

Endovascular Training Using a Simulation Based Curriculum is Less Expensive than Training in the Hybrid Angiosuite[☆]

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WHAT THIS PAPER ADDS

Surgical training outside of the operating room, using a PROficiency based StePwise Endovascular Curricular Training (PROSPECT) program, including e-learning and hands-on virtual reality simulation, increases trainees' operative performance of endovascular interventions in real life. However, financial concerns are the main barrier to implementation of this innovative training program into daily surgical training. This study shows that an annual curriculum cost of €3806 per trainee is cost saving compared with €5001 per trainee if the same proficiency levels were obtained by surgical training in the hybrid angiosuite on real patients, suggesting that endovascular training with the PROSPECT program is better (same outcome at a lower cost).

Objective/Background: This study aimed to determine the cost-effectiveness of a PROficiency based StePwise Endovascular Curricular Training (PROSPECT) program, including e-learning and hands on virtual reality simulation.

Methods: A prospective, single blinded, randomised controlled trial (RCT) was carried out to evaluate the impact of a PROSPECT training program on real life operative performance. Under supervision, all subjects performed two endovascular interventions on patients with symptomatic iliac and/or superficial femoral artery stenosis. Primary outcomes were technical performance (Global Rating Scale, Examiner Checklist), operative metrics, and patient outcomes, adjusted for case difficulty and the trainee's experience. Additionally, an analysis of costs and savings related to implementation of this endovascular training program was performed. Thirty-two general surgery trainees were randomised into three groups: group 1 ($n = 11$) received e-learning and simulation training (PROSPECT program); group 2 ($n = 10$) only had access to e-learning; group 3 ($n = 11$) did not receive supplementary education besides clinical training. Developmental cost, implementation cost, training time cost, and the operational cost of PROSPECT were determined. Time spent studying and practicing was converted to indirect saving of operating time. The costs of logistics, faculty time supervising simulation sessions, and 30 day complication rates were registered. Sensitivity analysis was performed to assess the robustness of the results.

Results: Fifty-eight peripheral endovascular interventions, performed by 29 surgical trainees (three dropouts) were included in this RCT from October 2014 to February 2016. Annual costs from the perspective of the hospital were €6589 for curriculum design, €31,484 for implementation, and €1143 in operational costs. Per trainee, simulation based training until proficiency cost €3806. In comparison, if endovascular proficiency levels were obtained with conventional training only, this may have cost €5001 per trainee.

Conclusion: Simulation based training in endovascular procedures may be cost saving, because training occurs outside the angiosuite. It is possible that cost savings are underestimated as, in contrast to the literature, prevented costs related to complications could not be defined.

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INTRODUCTION

Surgical skills training is moving away from the traditional principle of "learning by doing" and establishing simulation as a foundation to provide trainees with the necessary skills and competences,¹ mainly because traditional surgical training during real life interventions in the operating room (OR) has been reported to be inefficient,² endangering patient safety and prolonging procedure time.^{3–5}

