Hypothesis: The operative volume of chief residents would decrease with work-hour reform by the Accreditation Council for Graduate Medical Education (ACGME).

Design: Mixed-design study performed during July and December 2003. Collected data were from programs experimenting with work-hour reform and programs that had not yet implemented reform. New York programs were also included.

Setting: University-, community/university-, and community-based surgical residency programs.

Other Participants: Telephone conversations occurred with 10 randomly selected program directors.

Main Outcome Measures: Operative logs from chief residents graduating in 2002 and 2003 and a survey requesting information on programmatic changes.

Results: Of the 80 programs that responded, statistical analyses revealed the following findings: (1) there were no significant differences in the operative volume of chief residents based on work-hour model, program setting, or graduating class; (2) there was no significant difference in chiefs’ operative volume between programs that experimented with work-hour reform and programs that did not experiment with work-hour reform during 2002-2003; (3) there was no relationship found between work hours and volume of operative cases; and (4) there was an inverse relationship found between work hours and operative volume for residents in New York programs.

Conclusion: Several correlates must be considered for effective assessment and evaluation of the impact of work-hour reform on surgical training and education.

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Many surgical residents and faculty believe that limited work hours may be detrimental to resident training and education, potentially decreasing residents’ operative experience. After all, a common saying familiar among trainees is that “the problem with every other night call is that you miss half the cases.” While the impact of work-hour reform is yet to be determined, this event marks the beginning of a major transition in surgical training and education. Several studies have examined the effect of limited work hours on procedural experience since the 1989 state mandate that restricted work hours in New York training programs. Such studies demonstrate that no significant changes were noted in procedural experience when residents worked fewer hours. Yet, these studies provide limited utility because of the use of single programs and the potential for inconsistency among work-hour guidelines. Overall, the sparse data gathered to date prevent generalization about the impact of work-hour reform on operative experience.

The Accreditation Council for Graduate Medical Education (ACGME) mandate, declared in June 2002, prompted many programs to experiment with programmatic change during the 2002-2003 academic year. This transitional year provided a rare opportunity to collect and evaluate data, preparing a baseline for future study of this historic change. The full impact of work-hour reform on procedural experience will remain unknown until one cycle of surgical residents completes the 5-year training period that began with the class of 2008. The ACGME guidelines, already modified several times since the original mandate was issued, are certain to experience similar change upon implementation and evaluation. Empirical evidence regarding the consequences of reform must be introduced prior to evaluating the class of 2008.

The purpose of this study, then, is to explore how work-hour models affect the operative volume of chief residents. The chief year provides residents with a final
opportunity to train under supervision before entering independent practice. For those chiefs pursuing fellowship training, this year provides a final chance to learn and experience the broad range of general surgical procedures prior to subspecialization. Evaluating operative data from chief residents graduating in 2002 and 2003 provides baseline findings during the initial transition to work-hour reform. The impact of programmatic change during this critical phase of training may help decision makers more effectively assess and refine work-hour policy to best meet the needs of surgical trainees.

**METHODS**

Literature pertaining to motor-skill development theory, specifically the principles of repetitive practice and skill transference, and principles of assessment and evaluation were used to design a conceptual framework for this study. This framework considered the development and acquisition of technical skills in relation to work-hour models, as well as principles related to assessment and evaluation that emphasize external variables that may affect learning experiences. The institutional review boards at The College of William and Mary, Williamsburg, Va, and Eastern Virginia Medical School, Norfolk, approved this study.

Inclusion in this study required submission of the defined category reports for chief residents graduating in 2002 and 2003, as well as program directors’ completion of a brief survey. Programs were requested to omit resident names from submitted reports. The principal investigator was the sole person involved in data collection.

The total chief cases was the variable studied since this category isolates the operative experience achieved during the final year of training. All other categories in the defined category reports reflect cumulative operative experience, which does not distinguish the volume or breadth of operative experience according to rotation, and such data are not valid for the purpose of this study at this time.

