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Can Specialized Surgical Simulation Influence Resident Career Choice?

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Running title: Simulation and Resident Career Choice

Can specialized surgical simulation influence resident career choice?

1. Abstract

1.1 Objective: Our institution began Advanced Trauma Operative Management (ATOM) simulation course in 2007 for senior residents with the aim of increasing opportunities for surgical trainees to gain operative trauma experience. The aim of our study was to evaluate the effect of the ATOM simulation course on residents' choice of trauma as a career as demonstrated by entrance into surgical critical care (SCC) fellowships.

1.2 Design: Retrospective study of institutional data on graduating residents from 2002-2015. Residents were divided into pre-ATOM (2002-08) and post- (institution of) ATOM (2009-15) cohorts. The percentage of residents entering SCC fellowships was then compared among cohorts as well as to national trends.

1.3 Results: Nationally the pre-ATOM group had 7057 graduating general surgery (GS) residents (847 SCC) and post-ATOM had 7581 graduating GS residents (1268 SCC). Locally the pre-ATOM group consisted of 40 graduating GS residents (1 SCC) and while the post-ATOM cohort had 51 graduating GS residents (9 SCC). The number of SCC fellows increased by 4.7% nationally and 15.7% institutionally between the two study groups. The increased interest in SCC was more than could be accounted for by national trends.

1.4 Conclusions: Interest in a career in trauma was increased among residents graduating from this single institution after instituting ATOM as part of the educational curriculum.

2. Introduction:

Training in a surgical critical care fellowship is the most common pathway for general surgery residents interested in a career in trauma. Surgical critical care (SCC) fellowships have suffered from high numbers of unfilled positions within the last 15 years.^{1,2} In 2013, the SCC fellowship match saw only 107 US graduates choosing this as a career path of 185 available openings.³ This trend has been attributed to decreasing operative trauma experience in general surgery residency, uncomfortable lifestyle, and poor reimbursement.⁴ There has been ongoing concern that decreasing operative opportunities in trauma may have a negative impact on resident experience.

Our institution began Advanced Trauma Operative Management (ATOM) simulation course for senior residents (post graduate year 3-5) with the aim of increasing opportunities for surgical trainees to gain operative trauma experience. The ATOM course was developed at the University of Connecticut, Hartford,⁵ and comprises a six-lecture series followed by an operative exercise using a porcine model in a fully equipped operating room with anesthesia. During the operative simulation participants are tasked to repair injuries to the bladder, small bowel, kidney, ureter, duodenum, stomach, liver, diaphragm, spleen, pancreas, heart and inferior vena cava. The participants are then evaluated according to standard criteria for their ability to identify the injury, develop a correct treatment plan, and perform the necessary repair. Since ATOM has become incorporated into our residency training program there has been increased senior resident enthusiasm and interest on the trauma service.

We sought to evaluate the effect of the ATOM simulation course on residents' choice of trauma as a career. We hypothesized the increased interest on the trauma service has translated into

more residents entering into SCC fellowships as compared to a pre-ATOM cohort and national trends.

3. Methods:

Our institution's general surgery residency program is an academic program including a level 1 trauma center, graduating 6-8 residents per year. Our institution began the Advanced Trauma Operative Management (ATOM) simulation course for senior residents in 2007 and the first class of graduating residents that had all completed the ATOM course was in 2009. During the study period 2002-2015, our residency structure remained unchanged in that each resident would have 4-6 months of trauma surgery experience including a night float system. We acquired our institutional data on residents going into SCC fellowship from the office of the program coordinator. National data on graduating general surgery residents and SCC fellows was obtained from the ACGME open access website.^{6,7}

The study period was divided into equal pre-ATOM (2002-08) and post-ATOM periods (2009-15). The primary outcome was to compare the number of general surgery graduates who pursued a career in trauma during the pre-ATOM period with the number who pursued a career in trauma during the post-ATOM period. The great majority of surgeons in America who identify as "trauma surgeons" are boarded in surgical critical care. Therefore, additionally, we used the number of residents entering SCC fellowship as a surrogate for trauma career interest. This categorical data was then compared using Fisher's exact and Chi-square test (two-tailed) to determine statistically significant difference if any for each time period. The standard p value of less than 0.05 was the cutoff of statistical significance. For the national comparison of

graduates the Chi-square test because of the large variable numbers; and the Fisher' exact test was used for our institutional comparison since these variable numbers were relatively small.

