

Title: A model of basic surgical skills course to supplement the training of foundation year doctors by efficient use of local resources

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The main message of this article:

- Foundation year (FY) doctors in the UK have poor basic surgical skills (BSS)
- There is a need to incorporate BSS into FY training
- Provision of BSS can be achieved by utilization of local resources

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Dr M Eddama: Study concept and design; course delivery and assessments creation and design; data analysis and interpretation; and writing of the manuscript. Approved the final version and accountable for all aspects of the work.

Dr P Shah: Study design; data entry and analysis; reviewed and finally approved the final manuscript; and is accountable for all aspects the work.

Mr J McCullough: study design; and review/approval of the assessments, and final manuscript. Is accountable for all aspects of the work.

Miss J Franks: Study design; and review/approval of the assessments, and final manuscript. Is accountable for all aspects of the work.

Mr C John: Study design, and review of the assessments, and manuscript. Is accountable for all the aspects of the work.

Professor M Loizidou: Data analysis and review and approved the final manuscript. Accountable for all aspects of the work.

Mr R Cohen: Study design; data analysis and interpretation; fund; and reviewed/approved the manuscript. Is accountable for all aspects of the work.

Research questions emerged from this work:

- 1) What is the impact of a wider implementation of BSS training to FY doctors on patients' quality of care?
- 2) Does BSS training to FY doctors affect their long-term career choice?
- 3) How effective is locally delivered flexible BSS in comparison to the gold standard Royal College of Surgeons' (RCS) course?

Abstract:

Introduction:

This study investigates the efficiency of teaching basic surgical skills (BSS) to foundation year (FY) doctors and medical students by utilizing local resources.

Methods:

A course comprising four workshops, once a week, of three hours duration per session was delivered using local education centre facilities and utilizing the local faculty of consultants and surgical trainees. Teaching methods included practical skill stations supplemented with short didactic lectures and group discussion. Pre- and post-course assessments were completed by

candidates and analysed to measure outcomes of the course both subjectively and objectively.

Results:

A total number of 20 participants completed the course. On completion of the course: 1) Participants theoretical knowledge improved significantly ($p < 0.0001$), as measured by multiple-choice questions (MCQs), scores improved by 35% (mean = 44%, SD = 16%) before the course to (mean = 79%, SD = 13) after course; 2) The level of confidence in knowledge and skills was measured by a questionnaire: on a scale of 1-5, there was a significant ($p < 0.0001$) improvement on postcourse assessment (mean difference = 1.5, 95% CI = 0.7 to 2.4); 3) Practical skills such as suture position, knot tying and wound apposition significantly improved after the course, $\chi^2 (2) = 16, p < 0.001$; $\chi^2 (2) = 18, p < 0.001$; and $\chi^2 (2) = 22, p < 0.0001$ respectively.

Conclusion:

Effective delivery of BSS to FY doctors by utilizing local resources can be achieved at low cost.

Introduction:

In the UK, foundation year (FY) training is the first generic post graduate medical education that junior doctors must complete before applying to specialty core training. Although a minimum of 4 months rotation in surgery is a mandatory requirement for completion of FY training, there is a lack of emphasis on basic surgical skills (BSS).¹ General consensus amongst 51 FY doctors, supported by a questionnaire conducted at the University College London Hospital (UCLH) highlighted the lack of confidence in BSS knowledge and

practice. As a result, there may be a concern that seniors may perceive this as a lack of enthusiasm on the trainees' part to get involved in theatre. Hence, motivation to provide surgical training to FY doctors may diminish.

Furthermore, FY doctors may feel discouraged to attend theatre sessions and be fully involved in surgical patients' care.

A well-established model of teaching BSS is through the Royal College of Surgeons' (RCS) course, which can be considered as gold standard. Basic techniques such as handling of surgical instruments and tissues and surgical knot tying for example are ideally taught within controlled workshop environments before doctors can perform procedures on patients. The RCS' BSS course teaches, assesses and certifies the ability of trainees to safely perform basic surgical procedures. Currently, attending the BSS course is a mandatory requirement for core surgical training UK.² Although FY doctors are eligible to attend the BSS course, there are various limitations including: limited number of spaces; high cost; usually held over 2-3 days at certain centers and attendance may require study leave and travel.³

The authors believe that BSS, such as wound suturing, knot tying, excision of skin lesions, abscess incision and drainage, and basic understanding of laparoscopic surgery are essential for doctors rotating in surgery. Additionally, achieving competencies in these basic techniques may be necessary in most specialties and may represent an important component of patient safety. For example a doctor would be expected to suture a cut wound or perform basic invasive procedures in the majority of medical specialties. The provision of these skills should be encouraged and made available for free or at a low cost. In this article we present a model that effectively uses local resources to deliver in-

house teaching of BSS to junior doctors and medical students. This study evaluates the effectiveness of this teaching model. This model may not only motivate those who are seeking a career in surgery, but also create an engaging environment for FY doctors and improve their confidence level performing basic procedures.

Methods:

Participants and logistics:

Approval of the course was obtained from the UCLH Education Centre and held at the Simulation and Clinical Skills Laboratory. The course targeted junior doctors at the level of FY as well as elective and final year medical students. Collaboration was made with the foundation year program tutor, North Central Thames Foundation School (NCTFS). This has allowed the course to be incorporated within the FY1 weekly mandatory teaching. The existing weekly teaching sessions are generic surgical topic distributed over a period of 16 weeks and include management of clinical scenarios such as perioperative care of surgical patients, per-rectal bleeding, and pancreatitis. Weekly teaching sessions were rearranged to accommodate for the BSS course. After a careful opportunity cost considerations, conscience was reached amongst the trainers to incorporate the course into the foundation year dedicated educational programme.

Medical students, particularly those in their final years attending their elective in the surgical department, were also encouraged to complete the course. Advertisement was achieved through the medical staffing emailing list (UCLH).

Faculty members:

Senior surgical trainees at the level of specialty training year three (ST3) and above were invited to contribute to the teaching program as faculty members. A pool of faculty members was developed and all members attended an introduction session to inform them of the aims and objectives of the course as well as their role. All faculty members were senior surgical trainees who completed their Membership of the Royal College of Surgeons (MRCS) exam. We excluded from the faculty applicants who had not completed the MRCS exam and/or not attended the BSS college course.

Course design and teaching methods:

The course comprised of four, three-hour long training modules, once a week, in which students acquired surgical skills using pads and animal models, as well as laparoscopic stack system in an appropriate educational room. To achieve motivation and optimal theoretical knowledge and practical skills, a mixture of teacher-centered and student-centered approaches were used (Figure 1). For the theory domain, didactic short lectures as well as group discussion methods were adopted. Group discussion was deemed appropriate for the theory aspect of this course because the participants are fully trained doctors with existing background knowledge. The aim of this section was to emphasis on effective learning rather than exclusive teaching, sharing knowledge and ideas, promoting participation, reflective thinking in order to help foster interest in surgery.

Clinical scenarios were used in the group discussion and the surgical management was discussed amongst the group who had to answer targeted questions about the clinical scenario. This established knowledge in areas such as suturing material, instruments use as well as clinical assessment.

Furthermore, from the feedback it was mentioned that group discussion helped

participant understand the application of knowledge and practical skills to clinical scenarios. The limitations of group discussion such as one participant dominating the discussion and others not contributing to the discussion were avoided by careful guidance by the faculty member facilitating the session.⁴ For example, unthreatening question directed at participants who are not contributing to the discussion encouraged them to share their knowledge. For the practical domain, expert model of live demonstrations and pre-prepared short videos were used. Adequate time was allowed for candidates to practice the skills. The faculty members provided frequent, real time feedback on participants' performance.

Assessments:

1. Assessment of theoretical knowledge:

The participants' background knowledge of the basic surgical and laparoscopic skills was assessed through a multiple-choice question (MCQ) test. These consisted of a stem (a clinical case scenario), a lead-in (question) followed by 4-5 choice options (one correct/best answer and the other distraction answers) constructed based on high quality pertinent literature.^{5 6} MCQs were constructed using the same content domain covering all learning objectives and conducted at the beginning of the course as well as after completion.

2. Confidence in knowledge and skills:

A Participant questionnaire was designed to subjectively assess the level of confidence in their practical skills, specialty of interest and credentials. Theory-based guidelines for style, appearance, and layout of self-administered questionnaire were followed to develop the questionnaire.⁷ Sixteen items of the

questionnaire before and after were assessed for reliability by Cronbach's alpha test and resulted in a good degree of agreement before ($\alpha = 0.87$) and after ($\alpha = 0.854$).⁸ Candidates were asked to complete the same questionnaires before and after the course. Analysis of their score was then undertaken in order to assess improvement.