The self-designed survey contained 4 questions that generated program-specific information related to average hours worked by chief residents during 2001-2002 and 2002-2003, whether chiefs took in-house call, when work-hour change was implemented, and a description of changes made to the program. Of note, it is likely that most programs reported an estimate of chief work hours since actual work hours were typically not tracked during this time. Since chief residents rotate through the same services in succession, the estimated hours provide a context in which to consider the impact of work-hour reform during the period of study.

The second phase of data collection included the random selection of 15 program directors invited to participate in a telephone interview. Prior to scheduled telephone interviews, respondents were provided a list of 6 questions pertaining to defined category reports, motor-skill development, work-hour models, and study findings. Content analyses were performed on their responses.

All statistical analyses were performed using SPSS version 11.5 (SPSS Inc, Chicago, Ill), using 0.05 as the significance level. The total chief cases variable was aggregated into a new factor for each class year, which controlled for individual, program, and institutional differences. The aggregation of this variable eliminates differences related to individual residents, variability of residents’ operative experience according to rotation, and variability of the number of residents within and between each class year. Programs were categorized according to the classifications reported by the American Medical Association’s online residency and fellowship database. Currently, surgical residency programs are composed of 104 university-based programs, 76 community/university-based programs, 59 community-based programs, 12 military-based programs, and 2 other programs.

Data from New York programs were included in several analyses. The decision to include these data was based on whether the information fit with the research question. For example, the inclusion of New York data was beneficial to understanding the impact of work-hour models (ie, 80 hours/week vs more than 80 hours/week) on operative volume. Since all participating New York programs did not report compliance with the 80-hour model, inclusion in such analyses was further justified. The exclusion of New York data from the question relating to the impact of programs’ experimentation with work-hour reform was justified since New York programs are no longer in a transitional phase.

**RESULTS**

Of the 252 programs invited to participate, 80 programs (32%) submitted the defined category reports from 2002 and 2003 and the completed survey. Of this total response, 38 university-based programs, 27 community/university-based programs, and 15 community-based programs responded, which represent 37% of the total university-based programs, 36% of the total community/university-based programs, and 25% of the total community-based programs. Of the total programs responding, 7 programs were located in New York, which made up 23% of all programs in the state of New York. Ten program directors (67%) participated in telephone interviews, representing 50% each of university-based programs and community/university-based programs.

**QUANTITATIVE ANALYSIS**

Descriptive analyses provided information related to the number of chief residents in each program setting during 2001-2002 and 2002-2003 (Table 1); the aggregated means of operative cases for each class by program setting, representing the new, or aggregated, factor that controls for individual, program, and institutional

| Table 1. Mean of Individual Resident Operative Volume by Year and Program Setting |
|---------------------------------|---------------------------------|---------------------------------|
| No. of Residents                | Mean ± SD of Cases              | No. of Residents                | Mean ± SD of Cases              |
| University                      | 180                             | 253.3 ± 74.8                    | 181                             | 257.7 ± 67.9                    |
| Community/university            | 77                              | 269.4 ± 82.2                    | 84                              | 251.5 ± 83.8                    |
| Community                       | 42                              | 245.2 ± 59.6                    | 43                              | 241.6 ± 69.1                    |

Table 1. Mean of Individual Resident Operative Volume by Year and Program Setting

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differences (Table 2); the average hours worked by chief residents within the 3 program settings (Table 3); and the number of programs that experimented with work-hour change during 2002-2003 (Table 4).

Overall, 63% of participating programs (n=50), excluding New York programs, experimented with work-hour change during 2002-2003. Of programs experimenting with change, 30 programs (60%) reported compliance with an 80-hour model. Of note, 17 non–New York programs reported work hours of 80 or fewer per week during 2001-2002, indicating that some programs adhered to a nontraditional work-hour model prior to the official start date of the ACGME mandate.

