A Contemporary History of Healthcare Simulation Research

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Overview

This chapter reviews the major developments and milestones in simulation research over the last 20 years. While we acknowledge that simulation has many applications outside education, our focus in this chapter is on documenting contemporary history with a strong education focus. We first outline major developments in medicine and nursing. We consider different approaches to research. We note the importance of the role of professional societies and associations in the dissemination of healthcare simulation research.

Practice Points

- Research surrounding healthcare simulation began to appear in the 1990s, but started to increase dramatically in the mid-2000s.
- The evolution of healthcare simulation research has been propelled by several important milestones and events including the development of simulation societies and associations and peer reviewed journals.
- Research paradigms – qualitative, mixed methods and quantitative – all have potential value in healthcare simulation research.
- In healthcare simulation, researchers and their audiences are diverse and include simulation practitioners, health and social care professionals and educators, psychologists, sociologists, biomedical scientists, engineers, information technologists, economists, programme evaluators, policy makers and others.

Introduction

Healthcare simulation education has a long and at times ancient history [1], however, scholarly research on the topic has only appeared more recently. In 1902, The BMJ published an article in which the author called for "Future research … to determine the role of advanced educational techniques, including the use of simulators, in facilitating bronchoscopy education [2]." Owen (2016) notes how the first half of the twentieth century was the "dark ages" in healthcare simulation and it was only in the latter part of the twentieth century that healthcare simulation was "rediscovered" [1]. It is from this time that we describe the contemporary history of healthcare simulation research. It is really only in the last 30 years that research with and about simulation has grown, and this growth has been exponential. A PubMed search using the terms: simulation and patient safety, simulation and healthcare, and human patient simulation between 1980 and 2018, demonstrates the dramatic growth in simulation publications (see Fig. 2.1).

Research on healthcare simulation has been diverse with respect to intent, simulation modality and context. It has been descriptive, experimental, evaluative, explanatory and exploratory, meaning the methodologies and methods have drawn from quantitative, qualitative and mixed methods

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D. Nestel et al. (eds.), *Healthcare Simulation Research*, https://doi.org/10.1007/978-3-030-26837-4_2

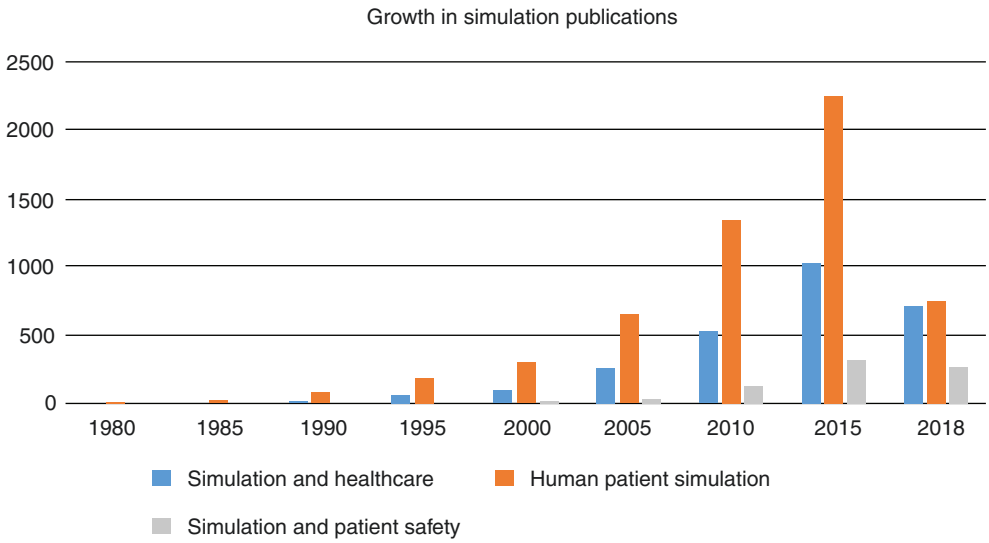

Fig. 2.1 Growth in healthcare simulation publications, 1980–2018

research approaches. Researchers and their audiences are also diverse and include simulation practitioners, health and social care professionals and educators, psychologists, sociologists, biomedical scientists, engineers, information technologists, economists, programme evaluators, policy makers and others [3]. While we acknowledge that simulation has many applications outside education, our focus in this chapter is on documenting contemporary history with a strong education focus. We first outline major developments in medicine and nursing. We consider different approaches to research. We note the importance of the role of professional societies and associations in the dissemination of healthcare simulation research.

