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Scoping Review: Interprofessional Simulation as an Effective Modality to Teaching Interprofessional Collaborative Competencies in the Emergency Department

Lily Barton, Kelly Lackie and Stephen G. Miller

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Article abstract

Background: A scoping review was conducted to map the current body of research pertaining to simulation-enhanced interprofessional education (Sim-IPE) as a modality for teaching interprofessional collaboration (IPC) in the emergencydepartment (ED). Methods and Findings: The research team followed the PRISMA Extension for Scoping Reviews framework. Studies were included if they involved two or more healthcare professions, utilized simulation as the learning method for interprofessional education (IPE), involved simulation pertaining to the ED, and identified at least one Canadian Interprofessional Health Collaborative or Interprofessional Education Collaborative IPC competency as a learning outcome. In total, 896 studies were included for title and abstract screening and 806 were deemed irrelevant. Ninety full-text studies were assessed for eligibility and 34 were included in the review. Conclusions: Eighteen studies found Sim-IPE to be an effective method for teaching interprofessional competencies in the ED. Simulation-enhanced interprofessional education appears to be a promising methodology for teaching IPC competencies to ED healthcare professionals. Interprofessional collaboration competency frameworks should be utilized to guide Sim-IPE, and assessment tools specific to interprofessional competencies should be used in the assessment phase of Sim-IPE. Faculty development is a crucial component of Sim-IPE. Further longitudinal and outcome-based research is required.

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Scoping Review: Interprofessional Simulation as an Effective Modality to Teaching Interprofessional Collaborative Competencies in the Emergency Department

Lily Barton[a], BScN, Kelly Lackie[b], BScN, MN, PhD RN, CCSNE, & Stephen G. Miller[c], BSc, MD, CCFP(EM), FCFP

a. MD candidate 2023, Dalhousie University, Halifax, Nova Scotia, Canada.
b. Faculty of Health/School of Nursing, Dalhousie University, Halifax, Nova Scotia, Canada.
c. Department of Emergency Medicine, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada.

Abstract

Background: A scoping review was conducted to map the current body of research pertaining to simulation-enhanced interprofessional education (Sim-IPE) as a modality for teaching interprofessional collaboration (IPC) in the emergency department (ED).

Methods and Findings: The research team followed the PRISMA Extension for Scoping Reviews framework. Studies were included if they involved two or more healthcare professions, utilized simulation as the learning method for interprofessional education (IPE), involved simulation pertaining to the ED, and identified at least one Canadian Interprofessional Health Collaborative or Interprofessional Education Collaborative IPC competency as a learning outcome. In total, 896 studies were included for title and abstract screening and 806 were deemed irrelevant. Ninety full-text studies were assessed for eligibility and 34 were included in the review.

Conclusions: Eighteen studies found Sim-IPE to be an effective method for teaching interprofessional competencies in the ED. Simulation-enhanced interprofessional education appears to be a promising methodology for teaching IPC competencies to ED healthcare professionals. Interprofessional collaboration competency frameworks should be utilized to guide Sim-IPE, and assessment tools specific to interprofessional competencies should be used in the assessment phase of Sim-IPE. Faculty development is a crucial component of Sim-IPE. Further longitudinal and outcome-based research is required.

Keywords: interprofessional, simulation, emergency

Introduction

Interprofessional collaboration (IPC) is defined as "multiple health workers from different professional backgrounds providing comprehensive services by working with patients, their families, careers and communities to deliver the highest quality of care across settings" [1]. Interprofessional collaboration has been demonstrated to have an impact on all aspects of healthcare delivery by means of ameliorating access to care, improving patient safety, and influencing provider satisfaction [1].

Corresponding author: Lily Barton. Email: ll689682@dal.ca

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Ongoing research continues to highlight ways in which interprofessional education (IPE) and IPC benefit patients, providers, and healthcare systems. Interprofessional collaboration is not a natural occurrence; healthcare providers must learn the competencies of IPC, via IPE, to demonstrate collaboration. Furthermore, collaboration is not learned at one particular moment but is a process of continuous learning over the course of a professional career [2]. Interprofessional education is defined as "occasions when members or students of two or more professions learn with, from and about each other to improve collaboration and the quality of care and services" [3]. Different educational strategies can be used as modalities for IPE, including case-based learning, problem-based learning, collaborative inquiry, appreciative inquiry, observation-based learning, experiential learning, reflective learning, simulated learning, continuous quality improvement, and others [3]. Studies show that simulation enhanced IPE (Sim-IPE) has become a preferred method for IPE due to its adaptability and effectiveness [4]. Simulation enhanced IPE allows for the practice of clinical and interprofessional skills in a controlled environment [4]. Learners reflect and debrief with colleagues and educators, increasing the potential for learning, self awareness, and growth [4]. It provides learners with a space in which they can practice realistic clinical situations, perform psychomotor skills without patient risk, challenge traditional hierarchies, share professional knowledge, and receive immediate feedback [5-8].

The emergency department (ED) is an intense and unpredictable environment, making it particularly susceptible to high rates of medical error, compassion fatigue, and staff burnout [6]. Patients accessing the ED require the attention of many healthcare professionals working collaboratively to address patients' healthcare needs. Interprofessional collaboration has been shown to positively contribute to healthcare provider team behaviours and reduce clinical error rates for ED teams [9]. Simulation enhanced IPE can be adapted to encompass a wide variety of clinical situations and professionals, making it a favourable technique when looking to advance IPC in the ED.