A 3-way analysis of variance was used to examine whether work-hour model, program setting, and graduating class affected the volume of operative cases performed by chief residents. The survey required that programs report the average number of hours per week that chiefs worked during 2001-2002 and 2002-2003. Based on this information, residents and programs were then classified as belonging to model A (more than 80 hours per week) or model B (80 hours or fewer per week). Since this analysis tested the impact of the work-hour model on operative volume, New York programs were included. The adjusted means of operative volume as a function of these 3 factors are presented in Table 5. Estimated marginal means are provided since unequal cell sizes contributed to these aggregated data. The 3-way analysis of variance indicated no significant interaction among work-hour model, program setting, or graduating class (P=.90). There were no significant interactions between work-hour model and program setting (P=.71), between work-hour model and graduating class (P=.99), between program setting and graduating class (P=.58). There were no significant simple main effects for program setting (P=.48), graduating class (P=.36), or work-hour model (P=.37). Statistically speaking, the work-hour model had no effect on the volume of cases in which chiefs participated.

A 2×3 analysis of variance was performed to evaluate whether the operative volume of chiefs in programs that experimented with change was significantly different than that in programs that did not experiment with change. The factors included whether programs changed in 2002-2003 and program type. Data from New York programs were excluded from analysis since these programs are no longer in the transitional phase of work-hour reform.

The adjusted means of chiefs’ operative volume as a function of these factors are presented in Table 6. The analysis indicated that no significant interactions occurred between whether programs experimented with work-hour change and program setting (P=.68). There were no significant main effects for whether programs changed (P=.68) or program setting (P=.70). Based on this analysis, there were no significant effects or interactions between whether programs experimented with work-hour reform and program setting during 2002-2003.

A Pearson product moment correlation indicated that there is no relationship between the volume of operative cases performed and the average hours worked (P=.49). A separate Pearson product moment correlation, using New York data only, indicated that there is a moderate-negative, or inverse, relationship between the volume of operative cases performed and the average hours worked of chief residents training in New York programs (r14=-.66, P=.01). These findings suggest that the inverse relationship also suggests that as average work hours increase, the volume of operative cases decreases. Considering that the average work hours are the predictor variable and volume of operative cases is the criterion variable, 43% of the variance of volume of operative cases is accounted for by its relationship with average work hours. The means of operative volume and work hours used in both correlations are presented in Table 7.

CONTENT ANALYSIS OF SURVEY

The survey included an item that described the work-hour changes made during 2002-2003. A content analysis of the 50 programs implementing change produced the following 4 themes: (1) clinical activity, (2) time, (3) education, and (4) support.

Thirty-seven programs (74%) implemented change that affected clinical activity. Fifteen programs indicated that residents were sent home early postcall. The actual postcall release time ranged from 8 AM to 1 PM. One program initially adopted this method but converted to a night-float model as a result of resident dissatisfaction. Fifteen programs indicated using a night-float model, of which 2 programs commented that this system “does not work,” “is of no educational value to the floating resident,” and “is certain to decrease the operative experience of residents.” Nine programs reported decreasing the frequency of in-house call, changing from an every third night model to an every fourth or fifth night model. Four programs indicated that chief residents, previously on home-call duty, were now used for in-house call duty. Four programs reported increasing the use of home call for all resident levels. Additional changes included less frequent coverage of cases, changed rounding pat-

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Table 2. Aggregated Means of Operative Volume by Year and Program Setting

<table>
<thead>
<tr>
<th></th>
<th>No. of Programs</th>
<th>Mean ± SD of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>38</td>
<td>250.0 ± 54.1</td>
</tr>
<tr>
<td>Community/university</td>
<td>27</td>
<td>278.1 ± 73.7</td>
</tr>
<tr>
<td>Community</td>
<td>15</td>
<td>257.5 ± 59.0</td>
</tr>
</tbody>
</table>

Table 3. Mean Work Hours Per Week

<table>
<thead>
<tr>
<th></th>
<th>No. of Programs</th>
<th>Mean ± SD of Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>38</td>
<td>96.2 ± 12.2</td>
</tr>
<tr>
<td>Community/university</td>
<td>27</td>
<td>86.7 ± 15.0</td>
</tr>
<tr>
<td>Community</td>
<td>15</td>
<td>93.3 ± 15.1</td>
</tr>
</tbody>
</table>
terns, cross-coverage of services, and assigning attending surgeons for in-house call duty.

