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SYSTEMATIC REVIEW OF THE EVIDENCE FOR USING SIMULATION TO REPLACE CLINICAL EXPERIENCE

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ABSTRACT

Background: In health professions education there is a shortage of clinical training opportunities and an increasing demand for workers, creating a need for alternative methods of clinical placements. One alternative method to replace clinical experience is simulation-based education. Currently, the efficacy of simulation as a clinical replacement in paramedicine is unknown. To understand the current state of evidence for substituting clinical experience with simulation in paramedic education, provide implications for SBE implementation, and direct further research in this area, a systematic review, following the PRISMA checklist guide, was conducted.

Methods: Five databases were searched. Primary source studies of all designs investigating replacing clinical experience in paramedicine were included, with eight articles assessed for eligibility screening. Three studies were selected for final inclusion, quality assessment and critical appraisal.

Results: Inter-rater reliability was good for the quality assessment and quality appraisal ratings were moderate to strong, though the articles were of low levels of evidence. None of the studies directly addressed whether simulation-based education can be used as a clinical replacement, though both learners and program directors found value in simulation and felt a combination of simulation and clinical time was best. Communication skills and high-acuity, low-frequency situations were identified as most appropriate for simulation substitution.

Discussion: The findings of the systematic review indicate a willingness to engage in simulation to replace some clinical experience and certain skill areas that could be suitable for simulation, but no practical recommendations can be made due to the low level of study design based on the levels of evidence and lack of evidence for direct clinical substitution. Simulation as a replacement for clinical experience has support in other health professions, but further research is needed in paramedicine to investigate its efficacy and to inform future educational practice.

Clinical, or "real world" experience, is a consistent aspect of training and assessing healthcare students to produce competent and entrustable professionals (Nyoni et al., 2021). Currently, multiple stressors are affecting healthcare delivery around the world, which also impact health professional education (HPE) (Bishen & Jacquet, 2023; Vandenbroucke, 2024). Two stressors impacting HPE are the need to train more healthcare professionals and access to fewer clinical training opportunities (Drummond et al., 2022; Nyoni et al., 2021; Pearce et al., 2022). The confluence

of these two stressors has led to the need for novel approaches to clinical experiences (McGregor et al., 2020; McLeod et al., 2021; Nyoni et al., 2021); one approach is replacing clinical hours with simulation (Breymier et al., 2015).

Simulation is a widely accepted, well-researched, and essential part of HPE that has begun to be used as a modality to train learners in place of clinical time (Anton et al., 2022). In the last decade, there has been a growth in the research and use of simulation-based education (SBE) to replace curriculum time previously dedicated to clinical experience. Nursing has led the way in this area with the large-scale 2015 National Council of State Boards of Nursing (NCSBN) study indicating that up to 50% of clinical time can be replaced with high-quality simulation with no decrement in student competency (Hayden et al., 2014). Other professions have also investigated replacing clinical time, including medical radiation sciences (Jimenez et al., 2023), physiotherapy (Watson et al., 2012), speech-language pathology (Hill et al., 2021), and medicine (Giblett et al., 2017). Research on replacing clinical time with SBE has generally demonstrated equivalence of learner outcomes between SBE and clinical experience, with no negative outcomes and potential benefits in certain areas such as interprofessional competency and collaboration (Bogossian et al., 2019). Increasingly, nursing associations are approving SBE to replace clinical hours, and programs are implementing SBE to replace clinical hours (Breymier et al., 2015; Curry-Lourenco et al., 2022).

Paramedicine is facing the same stressors as other professions (Cash et al., 2021; Newton et al., 2024), making the investigation of using SBE to replace clinical time prudent. While accrediting bodies in paramedicine have approved using simulation for competency assessment (CoAEMSP Interpretations of the CAAHEP 2023 Standards and Guidelines., 2024; Supplement to the National Occupational Competency Profile, 2014 Appendix A High Fidelity Simulation, 2014) presently, it is not apparent at what scale SBE is being used to replace clinical time in paramedicine. Additionally, for paramedicine, the high degree of variability in clinical experiences does not ensure uniform experience and training (Credland et al., 2020; Page et al., 2021).

A 2019 systematic review by Bogossian et al. (2019) investigated simulation as a substitute for clinical practice in pre-licensure health professional students but did not identify any literature on paramedicine, though the search was not focused on paramedicine and literature may have been missed. Bogossian et al. (2019) also looked for "gold-standard" evidence and applied stringent inclusion/exclusion criteria, potentially leading to evidence in paramedicine being missed. Squires et al. (2022) also conducted a review on the incorporation of SBE in professional placements, though they did not directly examine replacing clinical time nor find any evidence for paramedicine.

