Scotland's "Incentivised Laparoscopy Practice" programme

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Scotland's "Incentivised Laparoscopy Practice" programme: engaging trainees with take-home laparoscopy simulation.

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HIGHLIGHTS

- **Feasibility and implementation studies involving home-based laparoscopic simulation.**
- **A pioneering national deliberate practice programme achieving trainee engagement.**
- **A wider programme is needed to support the use of home-based simulated practice.**
- **Distributed access to practice, motivated learners, feedback and assessment are key.**

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INTRODUCTION

Laparoscopic operating skills gained in the early years of surgical training have been reported to fall short of desirable standards, (1) even in contexts where formal assessment of these skills has been introduced to support quality assurance (e.g. the Fundamentals of Laparoscopic Surgery exam (2)). The reasons for this gap between actual and desired levels of competence are complex. The gap may relate, at least to some extent, to trainee/resident simulation practice being mostly *ad hoc* and self-directed, rather than deliberate and structured.

Stefanidis et al described a formula for a successful laparoscopic skills curriculum which requires participant motivation, availability of resources and personnel, trainee and faculty commitment, goal-oriented training, sensitive and objective performance metrics, appropriate methods of instruction and feedback, deliberate distributed and variable practice, an amount of overtraining, maintenance training, and a cognitive component. (3) In their institution, attendance rates jumped from 6% to 71% when time was dedicated specifically to skills training and supervising personnel were hired. (4) Moulton et al also advocate distributed practice, showing improved skills transfer compared with the same training in a massed event. (5) However, these and other studies refer to workplace-based practice rather than take-home simulation.

Drawing on the principles and outcomes of Deliberate Practice (DP) reported widely in disciplines such as music and sports, some training programmes in the UK and Ireland have provided trainees with resources and guidance for self-directed DP in their own time, using portable simulators and a modular curriculum. Evidence suggests that DP is the most important variable in the development of expertise, (6-8) allowing motor skills to become automated and freeing up a trainee's attention ("bandwidth") for the higher cognitive functions of surgery, i.e., non-technical skills. (9) However, in contrast with professional musicians and sports people, it has proved surprisingly difficult to achieve consistent engagement with DP amongst surgeons in training. (10, 11) Yet if trainees do not engage with DP, they may struggle to gain necessary skills within limited training hours and restricted access to patients.

In the first of our group's two previous studies, (12) only seven of 21 Core Surgical trainees (CST, equivalent to residency year 1 and 2) completed a modular DP programme using take-home laparoscopic simulators ("Incentivised Laparoscopy Practice" (ILP v1)) despite free provision of robust and portable, well-validated simulators with an online curriculum, (13) metric scoring by

software and remote feedback on uploaded videos by faculty, and incentivisation in the form of an eCertificate to provide evidence to their trainers. Reasons given for non-completion included technical problems, competing demands on time (e.g., College examinations [MRCS]), lack of understanding of the educational rationale behind the programme, and career intentions in non-abdominal subspecialties. This was similar to experiences reported to us by colleagues in the Republic of Ireland (14) and in the Wessex and Severn deaneries of England (personal communications).

In a second study in 2017 we explored the barriers and facilitators to engagement with ILP in all four geographical regions. Analysis of data from focus groups with trainees, trainers and training programme directors informed the redesign of our ILP programme in Scotland. (15) Key findings included a lack of appreciation of the evidence for simulation in skill development, a focus on engaging with 'point scoring' tasks driving career progression and a desire for individualised in-person feedback. Programme redesign was also informed by a thematic analysis of 22 papers published in 2016 identifying the core factors for successful "off-site training of laparoscopic skills". (16)

In this, our third paper, we report how the principles of DP coupled with the information gathered from our previous two studies informed the further development of the ILP programme – v2.1 onwards – and affected trainee engagement when it was implemented as business-as-usual for three consecutive whole year-groups of new-start surgical trainees. The evidence-informed curriculum reform is detailed in table 1. ILP was incorporated into a fully-funded simulation strategy, which in turn was part of a wider curriculum reform known as "Improving Surgical Training" (IST), and delivered Scotland-wide since 2018. The wider simulation strategy is summarised in figure 1.

METHODS

This was a training quality improvement (QI) process, without any randomisation or changes to patient care, and we did not aim to generate generalisable results. Therefore research ethics committee approval was not required.

