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Surgical interns in 2018: Objective assessment suggests they are better but still lack critical knowledge and skill

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ABSTRACT

Background: The transition from fourth-year medical student to surgical intern is difficult. A lack of repetitions, experience, and knowledge is problematic. We report our experience using simulation-based technical and nontechnical skills to assess the competency of surgical interns in July and January of their intern year.

Design: As part of a larger assessment effort, our general surgery interns (2010–2016) have been tested on performing an emergent cricothyrotomy, interpreting 2 arterial blood gases, and reading 3 chest x-rays in fewer than 7 minutes. We retrospectively analyzed general surgery interns' performance on these 3 tests (total score = 20).

Results: A total of 210 interns completed both July and January (identical) assessments. Overall mean scores improved from July (12.62 ± 3.44) to January (16.5 ± 2.46; $P < .05$). During the study period general surgery interns' mean baseline scores improved in *both* July ($P < .05$) and in January ($P < .05$). Although most individual general surgery interns did *improve* their total scores (92% improved, 3% same, 5% worse) between July and January ($P < .05$), in January 40% could not perform an emergent cricothyrotomy swiftly, and 6% missed a tension pneumothorax on chest x-ray.

Conclusion: Our data suggest that surgical interns start residency training with low levels of skill and comprehension with emergent cricothyrotomy, arterial blood gas, and chest x-ray. They improve with 6 months of clinical and simulation training. Encouragingly, overall scores for both July and January assessments have improved during the study period. Given that some interns still struggle in January to perform these three tasks, we believe that 2018 interns are better, but still potentially lack critical knowledge and skill.

Introduction

A significant gap exists between being an enthusiastic medical student and a skilled surgical intern in their preparedness to address acute care situations.[1] Multiple factors contribute to this gap, but most hinge on experience: less exposure to surgical patients, limited participation in procedures, less time within teaching conferences, and perhaps less ownership and responsibility for patient care and their outcomes.[2,3]

Given the fact that all new interns begin residency with limited experience, sparse clinical skills, and a range of acumen and preparedness, this transition can be physically, emotionally, and technically demanding.[4] This transformation is especially challenging in disciplines that are highly procedural and knowledge driven, like surgery, where the experience and practical skills needed and developed in residency are vastly different from those of medical school. Acquiring surgical competency during residency is complex and requires extensive hands-on experience, time, and effort. Maturation does not happen overnight.

Many medical schools in the United States have developed programs and designed curricula for medical students interested in pursuing surgical specialties, and several have also incorporated a "boot camp" for fourth-year students to facilitate the transition to becoming a surgical intern.[5–7] Although some medical schools and general surgery programs have not adopted the use of boot camps for either graduating medical students or incoming residents, studies support that boot camps are useful particularly with intern confidence and skill performance.[5–7]

With these thoughts in mind, we pondered whether surgical interns at our institution have improved with time. Our program

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Table I
Scoring rubric of the three tasks

CXR 1					
Orientation	AP				
Soft tissue	Ok	CXR scoring			
Bony tissue	Rib FXS	0–1 fact	0		
Airway	Trach midline | trach tube	2–3 facts	1		
Breathing	R hemothorax	4–5 facts	2		
Circulation	Normal	≥ 6 facts	3		
Diaphragm	Ok				
Aorta	Ok				
Mediastinum	Wide				
CXR 2					
Orientation	AP	CXR scoring			
Soft tissue	Ok	0–1 fact	0		
Bony tissue	Ok	2–3 facts	1		
Airway	ET tube	4–5 facts	2		
Breathing	Patchy infiltrates | pneumothorax	≥ 6 facts	3		
Circulation	Cardiac shift				
Diaphragm	Ok				
Aorta	Ok				
Mediastinum	Shifted				
CXR 3					
Orientation	PA	CXR scoring			
Soft tissue	Ok	0–1 fact	0		
Bony tissue	Ok	2–3 facts	1		
Airway	Midline	4–5 facts	2		
Breathing	LLL obscured	≥ 6 facts	3		
Circulation	Cardiac border				
Diaphragm	Left injury			Overall Score	
Aorta	Ok			20	10
Mediastinum	Ok			19	9
Lines, other objects?	Gastric bubble			18	8
				17	7
ABG 1				16	6
O2/CO2/pH/base/HCO3	200 / 38 / 7.41 / -1 / 23	ABG scoring		15	5
Insight?	O2 up	0–1 fact	0	14	4
	Normal ABG	2–3 facts	1	13	3
		4–5 facts	2	12	2
		5 + insight	3	11	1
ABG 2				< 10	0
O2/CO2/pH/base/HCO3	75 / 32 / 7.15 / -9 / 16	ABG scoring			
Insight?	Met acidosis	0–1 fact	0		
	Resp compensation	2–3 facts	1		
		4–5 facts	2		
		5 + insight	3		
Cricothyroidotomy					
1 Generous midline incision					
2 Bluntly spread in midline		Crico scoring			
3 Expose cricothyroid membrane		0–1 fact	0		
4 Bluntly perforate CT membrane		2–3 facts	1		
5 Spread open with clamp		3–4 facts	2		
6 Keep clamp open		4 + skill	3		
7 Insert ET tube		5 + skill	4		
8 Twist ET tube into place					
9 Blow up cuff					
10 Connect, O2, check CO2, secure					