Other recent reviews focused on simulation and paramedicine have investigated the current state of simulation in paramedic education (Diamond & Bilton, 2021), how simulation is used as a teaching modality in paramedic education (Wheeler & Dippenaar, 2020), and the use of simulation with practicing paramedics (Bienstock et al., 2022). These reviews were primarily descriptive and focused on the general use of simulation in paramedicine and did not directly probe the literature for evidence related to replacing clinical experience with SBE.

If SBE can be a solution to alleviating the need for training more paramedics in the face of fewer appropriate opportunities for clinical experience, it is necessary to understand what current evidence exists for replacing clinical hours with SBE in paramedicine. As the final search of the literature by Bogossian et al. (2019) was completed in February 2018, it is timely to conduct another search to identify if new evidence has emerged. Understanding the current state of evidence will help guide future research and inform and direct the potential implementation of SBE to replace clinical time. Establishing the current evidence will also serve as an inflection point from which to measure change or progress.

The present review adopted a modified version of the Bogossian et al. (2019) review to focus on paramedicine. The present review aims to determine the current evidence for using simulation to replace clinical time in paramedicine, what this means for implementation, and future directions for research or evidence that needs to be gathered. To meet this aim, three research questions, adapted from Bogossian et al. (2019), were developed:

1. What is the level of research evidence and the quality of primary studies investigating simulation-based education as a substitute for a proportion of prelicensure clinical placement hours in paramedicine?
2. What are the measures and outcomes used, and does the evidence demonstrate statistically or clinically significant differences or equivalence for evaluation outcomes when simulation-based education is substituted for a proportion of paramedic clinical placement?
3. If evidence supports the use of simulation-based education as a substitute for clinical placement, what is the optimal proportion of simulation hours versus clinical placement hours, in what placement ratio, for what durations, and how is the evidence translated into paramedic education standards in health care disciplines?

METHODS

Procedure

Search Strategy

A systematic review was conducted to rigorously synthesize the literature to understand the current evidence for using SBE to replace clinical time in paramedicine. A systematic review method was chosen as it "attempts to collate all the empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question" and "uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made." (Lasserson et al., n.d.) The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist (Page et al., 2021) and Joanna Briggs Institute (JBI) methods (Aromataris et al., 2024) were used to guide the review.

A systematic search strategy of multiple databases was conducted using relevant keywords to identify relevant literature. The databases included Cumulative Index to Nursing and Allied Health Literature (CINAHL), Medical Literature Analysis and Retrieval System Online (Medline), PubMed, Education Resources Information Center (ERIC) and Google Scholar. The search was conducted between May 27th, 2024 and May 30th, 2024. A hand search of references from identified articles and already acknowledged articles was

also conducted. All literature was compiled using the electronic referencing software Zotero (Takats et al., 2024).

Inclusion/Exclusion Criteria

Primary source studies of all designs were included. As simulation is not well-defined and can mean different things to different people (Wheeler & Dippenaar, 2020), if the study indicated simulation was used, then it was eligible for inclusion. Studies that did not investigate the direct replication of clinical time with simulation were included as they could help to characterize the current state of SBE to replace clinical time and inform implementation. All levels of training for paramedics, including those practicing, were included. Studies from any time up to May 30th, 2024 were included. Only studies published in English were included. Studies that did not include paramedics as the primary sample were excluded.

Selection Processes

The titles and abstracts of the initial search results were independently screened by two members of the research team (EV, EV). After the initial extraction, the results were de-duplicated and reviewed in more detail, and articles for full-text review were identified. After the full-text review, a final set of articles for inclusion was determined by the two initial reviewers. (see Figure 1, Table 1).

