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Review

Improving the quality of care and patient safety in oncology, the contribution of simulation-based training: A scoping review

Nadia Al Wachami*, Mohamed Chahboune, Ibtissam Youlyouz-marfak, Mohamed Reda Mesradi, Hajar Lemriss, Abderraouf Hilali

Hassan First University of Settat, Higher Institute of Health Sciences, Laboratory of Sciences and Health Technologies, Settat, Morocco

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ABSTRACT

Objective: Simulation-based training (SBT) is an effective educational method widely used in many clinical settings, including oncology. This study aimed to undertake a scoping review of research related to SBT in oncology to provide a comprehensive understanding of the role of SBT in enhancing the skills of healthcare professionals and thereby improving the quality of care and patient safety in oncology.
Methods: We conducted a scoping review to map published studies in Medline, Scopus, and Web of Science databases. Peer-reviewed articles about data on the role of SBT in improving and enhancing the skills of healthcare professionals in oncology published in English and French from 2012 to 2022 were retrieved. Two researchers screened, extracted, and analyzed all identified studies independently.
Results: Of the 1,013 publications identified in the initial phase, 29 studies were included in the analysis. Twenty-five of these studies focused on non-technical skills, such as decision-making, communication, teamwork, and cognitive abilities. Thirteen studies focused on technical skills. The results of all included studies showed significant improvement in the skills of oncology healthcare professionals through SBT programs. Fourteen studies subjectively assessed the role of this educational tool, while nine objectively evaluated it. Six studies used a combined subjective and objective evaluation method.
Conclusions: SBT is a very effective tool for improving the skills of healthcare professionals in oncology. Supporting and promoting SBT is essential to providing high-quality care and ensuring patient safety in all areas of health care.
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What is known?

- Simulation-based training (SBT) is a safe and effective educational method in many clinical settings, including oncology.
- In oncology, research on the role of simulation-based training in improving the skills of healthcare professionals and, consequently, in improving patient safety and quality of care has not been clearly established.

What is new?

- SBT plays a crucial role in perfecting and enhancing the knowledge and skills, both technical and non-technical, of healthcare professionals. This translates directly into significantly improving the quality of care and patient safety in oncology.
- SBT should be integrated into the training programs of healthcare professionals for the continuous improvement of the quality of care and patient safety in oncology.

1. Introduction

Simulation-based training (SBT) is an effective educational technique in various healthcare settings [1]. It is an effective tool for promoting a patient safety culture by training a healthcare workforce capable of providing high-quality and cost-effective care, leading to optimal health outcomes [2,3]. A landmark report published by the Institute of Medicine reported that error is human and called for the creation of a safe healthcare system [4], and SBT is a potentially effective means of decreasing and absorbing medical

* Corresponding author.
E-mail address: n.alwachami@uhp.ac.ma (N. Al Wachami).
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errors through enhanced experience-based learning [5]. SBT is an effective educational method compared to traditional teaching modalities, as evidenced by published literature data showing significant performance improvement when using SBT compared to traditional learning activities [6,7]. Indeed, SBT allows learners to acquire skills through situations similar to those they encounter in real-life conditions. In addition, SBT allows the improvement of cognitive, technical, individual, and interpersonal performance and patient outcomes [8,9]. On the other hand, simulation has the advantage of securing the initial interactions with the patient by allowing the possibility of mastering new procedures and technologies in simulation before being practiced on real patients [10]. Thus, error is allowed in simulation, and debriefing sessions improve learning through constructive feedback [11].

SBT can take various forms, ranging from standardized patients to virtual reality techniques [8,12,13]. The contribution of this educational tool has been well documented in various clinical settings, ranging from consultation to specific care [14–19]. In oncology, error is amplified by the complexity of management [20–22] and the increasing number of cancer cases [23]. Error is well documented in radiotherapy, and the rate of serious injury due to radiotherapy is estimated to be a thousand times higher than the rates of adverse events observed in other healthcare fields [24]. Furthermore, the administration of chemotherapy is a complex task requiring skills in dose calculation and administration and is prone to numerous errors [25]. Soft skills such as communication and teamwork are potentially important in cancer care but are difficult to apply, mainly due to the high workload in this healthcare field [23]. Consequently, simulation is considered an effective training tool for improving the skills of healthcare professionals working in oncology, and its effectiveness in improving the quality of care and safety of cancer patients is well documented in the literature [26]. However, it is unclear how research on the role of SBT in improving the skills of healthcare professionals and, consequently, improving the quality of care and patient safety in oncology has been established. Thus, this scoping review aimed to provide a comprehensive understanding and synthesis of the available literature on the role of SBT in improving the skills of oncology care providers.

2. Methods

2.1. Review design

The present scoping review was conducted using the PRISMA Extension for Scoping Reviews checklist [27] and followed the methodological framework of Arksey and O'Malley [28]. This section outlines the steps taken in the development of the study.

