Danish Institute for Medical Simulation (DIMS)

Making a difference for quality of care and patient safety: Research with and about simulation.

Article by: Peter Dieckmann, Anne Lippert, Doris Østergaard, Marlene Dyrløv Madsen and Marlene Mohr.

Danish Institute for Medical Simulation (DIMS), Herlev Hospital, University of Copenhagen, Capital Region of Denmark.

Simulation is spreading – now also for research purposes

In recent years simulation in the health sciences has spread around the world [1]. More disciplines and professions are engaging in education and training activities using simulation as an educational tool. We gave an overview about the use of simulation in an earlier issue of this publication [2]. In this paper we explore the connections between simulation and research. Our aim is to describe uses of simulation that go beyond the educational use, while at the same time, helping in generating new knowledge that can inform simulation-based education as well as safe care for patients.

The connection between simulation and research has many aspects. A basic distinction is based on the use of simulation as (a) research object in itself or as (b) method to investigate another research object. Thus, one might distinguish (a) research on simulation and (b) research with simulation. We will describe both approaches in more detail below.

Another basic distinction can be made between simulation based research and evaluation. Evaluation studies investigate certain uses of simulation, for example, whether a training resulted in the desired improvement in competence of its participants. Research, on the other hand expands the view beyond the immediate context of the study. The aim is to describe, understand and predict characteristics and dynamics of a research object. Where evaluation asks for whether training 'x' worked under conditions 'y', research investigates the general characteristics of the relation between 'x' and 'y' and aims at a generalisation from this connection to similar contexts.

Simulation as research object – Research on simulation

Studies and theoretical frameworks that make simulation the object of research, primarily investigate how simulators can be built and used.

One branch of research focuses on the technical side, be it hardware or software. Modern simulators are the result of intense research and developmental processes. Simulators are meant to help fulfil learning goals, be durable and as realistic as it is needed for the purpose of the simulation in which the simulator is used. The devices have many electronic, electric and mechanical parts that are optimized based on research results. On the software side, simulators use some kind of simulation engine. Model-based engines depend on basic research, aiming to understand and replicate physiological processes using computers. A simulation-model would automatically adjust the vital signs of the simulated patient based on the input (medication, ventilation, etc.) for which the simulator provides sensors. Simulation users might administer a hypnotic drug, the simulation model calculates whether the dose is sufficient for the current patient and would trigger the mechanics that close the eyes of the manikin as well as decreasing the blood pressure. Research and development in these areas focus on optimizing specifications for simulators (which impact upon usefulness for specific purposes) and verifying that the specifications are actually met. This branch of research is connected to the technical aspects of how closely the simulator replicates the "simulated system" (e.g. the patient or physiological processes), addressing issues of the so called simulation fidelity [3].

Another branch of research looks beyond the tools themselves and at the use of simulators in relation to achieving the purpose of simulation. The concrete use of a simulator in a specific context impacts, for example, on aspects of simulation fidelity, not directly related to the technical issues.

Other meanings of simulation fidelity comprise the meaning which users assign to a simulation situation and the related phenomenal experience. Both senses of simulation fidelity may match the simulated system closely or not and depend strongly on the use of the simulator as a device. A highly realistic simulator might thus be used in an unrealistic way or vice versa. These studies and theoretical conceptualisations try to improve the conceptual basis for simulation practice and theory [4, 5]. Simulation and related terms like the fidelity concept seem to be straightforward at first glance but become more complex the closer one looks. One consideration is, for example, the question, whether fidelity is actually a characteristic of the device and its use or a characteristic of perception, cognition, and emotion: is simulation fidelity in the device or in the user, or – as we would suggest - in a combination of both?

Studies that investigate the use of simulators as research objects try to understand and predict connections between the actual use of simulators and the outcome of this activity. Outcome of simulator use in this sense could be assessment of training effects, reliability and validity of such assessments and/or research results.

A main aim of a third branch of research on educational uses of simulation is to understand learning relevant characteristics, like repetition or connecting experiences during simulation to reflections afterwards [6, 7]. A large part of research on simulation actually investigates the effect that simulation has on the participants and the organisations in which they work.

Studies are often a mix between evaluation, quality assurance and research and try to measure the effect of simulation. Typically, data is collected on the direct reactions to the course (happy scores), immediate learning (e.g. ability to perform a certain skill, having a piece of knowledge), behavioural or attitudinal changes (actually using a technique which was learned during simulation in clinical practice) and, less often, on effects for the organisation in which training participants work (e.g. increased patient safety, reduced costs) [8, 9].