Synthesis and Quality Appraisal

All authors confirmed the final set of articles to be included in the review. Articles were then ranked based on the JBI Levels of Evidence—Effectiveness (JBI Levels of Evidence,

Search	Terms	Database	Results	Extracted
1	simulation training or simulation education or simulation learning AND paramed* or ems or emergency medical service or prehospital or pre-hospital or ambulance or emergency medical technician or emt AND clinical training or clinical experience or clinical education or clinical teaching or clinical placement	CINHAL	25	2
		Medline	5	0
		PubMed	1563	10
		ERIC	3	1
		Google Scholar	4 Pages	4
		Total	1596 + 4 pgs	17
2	simulation training or simulation education or simulation learning AND paramed* or ems or emergency medical service or prehospital or pre-hospital or ambulance or emergency medical technician or emt AND clinical replacement or clinical substitution or replace clinical	CINHAL	2	2
		Medline	0	0
		PubMed	37	4
		ERIC	0	0
		Google Scholar	10 Pages	2
		Total	39 + 10 pgs	8
3	simulation training or simulation education or simulation learning AND paramed* or ems or emergency medical service or prehospital or pre-hospital or ambulance or emergency medical technician or emt AND practicum replacement or practicum substitution or replace practicum	CINHAL	0	0
		Medline	0	0
		PubMed	0	0
		ERIC	0	0
		Google Scholar	6 Pages	3
		Total	0 + 6 pgs	3
4	Hand Search			12
Total				40

Table 1. Search terms and results of database searches and extraction.

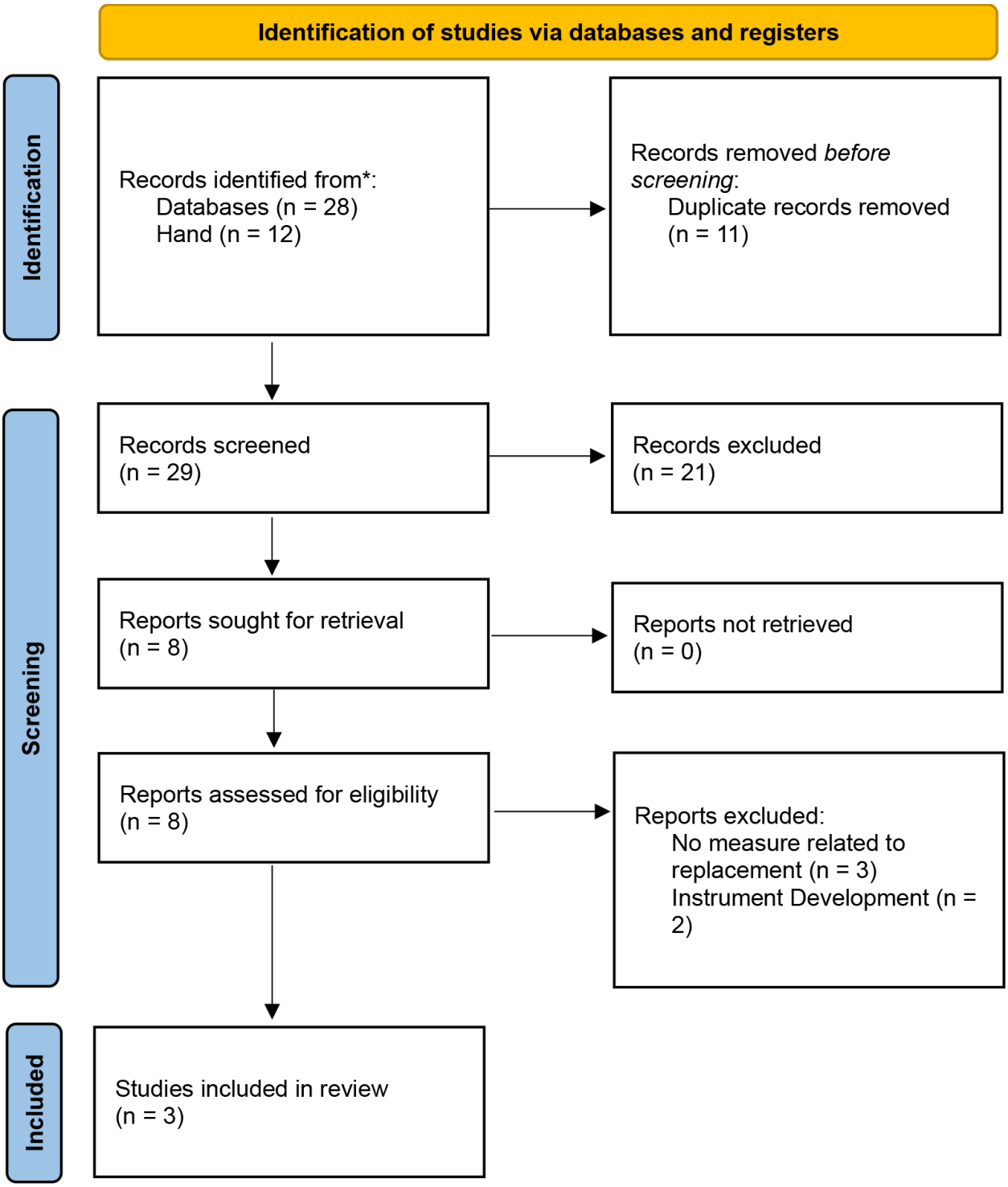

Figure 1. PRISMA flow diagram for article selection. *See Table 1 for reporting of the number of records identified from each database and register searched.