2.2. Establish the research problem

This scoping review aimed to answer the main question we have asked: "What is known about the available literature on the role of SBT in improving the skills of oncology care providers?". Specific research questions were also posed to delineate the larger main research question, which will serve as the basis for presenting and mapping the results. These questions are: 1) "How was research on the role of SBT in improving the skills of health care professionals in oncology undertaken?" 2) "What are the skills and attitudes targeted by SBT?" and 3) "What is the role of SBT in improving the skills of health care providers in this area?".

2.3. Identify relevant studies

The literature search was conducted in the Medline, Web of Science, and Scopus databases. We chose these three databases because they are among the most comprehensive, widely consulted, and commonly used in the scientific literature and, therefore, cover the most relevant studies on the subject. We used the PIO criteria (Population, Intervention, and Outcome) to guide our research. Our population of interest (P) comprises oncology healthcare professionals. The intervention (I) is simulation-based training (SBT), while the outcome (O) is the role of simulation-based training in improving healthcare professionals' skills and consequently improving quality of care and patient safety in the field of oncology. Search terms were grouped by key concepts: simulation-based training, patient safety, quality of care, and oncology. The supplementary data file detailed the search strategy used in each database. The search results were exported to Excel, and duplicates were deleted manually (Appendix A).

The inclusion criteria in this scoping review included articles published in the last ten years (2012–2022) on the contribution of SBT in improving healthcare professionals' skills in oncology. We limited our search to studies published in English or French. Articles were excluded if they did not focus on the role of SBT in improving oncology skills, if they were published before 2012, and if they were published in a language other than English or French. The data collection for this scoping review took place over 15 days, from October 1st to October 15th, 2022.

2.4. Study selection and data chart

The studies identified in the initial phase were screened based on title and abstract. If there was uncertainty about the eligibility of a study, a second selection was made by consulting the full text. Studies that did not meet the eligibility criteria were excluded from this scoping review. The selection of studies was conducted by two investigators. Any disagreement regarding the eligibility of a study was resolved by consensus between the authors.

Microsoft Excel created A data extraction form to extract data from the selected studies. The form included information on the first author's name, the publication year, the study objective, the study setting, the SBT target, the simulation technique used, the main results, and the authors' observations and conclusions.

2.5. Summarizing and reporting the results

To provide a rigorous presentation of our results, we will first describe the selected studies in a table representing the main characteristics of the studies included in the analysis. Then, in the form of tables, we will present the results related to the SBT methods and the main skills targeted by this educational tool in oncology. Finally, we will summarize, in narrative form, the role of SBT in improving the skills of oncology care providers.

3. Results

3.1. Study selection

A total of 1,013 potentially relevant records were identified through the database search. After deleting 91 duplicates, 847 studies were excluded based on their titles and abstracts. Reading the full texts of 75 studies excluded 46 articles that did not meet the inclusion criteria. Overall, 29 studies meeting the eligibility criteria were retained for this scoping review. Fig. 1 illustrates the strategy for selecting the included studies.

3.2. Characteristics of the included studies

All of the studies included in the review were published in English. Three studies were published in 2022, four in 2021, eight in

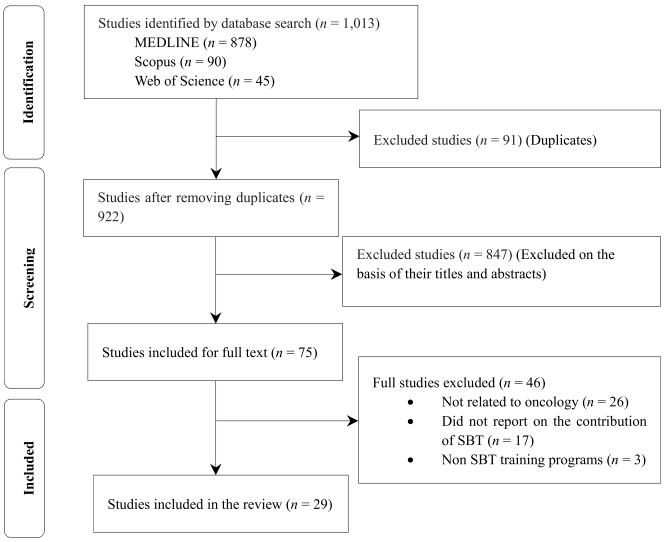

Fig. 1. Flow chart of the search and selection stages of the included studies. SBT= Simulation-based training.

2020, three in 2019, one in 2018, one in 2016, one in 2015, two in 2014, and one in 2012. Eligible studies were conducted in nine countries. Twenty-two studies were conducted in North America, four in Asia, one in Africa, one in Europe, and one study was conducted in Oceania. The main characteristics of the selected studies are detailed in Table 1.