Although research related to IPE and healthcare simulation has grown considerably in the past decade, more information is required on implementation, simulation evaluation/accreditation, advantages and risks of simulation, and impact on learner performance [10]. From the primary literature search, there have been no scoping reviews to date evaluating Sim-IPE as a strategy to teach IPC competencies in the ED. This scoping review maps and summarizes the current body of research about Sim-IPE as a modality for teaching IPC to healthcare professionals who work in the ED. The specific research question that guided this scoping review was: How is Sim-IPE utilized as an educational strategy to teach healthcare professionals working in the ED the competencies necessary for IPC?

Methods

The research team followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) framework to conduct this review [11]. A comprehensive search strategy was devised in collaboration with a health sciences librarian. The initial search was con-

ducted in Medline and is included in Table 1. The initial search strategy was translated for subsequent searches.

Table 1: Medline search strategy

S5	S1 AND S2 AND S3 AND S4
S4	((((((((continuing education[MeSH Terms]) OR (continuing medical education[MeSH Terms])) OR (activities, educational[MeSH Terms])) OR ("team-based learning"[Title/Abstract])) OR ("professional development"[Title/Abstract])) OR ("interprofessional education"[Title/Abstract])) OR ("interprofessional learning"[Title/Abstract]))) OR ((((((((("inter professional learning"[tiab]) OR ("inter professional education"[tiab])) OR ("interdisciplinary education"[tiab])) OR ("inter disciplinary education"[tiab])) OR ("interdisciplinary learning"[tiab])) OR ("inter disciplinary learning"[tiab])) OR ("multidisciplinary education"[tiab])) OR ("multi disciplinary education"[tiab])) OR ("multidisciplinary learning"[tiab])) OR ("multi disciplinary learning"[tiab])))
S3	((("Simulation training" [MeSH] OR "Patient Simulation"[Mesh] OR "Computer-Assisted Instruction"[Mesh]) OR ("Simulation"[Journal] OR "simulation"[tiab])))
S2	((ambulatory care[mh]) OR (emergency medicine[mh])) OR (emergency medical services[mh])) OR (emergency treatment[mh])) OR (ER[tiab] OR ERs[tiab])) OR (ED[tiab] OR EDs[tiab])) OR (ems[tiab])) OR (emergicenter*[tiab])) OR (trauma care[tiab])) OR (trauma center*[tiab])) OR (trauma centre*[tiab])) OR (trauma clinic[tiab] OR trauma clinics[tiab])) OR (accident clinic[tiab] OR accident clinics[tiab])) OR (casualty clinic[tiab] OR casualty clinics[tiab])) OR (casualty service*[tiab])) OR (casualty department*[tiab])) OR (casualty room*[tiab])) OR (casualty unit*[tiab])) OR (accident service[tiab] OR accident services[tiab])) OR (accident department*[tiab])) OR (accident room*[tiab])) OR (accident center*[tiab])) OR (accident centre*[tiab])) OR (accident unit*[tiab])) OR (emergency service*[tiab])) OR ("emergency care"[tiab])) OR (ED*[tiab])) OR (emergency center*[tiab])) OR (emergency centre*[tiab])) OR (emergency room*[tiab])) OR (emergent care[tiab])) OR (critical service*[tiab])) OR (critical care[tiab])) OR (critical department*[tiab])) OR (critical center*[tiab])) OR (critical centre*[tiab])) OR (acute service*[tiab])) OR ("acute care"[tiab])) OR (acute department*[tiab])) OR (acute center*[tiab])) OR (emergency ward*[tiab])) OR (emergency unit*[tiab])) OR (emergency hospital*[tiab])) OR (emergency clinic[tiab] OR emergency clinics[tiab])) OR (emergent patient*[tiab])) OR (emergency patient*[tiab])) OR (emergency treatment*[tiab] OR emergent treatment*[tiab] OR emergency medicine[tiab])))
S1	((((((multidisciplin*[tw] OR multi-disciplin*[tw] OR interdisciplin*[tw] OR inter-disciplin*[tw] OR interprofession*[tw] OR inter-profession*[tw] OR collaborat*[tw] OR Patient Care Team[MeSH]))))

Searches began in May of 2020. Databases searched included EMBASE, Medline, ERIC, CINAHL, and Google Scholar. Sources of grey literature (e.g., government documents, white papers) were searched but did not provide additional references. No restrictions were placed on date of publication.

Inclusion criteria

Inclusion criteria included studies involving two or more healthcare professions, studies using simulation pertaining to the ED to conduct IPE, and identification of at least one IPC competency as a learning outcome. Two competency frameworks were used to guide the assessment of included studies. The Canadian Interprofessional Health Collaborative (CIHC) competency domains include role clarification, team functioning, interprofessional communication, patient/client/family/community centered care, interprofessional conflict resolution, and collaborative leadership [2]. The

Interprofessional Education Collaborative (IPEC) core competencies include values/ethics for interprofessional practice, roles/responsibilities, interprofessional communication, and teams/teamwork [12]. The review considered peer-reviewed research studies of experimental and quasi-experimental nature.

Exclusion criteria

Studies were excluded if they involved only one professional group, did not pertain to the ED, did not involve simulation, and/or did not identify IPC competencies as learning outcomes. Conference abstracts, short reports, letters to authors, book reviews, and commentaries were excluded as the focus of this review relates to primary evidence. Systematic reviews were excluded for the same reason. Only English or English-translated articles were included due to the primary language of the research team.

Selection of sources of evidence

Citations obtained from the search were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia) for information management. Titles and abstracts were screened by two independent reviewers and, if eligible, were subjected to full text screening by two independent reviewers. Discrepancies identified during screening were resolved by a third research team member.

