



## Objective assessment of surgical trainees' non-technical skills: Improved performance following a two-year program of instruction



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### ABSTRACT

**Background:** Non-technical skills (NTS) encompass personal skills such as communication, situational awareness, decision making, teamwork and leadership. Poor performance of these skills has been shown to contribute to medical error. The Royal College of Surgeons in Ireland (RCSI) has delivered a mandatory program of instruction in NTS to all surgical trainees since 2005. We investigated whether the NTS of surgical trainees improved after the first two years of this program.

**Methods:** Baseline data was collected in a three-station OSCE assessment of NTS at the beginning of Year one and again at end of Year two of surgical training.

**Results:** Trainees' mean percentage NTS scores improved significantly over the two-year period for the NTS assessment ( $P < .001$ ). A significant difference was demonstrated using within-subject (paired) t-tests between the Year one and two time points for all three OSCE stations: Consent ( $-5.39$ ;  $P < .001$ ); Colleague Conflict ( $-8.63$ ;  $P < .001$ ); and Disclosure of Error ( $-7.56$ ;  $P < .001$ ).

**Conclusions:** RCSI offers a unique mandatory program of instruction in NTS. There was a statistically and practically significant improvement in the NTS scores of surgical trainees over the two-year period of the program.

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### Introduction

Non-technical skills (NTS) accompany the manual technical skills of surgeons and are considered by many to be equally as important for the delivery of optimal and safe patient care.<sup>1</sup> NTS include communication, situational awareness, decision making, teamwork and leadership, amongst other skills. Poor NTS have been shown to contribute to medical error and negatively impact patient safety and clinical outcomes.<sup>2–4</sup> Teaching and assessing NTS during postgraduate medical training has been debated in many specialties, not least of all in surgery. Historically, there has been a perception by some that, while these skills are an integral part of practice for healthcare professionals, they cannot be taught or assessed reliably. There is, however, increasing evidence in the more recent literature that NTS can be taught and assessed successfully.<sup>5–7</sup> Nonetheless, most postgraduate training programs do not have a sustained, structured curriculum regarding NTS.<sup>8</sup>

In surgery, systems of assessment for technical skills have

existed for many years,<sup>9</sup> but there have been few curricula described for NTS, in any specialty.<sup>8</sup> There are some published and well-accepted approaches to assessing surgeons' NTS in the clinical setting,<sup>10,11</sup> however, these have not generally been used for assessment within a surgery curriculum. Similarly, Objective Structured Clinical Exams (OSCEs) for NTS have been described for surgery and other training programmes,<sup>7,12</sup> but not generally as part of an NTS-specific curriculum.

When we reviewed NTS curricula for surgical trainees described in the literature, we found that the majority of programs are of short duration<sup>13</sup> and often not mandatory.<sup>8</sup> The Royal College of Surgeons in Ireland (RCSI) has been delivering a mandatory curriculum of NTS instruction to trainees, 'Human Factors in Patient Safety', in the National Surgical Training Centre for almost 15 years.<sup>1</sup> To evaluate whether the program was achieving its intended purpose of improving the NTS of surgical trainees in Ireland, we designed an objective assessment of surgery trainees' NTS. We describe here the implementation of an OSCE assessment of NTS at the end of the second year of surgical training to evaluate the program's effectiveness and to determine whether formal NTS instruction in a two-year curriculum, as described, improved the NTS of surgical trainees.

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## Materials and methods

A static group pre-post-test study design was utilized to evaluate the effectiveness of the NTS program. The pre-post testing points were defined by the year of training in which the OSCE assessment was performed, at the start of Year one and at the end of Year two. The independent variable was the intervention, a two-year NTS training program. The dependent variables were defined as the degree of NTS competence of surgical trainees when (1) obtaining consent, (2) dealing with a colleague conflict, and (3) disclosing a surgical error to a patient. This study received ethical approval from the Research Ethics Committee of the Royal College of Surgeons in Ireland.

### Subjects

All trainees (surgery residents) enrolled on the National Surgical Training Program who completed the OSCE assessment at the start of their first year of training were eligible for inclusion in the study ( $N = 73$ ). They were subsequently required to participate in the Human Factors in Patient Safety program at RCSI during the first and second year of their training and to complete an OSCE assessment at the end of their second year.