3.3. Overview of research methods in simulation-based training in oncology

Twelve studies ($n = 12$) used a human simulation technique of standardized patients ($n = 5$) [32,38,39,43,51] and role-play ($n = 7$) [29,35,42,44,49,53,55]. Ten studies used synthetic simulation techniques with procedural simulators ($n = 5$) [37,39,41,50,54] and high-fidelity patient simulators ($n = 5$) [34,36,52,56,57]. Nine studies used electronic virtual reality simulation ($n = 9$) [30,31,33,39,40,45–48]. Most of the included evidence ($n = 25$) used a didactic component aimed primarily at explaining the basic principles of the content of educational training programs to the learners [29–34,36,38–41,43–45,47–57]. More than half of the studies ($n = 17$) completed the simulation program with a debriefing [29,32,34–36,38–40,42,47,48,50,52–55,57]. Five studies ($n = 5$) demonstrated the technique targeted by the simulation before the practice stage [29,30,39,50,54], and seven studies ($n = 7$) used deliberate practice to promote learning through repetition [29,34,36,45,47,52,54]. Oncology SBT programs targeted learners with different levels of experience, such as residency and in-service training ($n = 18$) [30,31,33–37,39–41,44,45,48–51,54,55], continuing education and training ($n = 7$) [29,32,42,46,51,52,56], initial professional training ($n = 2$) [45,53], and university level ($n = 4$) [38,43,47,57].

3.4. Skills targeted by simulation-based training in oncology

3.4.1. Technical skills

Forty-five percent (13/29) of the included studies focused on technical skills. Of these studies, seven addressed the technique of brachytherapy for the treatment of gynecological cancers [30,33,34,37,39–41], three addressed the techniques of chemotherapy administration [50,52,57], two examined the technique of bone marrow biopsy [50,54], one has reviewed fiber optic laryngoscopy [36], and one study has examined the technique of abdominal hysterectomy for the treatment of cervical cancer [45].

3.4.2. Conceptual skills

Thirteen percent (4/29) of the eligible studies focused on the basic skills and knowledge required to perform professional functions. Of these, three focused on improving basic knowledge of brachytherapy for treating gynecological cancers [30,33,41], and one focused on enhancing knowledge of clinical oncological emergencies [42].

3.4.3. Decision-making skills

Half ($n = 15$) of the evidence conducted focused on oncology decision-making skills, such as rapid response to emergencies [29,55], symptom management, and education of families of cancer patients [57], reducing unwarranted variation in oncology care [46], root cause analysis [31], improving workload and situational awareness [32,51], hazard and incident recognition [48], chemotherapy prescribing [50], oncology drug therapy [47], error detection during treatment verification and administration [56], and cross-cultural skills [38].

3.4.4. Attitudes and behaviors

Twenty percent (6/29) of eligible studies evaluated the role of SBT in improving the attitudes and behaviors of oncology care providers. Of these studies, two focused on teamwork [29,35], and three on communication, including one on communication in palliative care [49], one on patient-centered communication [50], and one on breaking bad news [44]. One study addressed communication skills as well as teamwork skills [42]. Table 2.

3.5. Contribution of SBT in improving the skills of healthcare professionals in oncology

3.5.1. SBT and improving technical skills in oncology

SBT was associated with significant improvement in the technical skills of oncology providers. Three studies reported improvements in brachytherapy procedural skills and resident satisfaction in radiation oncology [33,34,41]. Other studies reported that through SBT programs, learners mastered the technique of interstitial brachytherapy [30], low dose rate brachytherapy [39], MRI-guided brachytherapy [37], and permanent implant brachytherapy [40]. The included studies also reported that SBT plays a critical role in enhancing learners' skills in chemotherapy administration. Indeed, three pieces of evidence confirmed the positive effect of simulation practice in improving the skills of nurses [52], nursing students [57], and radiation oncology residents [50] in chemotherapy drug administration. In addition, bone marrow biopsy is another technique addressed by SBT programs. Two studies have shown that practicing this educational tool has improved learners' technical skills in bone marrow biopsy [50,54]. Another evidence demonstrated the potential of procedural simulation in learning the fiber optic laryngoscopy technique [36].

3.5.2. SBT and improving non-technical skills in oncology

According to the studies in this scoping review, SBT improves decision-making skills, such as problem-solving, self-assessment, and critical thinking skills. Several studies ($n = 5$) have shown that SBT improves healthcare professionals' skills in identifying and managing clinical emergencies and allows for developing patient safety skills, such as the ability to detect errors when planning or administering cancer treatment [29,42,50,55,56]. Other evidence ($n = 2$) found an increase in learner performance in situational

Table 1
Characteristics of the studies included in the scoping review ($n = 29$).