Our revised Incentivised Laparoscopy Practice (ILP v2.1) programme was provided for all Scottish year 1 CSTs from 2018, the year of introduction of the afore-mentioned IST. These trainees are posted across 18 training hospitals.

As in our first pilot study of 2014-15 (ILP v1), (12) trainees were loaned robust and portable simulators free-of-charge (eoSim, eoSurgical, Edinburgh, UK; eosurgical.com). The simulators'

instrument tracking software complemented a well-validated online curriculum of modular tasks (figure 2) and instructional videos. The hardware and software enabled trainees to see their metric scores (e.g. time to complete task, hand dominance, economy of movement) and upload videos for structured scoring by faculty (app.surgtrac.com). (13) Moreover, trainees completing and passing the programme were rewarded with an incentive (an eCertificate) to provide evidence to their trainers.

Programme revisions resulting from the findings of the second study (see table 1) were incorporated for v2.1. Note that the list of responses (changes to the programme) includes face-to-face instruction, technical support, and attempts to engage Educational Supervisors and peer-groups. For assessments, trainees were required to upload videos of 2 of the 6 tasks for anonymous scoring by a panel of faculty using a structured assessment proforma similar to OSATS (Objective Structured Assessment of Technical Skill (17)), but with additional free text for feedback (see figure 3). A similar assessment of 2 further tasks was done face-to-face at the end of the programme.

For the 46 trainees in the 2019-20 and 2020-21 cohorts, we made some further refinements ("ILP v2.2 & v2.3"), to embed it even further into the wider core surgical training system. These were: shifting the timing of induction and assessments, group practice in Boot Camp, a requirement for six rather than 2 video uploads (one for each module, figure 2) for scoring. The latter was done not only for consistency but out of necessity for adaptation to the COVID pandemic.

Completing and passing the ILP programme could not be made a mandatory condition for progression in training because (a) that would have presented trainees in our deanery an additional hurdle compared with those in the rest of the UK, and (b) Core Surgical Training includes trainees pursuing non-laparoscopic and non-arthroscopic specialties. However, the Training Programme Directors and Associate Deans agreed that it would be "taken into account at Annual Reviews alongside other evidence of engagement and progression."

The pass mark (an average 9/21 per video) was determined by previous years' data. At previous end of year face-to-face assessments of task performance (2 tasks only – dice stacking and precision cutting), there had been a cluster of 4 trainees below this score who had informed us they had submitted videos but had not engaged with DP, while the remainder who had engaged all scored >11/21. In v2.3 the pass mark was adjusted to 11/21, as a result of recalibration using the v2.1 and v2.2 groups. This variation in pass mark during the programme was tolerated because the purpose of the assessment in this implementation phase was incentivising practice rather than investigating skills transfer.

After completion of year 1 of Core Surgical Training, each year group was sent an e-survey by Questback (questback.com) as part of routine feedback and QI for the whole IST simulation strategy. This included demographic information plus previous laparoscopy and gaming experience, so groups could be compared with the ILP v1 group. (12)

RESULTS

Once the revised programme was incorporated into the Core Surgery simulation strategy as business-as-usual from 2018, the 3 subsequent ILP cohorts included entire 1st year groups of trainees: 48 in 2018-19, 46 in 2019-20, and 53 in 2020-21. Of these, 25, 22 and 12 trainees respectively returned the Core Surgical Training programme's end-of-year feedback survey, which included questions about ILP. It should be noted that the earlier ILP v1 study in 2014-15 (effectively our historical control group) had recruited only those Scottish CST year 1 and 2 trainees who had volunteered for the study and whose first posting was to General Surgery (27 trainees),

Table 2 shows the proportion of each cohort completing the programme and attaining the OSATS pass mark of at least 9/21 (v2.1 & 2.2) or 11/21 (v2.3) (whether at 2 final face-to-face assessments in ILP v1, at 2 video uploads and 2 face-to-face assessments in v2.1, or across 6 uploaded videos in ILP v2.2 and v2.3). This completion rate rose from just 26% in the ILP v1 group, to 94% in ILP v2.1, 76% in v2.2 and 70% in v2.3.