3. Assessment of practical skills:

Two different assessors examined the suturing skills of the candidates. Marking of sutures position, knot quality and wound edge apposition of 2-3 sutures performed by candidates on a wound created at a suturing pad was used as an objective way to assess practical skills. We considered 2-3 sutures sufficient because this would allow the judgment on the position of the sutures distance from the edge of the wound and distance from each other. Knot quality was judged by the number of throws, the tightness of the knot as well as the position of the knot being on side of the wound. Wound edges apposition also required a minimum of 2 sutures to assess. Although most participants were able to perform more than 2 sutures, limitation of time could not allow mandating a full length wound closure. The marking scale consisted of three choices: good; satisfactory; or improvement required. The raters were blinded to the candidate identification as well as each other's marking. Inter-rater level of agreement on the marking was assessed by Cohen kappa coefficient. Conflict of scoring was settled to the next lower grade, for example if the scores are good and satisfactory, the latter was used for analysis. This was applied to pre- and post-course results to minimize bias.

Feedback:

The faculty members gave feedback to candidates verbally during the sessions. Moreover, to ensure feedback was recorded, workplace base assessments were used as formative assessment tools. Particularly, direct observation of procedural skills (DOPS) assessments in surgery were used to assess students' performance. Individual students were also asked to complete a written feedback form to the faculty after each session. This helped the faculty by creating documentation for their activities and effort, as well as providing opportunity to improve their practice and create a mutual learning environment.

Candidates who attended at least 2 sessions and successfully completed the final assessments were awarded a certificate of course completion. Faculty trainers who taught for two or more sessions were also awarded certificates for their contribution to teaching.

Statistical analysis:

The acquired data from the MCQs, participant questionnaire and suturing skills marking were analyzed using "statistical Package for the Social Sciences" (IBM SPSS Statistics for Macintosh, version 22, Armonk, NY: IBM Corp) and GraphPad Prism (GraphPad Prism version 6 for MAC OS X, GraphPad Software, San Diego California USA, www.graphpad.com). For inference statistics, paired t-test was used to analyse continuous data and chi square test was used to analyse categorical data. The level of statistical significance was set at 5% ($p \leq 0.05$) for all test procedures.

Results:

A total number of 20 participants completed the course over three periods: group 1 in February 2015; group 2 in May 2015; and group 3 in October

2015. This included 17 FY doctors and three fifth year medical students. The majority of participants were undertaking their surgical placement and expressed interest in surgery (table 1).

Assessment of theoretical background:

The MCQs scoring suggests that participants improved significantly ($p < 0.0001$), with mean difference of 35% (95% CI, 25% to 45%). The mean score improved from (mean = 44%, SD = 16%) before the course to (mean = 79%, SD = 13) after course (figure 2). MCQ score level of improvement was significantly ($p < 0.0001$) negatively correlated with the pre-course score ($r = -0.82$; 95% CI, -0.92 to -0.6) (figure 3).

Participants who attended more sessions significantly ($p < 0.05$) improved their final MCQ score in comparison to those who attended less sessions, ($r = 0.47$, 95% CI, 0.04 to 0.75) (figure 4).

Participants' questionnaire:

The level of confidence in knowledge and skills was measured on a scale of 1-5 and demonstrated a significant ($p < 0.0001$) improvement on postcourse assessment on variety of questions (Table 2 and figure 5). The overall score difference in mean was 1.5 points (95% CI = 0.7 to 2.4). Mean difference for individual questions is summarised in table 2.

Practical skills assessment:

There was good agreement between the two assessors' judgment of the practical skill, Cohen's $\kappa = 0.61$ (95% CI, 0.47 to 0.77), $p < 0.0001$. Further assessment of the assessors marking was examined against their trend of marking and there was no significant relationship between assessors marking

and the categories of choices including: good, satisfactory and improvement required, $\chi^2 (2, N = 168) = 0.78, p = 0.68$ (figure 6).

The marking showed significant improvement of the score of practical skills from “improvement required to satisfactory” and from “satisfactory to good”. All 3 domains to monitor practical performance, namely suture position, knot tying and wound apposition have significantly improved after the course, $\chi^2 (2) = 16, p < 0.001$; $\chi^2 (2) = 18, p < 0.001$; and $\chi^2 (2) = 22, p < 0.0001$ respectively (Figures 7,8,9).

Feedback:

Feedback received from participants to the course organizers was positive and highlighted the need for such training courses. Participants particularly enjoyed the group discussion and one-to-one teaching as well as the opportunity to practice basic surgical skills. This course is now implemented as part of the FY1 training programme at UCLH.

Discussion:

Our findings suggest that basic surgical and laparoscopic skills of FY doctors and medical students can be significantly improved by utilizing local resources. The results demonstrated a significant improvement in the pre- and postcourse ratings in MCQs score, confidence in BSS knowledge and skills as well as the ability to perform suturing.

All junior doctors in the UK must complete a 4 month rotation in surgery in order to achieve completion of foundation training, with the majority doing more than one surgical rotation.¹ Therefore, we believe that FY doctors ideally should be able to perform basic surgical skills given that they will all be on surgical firms at some point. This also seems imperative to patient safety that

they undertake BSS training at an early stage of their career.⁹ However, this study highlights that without the appropriate training FY doctors neither feel particularly confident themselves and our assessment of their abilities prior to training also proved this. Before doctors can perform procedures on patients, workshops and short courses are designed to enable skill acquisition in a controlled environment. As suggested by Benner (1982) experimental learning such as workshops can assist the novice trainers and helps them advance their skills and providing safe and accurate care for patients.¹⁰

The results show significantly negative correlation between the pre-course MCQ score and the overall improvement (Figure 3), suggesting that this course is better suited to novice participants. The number of sessions attended was significantly and positively correlated to the level of improvement in the MCQs (Figure 3). This is consistent with several previous studies that found a strong positive correlation between students' attendance and performance.^{11 12}¹³ Because most of the participants are clinicians with on call duties and other commitments, it is sometimes difficult to mandate the all the sessions. To accommodate for this, the course adopted a group discussion method to enable a repetitive nature and reinforcement of the core knowledge throughout the sessions. Our findings of a significant improvement in the MCQ score and level of confidence and practical skills are similar to Bauer et al, describing a model of teaching surgical skills to medical students.¹⁴

The teaching methods used in this course conform to Fitts and Posner's practical skills acquisition, which comprises three phases: cognitive, associative and autonomous phases. Initially learners identify and develop the component parts of the skill by the formation of a mental picture. Practicing the skill and

using feedback subsequently helps to achieve perfection and reinforces knowledge and skill acquisition. The autonomous phase is reached when there is a little conscious, thought or attention whilst performing the skill.^{15 16} A number of short didactic lectures and group discussion supported by handouts ensured that the core theoretical knowledge was achieved. Live demonstrations and video clips were also used to help participants develop a mental picture of the practical skill components. A foundation of basic knowledge, progressing to performing the practical skill added strength and validity to the course.¹⁷ Assessments were carefully designed and validated, including inter rater reliability and validation of the questionnaire performed before and after the course. In addition to the knowledge and skill acquisition this course created a friendly and encouraging learning environment. This was illustrated in the positive feedback given to the faculty from the participants. As demonstrated by Greenberg et al, clinical teaching improves the skills of the teachers themselves.¹⁸ Our model helped the faculty to exercise their teaching skills and develop their portfolio. The in-house nature of this course as well as the delivery and assessments methods although not entirely novel, but in this context and if implemented on a wider scale may be unique. The junior doctors are able to build up a rapport with their trainers, creates an environment of mutual confidence as was noticed from the feedback. The duration of the course being distributed over 4 weeks offers the opportunity of application of skills in theatre, promoting a feeling of involvement as the trainers may have more confidence in juniors ability to perform basic procedures.

This study is limited by 1) the sample size of participants, 2) the duration of the course, 3) lack of long-term follow-up and 4) the fact that it is describing a

single centre experience. It is unclear whether similar effect of this course would apply to other National Health Service centers due to the variability of resources across the UK. Smaller NHS institutions may still face challenges to follow this example. Also, the long-term impact of this course on patients' quality of care as well as FY doctors' career choice is unclear. However, we speculate that given the availability of the following equipments, similar results can be achieved elsewhere:

1. Appropriate facilities to run course – education centre facility with space for teaching, with pads, laparoscopic kit, suturing equipment
2. Local Surgical Faculty dedicated to running the course – offering formal certificate and portfolio entries for tutors to help incentivize faculty turnout, and keeping staff costs down.
3. Small amount of funding – in order to pay for basic suturing equipment, pads. This could be funded by local hospital, or by trainees for a nominal cost. Course materials can be purchased from the RCS website.
4. Curriculum of course – with pre- and post- course assessments. We recommend a student questionnaire, MCQ test and an objective measure of testing practical skills.
5. Inclusion of the course as part of the mandatory training in surgical block – all students should have allocated protected teaching time and this would help facilitate student turnout.