Twenty programs (40%) implemented programmatic change related to time distribution. Twelve programs indicated strict compliance with the ACGME regulations. Six programs indicated strict monitoring of work hours, evaluating residents’ handwritten time logs or computerized time reports generated by card-swiping systems. Two programs indicated that Sunday was the designated day off for all residents.

Six programs (12%) implemented change that supported the theme of education. Three programs merged clinical rotations to “enhance the educational value provided to residents.” Two programs indicated altering the educational conference schedule to “maximize the time spent in the [operating room].” One program indicated that faculty, residents, and staff were updated about work-hour change through periodic meetings.

Finally, 7 programs (14%) reported change consistent with the theme of support. Six programs indicated an increased use of nurse practitioners and physician assistants to provide patient care and “take care of the scut work.” One program responded that their chair was a visible leader in the change movement, explaining the need for “strong and visible leadership in this new era.” Of note, 2 programs reported that changes were not needed as their residents have “always worked less than 80 hours per week.”

### CONTENT ANALYSIS OF TELEPHONE INTERVIEWS

Program directors’ opinions of the defined category reports produced 2 emergent themes related to objectivity and actual experience. Fifty percent of respondents (n=5) reported that the defined categories are “a reasonable

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### Table 4. Programs Experimenting With Work-Hour Reform in 2002-2003

<table>
<thead>
<tr>
<th>Experimented With Change</th>
<th>Did Not Change</th>
<th>New York Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Programs</td>
<td>No. of Residents</td>
<td>No. of Programs</td>
</tr>
<tr>
<td>University</td>
<td>21</td>
<td>99</td>
</tr>
<tr>
<td>Community/university</td>
<td>17</td>
<td>48</td>
</tr>
<tr>
<td>Community</td>
<td>12</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>184</td>
</tr>
</tbody>
</table>

### Table 5. Adjusted Means of Operative Volume

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Programs</td>
<td>Adjusted Mean ± SE of Cases</td>
<td>No. of Programs</td>
</tr>
<tr>
<td>University</td>
<td>33</td>
<td>249.2 ± 10.8</td>
</tr>
<tr>
<td>Community/university</td>
<td>15</td>
<td>288.5 ± 15.9</td>
</tr>
<tr>
<td>Community</td>
<td>11</td>
<td>261.5 ± 16.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Programs</td>
<td>Adjusted Mean ± SE of Cases</td>
<td>No. of Programs</td>
</tr>
<tr>
<td>University</td>
<td>5</td>
<td>255.4 ± 27.6</td>
</tr>
<tr>
<td>Community/university</td>
<td>12</td>
<td>265.1 ± 17.2</td>
</tr>
<tr>
<td>Community</td>
<td>4</td>
<td>246.8 ± 30.9</td>
</tr>
</tbody>
</table>

### Table 6. Adjusted Means of Operative Volume During Experimentation With Work-Hour Reform

<table>
<thead>
<tr>
<th>Experimented With Change</th>
<th>Did Not Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Programs</td>
<td>Adjusted Mean ± SE of Cases</td>
</tr>
<tr>
<td>University</td>
<td>21</td>
</tr>
<tr>
<td>Community/university</td>
<td>17</td>
</tr>
<tr>
<td>Community</td>
<td>12</td>
</tr>
</tbody>
</table>