In v2.2 and v2.3, trainees were asked if their "experience of the simulation package (figure 1) was hampered by the COVID pandemic" (which arrived in March 2021, i.e. about two months before the closing date for ILP v2.2 video uploads, and caused extensive trainee redeployments). All of the 22 trainees who responded in v2.2 (during the start of the pandemic) reported it had been hampered – 16 "yes" and 4 "slightly" – with the effect recovering partially by the following year (see table 2).

The ILP 2018-21 trainee cohorts (v2.1-v2.3) were more evenly balanced for gender than the predominantly male ILP v1 group of 2014-15 (see table 2). Whereas 31% of the earlier, voluntary ILP v1 group had reported prior electronic gaming experience of at least 3 hours per week, only 12%, 9% and 8% of the v2.1-v2.3 respondents did so. The majority of v2.1-v2.3 respondents had assisted at laparoscopic surgery before starting the programme. In v2.1 & v 2.2, 44% and 42% had previously mobilised a gallbladder or an appendix, but only 8% in v2.3. No data on prior laparoscopic experience were available for the earlier ILP v1 group.

In all cohorts, only a minority of respondents (17/59) reported their local Educational Supervisor taking an interest in this centrally organised programme. Latterly, local hospital-based skills clubs

(for this and other technical skills) grew in popularity, such that a third of respondents in ILP v2.3 could engage in group practice at these clubs using their loaned eoSim or one like it, alongside other activities.

Across the 3 year-groups from 2018 onwards, 69% of respondents (41/59) said they would recommend the programme to others. However only 56% (33/59) reported they had "gained confidence in approaching laparoscopic surgery (eg appendicectomy or cholecystectomy)".

DISCUSSION

Following our earlier studies examining how best to engage core surgical trainees with home-based Deliberate Practice (DP) of laparoscopic skills using portable simulators, we report on how the findings became the basis for redesigning the programme (ILP) and how the reformed ILP, when implemented as part of a simulation strategy for Core Surgical Training and the IST pilot, saw improved trainee engagement.

In retrospect, what we designed was a complex educational intervention. In health services research, complex interventions are generally defined as those that involve more than one component. (18) The Medical Research Council (MRC) guidance for the development, implementation and evaluation of complex interventions describes several aspects of complexity. (19) These can be extrapolated to educational interventions such as the one we report: (20) the number of different components within the intervention (e.g., the different tasks, need to upload tasks, eCertificate); engaging with the task (involving motivation, time management, understanding why DP is relevant to them); who is involved (not only trainees but also educational supervisors); the outcomes (were the gains clear to trainees?); and how tailored the intervention is to individual learners (in respect of, for example, pace, but also wider issues such as proximity to the MRCS examination). All these components interact in non-linear ways which affect how an educational innovation is perceived and engaged with, and ultimately the outcomes it achieves. Simply issuing simulators, no matter how good, is clearly not sufficient. A whole programme is required, with motivated learning, easy, distributed access to practice, intermittent feedback, and clear goals and testing.

We drew on the evidence base for DP and simulation, and our own knowledge of surgical training. Our initial ILP v1 can be considered a feasibility study, to test our procedures, assess engagement/recruitment and retention and determine what worked and what didn't. In this way, following the cyclical, interactive process proposed by the MRC framework for complex

interventions, the findings from that initial study resulted in the thoughtful application of evidence-based frameworks and concepts to the current ILP programme: the introduction of a dedicated taught cognitive component at a Surgical Bootcamp prior to issue of the take-home simulators, (3, 21) automatic recruitment of all core trainees into the programme, (22) incorporating distributed practice with regular formative assessments, (5) proficiency-based partial-task training (23, 24) and faculty engagement. We also addressed technical issues. All these changes had the aim of incentivising DP.

It was not only the novel intervention at study that was complex; it in turn took place within an existing complex intervention (surgical training (25)) which itself was changing at the time of our studies (e.g. the Improving Surgical Training pilot [IST]). This wider curricular change may have impacted positively on ILP outcomes: the IST proposal recommends simulation as part of the core curriculum, and this is likely to have helped trainee engagement. This hypothesis is supported by the fact that the advent of IST was temporally correlated with an increasing interest in the CST programme, as evidenced by the competition ratios (number of applicants for each successful appointment): 2016 - 2.53, 2017 - 2.56, then for IST 2018 - 2.94, 2019 - 2.93, 2020 - 3.84, and 2021 - 4.16.