2014) where Level 1 is Experimental designs, Level 2 is Quasi-experimental designs, Level 3 is Observational-analytic designs, Level 4 is Observational-descriptive studies, and Level 5 is Expert Opinion. Characteristics of each study were identified to extract information from the studies and address the research questions. The extraction was conducted by (EV, JR, ML, and LV) independently with confirmation conducted by the final author (EV). The four authors used the Modified Medical Education Research Study

Quality Instrument (MMERSQI) (Al Asmri et al., 2023) to assess the quality of quantitative studies. The Joanna Briggs Institute Critical Appraisal Checklist for critical and interpretive research (Lockwood et al., 2015) was used for quality assessment of qualitative research. Inter-rater reliability (IRR) for scoring the MMERSQI and JBI checklist was conducted using Fleiss's kappa (Fleiss et al., 2003). Intraclass correlation coefficients (ICC) were calculated for the summary scores /100 of the MMERSQI. All calculations were conducted based on the initial scoring of each article by the raters prior to a discussion of differences in scoring. Summary scores are based on the average across all raters. All analysis was conducted using R and the IRR package (Gamer et al., 2019).

Title of Study	Author/ Origin	Sample	Design	Measures Used	Reliability/ Validity	Results
Simulation Use in Paramedic Education Research (SUPER): A Descriptive Study	Mckenna et al. (2015) (USA)	N= 389 Participants were paramedic programs accredited by the Commission on Accredited Allied Health Education Programs and the Committee on Accreditation of Educational Programs for the Emergency Services profession.	Cross-sectional survey	Census survey developed based on NCSBN survey and cognitive interviews.	The survey was revised through consensus decision-making and cognitive interviews to confirm respondents' understanding.	Simulation was used to replace skills required as a part of clinical experience and was done more frequently than directly replacing clinical or field hours. 23% of programs never used simulation to replace clinical or field skills while 66% said they never replace clinical hours and 77% never replace field internship hours. Of ten skills identified for replacement pediatric intubation was most frequently reported as being replaced.
Can DVD simulations provide an effective alternative for paramedic clinical placement education?	Williams et al. (2009) (Australia)	Participants (n=97) were students in a Bachelor of Emergency Health program. Qualitative data was collected from two focus groups of paramedic students (n = 6).	Cross-sectional mixed methods	25-item self-report questionnaire consisting of these scales: Sustained Attention/ Mental Effort, Clinical Experience/ Relevance, Learner Satisfaction, Information Processing Quality	All four standardized scales were assessed for test-retest reliability (Pearson's r correlation: 0.30-0.87) and internal consistency (Cronbach's : 0.51-0.90). Focus group questions were created based on experiences, general evaluation, and feedback. Coding analysis used multiple approaches and credibility checks to increase objectivity.	Paramedic students positively perceived the video simulations as maintaining attention and concentration. Simulations provided clinical authenticity and relevance to practice. Themes emerging from the focus group were impact on employment, appreciation for teamwork, potential to replace some clinical placements due to learning wastage during placements.
Directors' Perceptions of Supplementing Clinical Requirements with Simulation-Based Education in Paramedic Education	Whitten-Chung (2023) (USA)	N = 6 Participants were program directors of paramedic programs accredited by Commission on Accredited Allied Health Education Programs.	Qualitative semi-structured interview	Semi-structured interview interpreted with themes identified through open coding	Philosophical perspective (Experiential Learning Theory) was demonstrated, and credibility was established through saturation, member checks, and maintaining reflexivity. An audit trail was used to track the process.	The research found that PDs view SBE and clinical education as equally essential and complementary. The PDs found common ground during independent interviews for SBE to replace clinical experiences during high-acuity, low-frequency patient cases where clinical decision-making and opportunities for clinical judgment are limited.

Table 2. Characteristics of studies included for final review.