Data charting

Data extraction from eligible citations was facilitated using Covidence and a data extraction tool developed by the research team. A calibration exercise was conducted prior to data extraction to ensure rigor. This included the completion of a test extraction by each reviewer. Two independent reviewers conducted data extraction, with discrepancies resolved by a third reviewer.

Synthesis of results and quality assessment

Each of the variables extracted in the dataset were reviewed in relation to the research question. Study characteristics and themes were derived to provide a descriptive account and overview of what included studies offered in relation to the research question. As per the goals of this review, no quality assessment of the information sources was conducted.

Results

Sources of evidence

Figure 1 outlines the number of articles retrieved, screened, excluded, and extracted. Reasons for exclusion included wrong setting, lack of identified IPC competencies as learning outcomes, uniprofessional studies, foreign language studies, conference abstracts, short reports, letters to authors, book reviews, and commentaries.

Characteristics of sources of evidence

Characteristics of the studies included in this review are outlined in Table 2. The number of professions included in studies ranged from 2–16 Simulation-enhanced interprofessional education was utilized in 14 areas of emergency medicine. The area of emergency medicine most frequently targeted was trauma (n = 11; 32.4%), followed

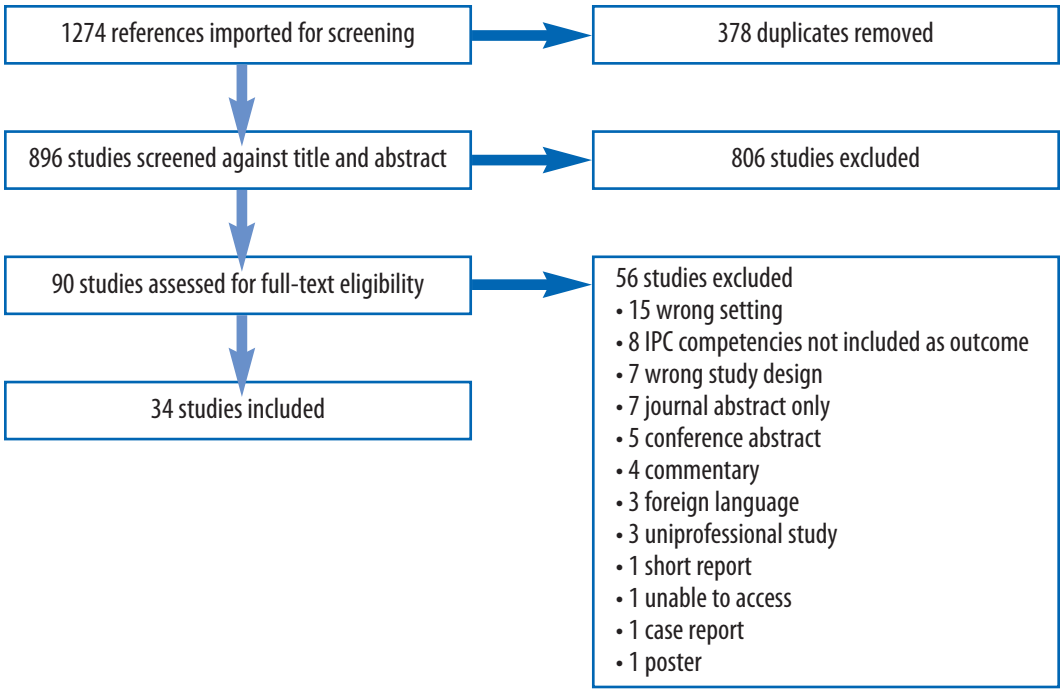

Figure 1: Sources of evidence

by cardiac resuscitation (n = 5; 14.7%) and general adult emergencies (n = 5; 14.7%). Twenty-four studies (70.6%) included post-licensure healthcare professionals, while eight (23.5%) had pre-licensure learners, and three (8.8%) consisted of a mix of the two. Simulation-enhanced interprofessional education was most frequently conducted in simulation suites (n = 14, 41.2%), followed by in situ (n = 9, 26.4%), university settings (n = 6, 17.6%), mixed (n = 2, 5.9%), and online (n = 1, 2.9%).

Interprofessional communication was the interprofessional competency that was most frequently identified as a learning outcome (n = 24; 70.6%). Nineteen studies (55.9%) identified an interprofessional team in the development of the simulation activity. Three studies (8.8%) utilized an IPC framework to guide simulation development. Two of those studies used the IPEC framework, while another utilized a theoretically based competency framework developed by the research team. Eighteen of the 34 (52.9%) studies identified educational theories that guided their IPE initiatives. Assessment tools specific to the evaluation of IPC competencies were utilized in nine of the 34 studies (26.5%). All theories and assessment tools utilized are outlined in Table 3.

Debriefing was utilized in 32 of the 34 (94.1%) included studies. Five studies (15.6%) identified specific debriefing theories used by facilitators. Three studies (9.3%) utilized teamwork or communication experts to facilitate debriefing. Twenty-eight of the 34 included studies (82.4%) utilized facilitators to implement Sim-IPE. Six of these studies (21.4%) referenced facilitator training or ongoing education for facilitators.