In conclusion, BSS acquisition is imperative for patient safety. The provision of workshops dedicated to teach BSS should be encouraged, made locally available

and at a low cost. The RCS BSS course is the gold standard and therefore the BSS methods and techniques should be adopted when possible, however as described earlier, we appreciate this is not always possible. Local resources including a faculty of surgical consultants and specialty trainees could be utilized in order to minimize the cost and facilitate delivery.

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Figure 1. An example of a three-hours session, note that most of the time is spent on skill practice, real time feedback and group discussion

Table 1. Participants baseline characteristics (n=20)	
Gender:	
Male	9 (45%)
Female	11 (55%)
Grade:	
FY	17 (85%)
Fifth year medical students	3 (15%)
Current placement (specialty):	
Surgery	17(85%)
Medicine	1
Anaesthesia	1
General practice	1

Interest in surgery:	
High	11 (55%)
Moderate	4 (20%)
Unsure	3 (15%)
Not interested	2

Table 2. Assessment of participants' level of confidence in knowledge and practice. Comparison is made before and after the course, multiple comparisons are made to individual questions. Difference in mean, significance and 95% confidence interval (CI) are listed. * $p < 0.05$; ** $p < 0.01$, **** $p < 0.0001$

Assessment	Difference in mean	95% CI
Knowledge of LA drugs**	1	0.2 to 1.8
Knowledge of appropriate dosing****	1.6	0.8 to 2.4
Technique of giving LA**	1	0.2 to 1.7
Complications associated with LA*	1	0.03 to 1.6
Handling of suturing instruments****	1.3	0.5 to 2
Knowledge of which suture to use****	1.6	0.8 to 2.3
Knowledge of which needle to use****	1.8	1 to 2.5
Instrumental knot tying****	1.5	0.7 to 2.2
Hand ties****	1.5	0.7 to 2.3
How to close a wound correctly****	1.8	1 to 2.5
Excision of a skin lesion****	1.9	1 to 2.7
I&D of an abscess****	1.9	1 to 2.6
Types of laparoscopic instruments****	1.9	1.1 to 2.7
Handling of laparoscopic instruments****	1.9	1.2 to 2.7
Holding the camera****	1.6	0.8 to 2.3
Suturing and tying laparoscopically****	1.4	0.6 to 2.2

Figure 2. Pre- and postcourse MCQ score ($n = 20$), error bars: standard error of the mean, (****) = $p < 0.0001$

Figure 3. Correlation between the precourse MCQs score and the improvement achieved, r : pearson correlation

Figure 4. Correlation between the number of sessions attended and the level of improvement achieved in the MCQs, r : pearson correlation

Figure 5. Participants' level of confidence in knowledge and skills before and after the course, (****) = $p < 0.0001$, LA: local anaesthetic, I&D: incision and drainage, error bars: standard error of the mean

Figure 6. Comparison of proportions of marking choices between assessors

Figure 7. Participants' competency in suture position before and after the course, $\chi^2 (2) = 16$, (***) = $p < 0.001$

Figure 8. Participants' competency in knot tying before and after the course, $\chi^2 (2) = 18$, (***) = $p < 0.001$

Figure 9. Participants' competency in wound apposition before and after the course, $\chi^2 (2) = 22, (**) = p < 0.001$

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Results:

A total number of ~~2014 participants~~ participants completed the course. On completion of the course; 1) Participants theoretical knowledge improved significantly ($p < 0.0001$), as measured by multiple-choice questions (MCQs). ~~s-~~ Scores improved by ~~approximately 3529%~~ (mean = ~~446.43%~~, SD = 16.46%) before the course to (mean = ~~795.4%~~, SD = ~~131.65~~) after course; 2) The level of confidence in knowledge and skills was measured by a questionnaire: on a scale of 1-5. Validated questionnaires there was a significant ($p < 0.0001$) improvement on postcourse assessment (mean difference = 1.5, 95% CI = 0.7 to 2.4) to measure the level of confidence of knowledge and skills pre and post course demonstrated a significant improvement ($p < 0.001$). On a scale of 1-5, scoring improved from (mean = 2.12, SD = 0.51) to (mean = 3.84, SD = 0.46) after the course. 3) Practical skills such as suture position, knot tying and wound apposition significantly improved after the course, $\chi^2 (2) = 161.96$, $p < 0.001$; $\chi^2 (2) = 1814.83$, $p < 0.001$; and $\chi^2 (2) = 2215.06$, $p < 0.0001$ respectively.

Conclusion:

Effective delivery of BSS to FY doctors by utilizing local resources can be achieved at low cost.

Introduction:

In the UK, foundation year (FY) training is the first generic post graduate medical education that junior doctors must complete before applying to specialty core training. Although a minimum of 4 months rotation in surgery is a

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mandatory requirement for completion of FY training, there is a lack of emphasis on basic surgical skills (BSS).¹ General consensus amongst 51 FY doctors, supported by a questionnaire conducted at the University College London Hospital (UCLH) highlighted the lack of confidence in BSS knowledge and practice. As a result, there may be a concern that seniors may perceive this as a lack of enthusiasm on the trainees' part to get involved in theatre. Hence, motivation to provide surgical training to FY doctors may diminish. Furthermore, FY doctors may feel discouraged to attend theatre sessions and be fully involved in surgical patients' care.

A well-established model of teaching BSS is through the Royal College of Surgeons' (RCS) course, which can be considered as gold standard. Basic techniques Basic surgical skills (BSS) acquisition is an integral part of the core surgical training in the UK.² Techniques such as handling of surgical instruments and tissues and surgical knot tying for example are ideally taught within controlled workshop environments before doctors can perform procedures on patients. The RCS' BSS course organized by the Royal College of Surgeons (RCS) is designed to introduce surgical trainees to basic techniques and procedures. It teaches, assesses and certifies the ability of trainees to safely perform basic surgical procedures. Currently, attending the BSS course is a mandatory requirement for core surgical training UK.², however not for the completion of foundation years training (FY). In the UK, foundation training is the first generic post graduate medical training that junior doctors must complete before applying to specialty core training. Foundation training consists of two years and depending on the year of training junior doctors are nominated as FY1 and FY2 doctors.¹ Although FY doctors are eligible to attend the BSS course, there are

various limitations including: limited number of spaces; high cost; usually held over 2-3 days at certain centers and attendance may require study leave and travel.³

The authors believe that [basic surgical skills BSS](#), such as wound suturing, knot tying, excision of skin lesions, abscess incision and drainage, and basic [understanding of laparoscopic surgery skills](#) are essential [for doctors rotating in surgery not only for surgical trainees but also for FY doctors](#). [Additionally](#), [achieving competencies in these basic techniques may be necessary in most a multitude of specialties](#) and may represent an important component of patient safety. [For example](#) a doctor would be expected to suture a cut wound or perform basic invasive procedures in the majority of medical specialties. The provision of these skills should be encouraged and made available for free or at a low cost. In this article we present a model that effectively uses local resources to deliver [inhouse](#) teaching of [basic surgical and laparoscopic skills BSS](#) to junior doctors and medical students. This study evaluates the effectiveness of this teaching model. This model may not only motivate those who are seeking a career in surgery, but also create an engaging environment for FY doctors and improve their confidence level performing basic procedures.

Methods:

Participants and logistics:

Approval of the course was obtained from the [University College London Hospital \(UCLH\)](#) Education Centre and held at the Simulation and Clinical Skills Laboratory. The course targeted [novice](#) junior doctors at the level of [FY1](#) as well as elective and final year medical students. Collaboration was made with the foundation year program tutor, North Central Thames Foundation School

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(NCTFS). This has allowed the course to be incorporated within the FY1 weekly mandatory teaching. The existing weekly teaching sessions are generic surgical topic distributed over a period of 16 weeks and include management of clinical scenarios such as perioperative care of surgical patients, per-rectal bleeding, and pancreatitis. Weekly teaching sessions were rearranged to accommodate for the BSS course. After a careful opportunity cost considerations, conscience was reached amongst the trainers to incorporate the course into the foundation year dedicated educational programme.

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Medical students, particularly those in their final years attending their elective in the surgical department, were also encouraged to complete the course. Advertisement was achieved through the medical staffing emailing list (UCLH).

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Faculty members:

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Senior surgical trainees at the level of specialty training year three (ST3) and above were invited to contribute to the teaching program as faculty members. A pool of faculty members was developed and all members attended an introduction session to inform them of the aims and objectives of the course as well as their role. All faculty members were senior surgical trainees who completed their Membership of the Royal College of Surgeons (MRCS) exam. We excluded from the faculty applicants who had not completed the MRCS exam and/or not attended the BSS college course.