mandates that all surgical trainees participate in an objective assessment (16 skills and knowledge tasks for surgical interns) twice each year.[8,9] Although many skill and knowledge stations have changed within our "Surgical Olympics" during the past decade, station 1A (trauma: emergent cricothyrotomy [EC], interpreting arterial blood gases [ABGs], and reading chest x-rays [CXRs]) has not changed. We report on a 6-year experience, using simulation-based technical and nontechnical skills to assess the competency of surgical interns in July and January of their intern year.

Methods

The Surgical Olympics is a comprehensive simulation-based assessment that is held twice each year (July and January) for surgical interns. It includes a total of 16 tasks that are completed within 9 separate rooms: some tasks take 2 to 3 minutes, and others take up to 14 minutes. The first station—the trauma station—has stayed consistent in its requirements, the grading system, and has had the same rater for the past 9 years. The station lasts 7 minutes and is composed of 3 tasks that are performed in a consecutive manner. Written and verbal instructions were given to each intern. The first task is to read 3 CXRs, taking 30 seconds to verbalize as many facts (normal and abnormal findings) as possible with each image. The second task is to interpret 2 ABGs in less than 60 seconds each. The final task is to perform and verbalize the steps and skills of a safe but EC. Participants have 45 seconds to effectively place an endotracheal tube within an inexpensive, low-fidelity neck or trachea model, using surgical instruments (Table I).

Table II
Comparison between July and January mean (SD) scores for the chest x-rays, ABGs, and cricothyrotomy task and the overall scores

	July: Mean (SD)	January: Mean (SD)	Δ: Mean	*P* value
Chest x-rays	5.8 (± 1.97)	7.08 (± 1.9)	+ 1.21	< .0001
ABGs	4.5 (± 1.48)	5.26 (± 1.27)	+ 0.69	< .0001
Cricothyrotomy	2.19 (± 1.29)	3.75 (± 1.06)	+ 1.49	< .0001
Total	12.62 (± 3.44)	16.50 (± 2.46)	+ 3.72	< .0001

The assessment has 3 individual score sheets that were constructed for the respective tasks. The cricothyrotomy was assessed using a procedural checklist consisting of 10 steps, each representing 0.5 points with a maximum of 5 points. The scoring rubric was created by the consensus of 6 trauma, critical care, and general surgeon attendings.[10] The ABGs and CXRs score sheets were based on the number of accurate facts that could be verbalized within the given time. Score totals from each task were then combined to provide a final score for each participant. The station used a total of 20 points scored for each intern in July (Summer Olympics) and retested again in January (Winter Olympics). One staff surgeon (D.R.F.) within the room evaluated each of the interns separately within the 7-minute time slot. This study was judged exempt by the Mayo Institutional Review Board. All participants provided consent.

Results

A total of 210 interns completed the Surgical Olympics in both July and January assessments. Individuals' mean scores are presented in Table II. The mean (± SD) scores in July for cricothyrotomy was 2.19 (± 1.29), CXRs = 5.8 (± 1.97), and ABGs = 4.5 (± 1.48). The mean overall score for July was 12.62 (±3.44). Mean scores for January were better: cricothyrotomy = 3.75 (± 1.06), CXRs = 7.08 (± 1.9), and ABGs = 5.26 (± 1.27). The overall score = 16.5 (± 2.46) and improvement in all tasks was significant ($P < .05$). With time, comparing one year to the next, mean CXR, ABG, and total scores have improved in both July ($P < .05$) and January assessments ($P < .05$; Fig 1). We observed no differences among interns in a year-to-year comparison for the cricothyrotomy task (P = NS).