Half of the studies (n = 18, 52.9%) identified Sim-IPE as being effective in teaching IPC competencies. Four of these 18 studies (22.2 %) utilized a validated IPC

Table 2: Study characteristics (*n* = 34)

Category	Number (*n*)	Percentage (%)
Country		
United States	15	44.1
Canada	6	17.6
United Kingdom	4	11.8
Norway	3	8.8
Australia	2	5.9
Germany	1	2.9
Italy	1	2.9
Romania	1	2.9
Switzerland	1	2.9
Simulation setting		
Simulation suite	14	41.2
In situ	9	26.4
University	6	17.6
In situ and simulation suite	2	5.9
Not reported	2	5.9
Online	1	2.9
Professions involved in simulations		
Medicine	34	100
Nursing	32	94.1
Other (management, administration, human resources, infection control, chaplain)	11	32.4

Category	Number (*n*)	Percentage (%)
Professions involved in simulations (continued)		
Respiratory therapy	9	26.5
EM technicians	4	11.8
Paramedicine	4	11.8
Physician's assistants	3	8.8
Police/security	3	8.8
Radiography	3	8.8
Social work	3	8.8
Midwifery	2	5.9
Pharmacy	2	5.9
Physiotherapy	2	5.9
Occupational therapy	2	5.9
Nurse practitioner	1	2.9
Patient care assistants	1	2.9
Area of EM targeted		
Trauma	11	32.4
Adult emergencies (general)	5	14.7
Resuscitation	5	14.7
Mental health	3	8.8
Burn management	2	5.9
Disaster preparedness	2	5.9
Obstetric emergencies	2	5.9
Emergency airway response	1	2.9

Category	Number (*n*)	Percentage (%)
Area of EM targeted (continued)		
Patient safety	1	2.9
Pediatric emergencies	1	2.9
Sepsis management	1	2.9
IPC competencies targeted by simulationIPIPC		
Interprofessional communication	24	70.6
Other related to collaboration (situational awareness, decision making, CRM, teamwork)	17	50
Team functioning	16	47.1
Role clarification	15	44.1
Collaborative leadership	12	35.3
Interprofessional conflict resolution	1	2.9
Patient/Client/Family/ Community Centered care	1	2.9
Simulation participant characteristics		
Post-licensure	23	67.6
Pre-licensure	8	23.5
Pre- and post-licensure	3	8.8

competency assessment tool to evaluate their intervention. Sixteen studies (47%) did not explicitly report Sim-IPE as being effective in teaching IPC competencies. No studies in this review attempted to directly measure the effect of the intervention on patient outcome.

Synthesis of results

Table 3 (see pages 15–31) provides a summary of the included studies and their characteristics pertaining to the research question.

Discussion

The results outlined above exemplify that although Sim-IPE seems to be a promising method of delivering IPE, there remains significant room for improvement. Very few studies are employing IPC frameworks to plan and guide programs. Assessment tools specific to IPC competencies are rarely being used to assess intervention outcomes. Most Sim-IPE programs are utilizing facilitators to guide simulation and debriefing, but few are providing faculty with formal facilitator/debriefing training. The discussion below expands on these concepts and how their incorporation contributes to the delivery of evidence-based Sim-IPE.

IPE and simulation

Interprofessional education is a complex process that can be delivered in a multitude of settings and pedagogies. The Centre for the Advancement of Interprofessional Education (CAIPE) identified that a chosen teaching method for IPE should meet several criteria. It should be "active, interactive, reflective and person-centred, service user/carer-focused, creating opportunities to compare and contrast roles and responsibilities, power and authority, ethics and codes of practice, knowledge and skills in order to build effective relationships between the professions and to develop and reinforce skills for collaborative practice" [3]. As seen by these results, when applied appropriately, simulation has the potential to provide such a foundation for learners. Learners benefit from IPE most when there is a degree of authenticity, and the learning experience is adapted to be relevant to learners and their areas of care [73]. We saw studies in this review customize simulation in many ways to engage learners. This included the use of realistic clinical scenarios, simulated patients, and makeup/moulage. Simulation gives learners an opportunity to practice repetitively in a controlled environment that can be adapted to resemble many different areas of clinical practice [4]. Appropriate feedback and debriefing can be provided immediately and in a personalized manner, increasing potential attainment of identified learning objectives [4]. These examples help demonstrate why, with the appropriate planning and delivery, simulation can be an effective form of IPE.

Competency frameworks and Sim-IPE

The World Health Organization promotes IPE for healthcare professionals and students to facilitate the attainment of IPC competencies necessary to practice collaboratively within a healthcare team [1]. Interprofessional education should be planned according to relevant educational theories and IPC competency frameworks to ensure effective interprofessional learning [3]. As per Healthcare Simulation Standards of Best practice

established by the International Nursing Association of Clinical and Simulation Learning (2021), the necessary criteria include conducting Sim-IPE based on a theoretical/conceptual framework, utilizing best practices in the design/development of Sim-IPE, recognizing/addressing potential barriers to Sim-IPE, and devising an appropriate evaluation plan for Sim-IPE [74]. The results in this study confirm that the majority of Sim-IPE interventions are not utilizing IPC competency frameworks as guidance.

Competency based-learning aims to provide educators and learners with a common language and succinct learning objectives to guide successful educational experiences [75]. It allows educators to assess learner's development of IPC competencies, and therefore the effectiveness of an intervention [76]. Assessment of learners should be based on demonstrated IPC competencies, necessitating a clear identification of competencies as learning outcomes [3]. An important component of assessing the effectiveness of an IPC intervention is the use of an assessment tool specific to IPC competencies. Utilizing an IPC competency framework and a tool that aligns with research objectives and learning outcomes is critical to ensure accurate measurement of outcomes [77]. As identified in our results, most studies are not using validated IPC competency tools to assess interventions.