### Intervention

The study intervention consisted of participating in the two-year Human Factors in Patient Safety program. The program's goal is to train surgical trainees regarding NTS and is delivered as part of a formal curriculum that also includes technical skills and core surgical theory instruction. Teaching of NTS occurs in a classroom setting and simulated environments where lecture-based instruction is kept to a minimum. To promote learner engagement, the instructional strategies used are meant to foster active participation through the use of small group discussions, role playing, high fidelity simulation and simulated patient and colleague encounters. The topics of instruction for the six full-day sessions (three per year over two years) were: Human factors, error and safety in hospital practice; Communication with patients and relatives; Crisis resource management; Conflict resolution and negotiation; Teamwork; and Disclosure and consequences of error. Over the two years described, each trainee underwent 42 h of instruction. The OSCE stations assessed three content areas within the curriculum: Communication with patients and colleagues; conflict resolution and disclosure of error.

Full attendance at the Human Factors in Patient Safety sessions and the final OSCE assessment were mandatory components of the trainees' surgical training program, thus all trainees received the intervention. As ours is a national training program, this meant that we were not able to study a control group who had no NTS instruction.

### Topics, outcome measures, and instrument

Baseline data regarding NTS was collected from a three-station OSCE prior to any instruction, at the very beginning of the first year of surgical training. The three topics addressed, one per OSCE station, were based on the content of the Human Factors in Patient Safety curriculum and their suitability for the assessment of both first and second-year surgical trainees. The topics were:

- 1. Obtaining consent:** The examinee was required to obtain informed consent from a simulated patient for a colonoscopy procedure.
- 2. Dealing with colleague conflict:** The examinee was required to negotiate assistance to conduct a bedside procedure from a nurse who is argumentative and reluctant to help.
- 3. Disclosing a surgical error to a patient:** The examinee was required to explain to a patient that a surgical sponge had been left in the patient's abdomen by the surgical team following a recent procedure and that a second procedure was now necessary to retrieve it.

Each OSCE station lasted eight minutes and was observed in real time by an attending level surgeon who had prior training in assessing NTS. Data was collected using the same three OSCE stations at end of Year two.

The scoring rubric for the OSCE was designed using the Calgary-Cambridge model<sup>14</sup> to assess simultaneously the content and process skills required for an effective consultation. 'Content' elements are specific to each station and consist of information that is considered vital to convey to the patient or colleague. 'Process' elements, are meant to measure how that information is conveyed, that is, generic communication skills that could apply to any scenario. These elements focus on effective and empathic communication. The examinees were observed by a single examiner per station and their performance was rated using a checklist to measure content and process variables. Each checklist element was marked as 'done' or 'not done'. For each OSCE station, there were nine content and 11 process (communication skills) elements. The 20 element scores were summed with equal weighting to produce an overall NTS score expressed as a percentage score for each OSCE station. A sample score sheet is included as an appendix.

The examiners were surgery faculty members currently involved in either the Human Factors in Patient Safety program or teaching clinical and communication skills to surgical trainees. Examiners had previous experience with the OSCE format and were given specific training with the scoring instrument used. The patients and colleagues in the scenarios were played (simulated) by professional actors who were experienced in the OSCE format and the fidelity standards required. The simulated patients and colleagues did not rate the candidates' performance.

### Data analysis

Paired *t*-test was used to test the differences between examinees' Year one and Year two OSCE mean NTS scores for each station. Data was analysed using the SPSS 18.0 software (SPSS Inc, Chicago, IL) and assessed for normality of distribution using the K-S independent test.

## Results

Subjects with incomplete data due to failure to complete either the pre or post training assessment were excluded from the study (23 excluded,  $n = 50$ ). These exclusions occurred because although the classes are mandatory, a certain cohort are occasionally unable to attend due to illness, personal reasons or clinical commitments. Others have exited the training program prior to completion of the two years, either voluntarily or because they have not passed their intercollegiate membership exam (MRCS) which is a prerequisite to completion of their Core Surgical Training. All 50 eligible residents consented to participate. The reliability of the OSCE scores was measured using inter-item correlation as it was a short-item scale (ideal range = .2 to .4). The inter-item correlation for the Year one OSCE was .18 and for the Year two OSCE was .24.

The mean percentage NTS OSCE scores obtained in Year two were significantly higher than those in Year one for all three OSCE stations (see Table 1 for details).