### Table 7. Means of Work Hours and Operative Volume of New York Programs

<table>
<thead>
<tr>
<th>No. of Programs</th>
<th>Mean ± SD of Hours</th>
<th>Mean ± SD of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>2</td>
<td>88.5 ± 10.6</td>
</tr>
<tr>
<td>Community/university</td>
<td>4</td>
<td>80.0 ± 8.2</td>
</tr>
<tr>
<td>Community</td>
<td>1</td>
<td>78.0 ± 0</td>
</tr>
<tr>
<td>2002-2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>2</td>
<td>75.0 ± 7.1</td>
</tr>
<tr>
<td>Community/university</td>
<td>4</td>
<td>78.8 ± 6.3</td>
</tr>
<tr>
<td>Community</td>
<td>1</td>
<td>78.0 ± 0</td>
</tr>
</tbody>
</table>
Participants were asked to discuss how residents most effectively learn the art of surgery, a question relating to motor-skill development. Responses produced themes specific to skill set and time. First, 80% of participants stated that repetition and skill-transference opportunities are both necessary components in surgical training and education. The use of both aspects of motor-skill development "teach[es] surgical decision-making and judgment," provides "experience [with] different anatomy and disease processes," and "combines the general principles of surgery with experience." Participants indicated that adequate opportunities for repetitive practice and skill transference must remain as reform efforts progress. Two respondents indicated that "repetition improves performance on specific cases but may not be helpful in the long run," explaining that breadth of experience "offers technical skills and learning of technical procedures during complex cases," allowing for "participation in work-ups and pre- and postop care [that] are not necessarily permitted when focusing on repetitive practice." Finally, all respondents discussed the aspect of time in relation to repetition and skill-transference opportunities, indicating "repetitive practice leads to more attention to movements, anticipation of next steps, and emphasizes teamwork, [allowing] cases [to be] done more efficiently and faster. When breadth is the focus, [there] are many pauses during the case because the resident is less efficient and knowledgeable about [the] next steps." Similarly, "repetition, [although] useful, is [also] not necessarily efficient…. [There is] a need to allow [opportunities] for skill transference so that a midcareer surgeon can perform cases he/she will run into that they haven’t experienced during training.”

Respondents were asked to comment on the traditional model of training that typically consisted of lengthy work hours. All respondents indicated satisfaction regarding their training, which was completed in a traditional model. Respondents agreed “the old model allowed for continuity of patient care, provided breadth of experience, and allowed for exposure to the disease process.” Yet, the main theme generated from their opinion of the traditional model can be described as malignant. Responses indicated that the "outdated model was “unnecessary and ridiculously hard,” was “great for service [but] not for education,” and provided “cruel and inhuman punishment” that was “bad for patient care, family life, and marriage.” Such training provided “poor resident supervision” that led to “inefficient[cy] with time utilization,” producing “overworked residents” who “[couldn’t] learn when dead tired.” One participant stated that he “could have learned the same amount in less time if people actually put thought into the curriculum.”

Program directors discussed their opinion of the 80-hour model, generating 2 themes related to exaggeration and outcomes. First, all respondents indicated that a mandated number of hours in which residents are permitted to remain in the hospital is “absurd,” “rigid,” and “unfortunate,” explaining that this change is an “overreaction to the Libby Zion case.” While the “80 hours themselves [are] not the problem…. it is the restrictions surrounding this number” that “promote an artificial system.” These restrictions make it “difficult to dissect service from education, [since] it is hard to draw the line [as] both impact each other.” Second, 70% of participants discussed anticipated outcomes resulting from an 80-hour model. Respondents, “concerned about [resident] opportunities for [operative] cases” and “continuity of [patient] care,” believed that this model “will negatively impact in places where the level of patient care is more intense and immediate, like in a trauma center.” Similarly, these participants believed the “level of resident responsibility is at risk” since this model “promotes a shift work mentality.” One respondent indicated that work-hour reform was necessary “for the arrogant chairs who refused to change working conditions until they were forced,” which “finally [allowed] for the ‘E’ in ACGME.” One respondent anticipated that the final outcome will be an elimination of any discussion pertaining to work hours since, “in about 5 or 10 years, we won’t be talking about this anymore because people’s thought process will have changed.”

Respondents were asked to discuss how the 80-hour model might affect the breadth and volume of operative cases experienced during training. Seventy percent of participants indicated that the new model would decrease operative experience by 10% to 25%. Thirty percent of respondents indicated that the 80-hour model “does not have to impact programs negatively,” as the “same breadth [of experience] will be provided,” “giving residents more than enough experience.” These participants, however, echoed that residents’ experience with preoperative and postoperative care is of concern.

Several respondents discussed rationales related to their perceptions that operative experience will decrease, all of which related to a service-oriented theme. One respondent commented that “we sacrifice educational experience for night and weekend call coverage.” He explained, “We haven’t formulated how to effectively deal with patient care delivery…. [a process that] we should rethink [so that] residents [are] people to teach and train, not [used] for labor.” One participant explained that a decrease in operative experience will “especially occur [during] the first 3 years of training because residents take in-house call.”

