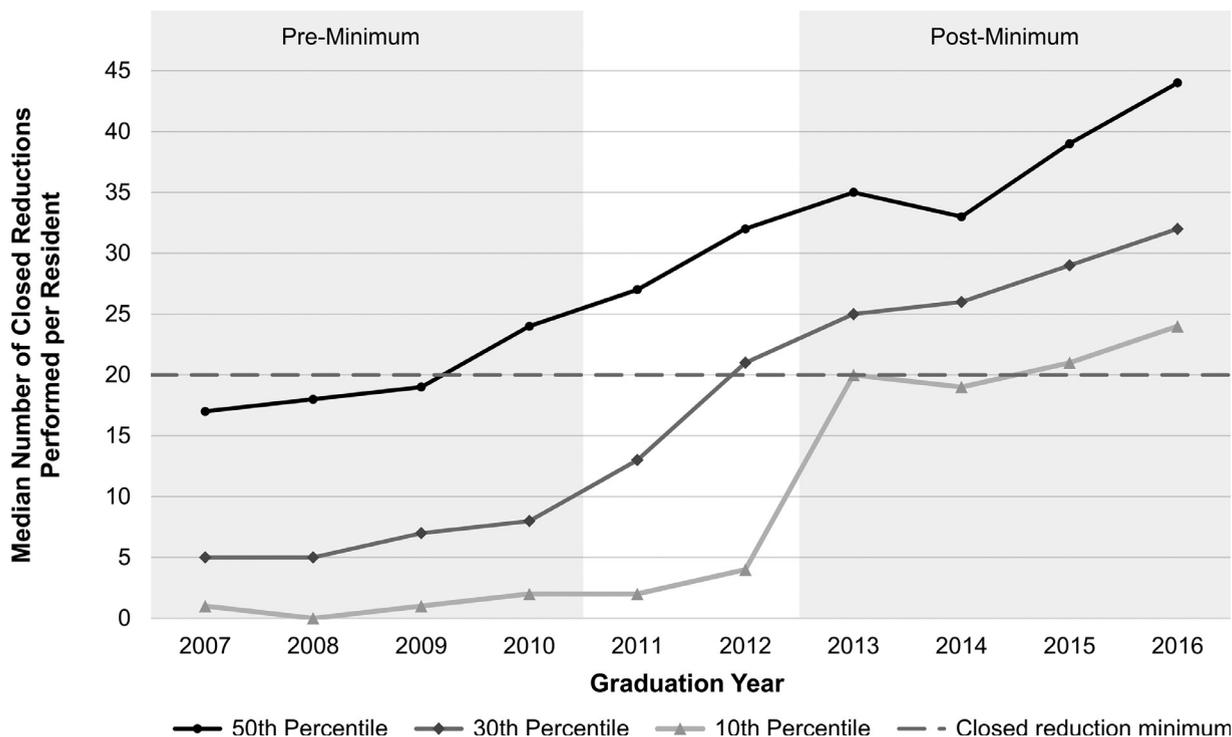


FIGURE 2. Number of closed manipulations of forearm and wrist fractures performed in adult and pediatric patients per resident in the 10th, 30th, and 50th percentiles of resident case volume. Horizontal dashed line represents the required ACGME minimum of 20 closed reductions per resident by the end of orthopedic residency training.

TABLE 4. Change in Median Number of Closed Manipulation of Forearm and Wrist Fracture Procedures for Orthopedic Residents in the 10th to 90th Percentile*

Year	10th	30th	50th	90th
2010 (preminimum)	2	8	24	78
2013 (first year of minimum)	20	25	35	84
2016 (postminimum)	24	32	44	85
Percent increase 2010-2016	1100.0	300.0	83.3	9.0
Fold increase 2010-2016	12.0	4.0	1.8	1.1

* 10th percentile: 10% of residents completed fewer than the listed number of CMFVF cases.

