Design of a simulator for training off-pump coronary bypass surgery

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Title

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Introduction

Coronary artery bypass graft surgery (CABG) is a solution for patients that suffer from coronary artery disease, one of the most common causes of death. When performed on a beating heart without cardiopulmonary bypass machine, the procedure is called off-pump CABG (OPCAB). OPCAB is better tolerated by high-risk patients than on-pump CABG but requires over 150 procedures to achieve proficiency. To accelerate this learning curve and reduce risks for patients, we design an OPCAB simulator and training program. We elaborate the design method adapted to medical simulators by Van Meurs (2011), by adding interviews with main stakeholders.

Description

Critical aspects of Training Needs Analysis (TNA), Training Program Design (TPD), and Training Media Specification (TMS) were addressed in interviews with experienced (>10 years) cardiothoracic surgeons (n=5), cardiothoracic surgeons (in training) with minor experience (<5 years) (n=3), and cardiothoracic surgeons in training without any experience in OPCAB surgery (n=3).
TNA: According to the interviewees the main tasks for the surgeon during OPCAB surgery are: keep stable hemodynamics (mentioned in 64% of the interviews) and efficient communication (45%). Only interviewees with minor or no experience in the OPCAB procedure mentioned making correct anastomoses (67%), most likely because experienced surgeons perform anastomoses routinely. Manipulating the heart to keep stable hemodynamics and access the lateral wall of the heart was perceived as a major challenge (73%). These observations inform the formulation of training needs in terms of "norm scenarios" which also guide further development and evaluation.
TPD: A training program should cover the norm scenarios mentioned above. The interviews call for modulation of these scenarios with increased difficulty using arrhythmias (73%), differences in left ventricular function and difficulties in cardiac manipulation (54%).
TMS: Essential characteristics for the simulator are a beating heart model (64%) and reactivity of hemodynamics to manipulation of the heart (64%). However, anatomically correct motion of the heart was considered not essential by 73%. Use of fluid in the coronaries was rated as highly desirable (82%).

Discussion

We used an existing design method combined with interviews of main stakeholders to design an OPCAB surgery training program and simulator. This process, which to our knowledge has not been described before, leads to valuable, practical design indicators. The future will show if this ongoing work leads to a program and simulator that meet the specified needs.

Clinical speciality keyword

Cardiothoracic surgery

References/Acknowledgements

Van Meurs W: Modeling and Simulation in Biomedical Engineering: Applications in Cardiorespiratory Physiology. McGraw-Hill, New York, 2011.