4. Results:

Nationally, in the pre-ATOM period 7057 residents graduated from general surgery programs, while 6439 graduated in the post-ATOM period. Entrance into SCC nationally increased from 12% of all pre-ATOM period graduates to 16.7% of all post-ATOM period graduates ($p<0.001$) as shown in Table 1.

Ninety-one general surgery residents graduated our program from 2002-2015. Due to an increase in resident compliment the post-ATOM group was 20% larger than the pre-ATOM group. Table 2 shows the distribution of residents. In the pre-ATOM cohort, one (2.5%) graduating resident advanced to SCC, whereas in the post-ATOM cohort nine (17.6%) graduating residents advanced to SCC ($p=0.039$). Figure 1 shows the number of residents entering SCC by year. On further examination, one resident from each group did not pursue trauma as a career. One went solely into surgical critical care and the other pursued another surgical subspecialty fellowship in which they now practice, leaving zero residents in the pre-ATOM cohort and 8 (15.7%) residents in the post-ATOM cohort ($p=0.008$).

Both groups experienced an increase in matriculation into SCC over the study period, however, the national increase was 4.7% compared to 15.7% at our institution. Overall, at our institution residents were highly likely to pursue fellowships of some kind in both the pre-ATOM cohort and the post-ATOM cohort (92.5% and 94% respectively, $p=0.8$).

Finally we reviewed our institution's trauma case load for changes during the study period. Total number of trauma cases remained essentially the same: 2518 cases during 2002-08 (pre-ATOM) and 2567 cases during 2009-15 (post-ATOM).

5. Discussion:

This study reviewed the matriculation to SCC fellowships for two time periods at one residency program -- before residents participated in the ATOM course and after they participated in the course. We found that there was a statistically significant increase in the number of residents pursuing SCC fellowship in the latter group. While causality is always hard to prove in retrospect, there is certainly an association. Potentially confounding variables are important to try to identify and below we discuss several factors thought to influence resident career choice.

In the United States there has been an increasing trend in fellowship training for general surgery residents. This trend is not new and has been well documented over the last 10 years with current fellowship rates over 70% nationally.⁸⁻¹⁰ Several factors are thought to be responsible for this trend, including economic pressures, lifestyle issues, and lack of general surgery mentors.^{8,9,11} In large urban areas of the United States, as where our institution is located, an even larger percentage of general surgery residents pursue fellowships. While the number of residents pursuing fellowships increased mildly in our institution for the time period it was not significant.

As early as 1982 there has been concern about low operative numbers in trauma compared to other general surgery areas and how this affects resident experiences.¹² From the late 1990's, there has been further documentation of decreasing operative numbers in trauma, again with

concerns about fewer residents pursuing the trauma as a career.¹³⁻¹⁶ Our institution's trauma case load remained the same during the study period.

In 1992, Richardson et al. indicated several factors affecting lower interest in trauma surgery as a career including low operative volume, in-house call requirement, and patient population. Trauma surgeons were also perceived as negative role models due to lack of interest/enthusiasm for operating.¹⁷ Almost 20 years later, Hadzikadic et al. found many of the same reasons such as limited operative volume, work hours, and patient population to be disincentives for entering into a career in trauma.⁴ At our institution, the trauma surgeons cover all emergency general surgery as well as traumas during on call hours. They also all have outpatient practices for both trauma and general surgery patients. This practice has long been in place and did not change during the study period. Furthermore, there was no change to the resident or attending work schedule during our study period to influence resident perceptions of the field.

Simulation courses such as ATOM provide an environment where trainees can practice their skills and promote collegial dialogue between residents and trauma faculty. This may help to reverse some of the aforementioned negative perceptions about the trauma subspecialty. The ATOM course has been shown to significantly increase both knowledge and self-confidence in trainees in treating penetrating trauma injuries.⁵ The ATOM course allows residents to gain experience and proficiency in techniques even as clinical operative opportunities decrease. There are other indirect effects of the ATOM course that may contribute to increased resident interest in trauma surgery. First residents spend dedicated time with trauma surgeons in a less pressured environment; second they may have more educational benefit out of their trauma rotation with the upfront investment in a simulation course; third they may feel more confident in caring for

the injured patients. Further, the residents may have more positive perceptions of trauma surgeons who participate in the course. The faculty may be seen as more invested in residents teaching, and as having higher job satisfaction and enthusiasm. Ultimately, allowing trauma surgeons to be seen as better role models.

