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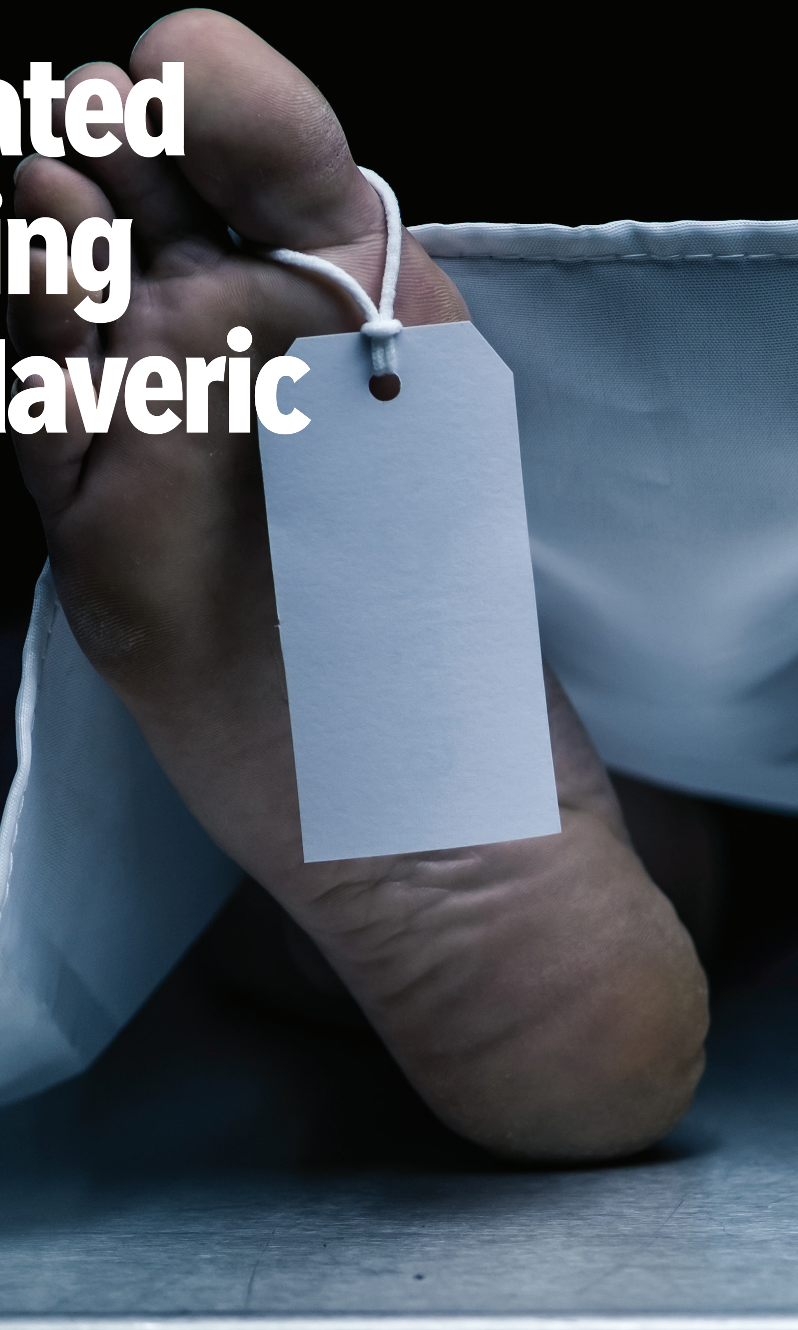
Closing the pandemic-related surgical training gap using cadaveric simulation



Can simulation training methods help recover surgical training and bridge the gap in learning opportunities?