Author, year, location	Study participants	Description of the simulation method used	Method of evaluating the role of the SBT	Main results
Kawamura et al., 2022, Japan [29]	Evaluate the effectiveness of a rapid response system using SBT	Simulation with simulated patients	Arrival time of the MET at the emergency site	Improved team skills to respond to emergency situations (team arrival time at the emergency site decreased from 7 min before the simulation to 4 min after the simulation).
Shiao et al., 2022, USA [30]	Develop a program based on SBT and didactic lectures to improve the knowledge and skills of radiation oncology residents in IS BT	Simulation in two hands-on workshops using a trans abdominal probe with a BK ultrasound system to identify needle placement in the gynecologic phantom, and Varian Brachy Vision with anonymous patients in training to plan a IS BT case.	Knowledge improvement was assessed subjectively through Likert-type questions and objectively through objective knowledge-based questions.	- Improvement in knowledge and skills of IS BT radiation oncology residents - Likert scale score increased from 2 to 4 in post-session $P < 0.01$. - Percentage of correct knowledge-based questions response increased from 44% to 88% post-session.
Wellace et al., 2022, USA [31]	Enhance the skills of hematology/ oncology fellows in the area of root cause analysis	Clinical vignette simulation	The impact of SBT was assessed through pre- and post-simulation surveys.	Improved root cause analysis skills
Mazur et al., 2021, USA [32]	To evaluate the effect of SBT supported by neurofeedback sessions on the workload, situational awareness, and performance of radiation technologists during routine quality assurance and treatment administration tasks	Procedural simulation using an emulator and a workstation that closely replicated the typical radiation technologists work environment and standardized patient simulation.	- Perceived workload was assessed using the NASA Workload Index. - Perceived situational awareness was assessed using the situation awareness rating technique. - Learner performance was calculated (average of procedural compliance scores with dead time and error detection components).	Participants who received SBT with neurofeedback interventions reported significant improvement in performance scores compared to controls. No changes in perceived workload and situational awareness between learners and controls were reported.
Williams et al., 2021, USA [33]	To evaluate the effectiveness of SBT in improving BT skills for the treatment of cervical cancer	Four-station procedural simulation (applicator selection, tumor contour, plan review, quality assurance)	Improvement in BT knowledge, procedural confidence, plan evaluation, and quality/safety were measured by a pre- and post-simulation survey. Objective assessment of knowledge improvement was performed by pre- and post-training questions.	Procedural simulation was associated with improved brachytherapy-specific knowledge as well as procedural skills of radiation oncology residents.
Donnelly et al., 2021, USA [34]	To describe a SBT program designed to improve the BT skills and confidence of radiation oncology residents	High-fidelity simulation using a pelvic cadaver model with an intact uterus.	Improvement in procedural knowledge in BT was assessed by a pre- and post-session survey.	SBT increased trainees' confidence in performing BT of gynecologic tumors.
Ball et al., 2021, United Kingdom [35]	Evaluating the effectiveness of SBT in improving interprofessional learning	Four plausible radiation therapy scenarios were simulated in a university simulation center.	Learners' skill improvement was measured by the Interprofessional Learning Readiness Scale and a post-training Likert-type survey.	Improving learners' knowledge of teamwork and collaboration
Price et al., 2020, USA [36]	Describe an educational simulation program in FOL	Simulation in two sessions using a computerized FOL program and practice on a mannequin.	Simulation in two sessions using a computerized FOL program and practice on a mannequin.	Simulation practice was associated with improved knowledge and procedural confidence in FOL: mean knowledge of neck and head anatomy increased from 2.4 to 3.7 ($P < 0.001$). Mean confidence in procedural skills in FOL increased from 2.2 to 3.3 ($P < 0.001$).
Singer et al., 2020, USA [37]	Developing a SBT workshop for magnetic resonance imaging guided MRI-guided BT for cervical cancer	Procedural simulation using two pelvic mannequins, a uterine simulator to illustrate the relationship between tandem angle and anatomy, and a suture simulator.	The effectiveness of the training program was evaluated by a pre and post simulation survey.	Significant improvement in learners' knowledge and skills was revealed after the simulation.
Ozkara., 2020, USA [38]	Evaluating the effectiveness of a SBT program in cultural competence-based nursing education.	Simulated transgender patients	Cross-cultural self-efficacy was measured by pre- and post-simulation surveys.	Simulation improved students' knowledge, skills, and attitudes about culturally competent nursing compared with controls.
Mesko et al., 2020, USA [39]	Develop a SBT program for radiation oncology residents for LDR-BT	- Procedural simulation using cadaveric torsos, mannequins to perform bone marrow biopsy and intratracheal chemotherapy administration. - Clinical vignette simulation to train in chemotherapy prescription. - Standardized patient simulation to develop patient-centered communication skills.	Improvement in knowledge and technical skills in LDR-BT were measured using a Likert-type question survey before and after the simulation practice.	SBT was associated with an increase in self-reported scores (mean Likert scale score was 2.4 and 3.3 before and after the course, respectively. $P < 0.001$).
Roumeliotis et al., 2020, USA [40]	Establish a SBT program for radiation oncology learners in permanent implant BT.	Procedural simulation using anthropometric breast phantom	Performance improvement was assessed by seed placement accuracy, time to complete the	SBT program was associated with an increase in learner performance (improved seed placement accuracy