Course design and teaching methods:

The course comprised of four, three-hour long training modules, once a week, in which students acquired surgical skills using pads and animal models, as well as

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laparoscopic stack system in an appropriate educational room. To achieve motivation and optimal theoretical knowledge and practical skills, a mixture of teacher-centered and student-centered approaches were used (Figure 1). For the theory domain, didactic short lectures as well as group discussion methods were adopted. Group discussion was deemed appropriate for the theory aspect of this course because the participants are fully trained doctors with existing background knowledge. The aim of this section was to emphasis on effective learning rather than exclusive teaching, sharing knowledge and ideas, promoting participation, reflective thinking in order to help foster interest in surgery. Clinical scenarios were used in the group discussion and the surgical management was discussed amongst the group who had to answer targeted questions about the clinical scenario. This established knowledge in areas such as suturing material, instruments use as well as clinical assessment. Furthermore, from the feedback it was mentioned that group discussion helped participant understand the application of knowledge and practical skills to clinical scenarios. The limitations of group discussion such as one participant dominating the discussion and others not contributing to the discussion were avoided by careful guidance by the faculty member facilitating the session.⁴ For example, un intimidating question directed at participants who are not contributing to the discussion encouraged them to share their knowledge. For the practical domain, expert model of live demonstrations and pre-prepared short videos were used. Adequate time was allowed for candidates to practice the skills. The faculty members provided frequent, real time feedback on participants' performance.

Assessments:

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1. Assessment of theoretical knowledge:

The participants' background knowledge of the basic surgical and laparoscopic skills was assessed through a multiple-choice question (MCQ) test. These consisted of a stem (a clinical case scenario), a lead-in (question) followed by 4-5 choice options (one correct/best answer and the other distraction answers) constructed based on high quality pertinent literature.^{5 6} MCQs were constructed using the same content domain covering all learning objectives and conducted at the beginning of the course as well as after completion.

2. Confidence in knowledge and skills:

A Participant questionnaire was designed to subjectively assess the level of confidence in their practical skills, specialty of interest and credentials. Theory-based guidelines for style, appearance, and layout of self-administered questionnaire were followed to develop the questionnaire.⁷ Sixteen items of the questionnaire before and after were assessed for reliability by Cronbach's alpha test and resulted in a good degree of agreement before ($\alpha = 0.87$) and after ($\alpha = 0.854$).⁸ Candidates were asked to complete the same questionnaires before and after the course. Analysis of their score was then undertaken in order to assess improvement.

3. Assessment of practical skills:

Two different assessors examined the suturing skills of the candidates. Marking of sutures position, knot quality and wound edge apposition of 2-3 sutures performed by candidates on a wound created at a suturing pad was used as an objective way to assess practical skills. [We considered 2-3 sutures sufficient because this would allow the judgment on the position of the sutures](#)

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distance from the edge of the wound and distance from each other. Knot quality was judged by the number of throws, the tightness of the knot as well as the position of the knot being on side of the wound. Wound edges apposition also required a minimum of 2 sutures to assess. Although most participants were able to perform more than 2 sutures, limitation of time could not allow mandating a full length wound closure. The marking scale consisted of three choices: good; satisfactory; or improvement required. The raters were blinded to the candidate identification as well as each other's marking. Inter-rater level of agreement on the marking was assessed by Cohen kappa coefficient. Conflict of scoring was settled to the next lower grade, for example if the scores are good and satisfactory, the latter was used for analysis. This was applied to pre- and post-course results to minimize bias.

Feedback:

The faculty members gave feedback to candidates verbally during the sessions. Moreover, to ensure feedback was recorded, workplace base assessments were used as formative assessment tools. Particularly, direct observation of procedural skills (DOPS) assessments in surgery were used to assess students' performance. Individual students were also asked to complete a written feedback form to the faculty after each session. This helped the faculty by creating documentation for their activities and effort, as well as providing opportunity to improve their practice and create a mutual learning environment.

Candidates who attended at least 2 sessions and successfully completed the final assessments were awarded a certificate of course completion. Faculty trainers who taught for two or more sessions were also awarded certificates for their contribution to teaching.

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Statistical analysis:

The acquired data from the MCQs, participant questionnaire and suturing skills marking were analyzed using “statistical Package for the Social Sciences” (IBM SPSS Statistics for Macintosh, version 22, Armonk, NY: IBM Corp) and GraphPad Prism (GraphPad Prism version 6 for MAC OS X, GraphPad Software, San Diego California USA, www.graphpad.com). For inference statistics, paired t-test was used to analyse continuous data and chi square test was used to analyse categorical data. The level of statistical significance was set at 5% ($p \leq 0.05$) for all test procedures.

Results:

A total number of ~~2014 candidates~~ participants completed the course over ~~three~~ two periods ~~of time~~: group 1 in February 2015; ~~and~~ group 2 in May 2015; ~~and~~ group 3 in October 2015. This included ~~174~~ FY4 doctors and three fifth year medical students. The majority of ~~the~~ participants were undertaking their surgical placement and expressed interest in surgery (table 1).

Assessment of theoretical background:

The MCQs scoring suggests that participants improved significantly ($p < 0.0001$), ~~with from~~ mean difference of 35% (95% CI, 25% to 45%). The mean score improved from (mean = 44%, SD = 16%) before the course to (mean = 79%, SD = 13) after course (mean = 46.43%, SD = 16.46%) before the course to (mean = 75.4%, SD = 11.65) after completion of the course. The mean improvement was 28.6%, 95% confidence interval for the difference is (16.75%, 41.12%) (figure 2). MCQ score level of improvement was significantly ($p < 0.0001$) negatively correlated with the pre-course score ~~and demonstrated a~~

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~~significant correlation ($p < 0.05$) with person correlation ($r = -0.82$; 95% CI, -0.92 to -0.6111) (figure 3).~~

Participants who attended more sessions significantly ($p < 0.05$) improved their final MCQ score in comparison to those who attended less sessions, ~~person correlation ($r = 0.47$, 95% CI, 0.04 to 0.7554) (figure 4).~~

Participants' questionnaire:

~~The level of confidence in knowledge and skills was measured on a scale of 1-5 and demonstrated a significant ($p < 0.0001$) improvement on postcourse assessment on variety of questions (Table 2 and figure 5). The overall score difference in mean was 1.5 points (95% CI = 0.7 to 2.4). Mean difference for individual questions is summarised in table 2. The level of confidence in knowledge and practical procedures among participants improved significantly, $F(1, 208) = 660.6$, ($p < 0.001$). The total score before (mean = 2.12, SD = 0.51) was significantly increased in comparison to the score after (mean = 3.84, SD = 0.46) when students were asked to rate their confidence in multiple domains on a scale of 1 to 5 (Figure 5).~~

Practical skills assessment:

There was good agreement between the two assessors' judgment of the practical skill, Cohen's $\kappa = 0.61$ (95% CI, 0.47 to 0.77), $p < 0.0001$. Further assessment of the assessors marking was examined against their trend of marking and there was no significant relationship between assessors marking and the categories of choices including: good, satisfactory and improvement required, $\chi^2(2, N = 168) = 0.78$, $p = 0.68$ (figure 6).

The marking showed significant improvement of the score of practical skills from "improvement required to satisfactory" and from "satisfactory to good". All 3

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domains to monitor practical performance, namely suture position, knot tying and wound apposition have significantly improved after the course, $\chi^2 (2) = 161.96$, $p < 0.001$; $\chi^2 (2) = 184.83$, $p < 0.001$; and $\chi^2 (2) = 2215.06$, $p < 0.0001$ respectively (Figures 7,8,9).

Feedback:

Feedback received from participants to the course organizers was positive and highlighted the need for such training courses. Participants particularly enjoyed the group discussion and one-to-one teaching as well as the opportunity to practice basic surgical skills. This course is now implemented as part of the FY1 training programme at UCLH.

Discussion:

Our findings suggest that basic surgical and laparoscopic skills of FY doctors and medical students can be significantly improved by utilizing local resources. The results demonstrated a significant improvement in the pre- and post-course ratings in MCQs score, confidence in BSS knowledge and skills as well as the ability to perform suturing.