Individual overall scores showed improvement (from July to January) in 193 interns, no change in 6 interns, and poorer scores in 11 interns. Granular data from July to January (July:Jan) for the 3 CXRs showed that 30%:20% of interns missed a right hemothorax on the first CXR, 25%:6% missed a tension pneumothorax on the second CXR, and 50%:20% missed a diaphragmatic hernia on the third CXR. In addition, 10%:0% could not identify all 5 numerical values on an ABG, 50%: 25% missed interpreting a normal ABG, and 20%: 5% some missed the metabolic acidosis on the second ABG (Tables III and IV). Although most interns made several correct steps for an EC, many (July 80%:January 40%) did not get the endotracheal tube into the trachea within 45 seconds (Fig 2).

Discussion

This 6-year, retrospective study reports the objective assessments of 210 surgical interns in July, and then again in January, on 3 identical tests: reading 3 CXRs, interpreting 2 ABGs, and performing an EC. Our findings suggest the following:

- Our interns in July have had limited experience with our trauma station tasks;
- January interns fare much better than July interns on these 3 objective assessments;
- Surgical interns during the 6 years appear to be improving—both July and January scores have increased with time; and
- Granular data suggest we have wide variation in performance, and many January surgical interns remain deficient in critical knowledge and skills.

Although all program directors, surgical staff, and surgeon educators love to attract stellar medical students to our institutions, few of us in 2018 expect these new interns to be able to independently perform an EC on day 1, interpret ABGs with aplomb, or read CXRs like a veteran radiologist. Historically, in the 1960s, '70s, and '80s, American medical students had 3 months of surgery rotations as third-year medical students and several more months as fourth-year students for those preparing for a surgical residency.[11] This is considerably more time and surgical experience than most medical schools offer their students today[12–14] Although we have found *no* published literature that suggests surgical interns in the 1960s, '70s, or '80s could place an EC, interpret ABGs accurately, or read CXRs well, some studies suggest that modern day surgical interns feel very ill-prepared for a surgery residency.[1,2,4,15] Whether this feeling of ill-preparation relates to purely one of less time on surgical rotations, weak curricula, less teaching by surgical staff, increasing surgical complexity and knowledge, or other factors is unclear. The use of surgical boot camps by medical schools or surgery programs seems useful and may offer greater opportunities and practice for preemptive skill acquisition in 2018 and beyond.[5,6] Indeed, as an anonymous quote suggests, "Repetition remains the Mother of all Learning."

Our study shows January interns are more knowledgeable and more skilled than July interns. Improvement seems intuitive for a variety of reasons: 6 months of surgical training in the clinics, operating room, intensive care unit, and emergency room is useful; teaching rounds, conferences, and cadaver and simulation sessions offer a breadth of surgical education; simply taking an identical test 6 months later offers an advantage as well—examinations are an effective way to learn.[16–18] The ability to work with peers and more senior trainees that impart education in general and insights on this specific exam must weigh into improvement opportunities. Being less stressed and more capable of verbalization in a one-on-one setting with a surgical attending must be of some use. Although surgical interns have varying experiences and educational opportunities throughout 6 months of clinical duties, this study showed that 92% improved on their repeat assessment; however, it remains disappointing that some scored the same or worse on an identical assessment.[15]

We found it encouraging that the July scores are improving with time. Indeed, the 2 knowledge-based assessments (CXR and ABG) have steadily increased for the past 8 years. This could be for a variety of factors: interns are entering surgical programs better prepared to evaluate diagnostic tests compared with the past (medical school-driven success), interns are learning of our exam and practicing or obtaining answers, or the solo rater is subject to grade inflation. There is some evidence that medical school curricula *are* more heavily emphasizing and recognizing the importance of proficiency in diagnostic imaging and routine blood tests.[19–22] This may translate into better understanding of how to read a CXR or ABG and could explain why the initial intern knowledge assessment scores have been increasing during the past 8 years. Our own usage of a boot camp and orientation week for interns just before they begin may somehow increase the scores, although we intentionally do not cover these subjects. Conversely, we have found that the January scores have not increased with time, which suggests that, although recent interns come in better