To analyze differences in individuals' scores over the two time points, a series of within subject (paired) *t*-tests were conducted. A significant difference between the Year one and two time points were identified for all three OSCE stations: Consent ( $-5.39$ ;  $P < .001$ ); Colleague Conflict ( $-8.63$ ;  $P < .001$ ); and Disclosure of Error ( $-7.56$ ;  $P < .001$ ). The data for this analysis is illustrated in Table 1. This paired analysis was performed to establish that the group mean score was not affected by a small number of individuals scoring highly and was a genuine reflection of consistent improvement across the trainee population. Figs. 1–3 show the results of the within-subject variation seen in each station.

Eta squared was used to calculate the effect size for the paired-samples *t*-test results. A large effect size was found for all three stations ( $\geq .138$ ): Consent station Eta squared was  $= .232$ ; Conflict Eta squared  $= .437$ ; Disclosure of error Eta squared  $= .368$ .

## Discussion

There was a statistically and practically significant improvement in the NTS scores of surgical trainees over the two-year period of the program. The positive results from the OSCE assessments have practical, meaningful value. In two of the stations (Conflict and Disclosure of Error) the mean score would have been classified as a 'Fail' (45.97% and 41.44%) if a pass rate of 50% was used. The improved score for these stations at the end of Year Two (74.04% and 68.65%) correspond to an 'Honors' grade using a traditional postgraduate scoring scale. The mean score in the Consent station started in the 'Pass' range and moved to a high 'Honor.' These results show a practical importance as a trainee may reach a point of competence in NTS after two years of training that they did not possess at the start of Year-One.

The baseline scores of the trainees at the start of Year-One in the Consent station were higher than those for the other two stations (59.36% versus 45.975% and 41.44% in Conflict and Disclosure of Error, respectively). This may be explained by the fact that obtaining consent for a simple procedure (colonoscopy in this case) is a task much more commonly performed in their intern year (the year preceding the first assessment) than managing a conflict with a colleague or disclosing an error to a patient. However, we were encouraged that even in this task, there was a significant improvement in NTS scores over the two years, despite the fact that in the Irish system, these trainees would have performed this task less frequently as they became more senior.

We acknowledge that other clinical experiences during this long two-year time period (besides the 42-h NTS training program), corresponding to the first two years of surgical training, may have contributed to these results. While we would hope that these improvements were a result of the Human Factors training they received, it is not possible to rule out all potential confounding factors with this particular study design. Ideally, we might have randomized our trainees into two groups, with one group serving as a control, in order to remove the possibility of maturation bias.<sup>15</sup> However, as ours is a national training program, all surgical trainees in Ireland receive the same instruction in NTS. This was already

established as a mandatory part of their training at the time this study was commenced and therefore, it was not possible to randomize to groups who did not receive the instruction. This fact also motivated our use of the pre-test design. While we are aware that the use of a pre-test itself may introduce testing bias by familiarizing the participants with the post-test content and by encouraging learning directed towards the post-test, the lack of randomization and the fact that the pre-test was already an established part of the program for formative feedback supported use of this design.<sup>15</sup> Thus a time series design could be used in similar studies in the future.

The 'process' skills measured are encompassed in the following categories: Initiating the Session; Building the relationship; Aiding accurate recall and understanding; Achieving a shared understanding/incorporating the other individual's perspective; Shared decision making, planning and closure. Each category contains a number of specific measurable skills which assess how the trainee's message is conveyed in each of the scenarios. The Scenario-specific content covers what is conveyed (see appended checklist for more detail). In addition to the two main sections of the scoresheet, there is an opportunity for the examiner to make a judgement on whether the trainee is 'Competent' (pass), Borderline or 'Not Competent' (fail). This subjective examiner judgement, distinct from the numerical score, allows us to use the Borderline Regression Method to establish a pass mark for that station based on the score curve of the current cohort. The examiners also have a 'Black Card' box which allows them to signal extreme examples of worrying or unprofessional behavior, such as dishonesty or aggression.