Finally, program directors were asked to comment on the findings of this study, which found no significant differences in operative volume between work-hour mod-
els. Two respondents indicated these findings were anticipated, as these results were consistent with their programs’ experience. One participant stated these findings were “surprising and counterintuitive.” One respondent questioned the difference between university-based and community/university-based programs, suggesting the merging of these program types might demonstrate different results. Sixty percent of respondents agreed: “It is too early to comment, but this study provides a good snapshot [of baseline data] that will help us move forward.”

Sixty percent of respondents commented on the counterintuitive finding related to the inverse relationship of New York resident work hours and operative volume, stating that residents are “probably more efficient with assignment of cases and eliminating scut work.” Respondents stated that residents “must be spending most work hours in the [operating room],” explaining that “chiefs [are] fearful of being shortchanged, so when they’re in the hospital, they scrub more on cases.” One respondent stated that this finding should be interpreted “cautiously,” explaining that work hours and operative volume may not be accurately reported since New York programs “are scared to death” of the penalties, describing residents and faculty as “paranoid.”

**Comment**

At the start of this study, it was anticipated that fewer work hours would decrease operative volume. Perceptions of faculty and residents, many of whom were from New York programs, as well as conjecture from surgical leadership, fueled this expectation. The results of this study do not support these perceptions. Instead, these findings support the limited research that demonstrates fewer work hours do not jeopardize the volume of procedures in which residents participate. While operative experience makes up a large component of surgical training and education, the way in which work-hour reform may affect other components of surgical training must be considered.

The goal of surgical residency is “to prepare the resident to function as a qualified practitioner of surgery at the high level of performance expected of a board certified specialist.” Implicit in this goal is the ability to participate in all aspects of surgical patients’ diagnosis, management, and treatment. Any impact on residents’ nonoperative experience must also be considered as it relates to operative training. Since nonoperative and operative experience are interrelated components of surgical training and education, change in one area may affect the learning opportunities and skill development provided in the other area.

Thirty percent of program directors interviewed for this study implied that the ACGME mandate provides an opportunity to “rejuvenate” the system, which “finally permits a focus on education.” This “focus on education” requires an understanding of the new environments created by an 80-hour workweek.

**New Educational Environments**

The night-float model was 1 of the 2 most popular programmatic changes implemented by programs in this study to attain compliance with work-hour reform (n = 15). Many physicians consider the night-float model a detriment to resident education and training since the floater frequently participates in noneducational activities that can be performed by ancillary health care staff, a perspective similarly shared by several program directors interviewed for this study. The time spent involved in such activities may result in fewer opportunities to participate in operative cases during pivotal points in resident training. This model also perpetuates the “shift mentality,” defined as a mindset that “when time is up, the clock is punched, and patient care stops.” Several respondents expressed observing this mentality in junior residents.

The second popular programmatic change found in this study is the leave-early model (n = 15), which requires residents to leave the hospital early following a night of call and encourages residents to leave the hospital early whenever possible. This practice permits flexibility with work hours, allowing additional time to participate in cases and patient care when necessary. This model additionally attempts to avoid the shift mentality.

The night-float and leave-early models frequently cause contention among residents, many of whom are concerned that restricted work hours may limit their operative volume. A separate analysis of programs experimenting with these models was performed to examine whether a significant difference in operative volume occurred between programmatic models. Only those programs achieving compliance with an 80-hour workweek were used for analysis. Ten programs achieved work-hour compliance using a night-float model, while 8 programs attained compliance using the leave-early model. A 1-way analysis of variance demonstrated no significant difference in chiefs’ operative volume between these 2 models (P = .23).

The increased use of home-call duty is another change implemented by many programs in this study. This practice attempts to ensure that residents spend more time in the hospital during the operative day, as opposed to spending work hours as a floater or assigned to in-house call. Currently, there are no guidelines restricting the frequency for assignment to home-call duty. Undoubtedly, the ACGME mandate has changed the face of surgical training and education.