Finally, the context of surgical training is itself not free from other external influences: for example, the COVID19 lockdown (including redeployment of some surgical trainees to other departments) clearly impacted on the engagement and outcomes of the ILP v2.2 group, even though ILP might have been seen by many as the ideal remote training modality. (26-28) It should be noted that this survey question referred to the whole simulation strategy, including face-to-face training events, not just to ILP. However, another parallel qualitative study of our IST pilot will soon report that redeployment and loss of a sense of belonging to the programme could indeed have resulted in a disengagement even with ILP during this period (work in progress). This is consistent with our argument that ILP does not work in isolation.

The growth in popularity of Skills Clubs, however, was encouraging and may have offset some effects of the pandemic. These are regular meetings for peer-to-peer learning using eoSims and other task trainers. With small numbers of survey respondents in the final year group (v2.3), it is difficult to draw firm conclusions, but further qualitative study of IST is under way which will illuminate this growing phenomenon.

There are strengths to our data, notably its inherently PDSA (or Plan-Do-Study-Act) nature, which allowed new learning to improve ILP iteratively and across multiple sites (18 hospitals). This helped us adapt ILP to work in local settings. However, there are also limitations to note, even when our

data are considered a continuous QI process rather than a controlled study. The complexity of context noted above, the multi-faceted nature of ILP, our annual QI revisions to the programme and the relatively small number of Core Surgical trainees in our programme all limit statistical analysis of outcomes.

There are also weaknesses to learn from in the implementation. Perceived support from local trainers for example, was lacking in our programme. Face-to-face feedback had been a priority for ILP v2.1 (due to dissatisfaction with automated or remote feedback found in the previous studies) and was to be provided by local trainers as well as in Boot Camp and Skills Clubs. Trainer engagement through newsletters and IST "Trainers' Bootcamp" was maximal at the start of IST in 2018 but this drive was not sustained. In retrospect our decision in v2.3 to abandon face-to-face final assessment was contrary to this stated priority and was driven by post-pandemic fatigue and logistic constraints rather than by design. Therefore, trainer engagement and increasing face-to-face feedback are remaining priorities for improvement. The rise in Skills Clubs may not be sufficient to offset this.

Overall, however, the proportion of trainees who completed the core level of ILP in the second group was substantially greater than those who took part in the first intervention. This was despite the v2 groups including trainees in non-laparoscopic departments and destined for non-laparoscopic specialties, unlike the participants in the earlier study. While acknowledging this might have been a cohort effect, we suggest it does indicate that the lessons learned, and the changes made after the first ILP, improved the effectiveness of ILP, as demonstrated on multiple sites, across 3 year groups, and with a reasonable historical control group.

The majority of trainees completing ILP would recommend it to others and most also reported that they gained confidence in laparoscopic surgery. This is supported by the rationale for practising basic laparoscopic motor skills – that it frees bandwidth for higher cognitive functions of the surgery – whether that is explicitly understood by the trainees or not.

However, was the improved engagement a consequence of one, or a combination, of the changes outlined in Table 1? What was the cause of the tailing off in engagement between groups 2.1 and 2.2-2.3? Was it all pandemic-related? We have no way of knowing. Clearly the programme is not perfect, and the aim of full engagement is far from achieved. Teasing out the active ingredients of ILP requires further study.

We aim to continue ILP. Version 2.4 will reprioritise trainer engagement and re-establish face-to-face formative assessments. Discussion with trainers has revealed concerns about the feasibility of time-

tabling supervised Skills Club sessions in all the training hospitals, and this clearly needs more consultation. Other suggestions from routine group feedback sessions with trainees include matching ILP with General Surgery posts, which can be in CST year 1 or 2, rather than with the start of year 1.

We will also apply the lessons from ILP to another take-home practice scheme for year 2 of CST, involving vascular anastomoses practised using 3D-printed hydrogel models and kits which are posted to trainees. (29) We know it will not be enough simply to issue the equipment, but that engagement will rely upon a number of factors including culture, systems and attitudes.

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Table 1

Table 1: Findings from the 2017 focus groups with trainees, trainers and programme directors, and consequent programme reforms for the ILP v2.1 – 2.3 (2018-2021).