RESULTS

Quality of Evidence

Three studies were included in the final analysis: McKenna et al. (McKenna et al., 2015), Williams et al. (Williams et al., 2009), and Whitten-Chung (Whitten-Chung, 2023). Based on the JBI Levels of evidence, the studies were rated Level 4 Observational-Descriptive 4.b Cross-Sectional (Mckenna et al., Williams et al.) and Level 5 Expert Opinion 5.b Expert Consensus (Whitten-Chung). Based on the low level of evidence no CONSORT checklist or risk of bias assessment was conducted.

Fleiss Kappa for m raters indicated good IRR for McKenna et al. (.66) and Williams et al. (.7), with perfect IRR for the qualitative Whitten-Chung paper. Based on a one-way random effects model, there was a significant ICC across all raters for the summary scores on the MMERSQI-rated papers, ICC = .95, F = 20.4 (1,6), p = .004, 95% Confidence Interval = .57 – 1. The results indicate consistent and reliable ratings. The MMERSQI summary score for Williams et al. was 64.3 and 73.5 for McKenna et al., while Whitten-Chung met all criteria for the JBI Critical Appraisal Checklist. After review and discussion complete agreement was achieved between raters.

Summary and Synthesis

As part of a broader survey, McKenna et al. (2015) included items investigating how often and for what competencies accredited paramedic programs used simulation to replace clinical time. McKenna et al. (2015) found variable use of SBE to replace clinical experience and various skills for which SBE was most frequently used as a replacement. It is not reported why or how skills are replaced. Williams et al. (2009) found paramedic students were engaged with and accepting of using video 'simulations' of clinical scenarios to replace clinical time. Students were able to move through the simulations freely, though whether pre-briefing or debriefing occurred was not reported. Whitten-Chung (2023) investigated Program Directors' perceptions of the potential of the use of simulation to replace clinical time. Program Directors valued both SBE and clinical time, believing clinical time would always be essential but simulation could be valuable in situations where clinical opportunities are not optimal.

Neither McKenna et al. (2015), Williams et al. (2009), nor Whitten-Chung (2023) directly investigated the replacement of clinical time with simulation, and while the quality appraisal ratings were moderate to strong, the overall quality level of the research, based on the JBI rating, was low. Overall, the aims and research questions of the included studies were not adequate to address whether SBE can be used to replace clinical time with paramedic students. Participants in both the Williams et al. (2009) and Whitten-Chung (2023) studies did not think that simulation could be used as a complete substitution and thought a blend of both methods would be appropriate to prepare students for practice. Communication skills and skills where students do not have a high-level engagement in the provision of care were identified as the most suitable for substitution. Outside of identifying potential skill/competency areas to investigate for replacement, no educational practice recommendations can be made based on the literature.

DISCUSSION

Based on the current literature, only the first research question could be addressed. The current level of research evidence and quality of studies investigating SBE as a replacement for a proportion of paramedic clinical practicum time is low. It was not possible to address the second and third research questions or to make educational practice recommendations.

Aim of the Review

This review aimed to determine the existing evidence for using simulation to replace clinical time in paramedicine. What this means for implementation and future directions for research or evidence that needs to be gathered.

The current evidence for replacing clinical hours for SBE in paramedicine is generally absent, with only three studies of low-level evidence that did not investigate the efficacy of the direct substitution of clinical hours with SBE. From the existing literature, some insight can be gained into the frequency with which replacement is occurring in the United States and for what skills, the willingness of program directors to replace clinical time with SBE and their perspectives on the topic, and student engagement and willingness for one 'simulation' modality to be used in place of clinical experience. Both administration and learners are willing to use simulation to replace clinical hours, and this is already being done to some extent.

Initial information on implementation regarding what skills may be a good target for investigation for replacement with SBE can be derived from the current evidence. Williams et al. (2009) and Whitten-Chung's (2023) findings indicate that certain skills and situations, particularly high-acuity, low-frequency situations and communication and interprofessional skills, are likely appropriate for initial investigation. These skills generally align with the skills most frequently being replaced, as reported by McKenna et al. (2015) Focusing on previously identified skills for replacement may support stakeholder buy-in.

Other professions have shown that it is possible to replace clinical hours with SBE and achieve the same learning outcomes with no negative effects (Bogossian et al., 2019). Paramedicine research should focus on the direct replacement of clinical hours with SBE and on what skill competencies are most readily obtained in simulation. Gathering this evidence should also help identify where the biggest gains can be made by using replacement to benefit student learning and performance, reduce instructor and preceptor stress/burnout, accelerate time to competency, realize cost savings, and increase workforce capacity.