**Correlates of Baseline Findings**

Effective assessment and evaluation of the impact of work-hour reform must consider several correlates that may contribute to these findings. Such correlates may affect the development, performance, and learning opportunities of surgical residents.

**Complex Cases**

The impact of the complexity of cases on operative volume must be considered when evaluating work-hour reform. Complex cases encourage the principles of skill transference, allowing residents to integrate all aspects of technical and cognitive skill in novel situations. They also represent more difficult procedures that typically require a longer period to complete, given the intricacies of the procedure, skill of the resident, and complica-
tions that may arise. The learning process that occurs during complex cases facilitates the technical, cognitive, and professional development of residents, which ultimately fosters competency. Participation in complex cases contributes to the breadth of operative experience but may reflect less volume of experience. Yet, limited volume does not indicate that residents spend less time operating or learn less. Complex cases may be as powerful a learning experience as a large number of simple cases in which repetition and skill refinement occur.

SETTING

Program setting is another correlate for consideration. First, residents training in university-based programs frequently spend more time involved in research and educational activities than residents training in non–university-based programs. The impact of this correlate must be considered as it relates to the development of technical skills and fund of knowledge. As programs acclimate to work-hour reform, there is a vital need to understand how residents spend their time to ensure they receive adequate participation in operative and nonoperative activity. This information enhances educators' awareness of the learning environment and its impact on residents' development.

Second, primary teaching hospitals, intrinsic to university-based settings, frequently include tertiary care and trauma centers. These centers often provide extensive resources that allow for the ability to be involved in an increased volume and breadth of complex cases. Residents training in these facilities may be more likely to participate in a wider breadth of complex cases, perhaps contributing to enhanced learning opportunities. Similarly, the breadth and volume of complex cases accepted in neighboring teaching hospitals may diminish as a result of sending patients to these specialized tertiary care and trauma centers. Residents training in these outlying facilities, then, are likely to participate in an abbreviated breadth of cases, which may limit their learning opportunities.

Third, institutional change must be considered in relation to these baseline findings. The health care delivery system experienced unprecedented change during the past 2 decades, resulting in hospital closings, conversions, and mergers, with similar experiences occurring in private practices. These types of environmental factors are likely to affect the learning environment of residency programs. For example, academic faculty members' expectations to generate revenue from increased participation in clinical activities may affect the volume and breadth of cases in which residents participate. Hospital closings or mergers may influence the types of patients and cases accepted in teaching hospitals and affect the number of residents and faculty involved in training programs. Overall, factors related to program setting provide variability in residents' learning environment, which may directly affect their operative and nonoperative experience.

LEADERSHIP AND ADMINISTRATION

The responsibilities inherent in the chief year of training present another correlate for consideration. Annually, chiefs are promoted on the first day of July and, virtually overnight, are expected to become leaders of a service. Their responsibilities include administrative duties inherent in leading a team of health care professionals, including increased administrative paperwork, interactions with physicians and allied health care providers, and teaching responsibilities for junior residents and medical students. Anecdotally, chiefs may be participating in more cases of a lesser complexity as they relieve residents of their clinical duties to ensure the team's compliance with an 80-hour workweek.

These administrative and leadership responsibilities, while necessary to the development of chief residents, contribute to the hours they spend in the hospital and the distribution of their time. Organization and leadership skills are necessary to effectively experience the chief year of training, but exercising these skills may displace the number of hours spent participating in operative cases.

NONOPERATIVE ACTIVITY

Participation in nonoperative activities may also displace the time residents spend operating. Nonoperative activities, including preoperative and postoperative patient care and formal educational activity, are integral to residents' education and training. Subsequently, the length of time residents spend involved in these activities may affect the time available for operating during an 80-hour workweek.

While these baseline findings demonstrate no relationship between work hours and operative volume, residents may indeed be actively participating in nonoperative experiences that contribute to their comprehensive training. However, assessment and evaluation of work-hour reform must consider the types of nonoperative activities in which residents are participating to ensure such activity complements their education and training.