HK James Registrar in Trauma and Orthopaedic Surgery[1]
C Langley Consultant Orthopaedic Surgeon[1]
V Menon Consultant Upper GI, Bariatric, Laparoscopic and General Surgeon[1] and Honorary Professor[2]
S Sankar Consultant Physician[1]
S Robertson Consultant Breast Surgeon[1]
[1]University Hospitals Coventry and Warwickshire NHS Trust, UK
[2]Warwick Mecical School University of Warwick, UK

Disruption to surgical training due to the combined effects of elective service cancellations and trainee redeployment during the COVID-19 pandemic has been widely acknowledged.[1] The viral success of the Twitter hashtag #NoTrainingTodayNoSurgeonsTomorrow shows the high level of concern among the profession about the enduring impact of the crisis. A review of trainee logbooks comparing activity in 2019 with 2020 found a 50% reduction in procedures with trainees recorded as the primary surgeon.[2] This is especially problematic in the modern training climate where minimum indicative logbook numbers must be achieved to complete training successfully.[3]

The General Medical Council has been clear that the usual outcomes of training must be met and that "the bar [...] will not be lowered" despite the challenges of the pandemic.[4] The timely throughput of Certificate of Completion of Training holders must be maintained both for consultant workforce planning and to enable continued recruitment into training programmes.[5] In April 2021, it was reported that approximately 20% of trainees across all surgical specialties were held on Outcome 10.1 or 10.2 (the COVID-19 "no fault" outcomes) at their annual review of competence progression,[2] suggesting a significant number are at risk of extensions and have unmet training needs.

With the restoration of normal surgical services well underway, attention is turning to the considerable challenge of training recovery. In collaboration with the Association of Surgeons in Training, the British Orthopaedic Trainees Association and the Confederation of Postgraduate Schools of Surgery, the Joint Committee on Surgical Training released a document in November 2020 entitled *Maximising Training: Making the Most of Every Training Opportunity*. Essentially a mission statement, it outlines a comprehensive and multifaceted training recovery strategy at local, regional and national levels. This includes the use of simulation to boost training where "relevant, available and deliverable".[2]

There is an emerging evidence base for the use of simulation to augment complex surgical learning curves. A meta-analysis from 2021 found that there is a significant effect of simulation training on operative performance as assessed by workplace-based assessments as well as a measurable reduction in operative time.[6]

High fidelity simulation (and specifically cadaveric simulation) has been of particular interest recently as it offers the opportunity for trainees to practise operations in their entirety with exceptionally high anatomical fidelity.[7] This is theorised to enable rapid acquisition of technical skills and attainment of competence in a safe, controlled environment that is remote from patients. In the post-pandemic training climate, this is an attractive technology to enable rapid upskilling of large numbers of trainees to address their learning deficits in a targeted and individualised manner.

A common criticism of cadaveric training is that it is expensive and resource intensive.[8] Previous work has explored the feasibility of delivering multispecialty[9] and multidisciplinary[10] cadaveric training courses in the same sitting to a diverse group of learners using one set of cadavers across multiple applications. We aimed to initially measure the training gap due to training disruption resulting from the COVID-19 pandemic, and then assess the feasibility and educational impact of a "catch-up" simulation training course delivered to a wide variety of surgical specialties using a single set of cadavers.

METHODS

The COVCUT course

The COVid Catch-Up Training (COVCUT) course was conceived to start addressing surgical training lost to local trainees as a result of the COVID-19 pandemic, utilising focused cadaveric training. The course was kindly supported with funds from the medical education department so it was free of charge to the trainees. Surgical and anaesthetic colleagues from different disciplines (general surgery, oral and maxillofacial surgery, otolaryngology, plastic surgery, trauma and orthopaedic surgery, and vascular surgery) joined forces to provide three days of intensive cadaveric training. This was hosted in May 2021 at the West Midlands Surgical Training Centre, a leading cadaveric laboratory in Coventry with permanent staff that hosts a wide portfolio of surgical simulation courses.

