1 Introduction

Simulation has been employed as an educational technique in healthcare, but is rapidly evolving as an approach for healthcare improvement. This Element reviews its current and potential future use. We outline the origins of simulation as an educational technique and characterise the increasing interest in, and use of, simulation as a way of improving care. We show how simulation can be used to explore working environments, and the practices and behaviours of those who work in them, to improve clinical performance and outcomes, to test planned interventions and infrastructural changes, and to help professionals learn about, and embed a culture of, improvement. We discuss the challenges of using simulation as an improvement technique, including the current lack of connection between the simulation and healthcare improvement fields – both in practice and in scholarship. We conclude by offering a way forward for simulation as an improvement technique in practice and for future scholarly directions to improve the method.

2 Healthcare Simulation as an Improvement Technique

This section provides an explanation of terminology, methods, and the scope of the term 'simulation'. We consider the history of simulation in healthcare – and its traditional role as an education and training technique focused on patient safety. Building on these traditions, simulation is now emerging as a method for examining and improving systems. Few published real-world examples have been described or evaluated in sufficient depth to be considered exemplars, so we offer in-depth, hypothetical case vignettes to provide granular illustration of the method and the diverse techniques employed under the umbrella term of simulation. We give an overview of efforts by the community of practice in healthcare simulation to crystallise these approaches into a consistent method and to explore the relationship with existing healthcare improvement methods, including addressing relationships, reliability, and risk.

2.1 Definition and Description of Healthcare Simulation

Simulation as an imitation of a situation or process has a long history within fields such as aviation and construction. Since the turn of the century, simulation has been adopted in healthcare as 'a technique that creates a situation or environment to allow persons to experience a representation of a real event for the purpose of practice, learning, evaluation, testing, or to gain understanding of systems or human actions'.[1]

In his seminal work, *The future vision of simulation in health care*,[2] Gaba outlines 11 dimensions that highlight the various applications of simulation.

Positing that 'simulation is a technique, not a technology', Gaba underscores the diversity of simulation techniques. Simulation can look like many different things, in different places, with different people. In a medical school, for example, students use simulation when they practise suturing on task trainers – plastic models with fake skin. Within a hospital context, a simulation may be conducted 'in situ' (within a real clinical space) with a manikin acting as the patient. Equipped with technology to emulate a heartbeat, vital signs, realistic lungs, and electronic haptic (touch) feedback, this could allow an interventional cardiology team to catheterize the heart while the intensive care team resuscitates the patient. In a resuscitation bay, an emergency department team standing around an empty stretcher could be engaging in a brief mental simulation exercise to start their shift.

In short, there is no single recipe for a simulation programme or simulation exercise. Box 1 describes a hypothetical case vignette of applying simulation to a specific healthcare improvement goal – improving performance in emergencies on a cardiac surgery ward. The vignette illustrates the complexity of the clinical performance being explored and the variety of simulation techniques that might be employed to achieve the improvement goal. In Table 1, we then explore that example through the lens of Gaba's 11 dimensions of simulation.[2]

2.2 How Simulation Became Integrated into Approaches to Improve Quality and Safety

The benefits of healthcare simulation for education and training in a variety of contexts are well described.[4] Historically, simulation was assumed to improve patient safety and care quality through the education of individual healthcare professionals and teams.

Early use of simulation focused on practising procedural skills using part task trainers – for example, using oranges to practise intramuscular injection, plastic arms to practise intravenous cannulation, and plastic head and neck simulators to practise airway management techniques. As technology has improved, educational applications for procedural skills now extend to virtual reality and software-based simulation of complex procedural tasks, such as laparoscopic surgery.