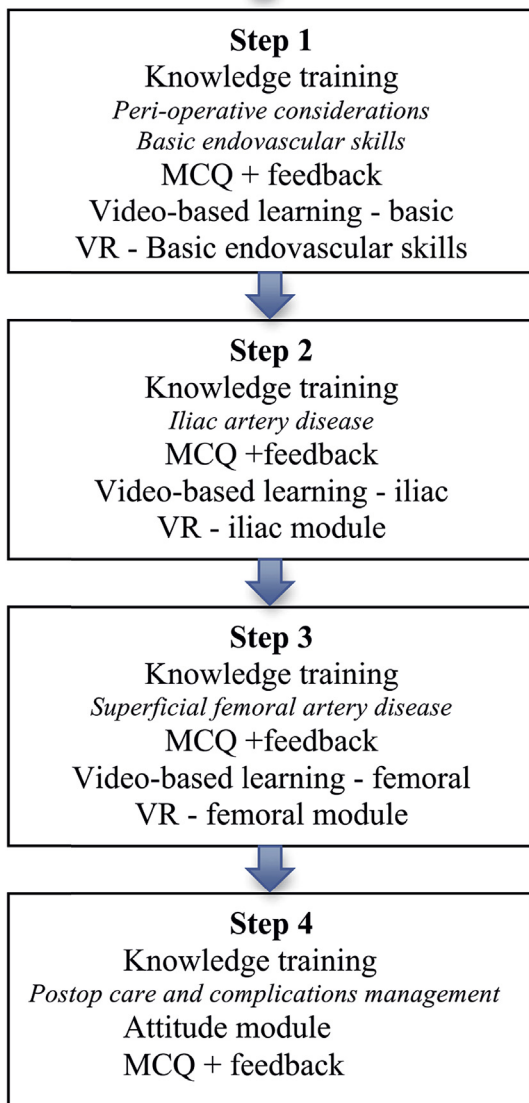


Figure 1. Steps of the PROficiency based StePwise Endovascular Curricular Training (PROSPECT) program. Note. MCQ = multiple choice questions; VR = virtual reality.

Simulation based surgical training programs may increase patient safety and lead to decreased complication rates and reduced costs associated with these complications.^{6,7} Cohen et al. showed that simulation based education in central venous catheter insertion reduced infection rates in the Medical Intensive Care Unit at an urban teaching hospital.⁸ The incremental cost related to treatment of a central venous catheter infection was determined to be €72,177 resulting in an annual saving of €616,143 due to lower infection rates.⁸

Similarly, the increased operating times for procedures with resident involvement and costs of medical errors leads to massive hidden costs.⁹ For example, each tympanoplasty intervention requires an incremental cost of €35.50,¹⁰ and the additional cost is €1323 for each laparoscopic anastomosis performed by supervised trainees.¹¹ Incremental costs associated with laparoscopic cholecystectomy and inguinal hernia repair were reported to be €8370 for residents and €22,922 for junior consultants per year.¹²

Therefore, investment in additional surgical education outside the OR has the potential to reduce costs to healthcare systems through improved operating room efficiency and reduction of medical errors.^{9,13} However, virtual reality (VR) simulation based education requires a significant financial investment and therefore health economic evaluations have been conducted to assess the cost-effectiveness of VR simulation based training programs.¹⁴ For example, simulation based robot assisted surgical training has been shown to save up to €528,123 owing to an indirect saving of OR time over one year at Roswell Park Centre for Robotic Surgery, taking into account investment, utilisation of equipment, and costs of operating room training.¹⁵ Similarly, simulation training in ophthalmological interventions reduces costs by increasing operating efficiency without affecting quality of care.¹⁶

In the field of endovascular surgery, a PROficiency based StePwise Endovascular Curricular Training (PROSPECT) program,^{17,18} including e-learning and VR simulation, to acquire endovascular skills has been shown to improve surgical performance in the OR (Fig. 1). However, to justify implementation of this simulation based curriculum in surgical education the costs of the program on the healthcare system should be critically analysed.¹⁹ The objective of this study was to perform an economic evaluation of the PROSPECT program in comparison to conventional training.

MATERIAL AND METHODS

Study design

Data were obtained in a single blinded prospective randomised controlled trial (RCT) at an academic centre and nine general hospitals, including 58 endovascular interventions in 56 patients from October 2014 to February 2016.¹⁸ The trial was registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT01965860).

Randomisation

The study followed a parallel group design in which 32 general surgery trainees were randomised, using the closed envelope technique, into three groups (Fig. 2). The first group received standard practice training combined with a simulation based proficiency based endovascular curriculum (PROSPECT; $n = 11$), including multimedia based training and simulation sessions. The second group had access to standard practice combined with multimedia based training modules ($n = 10$) and the third group only received standard practice ($n = 11$). Standard practice refers to conventional training based upon intra-operative learning and self study. There were no baseline differences in cognitive and technical skill level among the three groups. All real life endovascular cases performed and assisted in clinical practice during the course of the program and in the follow up period were registered.

Within 6 weeks of completing the training program, each trainee performed two endovascular interventions in the angiosuite under supervision. Patients were eligible if they suffered from symptomatic atherosclerotic stenotic disease

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