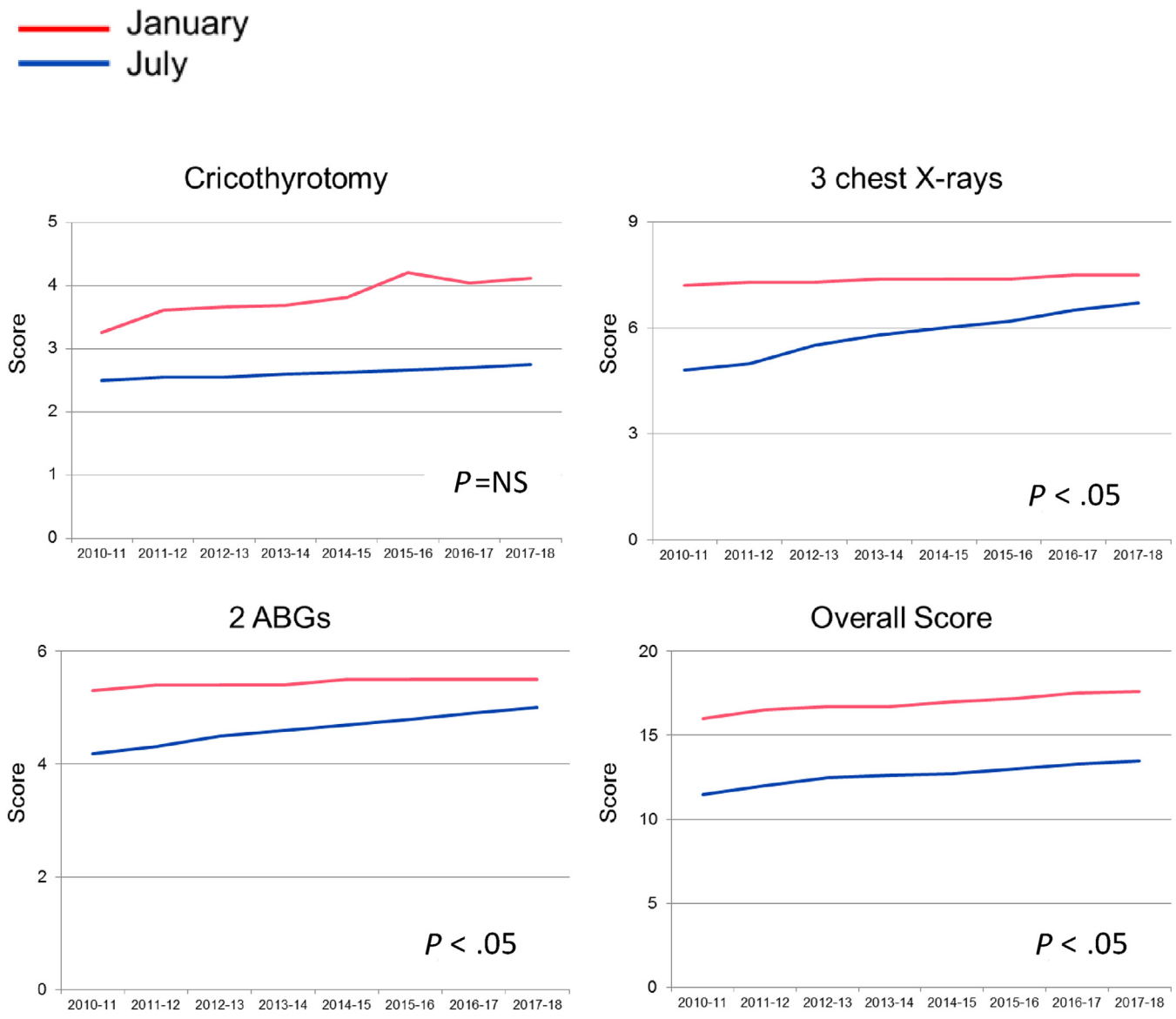

Fig 1. The mean scores of the 3 chest x-rays, 2 arterial blood gases, cricothyrotomy, and total trauma stations during the past 8 years.

Table III
Comparison between July and January interns' success rate for the chest x-rays, ABGs, and cricothyrotomy task

	July (success rate %)	January (success rate %)	Δ: %	*P* value
Cricothyrotomy	20	60	+ 40	< .0001
Identifying all 5	90	100	+ 5	
Identifying normal PH	50	75	+ 25	< .0001
Identifying metabolic acidosis	80	95	+ 15	< .0001
Identifying hemothorax	70	80	+ 10	< .0001
Identifying pneumothorax	75	94	+ 19	< .0001
Identifying diaphragmatic hernia	50	70	+ 20	< .0001

Table IV
Comparison between July and January interns number who scored <1 in the chest x-rays, ABGs, and cricothyrotomy tasks and <10 and >18 in overall scores

	July	January	Δ: number
ABG ≤ 1 points	24	4	+ 20
CXR ≤ 1 points	29	2	+ 27
Cricothyrotomy ≤ 1 points	73	2	+ 71
Total ≥ 18	18	98	+ 70
Total ≤ 10 points	60	6	+ 54

prepared in July, after 6 months, all interns become trained to a similar proficiency.