Table 1 (*continued*)

Author, year, location	Study participants	Description of the simulation method used	Method of evaluating the role of the SBT	Main results
			procedure, and two qualitative assessment tools.	and time to complete the permanent implant brachytherapy procedure).
Damast et al., 2020, Israel [41]	Describe the process of rolling out a gynecological brachytherapy simulation-based training program developed to an international scale	Procedural simulation incorporating a pelvic mannequin	Improvement in brachytherapy learners' knowledge and comfort was measured by pre- and post-simulation surveys.	SBT was associated with a significant improvement in learner satisfaction.
Lebouf et al., 2020, USA [42]	Create simulation-based scenarios to practice ambulatory emergency management skills Simulation of scenarios	Simulation of scenarios	Improvement in team skills to respond to an emergency situation was assessed using a form before and after the simulation scenario exercises.	Emergency drill simulations were associated with improved communication and teamwork skills.
Duffy et al., 2020, USA [43]	To describe the use of flipped classroom instruction and real patients in improving pharmacy students' skills in oncolytic therapy and patient counseling	Simulation with standardized patient	Learner perception and comfort were assessed by a pre- and post-training survey.	Significant improvement in confidence and procedural skills in oral oncolytic therapy (mean Likert scale score increased from 3 to 4.1 after the simulation)
Yakhforochha et al., 2019, Iran [44]	Training fellows to deliver bad news using a simulation model combined with artistic methods	Role-playing combined with artistic approaches.	Learners' performance was assessed by two evaluators using the breaking bad news evaluation checklist.	Significant improvement in learners' performance in delivering bad news
Bing et al., 2019, Zambia [45]	To evaluate the effectiveness of a virtual simulator in training surgeons in abdominal hysterectomy for the treatment of cervical cancer	Virtual reality simulation (surgical simulator with a simple computer game)	The effectiveness of the procedure was assessed by two independent measures (motion and time) and a composite measure (a measure that incorporated both motion and time).	Mastery of the abdominal hysterectomy procedure (significant improvement in motion and time efficiency over time)
Richards et al., 2019, USA [46]	Reducing unwarranted variation in oncology care using SBT	Online patient simulation (clinical vignettes)	The overall quality score was provided by the simulation system.	The overall quality score increased from 64.9 to 72.6 ($P < 0.001$). The SBT was associated with standardization of oncology care (increased diagnostic accuracy by 6.7%, $P < 0.001$, increased evidence-based chemotherapy regimen, increased management of palliative needs of advanced patients by 56%, $P < 0.001$, and decreased unnecessary test ordering by 25%).
Bernaitis et al., 2018, Australia [47]	Studying the effects of computerized simulation in oncology drug therapy	Computerized simulation of oncology patients using a DecisionSim™ computer-aided simulation platform.	- Learner satisfaction was assessed using a Likert scale questionnaire. - Learner performance was measured by comparing simulation learner scores with control group scores.	Simulation on computerized cases was associated with improved student performance.
Thompson et al., 2017, Canada [48]	To compare the effectiveness of two educational interventions in radiological medicine learning	Simulation with simulated patient (5-min video)	Hazard and incident recognition ability was assessed by measuring sensitivity and specificity of hazard detection. - Learners' perceptions were measured by a pre- and post-training survey.	The SBT resulted in improved hazard and incident detection skills compared to discussion-based training.
Borck et al., 2017, USA [49]	To study the effectiveness of two educational interventions in pediatric training	Role play (three scenarios)	- Skill improvement was assessed by self-report questionnaires before and after training. - The nine communication domains were assessed by two external raters using the MKCAT. - Palliative care consultation rates	The SBT resulted in a significant improvement in palliative oncology communication skills (improved self-efficacy scores and communication domains, and increased palliative care consultation rates).
Reiss et al., 2017, USA [50]	To highlight the effectiveness of a communication-based workshop series in improving oncology fellows' skills.	Procedural simulation using cadaveric torsos, mannequins to perform bone marrow biopsy and intratracheal chemotherapy administration, clinical vignette simulation to train learners in chemotherapy prescription, and standardized patient simulation for the patient-centered communication skills workshop.	Improvement in knowledge, attitudes, and behaviors was assessed by a survey before and after the training workshops.	The SBT workshops were associated with improved communication skills, chemotherapy prescribing skills, and procedural skills.
Mazur et al., 2017, USA [51]	To evaluate the effectiveness of SBT in improving workload and performance of radiation oncology residents	Standardized patient simulation (practice scenarios in a simulated clinical environment)	- Workload was measured by the NASA Task Load Index. - Performance was measured by procedural compliance and time to complete simulation scenarios.	Significant improvement in procedural compliance score ($P < 0.001$) and scenario completion time. No change in perceived workload was found.
Corbitt et al., 2017, USA [52]	Implement a drug administration tool to ensure patient safety in chemotherapy	High-fidelity simulation using a mannequin	Validation of nurses' skills was done through a skills validation checklist.	Improvement of vincristine administration skills in mini-bags