Finding	Response
Lack of awareness of ILP and the benefits of simulation and deliberate practice among trainers.	ILP was incorporated into a wider simulation strategy within the Scottish arm of the UK "Improving Surgical Training" pilot ("Improving Surgical Training — Royal College of Surgeons," 2015). This allowed inclusion in IST update sessions, reaching trainers across the 14 Scottish hospitals involved.
Lack of awareness of ILP and the benefits of simulation and deliberate practice among trainees.	Teaching on the rationale for simulation, DP and ILP incorporated into trainees' Boot Camps. (surgicalbootcamps.com)
Technical issues.	Technical trouble shooting incorporated into Boot Camps
Competing commitments; timing too close to MRCS exams.	(ILP 2.2) Induction moved to start-of-year, practice built into Boot Camp, face-to-face assessments earlier (thus avoiding exam season).
A dissatisfaction with automated or remote feedback, and a preference for face-to-face performance feedback (1).	Boot Camp introductory session. Thereafter trainees could practise on their own but also in "Skills Club" groups (in some hospitals) and/or with Educational Supervisors (every hospital).
A dissatisfaction with automated or remote feedback, and a preference for face-to-face performance feedback (2).	Promotion of local Skills Clubs. Local Educational Supervisors were also asked to offer observation and feedback. Video uploads and face-to-face assessments of tasks during the year, with feedback. <u>For ILP 2.1</u> - 2/6 tasks to be uploaded during the year (specified at three weeks' notice) and 2/6 tasks at face-to-face assessment after 5-7 months (specified on the day). <u>For ILP 2.2</u> - video upload of all six tasks during the year, and 2/6 repeated at final face-to-face assessment. <u>For ILP 2.3</u> - video upload of all six tasks during the year, no face-to-face assessment. (Minimum mean score of 9/21 required on structured assessment of videos and live assessments - figure 2. Increased to 11/21 for ILP 2.3)
A focus on "points scoring" for career progression.	ILP completion could not be made an absolute condition for satisfactory ARCP outcome (UK-wide system). However, it was considered alongside other evidence of engagement and progression.
A perception that operative skill was not rewarded.	Assessments were required to achieve a core level certificate. On completion of core level, trainees could voluntarily compete for additional awards at advanced level.

Table 2. Comparison of the ILP groups.

			ILP 1 (2014-15)	ILP 2.1 (2018-19)	ILP 2.2 (2019-20)	ILP 2.3 (2020-21)
Obligatory & part of IST pilot			No	Yes	Yes	Yes
No of trainees participating			27	48	46	53
Core level result		Completed & passed	7 (26%)	45 (94%)	35 (76%)	37 (70%)
		Did not complete & pass	20 (74%)	2 (4%)	11 (24%)	16 (30%)
		Absent from final assess[t]	0	1 (2%)	0	-
No responding to post-ILP survey			23/27	25/48	22/46	12/53
Was your experience of the sim strategy hampered by the COVID pandemic?		Yes			16 (80%)	4 (33%)
		Slightly			4 (18%)	4 (33%)
		Not sure			0	3 (25%)
		No			0	1 (8%)
		No answer			2 (9%)	0
Age		24-29	19 (83%)	12 (48%)	15 (68%)	11 (92%)
		30-35	4 (17%)	10 (40%)	7 (32%)	1 (8%)
		>35	0	3 (12%)	0	0
Gender		Male	17 (63%)	12 (48%)	11 (50%)	6 (50%)
		Female	10 (37%)	11 (44%)	10 (46%)	6 (50%)
		Prefer not to say / answer	0	2 (8%)	1 (5%)	0
Prior laparoscopic surgery experience		Assisted lap surg 1-5 x		4 (16%)	6 (27%)	4 (33%)
		Assisted lap surg >5 x		14 (56%)	10 (45%)	7 (58%)
		Mobilised GB or appendix		11 (44%)	9 (41%)	1 (8%)
		1-5 prior lap sim sessions		6 (24%)	5 (23%)	0
		>5 prior lap sim sessions		1 (4%)	0	0
Gaming experience		>3 hrs /week	7 (31)%	3 (12%)	2 (9%)	1 (8%)
		None or < 3hrs /week	15 (65%)	22 (88%)	19 (86%)	4 (33%)
		Did not answer	1 (4%)	0	1 (5%)	7 (58%)
Did you attend a local skills club?		Yes		3 (12%)	3 (14%)	4 (33%)
		No		22 (88%)	19 (86%)	9 (67%)
How would you rate the interest of your local Educational Supervisor showed in ILP?		Extremely int		4 (16%)	1 (4%)	0
		Interested		6 (25%)	4 (18%)	2 (17%)
		Impartial		8 (32%)	7 (32%)	6 (50%)
		Not interested		2 (8%)	3 (14%)	2 (17%)
		Not at all		5 (20%)	7 (32%)	2 (17%)
Would you recommend the ILP programme?		Yes		17 (68%)	14 (64%)	10 (83%)
		No		4 (16%)	5 (23%)	1 (8%)
		Don't know		4 (16%)	3 (14%)	1 (8%)
Did ILP enhance your confidence approaching laparoscopic surgery (eg append[y], chole[y])?		Yes a lot		6 (24%)	2 (9%)	2 (17%)
		Yes slightly		11 (44%)	8 (36%)	4 (33%)
		No change		7 (28%)	12 (55%)	5 (42%)
		Decreased		1 (4%)	0	1 (8%)