Improving a wider range of clinical skills such as communication is also a common use of simulation. Simulated patients are trained educators acting as patients, recreating everyday and challenging conversations, such as history taking, discussing bad news, or end-of-life conversations, and offering thoughtful feedback to learners in real time.[5]

Box 1 Improving performance in emergencies on a cardiac surgery ward

A cardiac surgery ward wants to improve its ability to respond to a rare but critical event: cardiac arrest in patients after cardiac surgery. This clinical situation requires a functioning ad hoc team, clinical decision-making that falls outside of usual cardiac arrest algorithms, and specific equipment.

Four simulation sessions are organised to take place over the course of a year, with the aim of clinical teams practising together for this critical event, and reflecting on the human factors that contribute to success or failure. A scenario is designed by the simulation delivery team – a group comprised of clinician experts and members with specific simulation technical skills and group facilitation expertise. The scenario outlines stages of the clinical encounter: initial patient deterioration 2 hours after surgery, sudden loss of cardiac output, and recovery after appropriate team interventions.

The simulation delivery team expects that the four sessions will offer a chance for iterative improvement if clinical teams identify opportunities for better teamwork or systems. In each session, staff who would be involved in such a clinical situation are organised to attend the simulation, which is conducted in a bed space in the cardiac surgical ward. Each simulation includes 10 participants from the clinical teams who would come together for this critical event (rapid response registrar and nurse, ward nurses, anaesthetics registrar, intensive care unit registrar, cardiac surgeon, intensive care unit administration clerk, and porterage staff).

Each session involves:

(1) a short pre-briefing for the clinical team, outlining the aims of the exercise and clarifying expectations
(2) the scenario, during which the clinical team is required to recognise the patient deterioration and respond appropriately
(3) a debriefing discussion with the clinical team, facilitated by a member of the simulation delivery team.

The debrief includes addressing any knowledge gaps (educational outcomes) but is mostly focused on supporting the clinical team to identify opportunities for better teamwork, equipment set ups, call systems, and cognitive aids. After each session, the simulation delivery team creates a report on the findings from the simulation and a debrief that is circulated to participants and to departmental leadership.

- In the first simulation, participants identify that having two different cardiac arrest trolleys on the ward leads to confusion.

- In the second simulation, the rapid response registrar voices unfamiliarity with the alterations to the cardiac arrest algorithm for patients after cardiac surgery. This provides the opportunity for the expertise of cardiac surgical ward nurses to be uncovered and amplified in the debrief.
- In the third simulation, a newly designed single cardiac arrest trolley (based on issues identified in the first simulation) is trialled.
- In the final simulation, the facilitator notices that the ward nurse gives the rapid response registrar a cue card when they arrive bedside to remind them of the differences in cardiac arrest management in this particular clinical situation. This card was designed by the ward charge nurse and a rapid response registrar after the second simulation.

Computer-based simulation of patient care scenarios, which require learners to synthesise information and make decisions about investigations and treatments, can improve decision-making and support cognitive aspects of healthcare delivery.[6]

And, in recognition of the critical role of teamwork in healthcare, simulations can be focused on teamwork behaviours. These involve teams of healthcare practitioners caring for a patient to support learning about both common and rare presentations, while providing opportunities to practise role allocation, leadership, and communication within the team.

If appropriately embedded within an educational framework,[7] these examples of simulation-based education can lead to faster and more effective learning without the attendant risks of subjecting patients to practitioners' learning curves. Best practice for educationally focused simulation includes integrating simulation into curricula, capturing clinical variation, allowing repetitive practice, and incorporating useful feedback or time for reflection.[8,9] An exponential growth in educational simulation research since 1980 has also led to an increased emphasis on sound educational principles – for example, maintaining psychological safety for participants and increasing emphasis on debriefing and reflective practice.

Box 2 describes a hypothetical case vignette illustrating the need for simulation activities to be supported by educational frameworks (including assessment) and cultural change to be successful.

Recent years have seen widespread adoption of simulation in healthcare professions' curricula for education, continuing professional development, and team improvement.[9] Here, simulation is seen as an educational adjunct, manifested in a desire for standardised educational opportunities, the need to practise skills before applying them in a clinical environment, and to supplement scarce