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The COVCUT course was designed for maximum resource efficiency in terms of both time and cadaveric material. Fresh frozen, whole-body cadavers were purchased and imported under licence. The course programme was deliberately

Table 1 Course Program

Day 1:	General surgery and vascular surgery (torso)
	Laparoscopic/open appendicectomy*
	Laparoscopic cholecystectomy*
	Open inguinal/femoral hernia repair*
	Laparotomy*
	Right hemicolectomy (bowel mobilisation)*
	Splenectomy*
	Left colonic mobilisation*
	Exposure of abdominal aorta/IVC/iliac vessels*
Day 2:	Trauma and orthopaedic surgery
	Fasciotomy for compartment syndrome*
	Approaches to the hip for THR*
	Approaches to the wrist for ORIF*
	Approaches to the knee for osteotomy/TKR*
	Pelvic packing
	Posterolateral approach to the ankle
Day 3 (AM):	Anaesthetics/otolaryngology/OMFS
	Emergency front of neck access in airway management*
Day 3 (PM):	Mastoid exploration*
	Cortical mastoidectomy*
	Parotidectomy
	Rhinoplasty
	Frontal sinus drainage
	Submandibular gland excision
	Neck abscess drainage
	Al-Kayat–Bramley/coronal flap
	Plastic surgery and vascular surgery (limb)
	Deep inferior epigastric perforator flap*
	Anterolateral thigh flap*
	Gracilis flap*
	Gastrocnemius flap*
	Forearm flap*
	Anterior tibial artery exploration

IVC = inferior vena cava; OMFS = oral and maxillofacial surgery; ORIF = open reduction and internal fixation; THR = total hip replacement; TKR = total knee replacement
*Index procedure

designed to enable reuse of the cadavers by different specialties; the timing was carefully planned so that relevant body areas were left unviolated wherever possible to increase the realism of the simulation. The course was overseen by faculty from the relevant specialties.

Participants were asked in advance of the COVCUT course to write down their own learning objectives and identify procedures they wished to undertake. The course programme was then designed to focus on the requested procedures while also permitting an unstructured element on the day to allow participants to focus on their bespoke learning objectives under consultant faculty supervision, depending on individual trainee needs. Consultant faculty were on hand for supervision and direction at all stages. The laboratory could accommodate up to 16 trainees owing to social distancing requirements and full personal protective equipment was provided. Six cadavers were available and shared between the different specialties on different days.

The course programme is shown in Table 1. Day 1 related to general surgery and vascular surgery (torso), and day 2 to trauma and orthopaedic (T&O) surgery. The morning of day 3 dealt with head and neck procedures (anaesthetics/otolaryngology/oral and maxillofacial surgery [OMFS]) while the afternoon covered plastic surgery and vascular surgery (limb).

Participants

Eligible participants comprised surgical trainees (CT1–ST8) who were in post at University Hospitals Coventry and Warwickshire NHS Trust in May 2021. An email invitation was sent by the medical education department to all eligible trainees. Participation was voluntary and free for trainees. Formal ethical approval was deemed not to be required as this work falls within the remit of course evaluation. The West Midlands Surgical Training Centre holds the appropriate Human Tissue Authority licence for the delivery of cadaveric surgical training.

Measuring the training gap, feasibility and educational impact

Given the known methodological difficulties of objectively measuring technical skill and surgical competence,[11] as well as the impact of cadaveric simulation training on workplace performance,[7] we took the pragmatic decision to measure the training gap and educational impact using trainee self-assessment of their procedure-based assessment (PBA) levels. The training gap is defined here as being the difference between where a trainee feels their performance is currently versus where it would be had there not been disruption to training as a result of the COVID-19 pandemic. The training gap is expressed using the PBA level descriptors from the Intercollegiate Surgical Curriculum Programme,[12] where a gap of 1 level is the difference between levels 1a and 1b or between levels 1b and 2a etc.

The PBA is a ubiquitous, pan-specialty assessment tool that has been widely validated for use in workplace performance assessment of higher surgical trainees.[13,14] The revised global rating scale level descriptors from the PBA[12] were used in this study as they can be applied to any procedure; the checklist items were discarded as these are procedure specific.