Figure 1

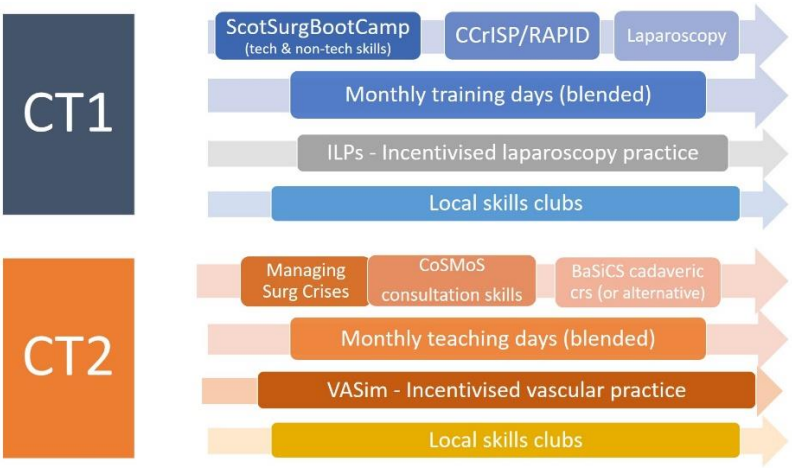
CT1
ScotSurgBootCamp
(tech & non-tech skills)
CCrISP/RAPID
Laparoscopy
Monthly training days (blended)
ILPs - Incentivised laparoscopy practice
Local skills clubs
CT2
Managing
Surg Crises
CoSMoS
consultation skills
BaSiCS cadaveric
crs (or alternative)
Monthly teaching days (blended)
VASim - Incentivised vascular practice
Local skills clubs