Currently, all junior doctors in the UK must complete a 4 month rotation in surgery in order to achieve completion of foundation training, with the majority doing more than one surgical rotation.¹ Therefore, we believe that FY doctors ideally should be able to perform basic surgical skills given that they will all be on surgical firms at some point. This also seems imperative to patient safety that they undertake BSS training at an early stage of their career.⁹ However, this study highlights that without the appropriate training FY doctors neither feel particularly confident themselves and our assessment of their abilities prior to training also proved this. Before doctors can perform

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procedures on patients, workshops and short courses are designed to enable skill acquisition in a controlled environment. As suggested by Benner (1982) experimental learning such as workshops can assist the novice trainers and helps them advance their skills and providing safe and accurate care for patients.¹⁰

The results show significantly negative correlation between the pre-course MCQ score and the overall improvement (Figure 3), suggesting that this course is better suited to novice participants. The number of sessions attended was significantly and positively correlated to the level of improvement in the MCQs (Figure 3). This is consistent with several previous studies that found a strong positive correlation between students' attendance and performance.^{11 12}¹³ Because most of the participants are clinicians with on call duties and other commitments, it is sometimes difficult to mandate the all the sessions. To accommodate for this, the course adopted a group discussion method to enable a repetitive nature and reinforcement of the core knowledge throughout the sessions. Our findings of a significant improvement in the MCQ score and level of confidence and practical skills are similar to Bauer et al, describing a model of teaching surgical skills to medical students.¹⁴

The teaching methods used in this course conform to Fitts and Posner's practical skills acquisition, which comprises three phases: cognitive, associative and autonomous phases. Initially learners identify and develop the component parts of the skill by the formation of a mental picture. Practicing the skill and using feedback subsequently helps to achieve perfection and reinforces knowledge and skill acquisition. The autonomous phase is reached when there is a little conscious, thought or attention whilst performing the skill.^{15 16} A number

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of short didactic lectures and group discussion supported by handouts ensured that the core theoretical knowledge was achieved. Live demonstrations and video clips were also used to help participants develop a mental picture of the practical skill components. A foundation of basic knowledge, progressing to performing the practical skill added strength and validity to the course.¹⁷ Assessments were carefully designed and validated, including inter rater reliability and validation of the questionnaire performed before and after the course. In addition to the knowledge and skill acquisition this course created a friendly and encouraging learning environment. This was illustrated in the positive feedback given to the faculty from the participants. As demonstrated by Greenberg et al, clinical teaching improves the skills of the teachers themselves.¹⁸ Our model helped the faculty to exercise their teaching skills and develop their portfolio. [The in-house nature of this course as well as the delivery and assessments methods although not entirely novel, but in this context and if implemented on a wider scale may be unique. The junior doctors are able to build up a rapport with their trainers, creates an environment of mutual confidence as was noticed from the feedback. The duration of the course being distributed over 4 weeks offers the opportunity of application of skills in theatre, promoting a feeling of involvement as the trainers may have more confidence in juniors ability to perform basic procedures.](#)

This study is limited by 1) the sample size of participants, 2) the duration of the course, 3) lack of long-term follow-up and 4) the fact that it is describing a single centre experience. It is unclear whether similar effect of this course would apply to other National Health Service centers due to the variability of resources across the UK. [Smaller NHS institutions may still face challenges to follow this](#)

[example](#). Also, the long-term impact of this course on patients' quality of care as well as FY doctors' career choice is unclear. However, we speculate that given the availability of the following equipments, similar results can be achieved elsewhere:

1. Appropriate facilities to run course – education centre facility with space for teaching, with pads, laparoscopic kit, suturing equipment
2. Local Surgical Faculty dedicated to running the course – offering formal certificate and portfolio entries for tutors to help incentivize faculty turnout, and keeping staff costs down.
3. Small amount of funding – in order to pay for basic suturing equipment, pads. This could be funded by local hospital, or by trainees for a nominal cost. Course materials can be purchased from the RCS website.
4. Curriculum of course – with pre- and post- course assessments. We recommend a student questionnaire, MCQ test and an objective measure of testing practical skills.
5. Inclusion of the course as part of the mandatory training in surgical block – all students should have allocated protected teaching time and this would help facilitate student turnout.

In conclusion, BSS acquisition is imperative for patient safety. The provision of workshops dedicated to teach BSS should be encouraged, made locally available and at a low cost. The RCS BSS course is the gold standard and therefore the BSS methods and techniques should be adopted when possible, however as described earlier, we appreciate this is not always possible. Local resources

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including a faculty of surgical consultants and specialty trainees could be utilized in order to minimize the cost and facilitate delivery.

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Figure 1. An example of a three-hours session, note that most of the time is spent on skill practice, real time feedback and group discussion

Table 1. Participants baseline characteristics (n=2014)	
Gender:	
Male	97 (4550%)
Female	117 (550%)
Grade:	
FY1	171 (8578%)
Fifth year medical students	3 (1522%)
Current placement (specialty):	
Surgery	172 (85%)
Medicine	1
Anaesthesia	1
General practice	1
Interest in surgery:	
High	117 (550%)
Moderate	4 (208%)
Unsure	32 (154%)
Not interested	21

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Table 2. Assessment of participants' level of confidence in knowledge and practice. Comparison is made before and after the course, multiple comparisons are made to individual questions. Difference in mean, significance and 95% confidence interval (CI) are listed. * $p < 0.05$; ** $p < 0.01$, ** $p < 0.0001$.**

<u>Assessment</u>	<u>Difference in mean</u>	<u>95% CI</u>
<u>Knowledge of LA drugs**</u>	<u>1</u>	<u>0.2 to 1.8</u>
<u>Knowledge of appropriate dosing****</u>	<u>1.6</u>	<u>0.8 to 2.4</u>
<u>Technique of giving LA**</u>	<u>1</u>	<u>0.2 to 1.7</u>
<u>Complications associated with LA*</u>	<u>1</u>	<u>0.03 to 1.6</u>
<u>Handling of suturing instruments****</u>	<u>1.3</u>	<u>0.5 to 2</u>
<u>Knowledge of which suture to use****</u>	<u>1.6</u>	<u>0.8 to 2.3</u>
<u>Knowledge of which needle to use****</u>	<u>1.8</u>	<u>1 to 2.5</u>
<u>Instrumental knot tying****</u>	<u>1.5</u>	<u>0.7 to 2.2</u>
<u>Hand ties****</u>	<u>1.5</u>	<u>0.7 to 2.3</u>
<u>How to close a wound correctly****</u>	<u>1.8</u>	<u>1 to 2.5</u>
<u>Excision of a skin lesion****</u>	<u>1.9</u>	<u>1 to 2.7</u>
<u>I&D of an abscess****</u>	<u>1.9</u>	<u>1 to 2.6</u>
<u>Types of laparoscopic instruments****</u>	<u>1.9</u>	<u>1.1 to 2.7</u>
<u>Handling of laparoscopic instruments****</u>	<u>1.9</u>	<u>1.2 to 2.7</u>
<u>Holding the camera****</u>	<u>1.6</u>	<u>0.8 to 2.3</u>
<u>Suturing and tying laparoscopically****</u>	<u>1.4</u>	<u>0.6 to 2.2</u>

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Figure 2. Pre- and postcourse MCQ score ($n = 20$), error bars: standard error of the mean, (***) = $p < 0.0001$

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Figure 3. Correlation between the precourse MCQs score and the improvement achieved, r : pearson correlation

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Figure 4. Correlation between the number of sessions attended and the level of improvement achieved in the MCQs, r : pearson correlation

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Figure 5. Participants' level of confidence in knowledge and skills before and after the course, (***) = $p < 0.0001$, LA: local anaesthetic, I&D: incision and drainage, error bars: standard error of the mean

Figure 6. Comparison of proportions of marking choices between assessors

Figure 7. Participants' competency in suture position before and after the course, $\chi^2 (2) = 16$, (***) = $p < 0.001$

Figure 8. Participants' competency in knot tying before and after the course, $\chi^2 (2) = 18$, (***) = $p < 0.001$

Figure 9. Participants' competency in wound apposition before and after the course, $\chi^2 (2) = 22$, (***) = $p < 0.001$

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Figure 1
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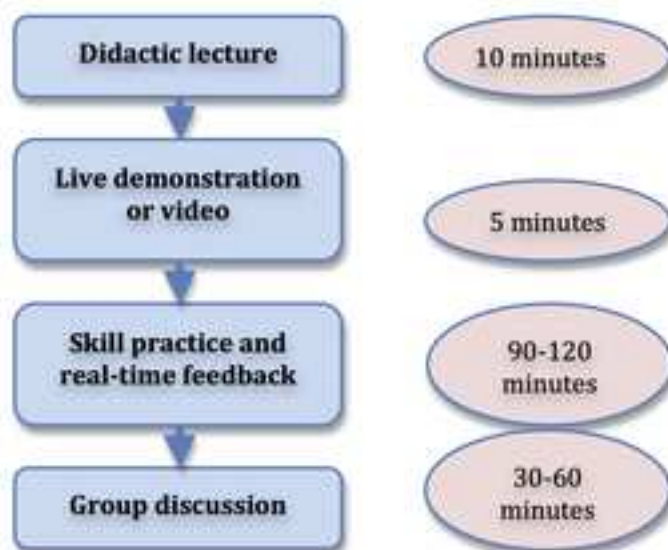


Table 1

Table 1. Participants baseline characteristics (n=20)	
Gender:	
Male	9 (45%)
Female	11 (55%)
Grade:	
FY	17 (85%)
Fifth year medical students	3 (15%)
Current placement (specialty):	
Surgery	17(85%)
Medicine	1
Anaesthesia	1
General practice	1
Interest in surgery:	
High	11 (55%)
Moderate	4 (20%)
Unsure	3 (15%)
Not interested	2