Participants were asked to list three procedures they performed on the COVCUT course, to indicate whether these were index procedures in their specialty, and to self-rate their PBA level from before and after the course (both items collected post-course). Trainees were also asked to estimate their training gap as measured by PBA global rating scale descriptors for each of their three procedures (as defined above) and to quantitatively estimate the number of weeks of training lost during the pandemic, judged against the Joint Committee on Surgical Training quality indicator criteria for the average surgical training week (indicative minimum of 3 consultant supervised theatre sessions and 2 consultant supervised clinics).[15] Feasibility and acceptability of the COVCUT training course were measured using a five-descriptor qualitative Likert scale (1 = strongly disagree, 5 = strongly agree).

RESULTS

Baseline participant characteristics are shown in Table 2. Twenty-six participants enrolled in the COVCUT course. Their training grades ranged from CT1 to ST6, with more than half being ST3 or below. Six

Table 1 Participant demographics

	n
Grade	
CT1/CT2	6 (23%)
ST3	9 (35%)
ST4	4 (15%)
ST5	4 (15%)
ST6	3 (12%)
Sex	
Male	19 (73%)
Female	6 (23%)
Not stated	1 (4%)
Specialty	
Anaesthetics/intensive care	6 (23%)
General surgery	4 (15%)
Oral and maxillofacial surgery	1 (4%)
Otolaryngology	3 (12%)
Plastic surgery	4 (15%)
Trauma and orthopaedic surgery	7 (27%)
Vascular surgery	1 (4%)
Total	**26 (100%)**

surgical specialties were represented: general surgery (*n*=4), OMFS (*n*=1), otolaryngology (*n*=3), plastic surgery (*n*=4), T&O (*n*=7) and vascular surgery (*n*=1). Anaesthetic and intensive care trainees (*n*=6) also participated by invitation. All participants completed the course evaluation survey.

The training gap

A wide range of procedures (*n*=29) were performed by course participants (Table 1). Eighteen (62%) of these were index procedures in the relevant specialty. A narrative, descriptive analysis of the results is presented in view of the small subgroups and heterogenous participants, which precluded formal statistical inference/significance testing.

A mean training gap of 1.36 PBA levels was reported across all procedures and specialties (range: 1–3, *n*=64) (Table 3). The mean training gap for index procedures was greater than for non-index procedures (1.74 [range: 0–3, *n*=47] vs 1.06 [range 0–3, *n*=17]).

When stratified by specialty (for all procedures), the mean training gap was largest for vascular surgery (3.0 [range: 3–3, *n*=3]) and smallest for T&O (0.9 [range: 0–2, *n*=21). When grouped by stage of training, the mean training gap was greatest for ST3/ST4 trainees at 1.5 (range: 0–3, *n*=32). This compared with a mean of 1.2 (range: 0–3, *n*=18) for CT1/CT2 trainees and a mean of 1.3 (range: 0–2, *n*=14) for the ST5/ST6 subgroup.

Trainees reported a self-estimated mean loss of 17 weeks of surgical training due to disruption from the COVID-19 pandemic (range: 2–52 weeks, *n*=26).

Educational impact of the COVCUT course

The change in trainee reported PBA level following the catch-up training course was measured (Table 4). This is representative of the progress towards closure of the training gap (as detailed in Table 3).

Overall, the mean change in PBA level following participation in the COVCUT course was +1.51 (with "+" indicating an improvement) (range: 0–5, *n*=64). All specialties showed improvement in training gaps for both index and non-index procedures (where measured). A greater gap closure was seen in index procedures than in non-index procedures (mean gain of +1.66 [range: 0–5, *n*=47] vs +1.19 [range: 0–5, *n*=17]).