This boost in higher scores each July for CXR and ABG tasks is in contrast to the skills assessment (EC) scores. They have been level in July for a decade. Most educators would suggest that operative skills must be practiced with hands-on experience, and EC is a rare procedure. Reports from the 1980s and 1990s found a cricothyrotomy rate of 14.8% for all prehospital intubations.[23,24] Hands-on practice and multiple repetitions are required to successfully perform a cricothyrotomy with few complications, whether real or simulated.[25,26] Although only 2 interns among 210 have performed an actual "unsupervised" cricothyrotomy on a real patient in the period from July to January (both performed successfully), virtually

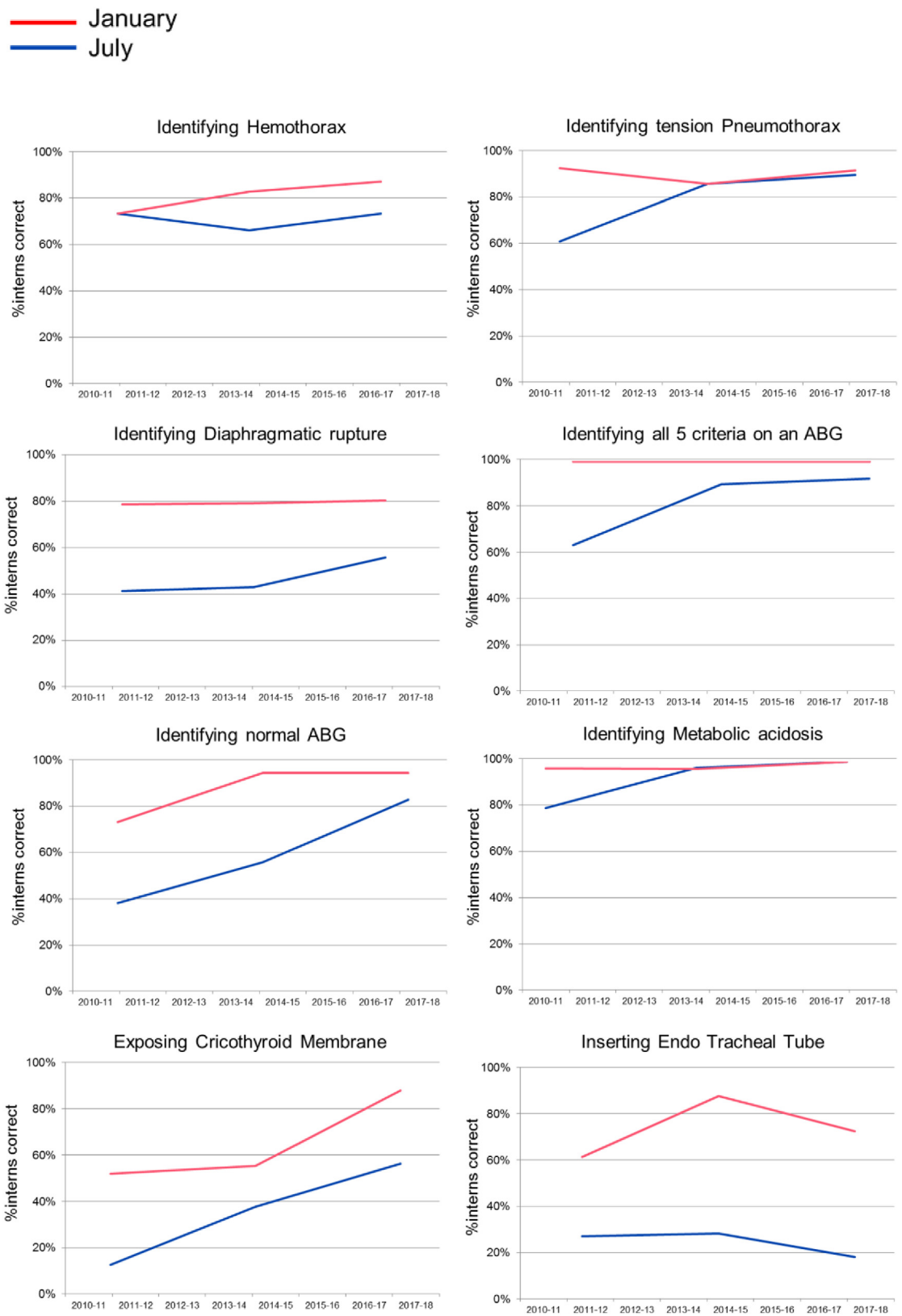

Fig 2. The percentage of the interns who correctly identified few of the facts on the chest x-rays and the arterial blood gases and performed on the vricothyrotomy model (July versus January) during the past 8 years.