Table 2. Assessment of participants' level of confidence in knowledge and practice. Comparison is made before and after the course, multiple comparisons are made to individual questions. Difference in mean, significance and 95% confidence interval (CI) are listed. * $p < 0.05$; ** $p < 0.01$, **** $p < 0.0001$		
Assessment	Difference in mean	95% CI
Knowledge of LA drugs**	1	0.2 to 1.8
Knowledge of appropriate dosing****	1.6	0.8 to 2.4
Technique of giving LA**	1	0.2 to 1.7
Complications associated with LA*	1	0.03 to 1.6
Handling of suturing instruments****	1.3	0.5 to 2
Knowledge of which suture to use****	1.6	0.8 to 2.3
Knowledge of which needle to use****	1.8	1 to 2.5
Instrumental knot tying****	1.5	0.7 to 2.2
Hand ties****	1.5	0.7 to 2.3
How to close a wound correctly****	1.8	1 to 2.5
Excision of a skin lesion****	1.9	1 to 2.7
I&D of an abscess****	1.9	1 to 2.6
Types of laparoscopic instruments****	1.9	1.1 to 2.7
Handling of laparoscopic instruments****	1.9	1.2 to 2.7
Holding the camera****	1.6	0.8 to 2.3
Suturing and tying laparoscopically****	1.4	0.6 to 2.2

Figure 2
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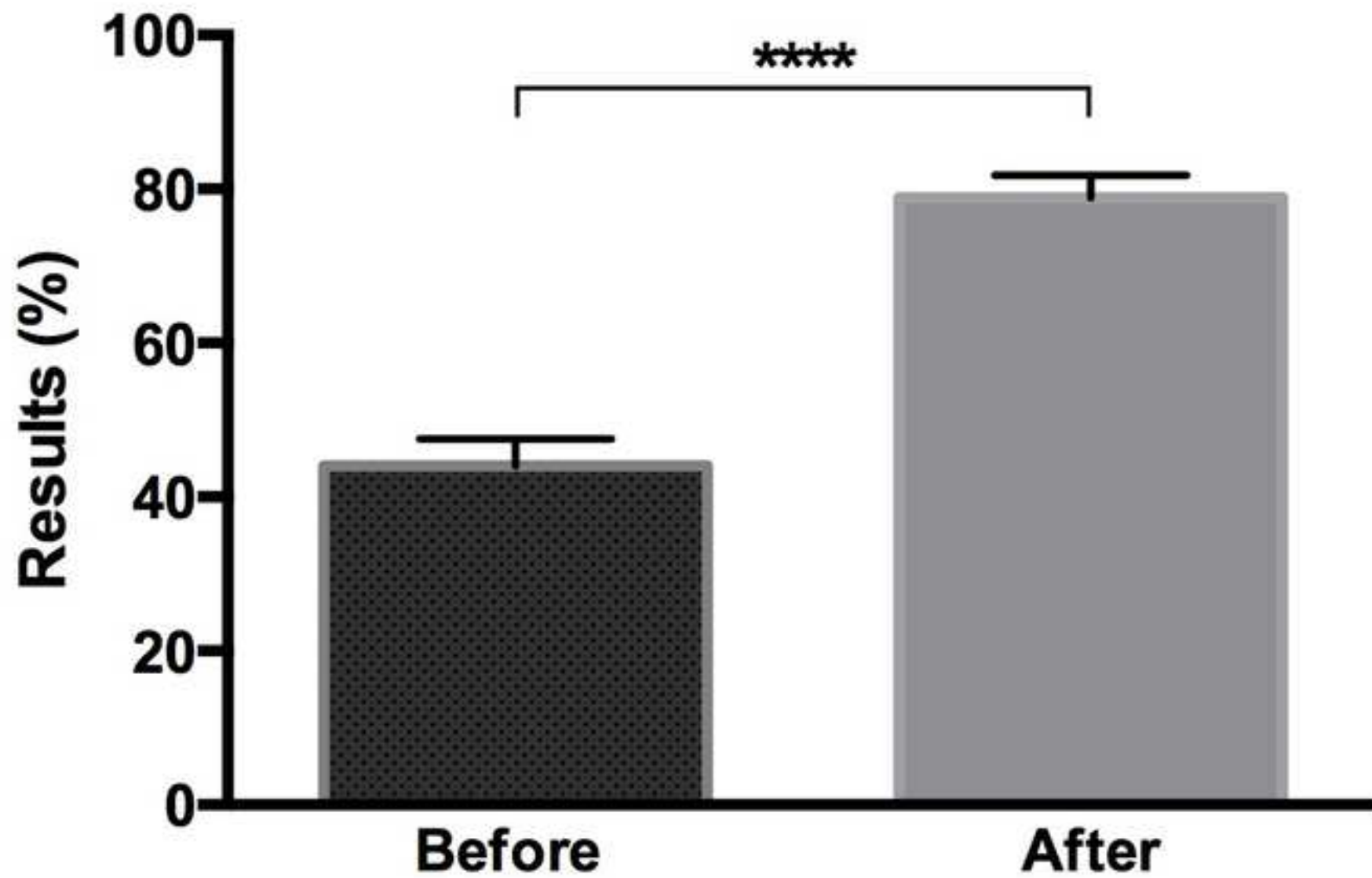
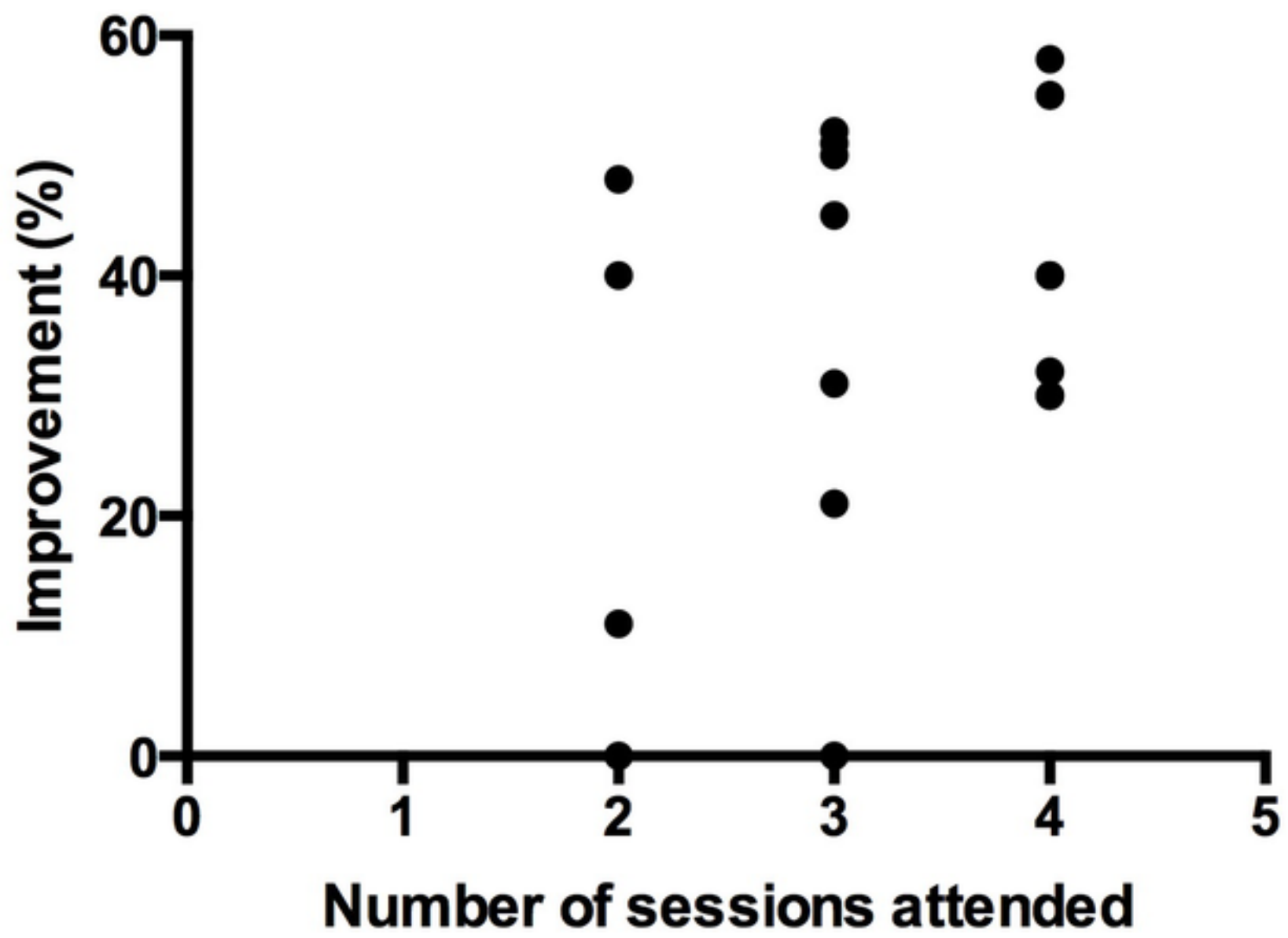