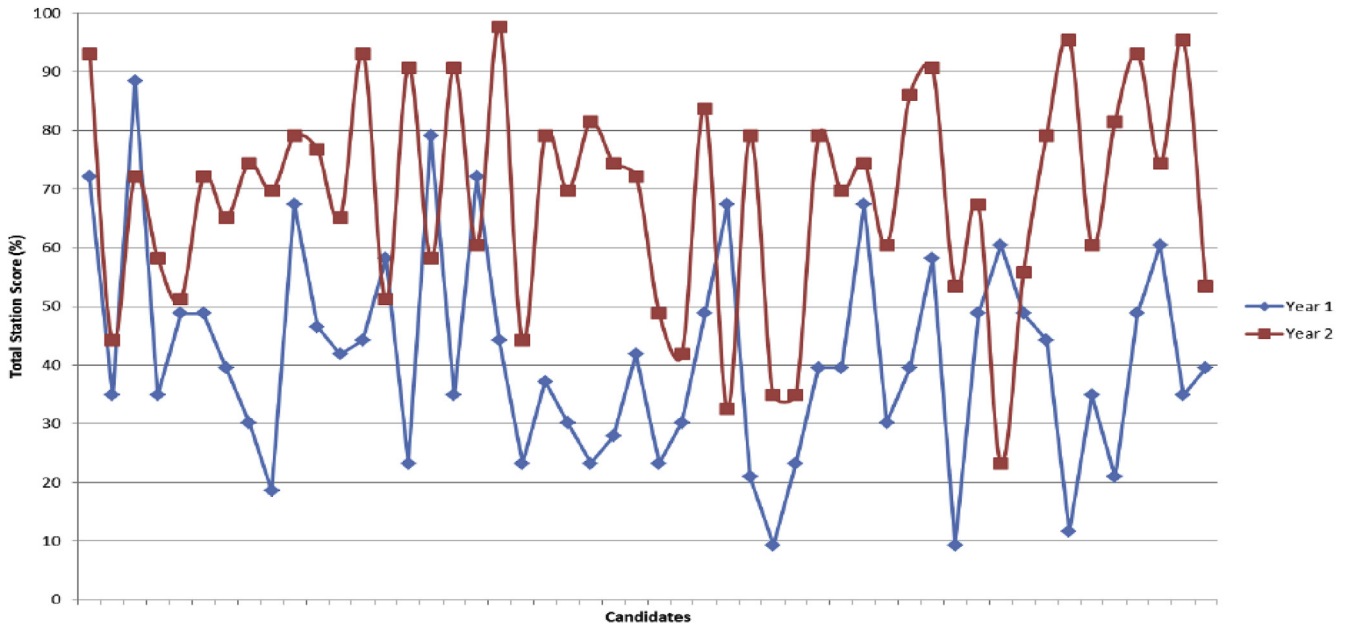
While the cohort of trainees as a whole shows significant improvement in these skills, a small minority of individuals within the group do not improve or show decreased scores over the two years. While these trainees do not represent the typical trajectory seen, we take remediation of this group very seriously. Those trainees who perform poorly in their NTS assessments (for example, fail the examination or have a 'Black Card' recorded against them) are offered remediation via one-to-one sessions with our Human Factors Director who is a trained Clinical Psychologist with three decades of experience in the field of healthcare NTS instruction. The individuals are given feedback on what areas of their NTS require development and offered further sessions as required, prior to their next assessment. Should this poor performance continue in subsequent assessments, they may be required to repeat some of the NTS instruction classes. The director of their residency program is also informed of this deficit in competency to allow for future monitoring and further remediation beyond the two-year program if required.

What we can say from our results is that trainees on the Irish Surgical Training Program as a group showed improved NTS scores at the end of their first two years of training. We are encouraged by this finding, as a strong body of published work has shown that these skills, particularly communication and empathy, often deteriorate as medical students or postgraduate trainees progress through their training.<sup>16,17</sup> All three OSCE stations measured communication skills and features of empathy in either the content or process scores on the checklists. The results indicate that our trainees' improvement in communication skills during their first two years of training is, at the very least, not consistent with trends in the literature towards a decline in these skills as trainees progress through their clinical career.

We sought to determine what elements within the first two years of training could be responsible for this improvement in NTS. Aside from the Human Factors program, trainees do not receive any other formal education or training in NTS during that time period. They may benefit from bedside teaching or role-modeling of these

**Table 1**  
Mean percentage NTS OSCE scores for the three OSCE stations in Years 1 and 2.

Station	Year	Mean	N	SD	t-test	P
1: Consent	1	59.36	50	15.00	-5.39	<.001
	2	73.82	50	17.53		
2: Conflict	1	45.97	49	27.01	-8.63	<.001
	2	74.04	49	18.58		
3: Disclosure	1	41.44	50	18.12	-7.56	<.001
	2	68.65	50	18.50		