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Table 1 (*continued*)

Author, year, location	Study participants	Description of the simulation method used	Method of evaluating the role of the SBT	Main results
James et al., 2016, USA [53]	Describe the effectiveness of a simulation-based program in improving oncology patient safety	Simulation scenarios	A form with Likert-type questions assessed the effectiveness of the program in improving patient safety.	The SBT program was associated with improved patient safety skills in students.
Yap et al., 2016, Singapore [54]	Describing the effectiveness of simulation in teaching internal medicine residents	Procedural simulation using the BMAT simulator	The effectiveness of the BMAT simulator in improving learners' procedural skills was measured by a survey with Likert-type questions.	The procedural simulation allowed learners to improve their knowledge and skills in bone marrow biopsy.
Brown et al., 2014, USA [55]	To prepare radiation oncology residents for the safe and timely administration of urgent radiation therapy	Simulation with role-play and procedural simulation using an anthropomorphic radiology phantom	Effectiveness of SBT was assessed by learner feedback after the simulation.	The SBT helped learners improve rapid response skills for oncology emergencies.
Prakash et al., 2014, Canada [56]	Evaluate the effectiveness of interventions in reducing chemotherapy drug verification and administration errors	High-fidelity simulation using a mannequin in an ambulatory chemotherapy unit	Nurses' performance was scored by two external observers.	The simulation allowed for the verification of the effectiveness of interventions aimed at reducing errors in the verification and administration of chemotherapy drugs and, consequently, improving patient safety.
Linnard-Palmer et al., 2012, USA [57]	Describe a learning process for chemotherapy administration and oncology care	High-fidelity simulation using a mannequin	- Training input was evaluated by a pre- and post-simulation test. - Student satisfaction was measured by an evaluation form.	Simulation sessions were associated with a high level of satisfaction and knowledge acquisition in pediatric oncology care.

Note: BT = brachytherapy. BMAT = bone marrow aspirate and trephine. FOL= fiber optic laryngoscopy. IS BT= interstitial brachytherapy. LDR-BT = low dose rate brachytherapy. MET = medical emergency team. MRI-guided BT = magnetic resonance imaging guided brachytherapy. MKCAT = the modified Kalamazoo Communication Assessment Tool. SBT= simulation-based training.

awareness compared to groups receiving training based on traditional learning activities (no change in workload was revealed) [32,51]. One study showed that SBT enabled learners to acquire root cause analysis skills and enable effective resolution of identified problems [31]. One study showed that simulation practice reduced unwarranted variation in care and, therefore, standardization of oncology care and was associated with diagnostic accuracy, reduced demand for unnecessary workups, increased evidence-based chemotherapy regimens, and increased palliative care for patients in advanced stages of the disease [46]. Other evidence ($n = 2$) revealed that after simulation, pharmacotherapy and chemotherapy prescription skills improved significantly [47,50]. In addition, another study improved learners' ability to detect hazards compared to discussion-based training [48]. Thus, the simulation-based intervention was associated with a significant increase in cross-cultural skills to provide high-quality care and ensure safety for transgender patients receiving cancer care [38].

The selected evidence indicated improved attitudes and behaviors necessary to provide high-quality care and ensure safety for cancer patients. Four studies ($n = 4$) demonstrated the effectiveness of simulation interventions in improving communication skills in different settings. The first focused on communication within the work team [42], the second on communication in palliative care [49], the third on breaking bad news [44], and the fourth on patient-centered communication [50]. The results of all these studies show a significant improvement in the communication skills of health professionals. Other evidence ($n = 3$) has highlighted the potential of SBT in enhancing teamwork and collaboration skills [29,35].

Simulation practice significantly improves cognitive abilities or conceptual understanding of the fundamentals required to perform oncology-related functions. The studies in this review ($n = 3$) revealed a significant improvement in knowledge of the basic principles of brachytherapy for treating gynecologic cancers [30,33,41]. Other results ($n = 1$) showed that simulation promoted improving learners' knowledge necessary to respond to oncological emergencies [42]. Table 1 summarizes the results reported by each of the included studies.