Figure 3
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$(r = 0.47, p < 0.05)$

Figure 4
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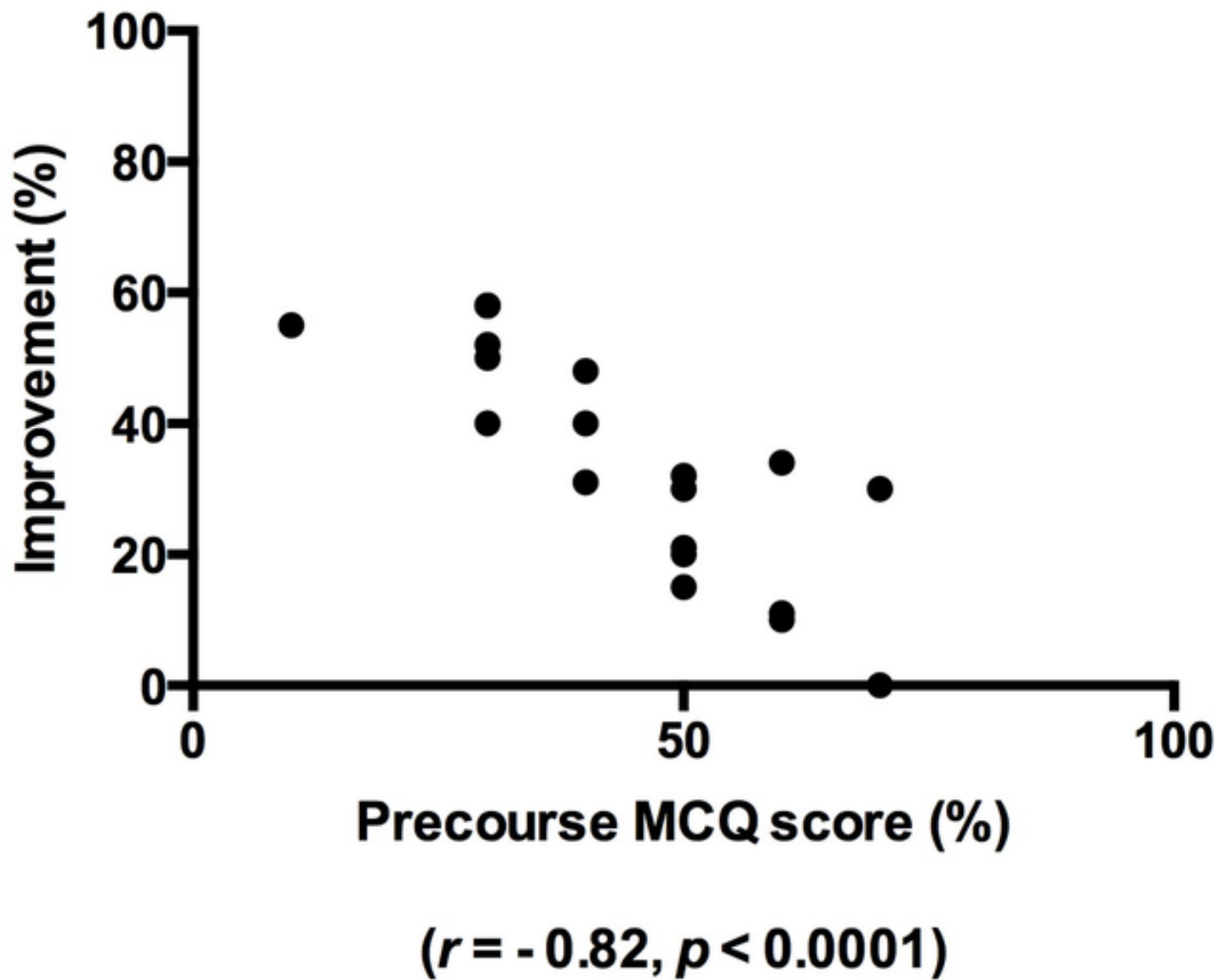


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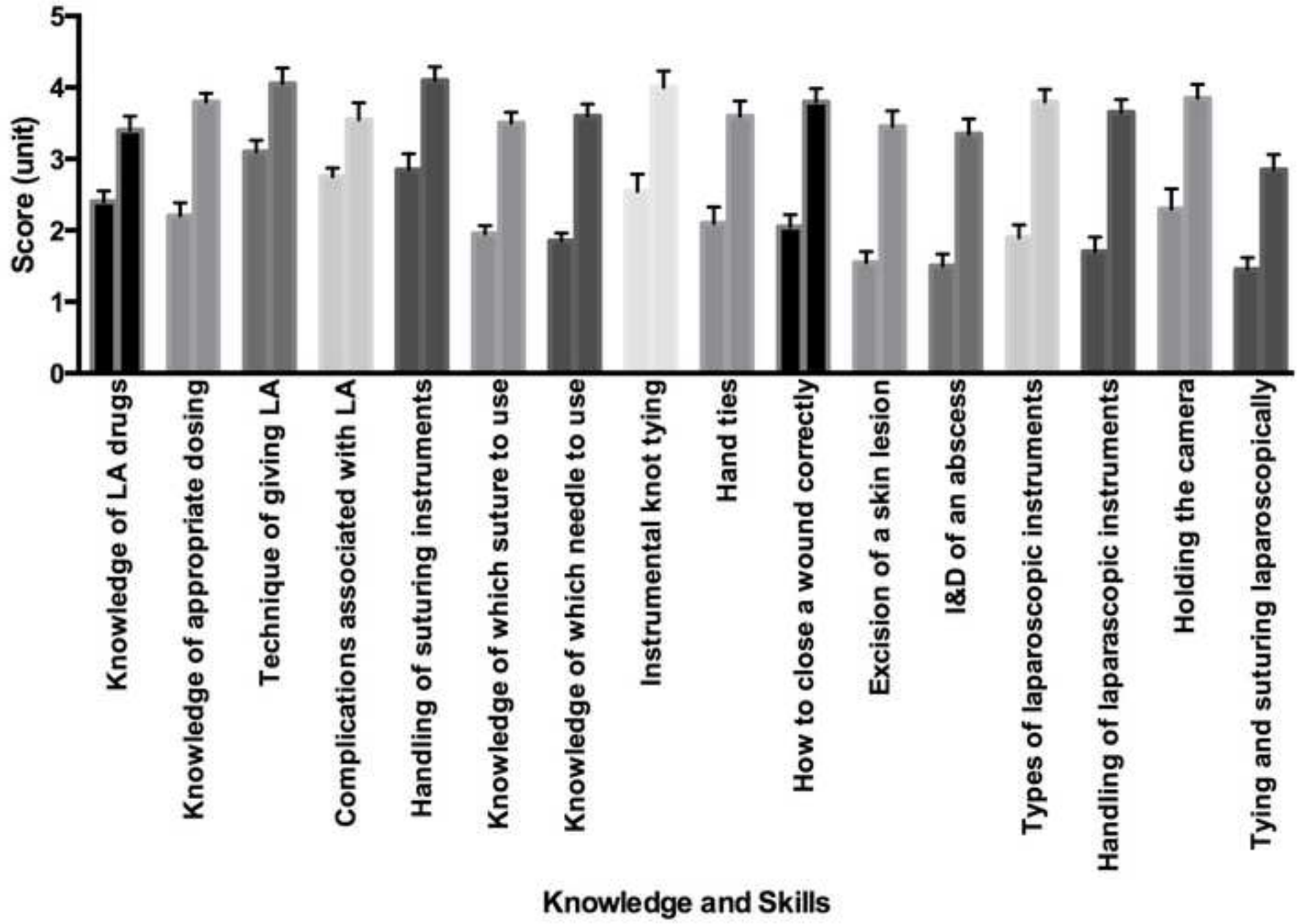