Without consistent language and learning outcomes, it is challenging if not impossible for programs to implement and assess IPE with a shared mental model [78]. Interprofessional education is complex, and discrepancies in language make it confusing, distressing, and ineffective for learners. Psychological safety (PS), defined as a shared belief amongst individuals that it is safe to engage in interpersonal risk-taking in the workplace, has been found to increase team and individual learning across multiple organizations [79,80]. Psychological safety has been found to be impaired when learners are unsure what to anticipate, or if there are discrepancies between facilitator expectations [81]. In order to promote PS and effective interprofessional learning, it is crucial to use an interprofessional framework, IPC competency assessment tools, and a consistent lexicon to plan and execute Sim-IPE.

Faculty development

Most studies included in this review utilized debriefing post-simulation to enhance learning. Deliberate reflection of an experience leads to deeper understanding of learned concepts, making debriefing one of the most important components of Sim-IPE [42]. Preparation for the facilitation/debriefing role is essential, as the delivery of IPE is a challenging process. It requires significant skill and tact to help diverse groups of students achieve complex learning objectives [3]. In a recent scoping review regarding PS in interprofessional simulation for health professional learners, Lackie et al. (2021) found that the most frequently cited enabler of PS was facilitator skill [81]. Very few studies in this review described faculty training or specific debriefing approaches for Sim-IPE interventions. Adequate training allows for confident delivery of Sim-IPE, leading to better reception of the program [73]. As debriefing methods and debriefer expertise can be widely varied, using a predefined structured approach guided by theory allows the debriefer to focus the conversation on important learning objectives [42].

Recommendations for future research

The most important goal of effective IPE and IPC is improved outcomes for patients. Simulation-enhanced interprofessional education is a resource intensive process requiring buy-in from educators, learners, and administration to be effective. Depending on the type of simulation employed, resources required include a simulation lab, simulator technicians, and expensive equipment [5]. Schedules of healthcare professionals and/or learners must be coordinated, facilitators/debriefers educated, and simulated patients trained [5]. To obtain the support necessary to facilitate Sim-IPE, it is important to be able to show the value and outcomes associated with the educational intervention. For the reasons outlined above, patient outcome-based research will be an important initiative moving forward.

There also remains insufficient information about the long-term benefits of Sim-IPE. As exemplified by the studies in this review, Sim-IPE can be delivered in many different formats and environments. These include but are not limited to the number of sessions provided, timing of sessions, high vs low fidelity, and simulation suite/in situ. In situ refers to simulation learning that is conducted in the actual clinical setting, while simulation suites are simulated healthcare environments where participants learn, removed from the patients and clinical care areas [74]. Fidelity refers to the accurate representation of a clinical scenario through cues and stimuli from the perspective of the learner [74]. This can be broken down into physical fidelity, conceptual fidelity, and psychological fidelity, which all contribute to the required perception of realism to allow learners to engage in the simulation [74]. Without a good understanding of knowledge decay, it is impossible for educators to know optimal intervals, lengths, and formats for refresher training. This highlights the importance of conducting longitudinal Sim-IPE studies to guide more evidence-based and effective Sim-IPE.

Limitations

Although an extensive search strategy was developed to include key terms, relevant studies may have been missed due to language discrepancies in interprofessional literature. Grey literature was searched, but not exhaustively, meaning sources may not be included if they were not published in searched databases. The search of the literature was conducted in June 2020. Studies published after this are absent from this review. As per the format of a scoping review, evidence was not assessed for quality, which may limit the utility of recommendations made by the authors.

Conclusions

Simulation-enhanced interprofessional education is a promising method for providing healthcare professionals and learners with the skills required to collaborate within an interprofessional healthcare team. Simulation-enhanced interprofessional education should be rigorously planned according to IPC competency frameworks and educational theory. Assessment methods specific to IPC competencies should be utilized to ensure appropriate assessment of IPC learning outcomes. Faculty development is a crucial component of providing psychologically safe and effective Sim-IPE.

More research is required on the impact of Sim-IPE on patient outcomes and optimal methods of Sim-IPE delivery. Longitudinal research would help identify rates of knowledge decay and recommendations for refresher training.

Although the context of the study was situated in the ED, it is the researchers' belief that the findings will be applicable to all who embark on planning and executing Sim-IPE in healthcare curricula.

Acknowledgements

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Abbreviations

CRM: Crisis Resource Management
ED: emergency department
HCP: healthcare provider
IPC: interprofessional collaboration
IPE: interprofessional education
PS: psychological safety
SP: simulated patient
Sim-IPE: simulation enhanced interprofessional education

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Table 3: Summary of studies

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Reime et al., 2017 [13]]	Compare learning outcomes (non-technical skills, team performance) of hands-on simulation participants and observers	Medicine Nursing	Not reported	Not reported	Adult Learning Theory [14]	Not reported	Questionnaire post intervention, focus groups	Facilitator-led simulation, video assisted debriefing in clinical skills lab, session 3 months later	**Education** Linking realistic situations and non-technical skills in EM has motivational effect on students **Research** Investigate observer vs. participant roles in simulation
Lavelle et al., 2018 [15]	Investigate training impact on participant knowledge/ confidence managing deteriorating pregnant patient, develop human factors skills.	Medicine Midwifery	Not reported	Not reported	Diamond Debrief Model [16]	Human Factors Skills in Healthcare Instrument (HuFSHI) [17]	HuFSHI pre/post course Qualitative survey six months post-training	Facilitator-led simulations/ debrief in simulation suite	**Research** Impact on objective outcome measures and clinical practice