Major Developments: Medicine

Even in the early 2000s, simulation in healthcare was viewed as a novelty by many. Over the course of the decade, however, there was a paradigmatic shift toward viewing simulation as an essential method for training and education. Several critical articles were published offering empirical evidence of the benefits of simulation training. In the late 1990s, Gaba and colleagues reported on the beneficial effects of simulation training in anesthesiology [4, 5]. In 2002, Seymour and colleagues published the first double-blind experiment comparing a traditional apprenticeship training approach to laparoscopic surgery with training on a virtual reality simulator [6]. Their results showed that residents who trained on the simulator needed 30% less time to perform a genuine procedure than those trained according to the traditional method and were also less likely to injure the patient. Then, in 2005, Issenberg and colleagues published a systematic review of the literature from 1969 to 2003 and concluded that 'high-fidelity' (manikin) medical simulation-based education was an effective method that complemented education in patient care settings, but that more rigorous research was still needed [7]. This review was repeated in 2010, and the authors noted advances from the earlier study [8]. It is valuable to report their findings since they reflect the focus of research to that time and have influenced what followed. The "features and best practices of simulation-based medical education" reported were: (i) feedback; (ii) deliberate practice; (iii) curriculum integration; (iv) outcome measurement; (v) simulation fidelity; (vi) skill acquisition and maintenance; (vii) mastery learning; (viii) transfer to practice; (ix) team training; (x) high-stakes testing; (xi) instructor training, and (xii) educational and professional context [8].

Perhaps equally important, several key leaders in medicine began to embrace the need to shift away from traditional approaches to training and education in favor of evidence-based alternatives that decreased the risk to patients [9–11]. In 2003, Ziv and colleagues argued that simulation-based training in healthcare had reached the point of becoming an ethical imperative [12].

Major Research Developments: Nursing

In 2005, the National League for Nursing (NLN) and Laerdal Medical jointly funded Jeffries and Rizzolo to develop simulation for nursing education in the USA. This work resulted in the first multisite nursing study in simulation and produced a framework which drove much future nursing research [13]. This was followed in 2015 with a more developed NLN Jeffries Simulation Theory [14]. In 2011, the Boards of Nursing in the USA pressed their National Council of State Boards of Nursing to provide evidence for the use of simulation in nursing education. This resulted in a cohort study of 600+ students in 10 schools of nursing around the USA over 2 years [15]. Results indicated that the substitution

of up to 50% of traditional clinical time with high quality simulation using the INACSL Standards of Best Practice, did not interfere with students' abilities to pass the final certification exam, the NCLEX. Hospital educators and charge nurses who hired those graduates in the first 6 months post-graduation could not distinguish their performance from other new graduates [15].

Focus of Contemporary Research

This book explores different research approaches – qualitative, mixed methods and quantitative. All are present in contemporary research. McGaghie et al. argue for translational research in healthcare simulation [16]. This is the *bench to bedside* notion associated with biomedical and clinical sciences. The multiple levels from T1 (e.g. research that measures performance during simulation scenario), T2 (e.g. performance in clinical settings) and T3 (e.g. economic evaluations and sustainability) [17] all need investigation. We see many examples of research at T1 & T2 levels and increasing interest in T3.

Writing from a broader perspective than simulation, Regehr wrote of the need to re-orient two of the dominant discourses in health professions' education research: (i) from the imperative of proof to one of understanding, and (ii) from the imperative of simplicity to one of representing complexity well [18]. In an editorial of a new simulation journal, Nestel argued that his words resonated with the importance of valuing research that seeks understanding of the complex practice of simulation-based education [3].

The Role of Professional Societies in Healthcare Simulation Research

Late in the twentieth century, professional societies dedicated solely to healthcare simulation began to emerge. The Society in Europe for Simulation Applied to Medicine (SESAM) was established in 1994 and shortly thereafter the Society for Medical Simulation (later renamed the Society for Simulation in Healthcare; SSH), was established in the United States. The International Nursing Association for Clinical Simulation in Nursing (INACSL) was incorporated in 2003. Numerous organizations have emerged since then serving special niches within healthcare (e.g. International Pediatric Simulation Society – IPSS etc.), different simulation modalities (e.g. Association of Standardized Patient Educators – ASPE, for educators working with simulated participants), different countries (e.g. national societies), or geographical regions (e.g. California Simulation Alliance, Victorian Simulation Alliance etc.).

In 2006, SSH published *Simulation in Healthcare* and the INACSL began publication of *Clinical Simulation in Nursing*, the first two peer-reviewed journals dedicated solely to simulation. Since then, additional simulation journals have emerged including, *Advances in Simulation* and *BMJ Simulation & Technology Enhanced Learning*. Both of these journals are associated with professional societies. Other journals that address modelling and simulation more broadly have also begun to dedicate sections to healthcare simulation technology and systems (e.g., *Simulation*). Most of these professional societies and associations provide at least annual events in which research can be shared (See Chap. 41).