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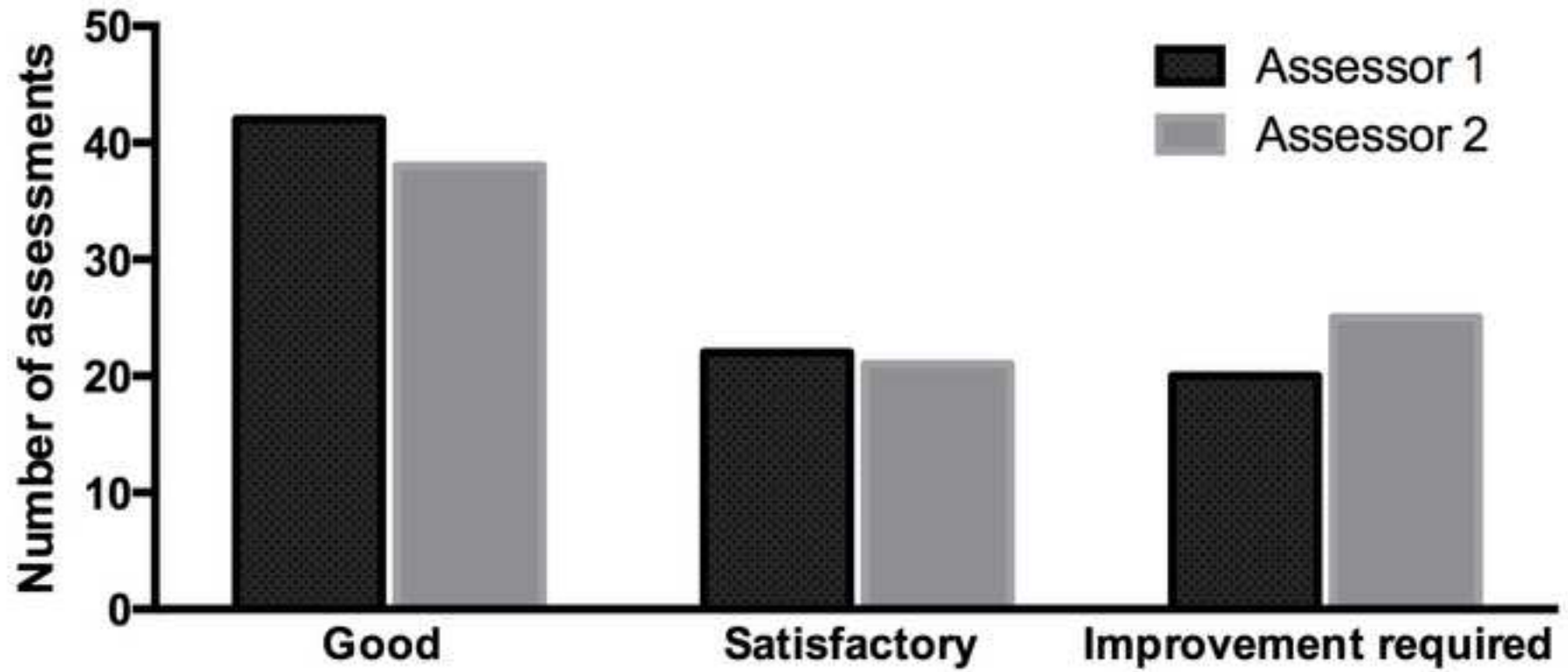


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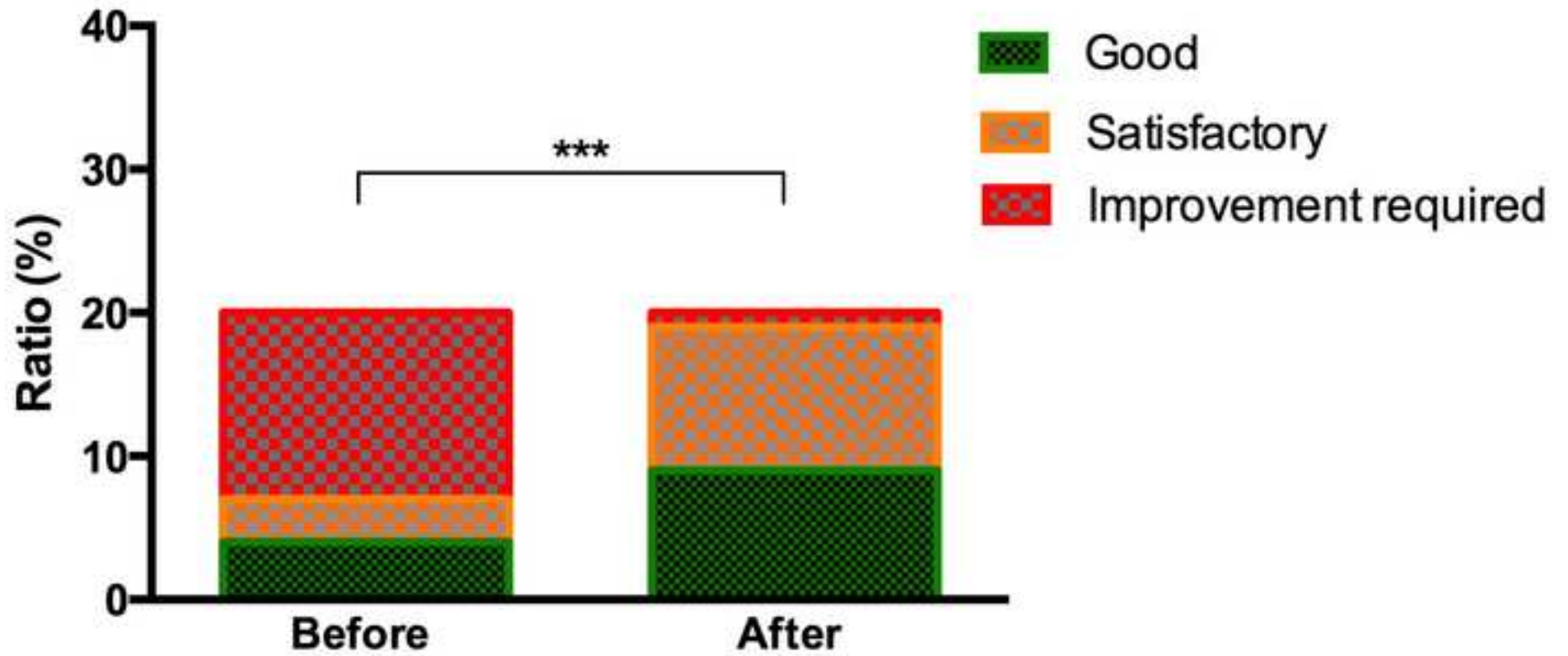


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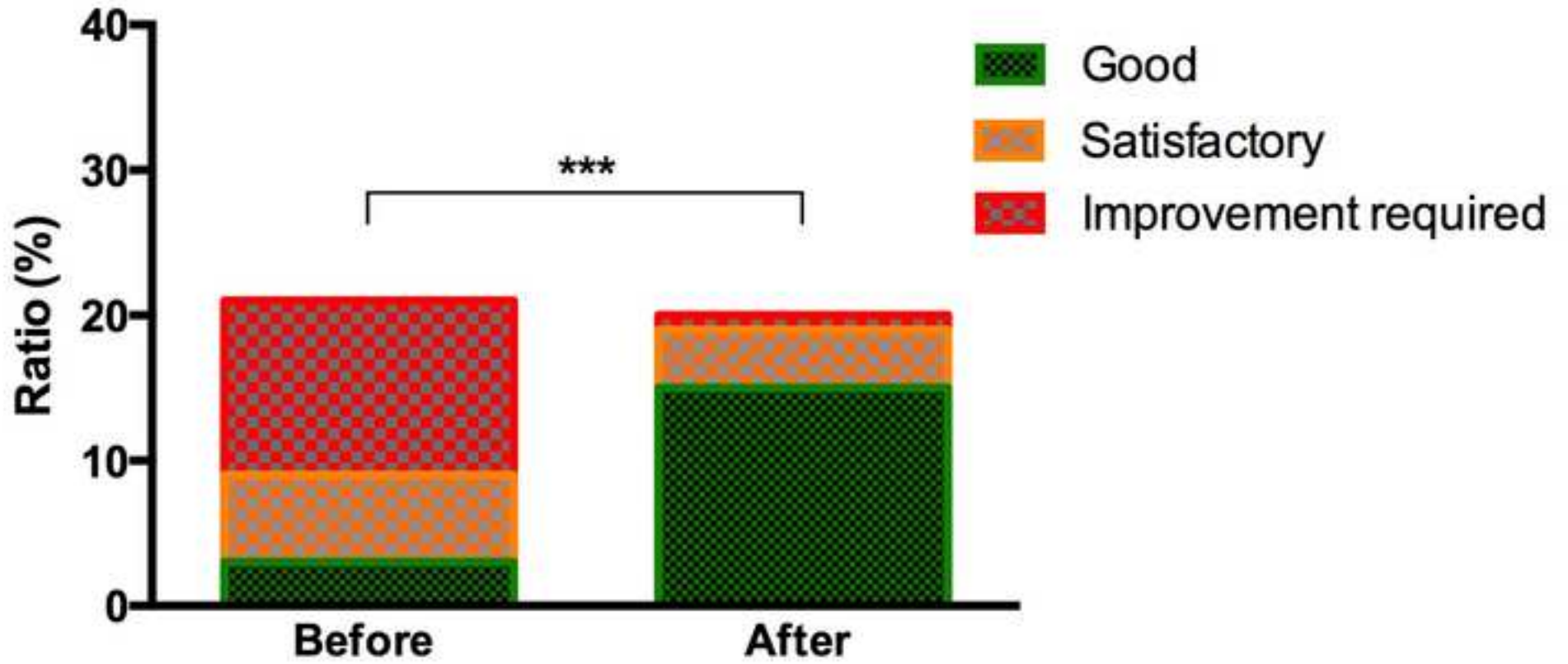


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