3.6. Evaluation of the role of SBT in enhancing the skills of health professionals in oncology

The role of SBT was assessed subjectively in forty-eight percent (14/29) of the studies using surveys consisting primarily of Likert-type questions administered to learners before and after the simulation [31,34,36–39,41–43,50,53–55,57]. Thirty-one percent (9/29) of the studies objectively assessed this role [29,32,40,44–46,51,52,56]. Several assessment tools were used, such as procedure completion time [29,40,45], knowledge-based question answering [30,33], needle placement accuracy for studies aimed at brachytherapy procedure training [40], calculation of specificity and sensitivity of hazard and incident detection [48], interprofessional learning readiness scale [35], and workload index [32,51]. In other studies, learner skill improvement was assessed by the simulation system [46] or by external observers [44,49,56]. Twenty percent (6/29) of the evidence rated the contribution of simulation objectively and subjectively [30,33,35,47–49].

4. Discussion

In this study, we conducted a scoping review to map the available literature on the role of SBT in improving and enhancing healthcare professionals' skills, thereby improving the quality of care and patient safety in oncology. We identified twenty-nine studies that answered the primary search question. Twenty-five of these studies focused on soft skills, while thirteen studies focused on technical skills. Most studies indicated significant strengthening and improvement in technical and non-technical skills, such as decision-making skills, communication and teamwork skills, and cognitive abilities, of participants in SBT programs.

SBT is an effective technique for training healthcare professionals and promoting patient safety, and it is considered a useful complement to traditional training methods [58]. Our results are consistent with the findings of other available literature review evidence that demonstrated the high effectiveness of educational simulation in oncology [26]. Simulation in oncology provider education is necessary to meet the educational needs of staff and

Table 2
Objectives and skills addressed by simulation-based training in oncology by each of the evidence ($n = 29$).

Author/year	Simulation aim	Skills addressed by SBT
Kawamura et al., 2022 [29]	Education	- Decision-making skills: rapid response to a deteriorating condition of the patient receiving radiation therapy (detection of emergency, call the MET, transport to the emergency room) - Attitudes and behaviours: teamwork
Shiao et al., 2022 [30]	Education training	- Conceptual understanding: improving the knowledge of radiation oncology residents in IS BT for gynaecologic malignancies - Technical Skills: IS BT procedure
Wellace et al., 2022 [31]	Education	Decision-making skills: Root cause analysis
Mazur et al., 2021 [32]	Education	Decision-making skills: Improved workload, situational awareness and performance of radiation therapists
Williams et al., 2021 [33]	Training	- Conceptual understanding: improving basic knowledge of BT - Technical skills: BT procedure for gynaecological cancers
Donnelly et al., 2021 [34]	Training	Technical skills: BT procedure for the treatment of gynaecological cancers
Ball et al., 2021 [35]	Education	Attitudes and behaviours: teamwork and collaboration
Price et al., 2020 [36]	Education training	Technical skills: FOL
Singer et al., 2020 [37]	Training	Technical expertise: MRI-guided IS BT for the treatment of cervical cancer
Ozkara., 2020 [38]	Training	Decision-making skills: cross-cultural skills (such as anxiety, barriers to accessing care, complications of hormone therapy, financial concerns, and lack of support mechanisms)
Mesko et al., 2020 [39]	Training	Technical skills: LDR-BT
Roumeliotis et al., 2020 [40]	Training	Technical skill: CT by permanent implants
Damast et al., 2020 [41]	Education training	- Conceptual understanding: improving basic knowledge of gynaecological BT - Technical skills: gynaecological BT
Lebouf et al., 2020 [42]	Education training	- Conceptual understanding: improve knowledge of clinical emergency management - Decision-making skills: identify and respond to an emergency situation - Attitudes and Behaviours: communication and teamwork
Duffy et al., 2020 [43]	Education	Decision-making skills: improving oncolytic therapy skills and patient counseling
Yakhforochha et al., 2019 [44]	Education	Attitudes and behaviours: communication (breaking bad news)
Bing et al., 2019 [45]	Training	Technical skills: abdominal hysterectomy
Richards et al., 2019 [46]	Education	Decision-making skills: recognize appropriate diagnosis and treatment to reduce unwarranted variations in oncology care
Bernaitis et al., 2018 [47]	Education	Decision-making skills in oncology drug therapy
Thompson et al., 2017 [48]	Education	Decision-making skills: hazard and incident recognition
Borck et al., 2017 [49]	Education	Attitudes and behaviours: communication in palliative care
Reiss et al., 2017 [50]	Education training	- Technical skills: bone marrow biopsy and administration of intratracheal chemotherapy - Decision-making skills: chemotherapy prescription - Attitudes and behaviours: patient-centered communication
Mazur et al., 2017 [51]	Education	Decision-making skills: improving workload and situational awareness
Corbitt et al., 2017 [52]	Training	Technical skills: administration of chemotherapy (Vincristine)
James et al., 2016 [53]	Education	Decision-making skills: identifying medical errors and other patient safety skills in oncology
Yap et al., 2016 [54]	Training	Technical skills: BMAT
Brown et al., 2014 [55]	Education	Decision-making skills: diagnosis and treatment management of oncology emergencies
Prakash et al., 2014 [56]	Education	Decision making skills: mitigate errors when checking or administering chemotherapy
Linnard-Palmer et al., 2012 [57]	Education training	- Technical skills: chemotherapy administration - Decision-making skills: oncology symptom management and family education for children with cancer