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Chung et al., 2016 [18]	Describe flexible IPE module for physicians, nurses, and RTs.	Medicine Nursing RT	Evaluation and feedback showed improvements in collaborative behaviours. 8-month follow-up survey found similar improvement in self-reported collaborative skills, communication.	Not reported	Not reported	Not reported	Knowledge quiz/survey	High- fidelity simulation and virtual patient simulation with video-enhanced, semi-structured debrief	**Education** High fidelity simulation not necessary for developing decision-making skills/clinical judgment Mixed simulation modalities lower costs
Sadideen et al., 2016 [19]	Explore role of "The Burn Suite" (TBS) in simulation-based team training (SBTT) and potential applicability of TBS as a tool for pediatric burns IPE.	Medicine Nursing	Not reported	Not reported	Not reported	Not reported	Likert style questionnaires, focus group and individual interviews post simulation	Facilitator-led high-fidelity simulation and debriefing	**Education** Team training size/feedback during debriefing important **Research** Factors influencing clinical performance Optimal team size per simulation

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
A.H. Wong et al., 2015 [20]	Develop ED Sim-IPE focusing on improving teamwork and attitudes toward patient violence	Medicine Nursing Police	Not reported	Not reported	Kolb's Experiential Learning Theory [21]	Not reported	Pre/post intervention Management of Aggression and Violence Attitude Scale [22]	Facilitator-led simulations, debriefing in simulation center with SPs	**Education** Trained educators ensure consistency Sessions within established training times **Research** Longitudinal data collection Comparison of different training methods Evaluate patient outcomes
Gilfoyle et al., 2017 [23]	Measure effect of 1-day Sim-IPE training course for pediatric resuscitation team members on adherence to PALS guidelines, team efficiency, teamwork	Medicine Nursing NP RT	Participation in Sim-IPE intervention improved teamwork during simulated resuscitation.	Not reported	Debriefing with Good Judgment [24]	Clinical Teamwork Scale (CTS) [25]	Change in Clinical Performance Tool and CTS pre/post-scenarios.	Trained facilitator-led high-fidelity simulations, scripted debriefing	**Research** Association between team performance and patient outcomes RCT to determine interventions resulting in most learning/retention

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Brown et al., 2016 [26]	Explore nursing, medical, and radiography students' perspectives on preparedness for trauma via SEIPE	Medicine Nursing Radiography	Students felt markedly more prepared for facing major trauma, significant difference seen in student perceptions of roles in trauma team.	Not reported	Not reported	Not reported	Pre/post scenario questionnaires	In situ facilitator-led high-fidelity simulation	**Research** Longitudinal follow-up
Gum et al., 2010 [27]	Determine if SEPIE improves maternity emergency care/team performance.	Medicine Midwifery Nursing	1-day Sim-IPE course can increase participants confidence/ease of team interaction. Many participants still thinking/reflecting about role in an emergency 3–6 months later.	Not reported	Crisis resource management (CRM) [28]	Not reported	Semi-structured interview 2 weeks and 3–6 months post workshop	Facilitator-led simulation and video guided debriefing	**Research** Longitudinal studies

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Shapiro et al., 2004 [29]	Determine if high-fidelity Sim-IPE improves clinical team performance when added to didactic curriculum.	Medicine Nursing	Positive but not statistically significant impact on teamwork behavior in a clinical environment following Sim-IPE	Not reported	CRM [28]	Not reported	Four trained ED teams followed prospectively and post intervention using Teamwork Dimensions Rating Form.	Scenarios in simulation suite, debriefing by teamwork experts	**Education** High fidelity SEIPE is the proper format for teamwork training **Research** Explore how much simulation augments didactic training Frequency of refresher courses
Siriratsivawong et al., 2016 [30]	Improve delivery of trauma care by emphasizing teamwork and effective communication among team.	Corps Men Duty Officers Medicine Nursing PA Paramedics	Not reported	Not reported	Not reported	Not reported	Written exam pre/post course	In-situ simulation over 6–11 days aboard US Navy Warship	Not reported

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Sigalet et al., 2012 [31]	Examine psychometric characteristics of KidSIM Attitude Towards Teamwork in Training Undergoing Designed Educational Simulation(ATTITUDES) questionnaire	Medicine students Nursing RT	Not reported	Not reported	Not reported	KidSIM ATTITUDES questionnaire [31]	Pre/post questionnaire	Facilitator-led simulations and debriefing	**Research** Examine student perceptions toward SEIPE team training Validated tools for learning/behaviour outcomes
Roberts et al., 2014 [32]	Design/deliver training to foster changes in leadership, team communication, and role-appropriate behaviors.	Medicine Nursing PA	Brief training exercises can change teamwork and communication behaviors on trauma teams. Changes sustained after 3-week interval with some loss of retention	Not reported	TeamSTEPPS [33], Roger's model of the Diffusion of Innovations[34], Kirkpatrick's Hierarchy of Evaluation [35]	Not reported	Review pre/post intervention Questionnaires post simulation	High-fidelity simulations, debriefing	Not reported

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Atack et al., 2012 [36]	Describe learner's perceptions of their own surge capacity competency and IP skills satisfaction following surge capacity course	Medicine Nursing OT Other Pharmacy PT RT Social Work	Strong gains made on all items of post-competency survey.	Not reported	Not reported	Not reported	Course satisfaction surveys	Online course, tabletop exercise, and ESim	**Education** Reduction of time demands could improve learner satisfaction. Advise learners about time commitment **Research** RCT comparing different educational approaches
Wisborg et al., 2006 [37]	Implement one-day training course for hospital trauma teams to improve communication, cooperation, leadership.	Lab technicians Medicine Nursing Radiographers Unit clerks	Not reported	Not reported	Not reported	Not reported	Questionnaires pre/post training	Low fidelity, facilitator-led in situ simulation, structured debriefing	**Education** Planning courses requires cooperation between departments Real patient stories increased clinical problem solving Post-training debriefing valuable, but most demanding. Low-fidelity Simulated Patient (SP) efficient training tool. **Research** Evaluate use of training mannequins versus live SP Investigate markers for optimal teamwork