Simulation courses have been shown to increase medical student interest in vascular, cardiothoracic, and general surgery residency.¹⁸⁻²⁰ However, the majority of these studies did not follow the medical students long term to show conversion of this interest into matching in a surgical specialty residency. Lee et al showed a trend toward increased matriculation into surgical residency. Several articles emphasized mentoring as an important aspect of the success of a simulation program.^{18,20} Lou et al specifically looked at this issue and found that unsupervised simulation lead to no increase in interest in a surgical field.²⁰

To our knowledge, no simulation (or trauma simulation) course has been shown to influence resident career choices. Therefore, we analyzed the effect of a trauma simulation course (ATOM) on senior residents' interest in advancing into SCC. We found a marked increase in our residents pursuing SCC. This increase was much greater than the national increase in SCC matriculation. We could not identify any other factors related to the program that would explain this increase such as changes in work hours, case volume, or overall interest in pursuing fellowships. There may be other factors that increased the influence of ATOM at our institution such as the fact that we do not have a SCC fellowship. This is valuable information about the potential positive effects of ATOM in addition to previous benefits shown in improving knowledge and self-efficacy.⁵

Our results should be interpreted with several study limitations in mind. Probably, most pronounced is that this is a single institutional experience with a sample size that may be considered relatively small by some. However, a power analysis to interpret our results with 99% accuracy and avoid a type II error revealed a requirement of 30 subjects (residents) in each cohort, pre-ATOM and post-ATOM respectively. As shown in our results, our sample size met those requirements.

Possibly a second limitation is the use of SCC as a surrogate marker for trauma interest. It is true that some residents in SCC fellowship go on to only practice surgical critical care and not trauma. However, the great majority of residents going into trauma pursue this via SCC fellowship. For this reason we thought SCC to be a reasonable surrogate marker for trauma interest. Moreover, this indirect relationship has more impact on the national data and probably slightly over inflates the percentage of residents going into trauma. Only one of our residents for the entire study period limited their practice to solely surgical critical care (pre-ATOM group). In other words, for our residents SCC was an accurate surrogate for pursuing a career in trauma.

Finally, the last limitation of our study is inherent in the retrospective nature of the study design and involves the inability to control for changes in trauma faculty and ATOM teaching faculty. There was some change in trauma faculty over the study period, in particular, a change in trauma medical director. However, the previous trauma medical director was responsible for helping to start the ATOM course and continues to teach the course regularly. Furthermore, the new trauma medical director was not new to the institution and had been an active member of the trauma service including ATOM faculty. The ATOM teaching faculty has stayed relatively constant with 60% of the faculty having taught since the initiation of our course site.

6. Conclusions

We believe that simulation courses, such as ATOM, allow for intensive high fidelity experiences with specialty attendings and may increase interest in the pertinent field. Given that there are few ways to increase the actual number of trauma cases, simulation courses during general surgery residency can increase exposure and familiarity with the discipline. Ultimately simulation courses like this, if widely used and thoughtfully produced, could help mitigate surgeon shortages in particular disciplines.

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Table 1. Distribution of National general surgery graduates and SCC fellows.

	Pre-ATOM Cohort (%)	Post-ATOM Cohort (%)	p Value
GS graduates	7057	7581	n/a
SCC fellows	847 (12)	1268 (16.7)	<0.001