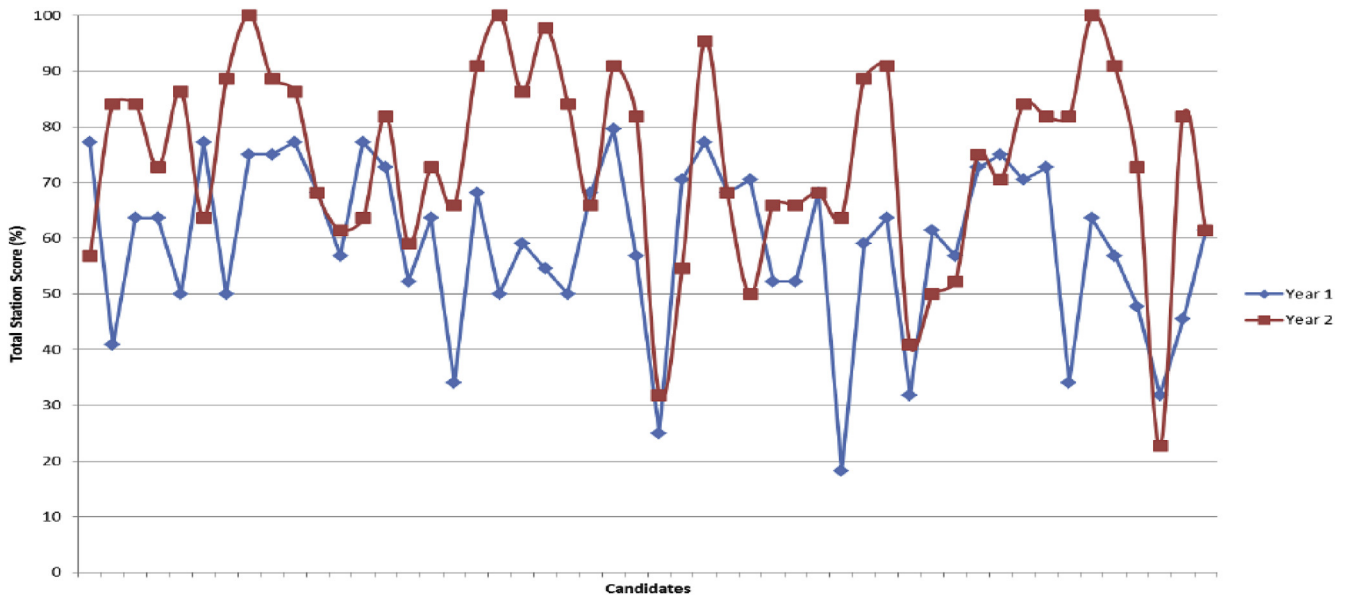


**Fig. 1.** Comparison of within-subject scores in ‘Disclosure of Error’ OSCE station for year one and two, demonstrating the difference in scores for individual trainees at each time point.

skills from their attending or more senior residents. However, a focus on NTS in the clinical setting is not common or consistent across surgical training posts. Our results show a consistent improvement across the trainee group as a whole, which indicates that an element common to each individual’s training is most likely to be responsible. As ours is a national training program, there is significant variation in each clinical training rotation (location, trainers, case mix, patient exposure and specialty). The only consistent variables are duration of experience in the clinical setting and the structured curricula in technical and NTS that they receive outside the clinical environment. It is possible that duration of training alone may lead to improvements in NTS by increasing the number of patient, relative, and colleague encounters, but the

opposite has been demonstrated in the literature as outlined above.<sup>16,17</sup> Further research is ongoing in our department to outline the possible sources of variability across multiple types of assessment of these trainees over the two year period. This will provide more detail on the performance of individual trainees and factors that may influence their competence.

In order to provide further evidence to support the role of the Human Factors program in the improved NTS scores, it would have been preferable to have performed additional pre and post measurements at more time points during the two years. Unfortunately, it was not feasible to gather this data as the OSCE style assessment required significant faculty and time resources. We are currently considering the design of an alternative, shorter assessment that