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Jakobsen et al., 2018 [38]	Describe implementation of Better and Systematic Team Training course to students.	Medicine Nursing	Students agreed that they gained insights about communication, teamwork, and leadership. Students believed they would be better leaders and/or team members following course. Facilitators agreed.	Not reported	Kirkpatrick's Hierarchy of Evaluation (35)	Not reported	First evaluation phase: student learning outcomes Second phase: developed questionnaire Third phase: facilitators.	Video-recorded, facilitator led simulations in a simulation suite, structured debriefing	**Education** Engaged faculty from all professional groups and faculty development crucial **Research** Investigate helpful vs harmful stress Longitudinal assessment
Nagraj et al., 2018 [39]	Use Sim-IPE to encourage collaboration between paramedic and medical students with emphasis on patient safety, handover, and teamwork	Medicine Paramedicine	Students think that SEIPE is an enjoyable way of learning collaborative skills, enhancing mutual respect and role recognition.	Not reported	Not reported	Not reported	Feedback questionnaire	Facilitator-led simulation sessions	**Education** Authentic scenarios with immediate constructive verbal feedback Presence of tutors from both professions **Research** Explore stress in simulation Longitudinal research

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Eisenmann et al., 2018 [40]	Implement and evaluate training module for students of three professions in ED to establish role clarity.	Medicine Nursing Paramedicine	Sim-IPE successful in promoting change to practice of emergency care, while training teamwork, communication skills	Not reported	Kern's Six Step Approach [41], Debriefing Three Step GAS Model [42]	Not reported	Commitment to Change Tool [43] following training and 2 months later	High-fidelity or SP facilitator-led simulations, structured debriefing by communication expert using GAS model	**Education** Considerable time/resources required Should be implemented as longitudinal program **Research** Correlation between teaching and objective workplace changes
Paige et al., 2019 [44]	Determine whether high fidelity Sim-IPE of trauma transfers teams has immediate impact on participants' team-based attitudes and behaviors.	Medicine Nursing	Trauma team transfer training using Sim-IPE changes attitudes toward team-based competencies leading to learning in the simulated environment.	Not reported	Kirkpatrick's Hierarchy of Evaluation [35]	Readiness for Interprofessional Learning Scale (RIPLS)[45], Interprofessional Teamwork questionnaire (IPT), Teamwork Assessment Scale (TAS)	Evaluations pre/post intervention via TAS, RIPLS and IPT	Facilitator-led scenario and structured debriefing	**Education** Educators must intervene early in training to promote IPC **Research** Longitudinal follow-up Evaluate in situ training

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Truta et al., 2018 [46]	Assess whether single day CRM training, improves non-technical skills of interprofessional ED teams.	Medicine Nursing	Not reported	Not reported	CRM [28], Kirkpatrick's Hierarchy of Evaluation [35]	Not reported	Video recording analysis of initial/final assessment scenarios	CRM trained facilitator-led simulation and debriefing	**Education** Institutional support necessary **Research** Investigate decay phase, skills prone to fade, method of repeated training Impact on patient safety
Patterson et al., 2013 [47]	Implement simulation training encompassing CRM, teamwork, and communication.	Medicine Nursing Paramedic Patient care assistants RT	Not reported	Not reported	CRM [28], Bloom's Taxonomy Matrix [48]	Not reported	Safety Attitudes Questionnaire [49], Modified Behavioral Markers for Neonatal Resuscitation Scale [50]	Facilitator-led in situ simulations, video assisted structured debriefing. 6-month follow-up simulation	**Research** Factors resulting in sustained behaviour change Clarify optimal retraining interval/method

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Baker et al., 2008 [51]	Carry out preliminary evaluations of an Sim-IPE project	Medicine Nursing	Not reported	Theoretically based competency framework developed by research team. Includes typology of shared, complementary, and profession-specific competencies.	Not reported	Developed questionnaire abstracted from Interdisciplinary Education Perception Scale and focus groups	Post intervention questionnaire and focus groups	Weekly facilitator-led simulation, debriefing in simulation suite	**Education** Sessions require planning, coordination, resources **Research** Evaluation of outcomes of intervention
D'Asta et al., 2019 [52]	Illustrate development of high-fidelity simulation program using CRM	Medicine Nursing	Not reported	Not reported	CRM [28]	Not reported	Survey post intervention	Facilitator-led simulation scenarios, debriefing in a simulation suite	**Education** Identifying participants' target, non-judgemental environment, defined learning objectives crucial

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
A. H.-W. Wong et al., 2016 [53]	Assess/improve ED staff attitudes and perceptions toward teamwork, communication, and IPC using Sim-IPE.	Medicine Nursing	Significant improvements in staff attitudes toward teamwork and communication; successful in sustaining changes to 3 of 6 safety culture survey constructs related to teamwork and communication at 1 year	IPEC [12]	Bloom's Taxonomy Matrix[48], Kirkpatrick's Hierarchy of Evaluation [35]	Not reported	Survey, Questionnaires completed post intervention, TeamSTEPPS Teamwork Attitudes Questionnaire (T-TAQ) [54], Hospital Survey on Patient Safety Culture	Facilitator-led simulation, debriefing in simulation suite. In situ simulations biweekly	**Research** Longitudinal data collection Compare different training methods Evaluate patient outcomes
Mahramus et al., 2016 [55]	Assess effectiveness of teamwork training program on perceptions of teamwork during simulated codes.	Medicine Nursing RT	Improved perceptions of teamwork behaviors	Not reported	CRM [28], TeamSTEPPS [33]	Not reported	Team Emergency Assessment Measure (TEAM) [56]tool post simulation	Facilitator-led simulation, debriefing in simulation suite	**Research** Investigate impact on patient outcomes Develop debriefing tool specific to teamwork