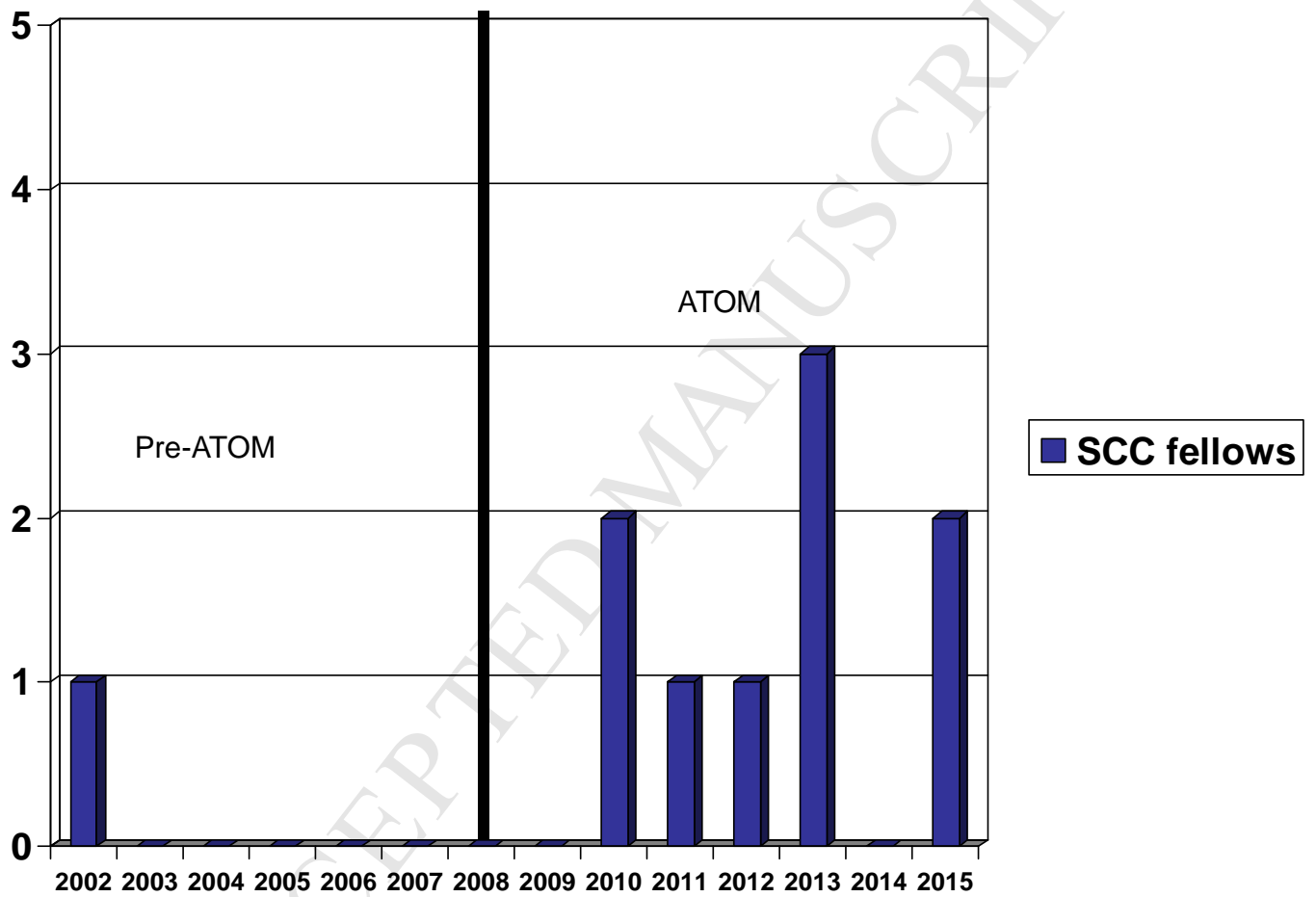
GS: General Surgery, SCC: Surgical Critical Care

Table 2. Distribution of local general surgery graduates, SCC fellows, and those pursuing trauma.

	Pre ATOM Cohort (%)	ATOM Cohort (%)	p Value
GS graduates	N=40	N=51	n/a
SCC fellows	1 (2.5%)	9 (17.6%)	0.039
Pursuing careers in trauma	0 (0%)	8 (15.7%)	0.008

GS: General Surgery, SCC: Surgical Critical Care

Figure 1. Number of local residents entering SCC throughout the study period.



Highlights for

Can specialized surgical simulation influence resident career choice?

1. A new trauma surgical simulation course was started
2. Resident interest in trauma increased after course implementation
3. Simulation may be a way to increase resident interest in needed specialties