Grouping the results by specialty, anaesthetics trainees reported the highest mean gain (+2.5 [range: 1–5, *n*=6]) and T&O trainees reported the lowest (+0.9 [range: 0–5, *n*=21]). Looking at the stage of training, the ST3/ST4 subgroup reported the greatest mean

Table 3 COVID-19 related training gaps reported by trainees

	Index procedures		Non-index procedures		All procedures	
	Mean change*	Range (n†)	Mean change*	Range (n†)	Mean change*	Range (n†)
Specialty						
Anaesthetics	1.0	1 (6)	–	–	1.0	1 (6)
General surgery	1.7	0–3 (11)	–	–	1.7	0–3 (11)
Oral and maxillofacial surgery	–	–	1.0	1 (3)	1.0	1 (3)
Otolaryngology	2.0	2 (2)	1.5	0–2 (6)	1.6	0–2 (8)
Plastic surgery	1.6	1–2 (12)	–	–	1.6	1–2 (12)
Trauma and orthopaedic surgery	0.9	0–2 (16)	0.8	0–1 (5)	0.9	0–2 (21)
Vascular surgery	–	–	3.0	3 (3)	3.0	3 (3)
All specialties	**1.74**	**0–3 (47)**	**1.06**	**0–3 (17)**	**1.36**	**1–3 (64)**
Stage of training						
CT1/CT2	1.2	0–3 (17)	1.0	1 (1)	1.2	0–3 (18)
ST3/ST4	1.3	0–3 (24)	1.9	0–3 (8)	1.5	0–3 (32)
ST5/ST6	1.6	0–2 (9)	0.8	0–1 (5)	1.3	0–2 (14)
All training stages	**1.34**	**0–3 (50)**	**1.42**	**0–3 (14)**	**1.36**	**1–3 (64)**

*Expressed as procedure-based assessment levels using descriptors from the Intercollegiate Surgical Curriculum Programme.[12] A gap of 1 level is the difference between levels 1a and 1b, 1b and 2a etc.
† Number of procedures

Table 4 Change in trainee reported procedure-based assessment (PBA) levels following catch-up training

	Index procedures		Non-index procedures		All procedures	
	Mean change*	Range (n†)	Mean change*	Range (n†)	Mean change*	Range (n†)
Specialty						
Anaesthetics	+2.5	1–5 (6)	–	–	+2.5	1–5 (6)
General surgery	+2.0	0–5 (11)	–	–	+2.0	0–5 (11)
Oral and maxillofacial surgery	–	–	+1.0	1 (3)	+1.0	1 (3)
Otolaryngology	+0.5	0–1 (2)	+1.5	0–2 (6)	+1.1	0–2 (8)
Plastic surgery	+1.1	1–2 (12)	–	–	+1.1	1–2 (12)
Trauma and orthopaedic surgery	+0.9	0–5 (16)	+1.0	0–2 (5)	+0.9	0–5 (21)
Vascular surgery	–	–	+1.5	1–2 (3)	+1.5	1–2 (3)
All specialties	**+1.66**	**0–5 (47)**	**+1.19**	**0–2 (17)**	**+1.51**	**0–5 (64)**
Stage of training						
CT1/CT2	+1.7	0–5 (17)	0	0 (1)	+1.6	0–5 (18)
ST3/ST4	+1.6	0–5 (24)	+1.6	1–3 (8)	+1.6	0–5 (32)
ST5/ST6	+1.2	0–3 (9)	+0.8	0–1 (5)	+1.1	0–1 (14)
All training stages	**+1.58**	**0–5 (50)**	**+0.89**	**0–2 (14)**	**+1.50**	**0–5 (64)**

*Expressed as PBA levels using descriptors from the Intercollegiate Surgical Curriculum Programme.[12] A change of 1 level is the difference between levels 1a and 1b, 1b and 2a etc.
† Number of procedures

gain (+1.63 [range: 0–5, *n*=32]) while ST5/ST6 trainees reported the lowest (+1.07 [range: 0–1, *n*=5]).

Feasibility

Feasibility and acceptability were found to be excellent (Table 5). There was unanimous (100%) agreement (strongly agree or agree) that the COVCUT course helped close the training gap, that it should run every year, that simulation is important for post-pandemic training recovery and that it should be centrally funded by Health Education England. Three-quarters (73%) of trainees agreed or strongly agreed that sharing cadavers with other specialties worked well and did not affect the anatomical fidelity of the simulation in their specialty in a negative way.