Note: BT= Brachytherapy. BMAT= bone marrow aspirate and trephine. FOL= fiber optic laryngoscopy. IS BT= interstitial brachytherapy. MET = medical emergency team. LDR-BT = low dose rate brachytherapy. MRI-guided IS BT = magnetic resonance imaging guided interstitial brachytherapy. SBT= simulation-based training.

improve clinical performance in oncology. Cancer patients are extremely sensitive, and any error can significantly affect their health outcomes. SBT is based on a fundamental principle that states “never first time on the patient” and allows for developing technical and non-technical skills essential to the successful cancer care process [59]. Other than oncology, SBT has been confirmed as an effective educational tool in a variety of different areas, including pediatrics [18,60,61], surgery [62], obstetrics [17,63], anesthesia [16,64], and psychiatry [19,65].

In reviewing the elements of SBT, we found that approximately two-thirds of the included studies reported the organization of a debriefing session at the end of the SBT programs. Indeed, debriefing is essential to simulation-based educational training [66]. Its usefulness stems from the fact that it helps learners identify errors, express concerns, and make suggestions to improve future training programs in a confidential setting [11]. The debriefing process promotes clinical reasoning and reflective thinking and helps to achieve learning objectives [67].

The importance of deliberate practice as a simulation component is indisputable [68]. It is an effective pedagogical method that allows for increased learning curves through the continuous repetition of activities [69]. Nevertheless, only a few studies included in this scoping review have used it. Deliberate practice achieves specific training objectives through repetition. It allows mastery of learning through the repetition of a procedure or concept. In this regard, future studies should include this essential component in their training programs to promote a safe and effective learning experience.

We also found that a significant number of the included studies subjectively assessed the role of SBT in improving the skills of health professionals based on learner self-reporting. Future studies need to go beyond subjective assessment to have valid measures that reflect the contribution of SBT, which can be generalized to other health fields and specialties.

Our results show that SBT is an effective teaching method, offering valuable recommendations for improving the quality of care and patient safety. Learning in a clinical environment and being confronted with real-life situations contextualizes learning, promoting skills acquisition and maintenance. SBT strengthens learners’ individual and practical skills and enhances their

confidence and competence in decision-making, communication, and emergency management, all essential to guarantee high-quality care and patient safety. In addition, SBT also helps promote a culture of teamwork and improve communication within the team, which directly impacts the quality of care and patient safety. Consequently, integrating SBT into medical and nursing training programs is essential to ensure high-quality care and enhanced patient safety.

There are several limitations to this scoping review that should be noted. First, our broad search strategies may fail to capture additional evidence related to our primary research question. Dedicated search strategies for each simulation or oncology specialty may capture further studies. Secondly, we limited our bibliographic search to only three databases (Medline, Web of Science, and Scopus), which may miss the inclusion of other relevant publications published in other databases. Finally, we did not assess the quality of the evidence included in the study, which could lead to generalization bias and the robustness of the results.

This study adds to the knowledge about the contribution of SBT in improving the skills of healthcare providers in the healthcare fields in general and the field of oncology in particular. Support and promotion of this educational tool are needed in all healthcare fields, including oncology. SBT must be integral to training programs for healthcare personnel to support safe and effective learning. This scoping review illustrates the need for further studies, including systematic reviews and meta-analyses, to provide a more in-depth analysis of the contribution of SBT to improving the skills of healthcare workers in oncology. Further studies of the contribution of this tool in other oncology subspecialties are deemed necessary.

5. Conclusions

SBT is an effective learning technique in a variety of healthcare fields. We have mapped the available studies on the role of SBT in improving the skills of healthcare professionals in oncology. Our scoping review illustrates that SBT is a promising tool for improving and enhancing the skills of oncology care providers and, consequently, improving the quality of care and patient safety. Such data illustrate and enhance our understanding of the importance of this educational tool in medical education. Supporting and promoting SBT is required in all clinical healthcare settings to provide high-quality care and promote a culture of patient safety.

Data availability statement

The data that supports the findings of this study are available in the supplementary material of this article.

CRediT authorship contribution statement

Nadia Al Wachami: conceptualization, methodology, resources, writing original draft, project administration, writing-review and editing. **Mohamed Chahboune:** conceptualization, methodology, resources, writing-review and editing. **Ibtissam Youlyouz-marfak:** conceptualization, methodology, writing-review and editing. **Mohamed Reda Mesradi:** methodology, resources, writing-review and editing. **Hajar Lemriss:** methodology, resources, writing-review and editing. **Abderraouf Hilali:** conceptualization, writing-review and editing.

Declaration of competing interest

The authors declare that they have no competing interests.

Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2024.03.005.

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