Standards of Simulation Practice

An important contribution to the healthcare simulation community has been the development of standards for simulation performance first published by the INACSL organization in 2010 [19]. The standards incorporated the then "best evidence" to provide guidance in the performance of high quality simulation education. The INACSL Standards for Best Practice: Simulation℠ are updated on a recurring cycle and are available freely to all (https://www.inacsl.org/inacsl-standards-of-best-practice-simulation/). Similarly, the ASPE have published standards for best practices for educators working with simulated participants [20]. Linked with the INACSL standards, the ASPE standards are based on research evidence in the discipline of simulated participant methodology.

Research Summits

Several professional societies and associations have held research summits and/or established research agendas. Nestel and Kelly have documented this history [21]. In 2006, the Society for Academic Emergency Medicine (SAEM) Simulation Task Force [22]. Issenberg and colleagues reported an Utsein-style meeting designed to establish a research agenda for simulation-based healthcare education [23]. In 2011, SSH held its first Research Summit bringing together experts from a wide range of professions and disciplines to review and discuss the current state of research in healthcare simulation and establish an agenda for future research [24]. Topics addressed at the Summit included: procedural skills, team training, system design, human and systems performance, instructional design and pedagogy, translational science and patient outcomes, research methods, debriefing, simulation-based assessment and regulation of professionals, and reporting inquiry in simulation. The Summit reaffirmed that research surrounding healthcare simulation had grown enormously. Although this increased research activity is certainly welcome, the reporting practices in the scholarly literature varied widely. Stefanidis et al.

(2012) report research priorities in surgical simulation for the twenty-first century using a Delphi study with members of the US-based Association for Surgical Education [25]. In 2013, the Australian Society for Simulation in Healthcare established a research agenda [21]. And, reported in 2014–2015, the International Network for Simulation-based Paediatric Innovation, Research, and Education (INSPIRE), brought together two research networks with the vision "to bring together all individuals working in paediatrics simulation-based research to shape and mould the future of paediatrics simulation research by answering important questions pertaining to resuscitation, technical skills, behavioural skills, debriefing and simulation-based education" [26]. These broad ranging initiatives all sit within professional societies and networks.

Research Reporting Standards for Simulation-Based Research

Several guidelines have been established to bring more uniformity to reporting research practices in medicine and other scientific disciplines fields, such as the Consolidated Standards of Reporting Trials (CONSORT) Statement for randomized trials and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement for observational studies. In 2015, a consensus conference was held to review the CONSORT and STROBE guidelines and introduce extensions aimed at simulation-based research. These modified guidelines represent an important step forward in standardizing and improving the reporting practices of healthcare simulation research. They were endorsed by four healthcare simulation journals; *Advances in Simulation, BMJ Simulation & Technology Enhanced Learning, Clinical Simulation in Nursing,* and *Simulation in Healthcare*; and appeared in the first joint publication among these journals (See Chap. 42) [27].

Recent Trends in Healthcare Simulation Research

In 2004, Gaba proposed eleven dimensions to describe the breadth of healthcare simulation at that point in time [28]. Scerbo and Anderson later organized those dimensions into three higher-level categories [29]. The first category describes the goals for using simulation (its purpose, healthcare domain, knowledge, skills, and attitudes addressed, and patient age). The second category addresses user characteristics (unit of participation, experience level, healthcare discipline of personnel, education, training, assessment, rehearsal, or research). The third category concerns the method of implementation (type of simulation or technology, site of event., the level of participation from passive to immersive, and the type of feedback given).

Several recently published articles confirm this broad scope of healthcare simulation research. Scerbo offered a picture of the breadth of research published in *Simulation in Healthcare* between 2013 and 2015 [30]. Regarding topic areas, articles on assessment, education/training, and technology accounted for almost two thirds of the publications. Another 10% of the articles addressed validation, teams, human factors issues, simulation theory, and patient safety. Articles on medical knowledge, patient outcomes, and patient care made up only 6% of the content. Articles addressing different clinical specialties revealed that most of the content came from anesthesiology, emergency medicine, general medicine, surgery, nursing, pediatrics, and obstetrics and gynecology. Three quarters of the articles addressed practicing clinicians and residents with a smaller minority focused on students or expertise at multiple levels. About half of the articles addressed research with mannequin or physical model simulators. Research with standardized (simulated) patients, virtual reality, hybrid systems, or multiple formats made up the remainder of the content. Scerbo concluded that much of the research published in the journal during that period focused on how to use simulation for training and assessment, how to improve the simulation experience for learners, and how to develop and evaluate new simulation systems. He also suggested that publications tended to come from clinical areas where simulation systems are more plentiful and have longer histories.