DISCUSSION

At the time of writing, to our best knowledge, this is the first work reporting a procedural training gap due to the pandemic. We also believe that this study is the first description in the literature of high anatomical fidelity simulation being applied to post-pandemic surgical training recovery.

Our results demonstrate that following the COVID-19 pandemic, there is a considerable trainee reported training gap (mean of 1.36 PBA levels), with a significant loss of training time (mean reported estimated loss of 17 weeks). This gap is seen across specialties and training grades, and in both index and non-index procedures.

The COVCUT course went a long way towards closing the training gap, with a mean gain of +1.51 PBA levels across all grades/specialties following participation in the course. It may be that the bespoke nature of the training meant that participants could target their own specific learning needs, as supposed to a "one-size-fits-all" model seen in more traditional didactic course structures. By prospectively identifying learning objectives and then being supported to address these individualised objectives by faculty, the cadaveric laboratory time was used to maximum effect by each trainee and wasted time was minimised. This method has been used successfully for other cadaveric training courses for higher surgical trainees.[10,16]

In designing the COVCUT course, we tried to optimise resource efficiency and not hinder other specialties following on. For example, bowel stapling and anastomosis work was avoided to reduce faecal contamination (instead focusing on bowel mobilisation during this course), and we were fair and considerate in use of body parts that multiple specialties would require (eg limb work was carefully coordinated between orthopaedic, plastic and vascular

Table 5 Trainees' perception of value of catch-up learning

With respect to training course:	% agree/ strongly agree
Helped close training gap	100%
Should run every year	100%
Sharing cadavers with other specialties worked well	73%
Simulation is important for training recovery	100%
Should be funded centrally by Health Education England	100%

surgery sessions so that learning objectives could be achieved for each specialty). Previous multispecialty cadaveric courses have shown this to be feasible.[9]

The length of the course and number of specialties that we could invite was limited by the laboratory time and resources available when the course was held (3 days in May 2021, during the pandemic). Ideally, more time would have been allocated to each specialty and we plan to alter the format for future courses to allow this. Nevertheless, the laboratory staff felt that extending the course beyond 3–4 days would be difficult as tissue quality can deteriorate significantly beyond that. It may be that we run the COVCUT course more frequently throughout the year in future so that each specialty can cover more procedures and more trainees can attend. Alternatively, subsequent courses could be broken down into more frequent sittings with fewer specialties in order to address this.

Study limitations

There are several weaknesses to this work. For pragmatic reasons, we relied on subjective, self-reported measures to draw inferences about the impact of the course. This may have introduced bias as the pre and post-course self-assessments were measured at the same sitting (after the course). A widely accepted and validated measurement tool was used in an attempt to mitigate this. Although the PBA is validated for workplace-based assessment rather than course outcomes, it was the most feasible and acceptable tool available to us. The finding that anaesthetic trainees had the greatest learning gains may be artefactual as they do not use the PBA global rating scale routinely in training and may therefore be less familiar with the appropriateness of the descriptors.

Our small and heterogenous participant cohort means that the subgroup analyses should be interpreted with caution, particularly in those specialties where there was only one participant (OMFS and vascular surgery). We chose to present a descriptive analysis rather than undertake statistical testing for this reason. The comparatively small learning gain seen in T&O may relate to the fact that implants were not available and so the learning objectives focused mainly on surgical approaches.

Questionnaires completed after the training course may be subject to recall bias. Participation was voluntary and it is possible that the cohort of trainees who took part were self-selecting, either in being exceptionally motivated or perhaps in perceiving themselves as having a particularly significant training gap as a result of training disruption compared with their peers.

CONCLUSIONS

There is a subjectively measurable training gap following COVID-19 disruption to surgical training and an intensive cadaveric simulation training intervention with bespoke learning objectives appears to go a long way towards closing this. It is feasible to deliver a time and resource efficient cadaveric course for multiple surgical specialties in one sitting. Catch-up simulation is acceptable to trainees, who report that it should be funded centrally and embedded in regular training provision.

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