all have had multiple repetitions of hands-on practice with the low-fidelity models used in this assessment during their Friday morning simulation sessions. We believe this establishes a comfort level with the procedure and should explain why year after year interns score higher in January. In addition, take-home practice kits containing station models and materials for residents preparing for the biannual testing assessments have been available during the past several years. The cricothyrotomy resources are available for "check out" and can be practiced at home.

Despite semisimilar intern rotations and a consistent Friday morning simulation surgery education curriculum for each intern, performance among trainees varied widely: 92% of the residents' scores improved from July to January, several did not, and 5% scored worse. Given that Ericsson et al[27] have offered compelling data that suggest it takes nearly 10,000 hours to become masterful at playing golf, flying an airplane, or playing the violin, it should come as little surprise to surgical educators that it takes deliberate practice, feedback, and drive to create competent, if not masterful, surgical interns. So why is it that some surgical trainees were nearly perfect in their performance on these three tests and others were abysmal? Our group has reported on surgical assessments for more than a decade,[28] and only recently have we gained some insight into expected variation in performance. Duckworth's work on *grit*[29] and Ericsson's breakdown of the importance of *drive*[30] are clearly useful for surgical educators—motivated learners seek additional repetitions and inherently *want* to learn the material. We agree this is a big part of the variation in performance we see. The grit and drive of interns are varied. Powerful educational insights from others,[31–35] however, lead us to believe our surgical simulation curriculum suffers from major educational flaws: learners must not be sleep deprived, trainees must be continually engaged, they need to see the relevance of the education, students need to write down or verbally recite facts, learners need examples of good and bad performance, trainees need voluminous feedback and coaching, students need to tackle problems and challenges initially without assistance, and they need to be actively tested and quizzed repeatedly. Brown et al[31] clearly show that sequential learning allows long-term retention and better comprehension. On each of these factors, our surgical simulation program has weaknesses and likely has not delivered an equitable educational resource to each of our learners. We aim to remedy these deficiencies, using a surgical education program that offers more repetitions, frequent quizzing, enhanced engagement, greater time with hands on skills, and ideally, offers insights into why this knowledge is important and inherently relevant and useful.

This study has numerous limitations. It is a retrospective look at one 7-minute objective structured clinical examination station grading learners from one institution by one rater during a 6-year period. Bias could clearly be present. The ABG and CXR checklists have not been validated; however, they do carry some sense of face, content, and construct validity based on research with senior residents and 6 staff general surgeons.[10] Interns should theoretically improve their scores as they each repeated an identical test in a span of 6 months. They knew the test was coming and had experience with it. Confounding factors must exist and include examinees with different clinical experience, interns with different surgical interests, no protection for post-call trainees versus rested individuals, and so on. The exam is stressful and time constrained, and learners are nervous. This is not a setup for superior performance. On the positive side, having 210 interns take an identical test 6 months apart offers a consistent assessment platform with a large number of postgraduate year-1 trainees. Given that each of the skills is graded with a checklist, the accuracy and consistency of rating is high. Although time constrained and intense, each individual knew of the exam, and at least in January, knew exactly what questions would be asked and what skills would be required. We believe the data show that a majority of trainees are learning, but we have vast room to improve our educational process.

In conclusion, although surgical interns come into our surgical training program ill-prepared for many tasks, it appears that 6 months into their residency they develop improved skills pertinent to being a successful general surgeon. We are encouraged that surgical interns seem to be arriving better prepared with surgical knowledge during the past 6 years. This is likely a function of medical school preparation, surgical boot camps, and test familiarity. The lack of improvement with EC indicates to us that physical repetitions are vital for success with surgical skills, and performance on such uncommon procedures will not improve without dedicated educational effort—likely best done in a simulated setting.

Conflict of interest

The authors have indicated that they have no conflicts of interest regarding the content of this article.

Ethical approval

This study was judged Exempt by the Mayo Institutional Review Board. All participants provided consent.

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