Figure 2

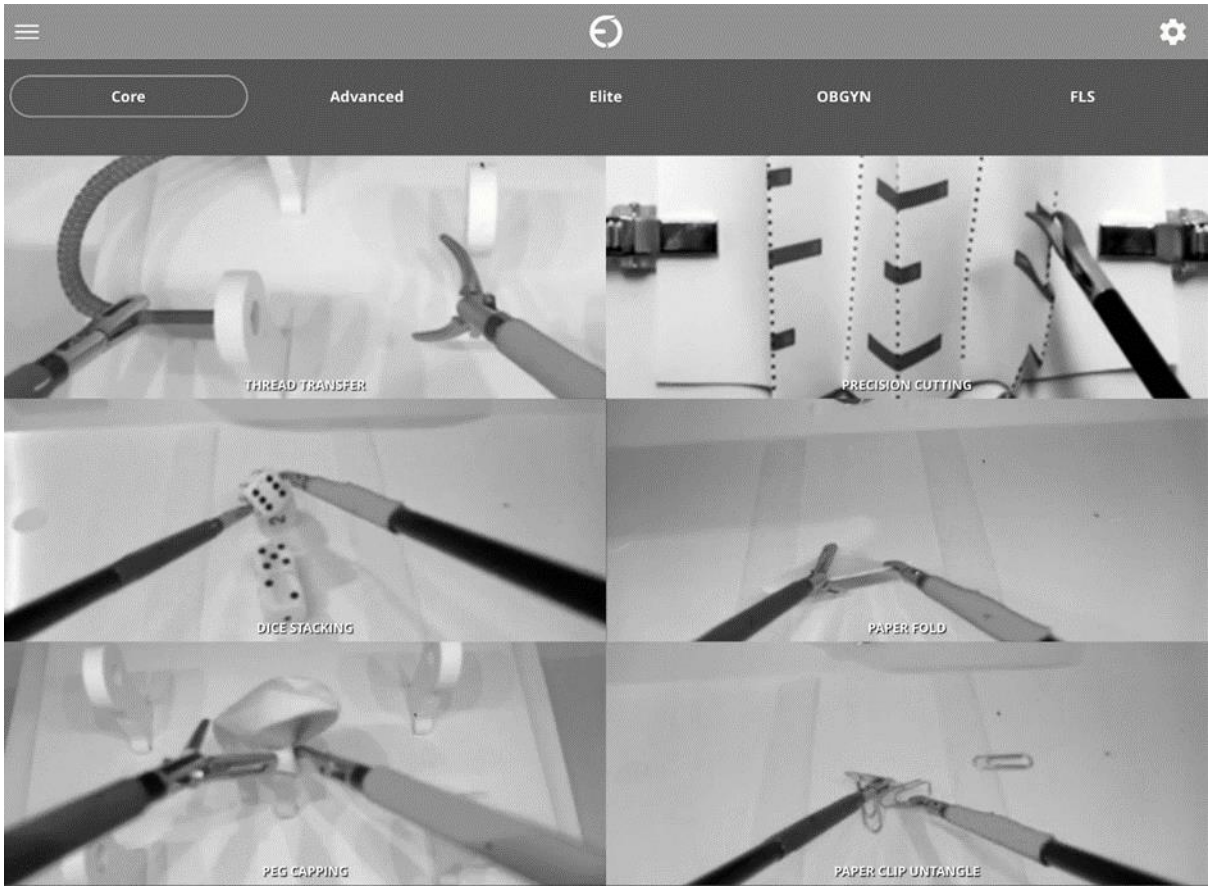
Core
Advanced
Elite
OBGYN
FLS
THREAD TRANSFER
PRECISION CUTTING
DICE STACKING
PAPER FOLD
PEG CAPPING
PAPER CLIP UNTANGLE

Figure 3

HANDLING OF INSTRUMENTS	FLOW OF PROCEDURE	RESPECT FOR TISSUES
1 - 2: Repeatedly awkward & unsure; inappropriate handling	**1 - 2:** Frequently stopped & seemed unsure of next move	**1 - 2:** Frequently used unnecessary force, displacement or damage
3 - 5: Occasionally stiff & awkward, but mostly appropriate choice & use of instruments	**3 - 5:** Reasonable progression through the task, demonstrated forward planning	**3 - 5:** Careful handling of tissue but occasionally caused inadvertent displacement or damage
6 - 7: Fluid movements & obviously familiar with the instruments	**6 - 7:** Effortless flow from one step to the next	**6 - 7:** Consistently handled tissues well with minimal damage

Assessor Comment

Figure Legends

Figure 1. An infographic summary showing the place of ILP within the wider simulation strategy for Scottish Core Surgical Training.

Figure 2. The 6 modular tasks comprising the core level programme (from eosurgical.com).

Figure 3. Web-based structured assessment form for scoring uploaded videos (app.surgtrac.com).

DISCLOSURES

Paul Brennan, a clinical academic surgeon, is a shareholder in eoSurgical Ltd, Edinburgh, UK. He co-designed the eoSim simulator used in this programme and co-established the eoSurgical company which manufactures it. eoSurgical also markets the 'InsTrac' and 'SurgTrac' software used in this programme.

Kenneth Walker, Satheesh Yalamarthi and Mark Vella are each part-employed and salaried by NHS Education for Scotland. Their roles include delivery of the Scottish IST pilot, of which the ILP programme is a part. KW is an Associate Postgraduate Dean (Simulation Lead); SY and MV are Core Surgery Training Programme Directors.

Adarsh Shah, Laura Nicol, Vivienne Blackhall and Jennifer Cleland have no conflicts of interest or financial ties to disclose.