Karolinska Institutet, Department of Medicine, Cardiology Unit,
Karolinska University Hospital, Stockholm, Sweden

The role of simulator training for skills acquisition in coronary angiography

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av

Ulf Jensen

Karolinska Institutet

Huvudhandledare
Docent Per Tornvall
Enheten för kardiologi
Institutionen för medicin, Solna
Karolinska Institutet

Bihandledare
Med Dr Gunnar Ahlberg
Institutionen för molekylär medicin och kirurgi, Solna
Karolinska Institutet

Docent Jens Jensen
Enheten för kardiologi
Institutionen för medicin, Solna
Karolinska Institutet

Fakultetsopponent
Professor Carlo Di Mario
Imperial College
London
United Kingdom

Betygsnämnd
Docent Jan Harnek
Institutionen för kliniska vetenskaper
Lunds Universitet

Professor Håkan Hult
Institutionen för klinisk vetenskap, intervention och teknik
Karolinska Institutet

Docent Peter Henriksson
Institutionen för kliniska vetenskaper
Danderyds sjukhus
Karolinska Institutet

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ABSTRACT

Introduction

Coronary angiography (CA) is one of our most common invasive techniques in medicine today and is used to investigate coronary anatomy and pathology. The method is crucial and lifesaving in diagnosing acute coronary syndromes and so far not interchangeable to any other modality. The skills of performing a CA are compulsory for the general cardiologist according to present international guidelines but the methods for achieving these skills are not well defined. CA is a relatively safe procedure but complications occur, particularly during training. Simulators are proposed to be safe alternatives to achieve necessary skills but the methods for their use are not described. The aim of this thesis was to demonstrate that simulator training improve CA skills in real life. To be able to recommend simulators for skills acquisition, transferability from virtual reality to real life catheterization lab must be demonstrated, i.e. transfer validity.

Methods and results

Study I: The aim was to explore factors related to proficiency in CA and to construct learning curves to describe the improvement in CA skills over time. Swedish Coronary Angiography and Angioplasty Registry (SCAAR) was used to track experts and novel operators in CA and to compare their performances. Fluoroscopy time turned out to be the only solid marker for proficiency demonstrating a learning curve in the beginners group who reached expert level after 150 CAs. Complications were more frequent during training and were associated to fluoroscopy time.

Study II: The concept of simulator constructs validity, i.e. to demonstrate that the simulator can measure the differences it is supposed to measure was explored in study II. Twenty-four participants with three different levels of proficiency in CA performed five consecutive virtual reality CAs each in the simulator. Three different levels of skills in the simulator were demonstrated that corresponded to their proficiency level. Beginners had a fourfold increased risk of errors compared to the experts assessed by evaluating video recordings of their performances.

Study III: It was investigated if a structured simulator-based two day course in CA had any impact on the learning curve in CA. Twelve course participants continued to training in invasive cardiology and were tracked in SCAAR. Compared to a matched beginners group without simulator experience in SCAAR the virtual reality trained group demonstrated a less consistent improvement in fluoroscopy time previously discussed to be associated to proficiency. The complication rate was higher in the simulator trained group. Course transfer validity from virtual reality to real life was therefore rejected.

Study IV: In this randomized study it was explored if proficiency based training in CA could transfer skills achieved in virtual reality to real world. Sixteen senior cardiology residents were randomized to preparatory simulator training or control. The simulator group practiced in mean 10 hours in a CA simulator. Both groups performed thereafter two consecutive CAs on patients. The simulator trained residents outperformed the conventional trained residents in quality and safety of the procedure and had shorter fluoroscopy time reflecting higher proficiency.

Conclusion

Simulator training improves the performance in CA during training. The strongest factor related to proficiency demonstrating a learning curve was fluoroscopy time. The Mentice VIST™ simulator can differentiate between CA skills in different proficiency levels. Particularly fluoroscopy time demonstrated to correspond well to real life conditions. A structured course in CA involving non-proficiency guided simulator practice in CA had no impact on the learning curve in CA but with an increased risk of complications. Proficiency based skills training in virtual reality CA was superior compared to conventional mentor-based training in real life CA both in quality and in safety thereby proving the concept of transfer validity.

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