strengths and weakness in terms of educational opportunities provided to residents. This point was highlighted in a survey of 157 residents (training years 4-5) participating in the 2011 and 2012 Resident Leadership Forum.^{26,27} However, although resident case logs can be useful in assessing opportunities and adequate exposure to essential orthopedic procedures, they cannot fully identify mastery of technical skill sufficient to be a stand-alone metric in determining resident preparation for entering independent practice.^{4,26,28}

Various qualitative and quantitative metrics are used by residency programs to gauge whether a resident has

adequately developed the clinical and surgical skills necessary to graduate. One current method of quantitatively evaluating resident clinical and procedural experience is through case logs. Controversy exists regarding the utility of case log data to assess resident preparedness for independent practice. A common theme surrounding the use of case minimums as a proxy for adequate resident training and performance is that quantity may not necessarily translate into a competent and technically skilled surgeon.^{26,28} There is little evidence that surgical volume in residency directly correlates with surgical skill. This counter-argument challenges whether case minimums ought to be utilized as a tool for resident assessment, and

by extension whether including case minimums as a graduation requirement is truly necessary.

Our study has several limitations by nature of using aggregated national ACGME case logs as a representation of residents' actual procedural experience. First, ACGME data lacks differentiation in resident role and level of involvement during logged cases. Under ACGME guidelines, cases can be reported even if the resident is participating as an assistant in casting, splinting, or maintaining reduction. However, given that most closed forearm and wrist reductions typical require a single clinician performing the procedure, we expect that most logged cases were performed by the resident. Second, the ACGME case logs are a self-reported case-log system that lacks standardization in the way cases are logged. A recent survey of 298 residents (training years 2-5) found a high variability in resident case log practices; only 56% of respondents routinely reported procedures performed in the Emergency Department, and only 13% reported cast or splint application that occurred in outpatient setting.²³ The inconsistent nature of resident case logging practices highlights the argument against using case logs as a stand-alone metric for resident technical skill and points to needing more accurate means of tracking resident clinical experience. Finally, we are unable to determine whether case counts increased due to increased opportunities sought by residents, an increased incidence of forearm and wrist injuries, or improved reporting to ACGME by residents, or a combination thereof. However, regardless of the cause, we feel that implementation of case minimums still offers programs a more accurate representation of resident experience during training compared to before minimums were in place.

Although we see a clear improvement in resident case logs for CMFWF after implementation of case minimum requirements, there is still room for improvement. First, we observed a large disparity in case volume between residents in the top and bottom percentiles, which has been reported in previous studies that evaluated orthopedic surgery resident case volume.¹⁷⁻²² Similarly, the national minimum number of reductions reported for residents graduating in 2015 and 2016 were 0 and 12, respectively. Thus, although we see the national median among the lowest volume performers has improved, there are still residents failing to meet the ACGME minimum requirement. Additional measures are therefore needed to ensure no resident lacks sufficient clinical experience prior to the end of residency. Further investigation is also needed to better define programs that need assistance improving training environments. Additionally, further investigation is needed to determine whether this positive trend is also occurring in the other 14 operative orthopedic procedures after implementing case

minimums and whether there is a difference in the effect of case minimums on resident volume when comparing nonoperative versus operative procedures. We have also highlighted that while implementation of case minimums may improve resident case volume and/or documentation of procedures performed, utilization of case minimums as a metric for competence in procedural skills is not sufficient. Additional assessment tools (ie, real time performance assessments) are needed to more accurately document resident procedural skills.

CONCLUSIONS

Our study provides an objective overview of the impact of the ACGME policy change on resident training practice in the management of CMFWF. We demonstrate that an increase in number of CMFWF performed by orthopedic surgery residents corresponded to implementation of ACGME minimum case requirements in 2013, with the greatest positive impact noted among residents in the bottom 10th, 30th, and 50th percentiles. We also highlight that utilization of case minimums can offer a more accurate representation of resident experience, which may serve as a tool to monitor program success. Ultimately, the effect of case minimum requirements likely made a positive impact on resident training; however, case volume alone as a metric for resident procedural mastery is insufficient and additional measures are necessary to make this assessment.

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SUPPLEMENTARY INFORMATION

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