**Fig. 2.** Comparison of within-subject scores in ‘Consent’ OSCE for year one and two.

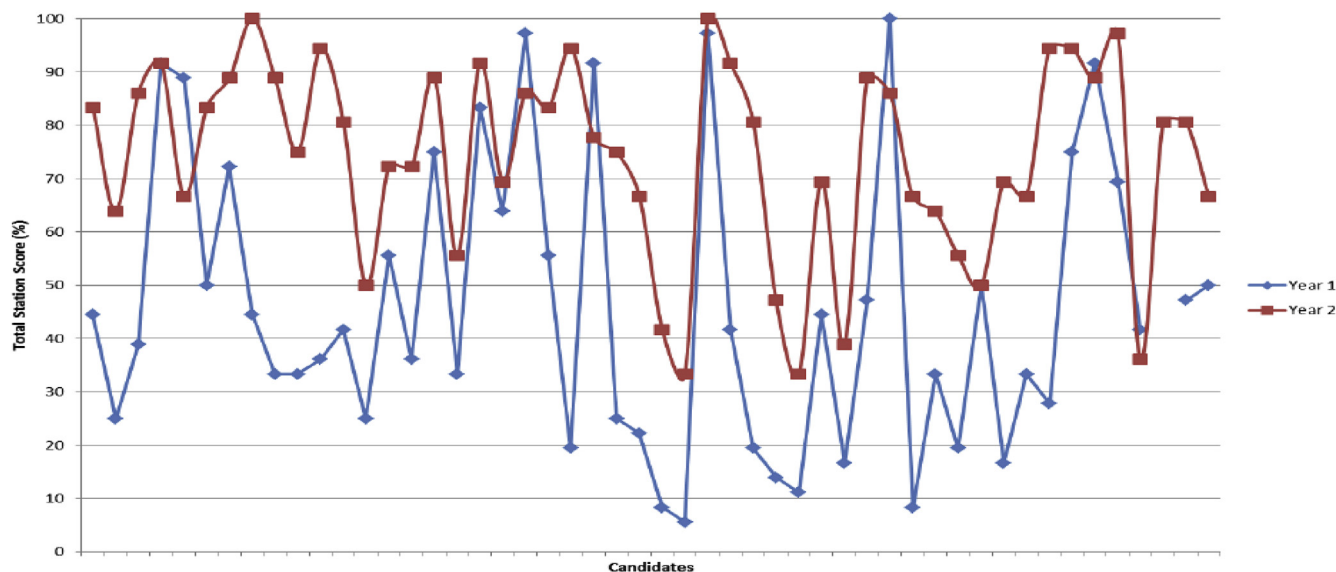


Fig. 3. Comparison of within-subject scores in 'Colleague Conflict' OSCE for year one and two.

may be conducted at multiple times throughout the program, in a time series fashion. Our group is also investigating changes in attitudes toward NTS instruction amongst senior surgical training faculty to see if there has been a culture shift within surgery in Ireland that may account for the improved NTS seen in our trainees.

We are conscious that the Human Factors program is a multifactorial intervention encompassing many different instructional methods as mentioned above.<sup>1</sup> In addition to this, the trainees' clinical experience over the two years is also multifactorial and therefore subject to confounders. However, the formal NTS instruction provided, based on Kolb's learning cycle,<sup>18</sup> compliments the trainees' clinical experience by focusing on reflection on simulated and real events. Consistent with Kolb's theory of experiential learning, the design of the instruction, taking place on six days, separated by a number of months, over two years, allows the trainee to practice use of the skills taught in the classes in the clinical environment. In this way, we hope the cycle of experiential learning is completed, and repeated many times, over the two-year period. This design also supports *Transformative Learning*, where critical reflection challenges the learner's beliefs and assumptions.<sup>19</sup> This theory is essential to the type of attitudinal and behavioral change that we are attempting to achieve with this training.

## Conclusions

As governing bodies in graduate medical education worldwide move to mandate instruction and assessment of core competencies, many of which relate to NTS,<sup>20–22</sup> NTS curricula, instruction, and assessments are in high demand across specialties.<sup>23</sup> RCSI has a unique NTS program that can contribute to the development of NTS skills of trainees. We currently deliver this program to cover all eight years of surgical training and already have a cohort of attending level surgeons who have received formal NTS instruction from the start of their training. We plan to compare this group to a similar cohort who have not received this type of instruction and hopefully show the full extent of the impact of structured education in non-technical skills.

## Declaration of competing interest

This material has not been published, submitted for consideration or presented elsewhere. All authors listed have contributed sufficiently to the project either in the study design, data collection or analysis. All have assisted in writing, reviewing or editing the manuscript.

To the best of our knowledge, no conflict of interest, financial or other, exists.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2020.04.039>.

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