A currently much discussed series of studies looked at the effects of team training in a British Hospital by measuring the effect on the APGAR scores of newborns. One of these studies showed improvement of the scores and less neurological deficits which were associated with the implementation of simulation-based team training [10]. Such studies, investigating the effect of simulation-based training on the organisation, are difficult to conduct and thus very rare, nevertheless needed to support the case of simulation on a broad basis.

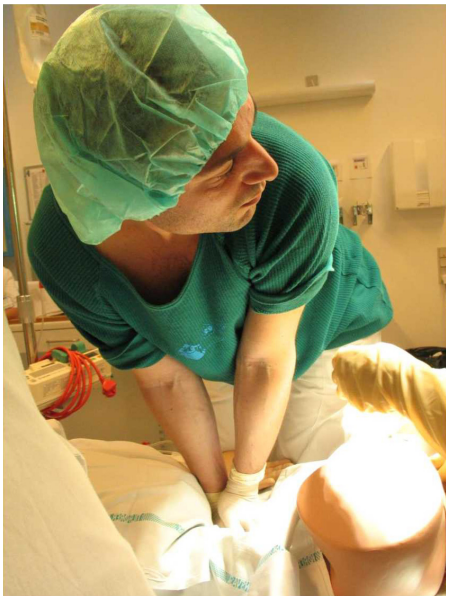
Simulation as investigation method – research with simulation

In many studies simulation is the method, not the object. A key benefit of using simulation is that it allows for combining controlled study conditions with ecological validity of the study setting. The research team can, to a large extend, control what participants perceive, while at the same time the context in which participants act is very similar to the simulated health care context.

Multiprofessinal treatment teams require a lot of co-ordination and collaboration. Simulation base research can help identify the needs and evaluate the effects of interventions.

Prominent examples of this type of research is to use simulators to investigate aspects of human factors and patient safety. For example, simulators were used to investigate the effects of severe fatigue on providing anaesthesia in a simulation environment [11]. Here, it becomes obvious that simulation offers study conditions which could not be produced in health care settings because their patients would be endangered. In our group, we have investigated failures of prospective memory in a simulation setting [12]. We investigated under which conditions a failure of prospective memory would lead to missing to execute an intended action. A study, which would not have been possible, nor ethical in health care settings.

Simulation studies can also serve to identify learning needs of health care professionals. In this sense simulation can be used both as a tool for the analysis and intervention [13]. Health care professionals work through a set of scenarios, while the research team at the same time investigates the strengths and weaknesses in the treatment of patients in these particular settings.



Engaging real professionals in highly realistic care settings combines research relevant control with ecological validity.

In a current research project on handover, we used simulation as part of an interventional training program securing safe handover between departments and between different professions.

The intervention is based on in-depth analyses of the actual process in the work system. Simulation serves a double role in (a) creating recognition of handover as a critical situation (although routine) and a moment of shifting the responsibility for the patient and (b) in training a clear and relevant communication in the specific situation, using a structured handover guide developed for that specific purpose and context.

Our group used the concept of “in-situ” simulation trying to optimize health care processes around delivery, while at the same time identifying training needs for the professionals involved.

In this study, the simulator was taken to the real work environment. A part task trainer, combined with a simulated patient were brought into an actual delivery room of a hospital in Denmark and the actual inter-professional team of health care professionals working there treated the simulated patient during relevant scenarios.

In situ simulation – moving the simulated patient from the delivery room to the operating theatre revealed potential obstacles on the way.

The actor allows for highly realistic interactions with the patient, while the part task trainer allows for invasive treatment steps. This approach had several research related outcomes, resulting in the development of a curriculum for systematised training and several recommendations for improvements in the processes and the environment.

By using simulation as a research tool in this way, many of the weaknesses in current health care systems can be discovered and remedied. Weaknesses that might otherwise stay hidden in the system until an unfortunate constellation of real care reveals them. Simulation as a research tool allows for enlarging the search scope and chances of discovering safety holes in the work system without endangering patients and health care professionals.

With bringing the actual teams together during the simulation session, it was possible to include those people who can actually make a difference in the work environment. Having the change agents there help subsequently to improve the interplay between human, technology and organisation – which, in the end will make or brake high quality care and patient safety.

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DIMS
DANISH INSTITUTE FOR MEDICAL SIMULATION

For further information please contact:

Anne Lippert
Consultant
Danish Institute for Medical Simulation

Email: annlip01@heh.regionh.dk
www.herlevsimulator.dk