NEW YORK, NY

The extent to which residents training in New York programs “do more than just operate” remains uncertain. The findings of this study demonstrate an inverse relationship between the operative volume and the work hours of residents training in New York programs (n = 7). Sixty percent of program directors interviewed for this study indicated that these programs are “probably more efficient” and “focus on education over service,” suggesting that programs probably demonstrate efficiency when rounding, use physician assistants efficiently, and reduce participation in noneducational activities. These presumed changes to the learning environment may indeed allow residents more time to operate, suggesting that more operative cases are performed during fewer work hours. However, such an inverse relationship raises opposing implications that fewer cases may be performed while residents work more hours. Participation in fewer cases while working more hours may imply that residents are involved in more complex cases, which may provide a much richer learning experience. Additionally, participation in fewer cases while working more hours may imply that residents spend more time involved in

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nonoperative patient care, educational activities, or scut work that may or may not contribute to their learning.

Program directors interviewed for this study anticipate that New York residents demonstrate more efficiency in their work habits, which allows for increased operative time. To date, New York training programs have provided sparse information regarding their transition to work-hour reform, preventing speculation about how to interpret this finding. The inverse relationship between work hours and operative volume suggests that New York programs are a rich resource for evaluating the impact of work-hour reform. These programs hold valuable information that may assist all surgical programs to more effectively transition to an 80-hour workweek.

LIMITATIONS OF STUDY

Several limitations should be considered when interpreting these findings. First, the average work hours variable reported by program directors for 2001-2002 and for programs that did not implement change during 2002-2003 is most likely based on estimated data. Prior to the work-hour mandate, programs were not mandated to track work hours. Second, the way in which the ACGME calculates the total number of operative cases performed by chief residents is not clearly understood by surgical leadership, casting uncertainty on the accuracy of the defined category reports. This point of contention was discussed by one program director indicating that the ACGME “should have a transparent way for us to realize how cases are counted.” Additionally, the accuracy with which residents enter cases must be considered. A recent study of residents’ tracking of cases found that residents may be underreporting their operative experience or coding their experiences differently, which may affect volume and breadth. Third, the influence of external factors during the years of study is unknown. Such factors may include changes to surgical caseloads, program leadership, or number of residents or faculty.

FUTURE RESEARCH

The impact of work-hour reform on the operative experience of residents provides an abundance of research opportunities. First, the effect of work-hour reform on the competency of independent surgeons is an area for further investigation. This line of research is a next step in evaluating the long-term impact of training under the ACGME mandate, examining such variables as measures of stamina, number of hours worked posttraining, patient satisfaction, pursuit of fellowship training, quality of life, and career satisfaction. Second, simulation, a method of training and education that is rapidly gaining popularity, is yet another area for investigation. Studies related to the transfer effects of simulated training have not demonstrated definitive evidence that skill transfer indeed occurs during real-life situations. The inability to mimic reality or provide appropriate tactile capabilities is the major complaint about simulated training. Despite this lack of definitive evidence, many residency programs are implementing simulated-training curricula. An investigation of the impact of simulated training on residents’ learning and development is necessary, allowing programs to determine whether simulated training is an appropriate use of time and resources in the new surgical learning environment.

CONCLUSIONS

Residency training is under tremendous public scrutiny as programs adapt to the ACGME work-hour guidelines. The surgical profession is perhaps most affected by this scrutiny, given its history of lengthy work hours. Successful compliance with work-hour reform is mandatory, for if success does not occur, “it is going into the political arena, where [the profession] might not have as much control.”

The hallmark of the profession remains the ability to provide an extensive range of patient care, which must be recognized in the assessment and evaluation of work-hour reform. Surgical training and education must now focus on providing organized and effective curricula that most efficiently allow residents to experience the breadth and volume of all aspects of surgical patient care in fewer hours. This study is one step in building a foundation that allows for examination of the issues surrounding this paradigm shift. Decision makers also have a responsibility to the public at large to recognize the differences that are unique to surgical training and education, ensuring that the work-hour guidelines continue to allow surgical trainees adequate opportunity to acquire the expertise needed for the challenges facing contemporary and future surgeons.

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