Nestel (2017) thematically analysed articles published in *Simulation in Healthcare* as *editorials* [31]. This is an indirect way of making meaning of contemporary healthcare simulation research. The five themes were:

1. "Embedding" simulation (Research that sought ways to embed simulation in medical and other curricula, in healthcare organisations such that simulation is part of education and training across professional practice trajectories);
2. Simulation responding to clinical practice (Research that addressed to elements of clinical practice that required improvements such as handoff, sepsis guidelines, etc.);
3. Educational considerations for simulation (Research that addresses ideas such as the relationship of realism to learning, the importance of creating psychological safety for participants, exploring debriefing approaches etc.);
4. Research practices (Research that considers methods and methodologies especially important to healthcare simulation); and,
5. Communicating leadership and scholarship about the community (This theme addressed ideas offered in editorials that were of interest to the simulation community such as language preferences etc.)

In nursing education, three major research reviews of simulation were published in the last 4 years [32–34]. Findings from these reviews indicated incremental improvements in research rigor over time but equivocal results overall. They also indicated the realities of educational research, a continued lack of funding, many one-group posttest designs, an abundance of self-report measures unaccompanied by objective measures, a lack of trained evaluators, inconsistent use of terminology, and a lack of adherence to standardized reporting guidelines [32–34]. In 2018, both Mariani et al. [35] and Cant et al. [32] evaluated research articles published in *Clinical Simulation in Nursing* for research rigour using the Simulation Research Rubric [36] and/or the Medical Education Research Study Quality Instrument [37]. The ratings from both evaluations showed the research to be of moderate to high quality. In summary, research in nursing is thriving and improving in rigor but continues to be underfunded. More multisite studies using reliable and valid instruments are needed. The INACSL publishes a research priorities needs list which can be found on its website (https://member.inacsl.org/i4a/pages/index.cfm?pageID=3545).

Another way to view the breadth and trends of healthcare simulation research is to examine what gets cited in the literature. Recently, Walsh and colleagues offered a bibliometric review of the 100 most cited articles in healthcare simulation [38]. They searched in Scopus and the Web of Science databases (Clarivate Analytics, Philadelphia, PA) in 2017, but compiled their list based on the Scopus search. The found that there were very few citations until about 2005. In fact, of their top 100 articles, citations did not exceed 10 per year until 2005. As might be expected review articles received the most citations followed by articles on interventions and tool development. Regarding topics and discipline, the most cited articles addressed clinical competence and quality of care, but those citations were limited to just six articles on their list. Other topics that were cited most frequently were medical training/education, surgery, primary care, oncology, anesthesiology, and doctor-patient communication. Articles addressing technical skills or the combination of technical and so-called 'non-technical' skills were cited more often than non-technical skills alone. Also, articles addressing physical and virtual reality part-task training systems and standardized or simulated patients were cited more frequently than other forms of simulators.

Closing

In his 2004 article, Gaba offered two different predictions for the future [28]. One path was pessimistic where he cautioned that interest in simulation within the medical community could wane. The other path was much more optimistic where he saw simulation training in healthcare becoming a requirement and a driving force behind changes to healthcare curricula. He also envisioned a public that demanded levels of safety in healthcare comparable to those in aviation and regulatory agencies that required simulation-based standards for training and evidence for devices gathered in trials using simulation.

Today, one could argue that we are closer to Gaba's optimistic view. There is no doubt that simulation has begun transforming healthcare training and education, but there is still a way to go. Healthcare research is increasing in importance in the scholarly literature. The articles at the top of Walsh et al.'s list of most cited papers exceed 1000 citations. New scholarly journals addressing special areas of healthcare simulation continue to emerge. However, this growth is certainly not uniform across the 11 dimensions that Gaba described 15 years ago. There are clinical specialties that are still underrepresented in the simulation literature. The promise of some forms of simulation technology have still not been realized. Translational studies showing direct benefits of simulation training on patient outcomes are still few and far between.

Collectively, these gaps in the research paint a picture of a discipline that is still evolving and volatile. Clearly, there is a lot of work to be done, but this is a picture of a research landscape that is ripe with opportunity for inquisitive minds. We hope that the research methods and tools described in this book provide a sturdy canvas for investigators to contribute to the bigger picture.

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