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Capella et al., 2010 [57]	Investigate impact of team training on team behaviors in trauma resuscitation, efficiency in trauma bay, and clinical outcomes.	Medicine Nursing	Not reported	Not reported	TeamSTEPPS [33]	Not reported	Trauma Team Performance Observation Tool (TPOT) by trained evaluators	Simulation scenarios/video assisted debriefing in simulation suite	Not reported
McCave et al., 2019 [58]	Increase interprofessional practice, knowledge and skills when working with a transgender patient in ED	Medicine Nursing OT PA PT Social work	Utilizing SPs promoted learning of IPEC competencies	IPEC	Not reported	Adaptation of Dow (2012) IPEC Competency Survey [59]	Post simulation student/facilitator surveys	Student-led simulation with SP, facilitator-led debriefing in small/large groups	**Education** All four IPEC core competencies essential for development, implementation Essential to develop script/train SPs Important to adjust based on feedback. **Research** Longitudinal data

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Wenham et al., 2018 [60]	Gain understanding of what students learn through participation in multi-casualty crash simulation exercise.	Medicine Nursing Social work	Collaboration within a team, confidence in co-workers and communication observed by students	Not reported	Not reported	Not reported	Semi structured interviews, questionnaires	Simulation with focus groups	Not reported
A. H. Wong et al., 2018 [61]	Examine impact of Sim-IPE for ED agitation management	Medicine Nursing PA Security	Significant improvements in attitudes toward learning with SEIPE and core competencies in IPC.	Not reported	Not reported	KidSIM ATTITUDES Questionnaire [31]	Focus groups, questionnaire	Facilitator-led simulation with SP and focus groups	Not reported
Sullivan et al., 2018 [62]	Investigate NTS in simulated trauma setting pre/post debriefing	Medicine Nursing	Interprofessional team simulation in trauma resuscitation scenarios followed by debriefing significantly improved communication and interaction	Not reported	PEARLS Framework [63]	Not reported	T-NOTECHS [64] ratings completed by facilitators	Facilitator-led simulation, debriefing	**Education** Create space for discussion of team member responsibilities Learner-focused debriefing allows learners to reflect/set goals Facilitation strategies used by debriefers shape focus of debriefing **Research** Develop debriefing tool

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Zimmermann et al., 2015 [65]	Describe development, implementation and impact of an Sim-IPE resuscitation program	Medicine Nursing	Not reported	Not reported	Kern's Framework for Curriculum Development [41], 3D Model of Debriefing[66], Debriefing with Good Judgment [24], Van der Vleuten's Framework [67]	Team Monitor [68]	Post simulation questionnaire TeamMonitor self-assessment	Monthly, facilitator-led in situ training sessions and debriefing guided by the 3D Model of Debriefing and Debriefing With Good Judgment	**Education** Specific needs analysis defined program goals Applying Kern's Approach for Curriculum Design may help identify important objectives
Tsai et al., 2016 [69]	Evaluate efficacy and utility of simulation of the Emergency Airway Response Team to improve team dynamics, confidence, and knowledge in managing emergency airways.	Medicine Nursing RT	Not reported	Not reported	CRM [28]	Not reported	Pre/post simulation questionnaires	Facilitator-led simulations and debriefing	**Education** Those who are early in their clinical training benefit most from training. **Research** Impact on patient outcomes

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Steinemann et al., 2011 [70])	Evaluate impact of team training curriculum on communication/coordination, and clinical efficacy of trauma resuscitation	ED technicians Medicine Nursing RT	A human-based simulator curriculum can improve teamwork and clinical performance of trauma teams. Improvement evidenced in simulated and actual trauma settings.	Not reported	Not reported	Not reported	Prospective clinical data collected via chart review T-NOTECHS scale after resuscitation Debriefers reviewed video, recorded time to completion of 8 tasks	Facilitator-led simulation session, debriefing with teamwork expert	**Research** Length/format, interval for refresher training
Miller et al., 2012 [71])	Determine whether in-situ simulation program could be instituted in ED of a Level I trauma center and if teamwork/communication improve.	ED technicians Medicine Nursing Pharmacy RT	Teamwork and communication in clinical setting may be improved during in-situ simulation program.	Not reported	Not reported	Clinical Teamwork Scale (CTS) [25]	Observed trauma activations, CTS.	8-weeks of weekly in-situ trauma simulations, debriefing led by physician with simulation training	**Education** Simulations during less busy hours of day/week Moulage enhances enthusiasm Simulations must be continued to maintain learning **Research** Larger sample sizes and outcome measurement

Table 3: Summary of studies (continued)

Reference	Aims and purpose	Professions included in Sim-IPE	Effective in teaching IPC competencies?	IPC framework utilized	Theoretical framework utilized	IPC assessment tool utilized	Assessment tool utilized	Simulation description	Education and research recommendations
Ginsburg & Bain, 2017 [72])	Develop/ evaluate simulation workshop promoting speaking up behaviours	Medicine Nursing Allied health	Not reported	Not reported	Kirkpatrick's Hierarchy of Evaluation[35], Team STEPPS [32]	Not reported	Pretest teamwork climate data, Post test measures 3/7 months post workshop	Role playing simulations, small/large group debriefing	**Research** Larger sample sizes Impact on patient/system outcomes