Limitations of the Included Studies

In addition to the limitations related to the quality of the evidence, there are other critical limitations to the included evidence. The extent to which the video intervention used by Williams et al. can count as simulation is debatable. Though learners were able to move through chapters in the videos, no other engagement with the portrayed scenario or any pre-briefing or debriefing was described. Based on current standards (Watts et al., 2021), the intervention used would likely not be considered simulation by most; however, due to the early date (2009) and the current definition of simulation (Downing et al., 2020) al-

lowing for personal interpretation with simulation meaning different things to different people (Wheeler & Dippenaar, 2020), the Williams study can be considered.

The McKenna et al. (2015) paper only investigated SBE to replace clinical time as one aspect of a broader survey study. While the frequency with which replacement is occurring is described, there was minimal discussion or interpretation of this finding. Why certain skills are being used more frequently for replacement can only be speculated on. Whitten-Chung (2023), though methodologically of high quality, had a very limited and localized sample.

The current systematic review, because of the prior absence of literature for paramedicine, used similar though less stringent inclusion/exclusion criteria to Bogossian et al's. (2019) more general investigation of SBE to replace clinical time. Had a more stringent approach been taken, an empty review would have been produced.

Lack of Research

Based on prior reviews the results of the present study are not surprising, though as the evidence from other areas for replacing clinical hours with SBE has increased it could have been expected more research would have been found for paramedicine. There are likely several reasons for the paucity of research on this topic.

Paramedic practice has undergone dramatic change and in its current scope represents a new role compared to traditional prehospital practice (Credland et al., 2020; Smith, 2017). Compared with other professions where roles and scope have been more stable, paramedicine is an emerging and evolving practice and so research may still be becoming an integrated component of the profession (Smith, 2017).

Simulation has only become an established and prevalent educational modality in approximately the last twenty years (Anton et al., 2022), and though paramedics are heavy users of simulation, simulation-focused research in paramedicine is minimal and has only emerged in the last 10-15 years (Bienstock et al., 2022; Diamond & Bilton, 2021; Wheeler & Dippenaar, 2020). Relatedly, using SBE as a replacement for clinical hours is a new approach with evidence accumulating in only the last 15 years, primarily in nursing; in 2018 Bogossian et al. (2019) only identified 10 studies, and in 2019 Roberts et al. (2019) identified 12 in a review focused on nursing. Simulation, paramedic simulation, paramedic research, and replacing clinical time with SBE are emergent, and it takes time for research, knowledge, and practice to become established.

Finally, buy-in from programs and other stakeholders to use SBE to replace clinical time may be lacking. Prevailing modalities and methods may tend to persist through inertia and a sense of tradition. Further, skepticism about the use of SBE may arise from a prevalent issue within simulation itself. When using SBE to replace clinical time, the simulation conducted should be "high-quality" simulation (Hayden et al., 2014), yet what is meant by "high-quality" and simulation itself is unclear. The current definition of simulation is ambiguous enough that simulation can mean many different things to many different people, with much room for personal interpretation (Wheeler & Dippenaar, 2020). Whitten-Chung (2023) identified this as an issue for the wider use of SBE in paramedicine and recommends "the need for clear definitions and standards for SBE… more specific language regarding simulation for clinical education in initial paramedic

education… well-designed SBE experiences for initial paramedic education to avoid misunderstanding and discrepancies." With the high level of ambiguity, a lack of buy-in is likely, and doing a better job of defining simulation and specifying what it is and how it should be used and implemented could help increase the investigation of SBE to replace clinical hours.

Review Limitations

The present systematic review was subject to the extant limitations of an academic review. Search terms were selected to be as comprehensive as possible; however, different terms and different nomenclature for paramedicine based on global regions may have led to missed literature. Concomitantly, the search was limited to the English Language, potentially leading to missed research. It is also apparent that some programs are already using SBE to replace clinical time; information on these implementations may have been distributed through forums not included in the search.

CONCLUSION

The three papers included in the review addressed aspects of replacing clinical time with SBE but did not address the direct replacement of clinical time with SBE or reach a high enough level of design and rigor to make any practice recommendations. The lack of evidence for replacing clinical time with SBE is a case of an absence of evidence rather than evidence of absence. It was possible to identify avenues for future investigation and make inferences about the willingness of programs and learners to use SBE in place of clinical time. Though the evidence for paramedicine is very limited, evidence from other areas indicates that using SBE to replace clinical time has "conditional support" and no negative outcomes (Bogossian et al., 2019). Based on the existing evidence, if high-quality simulation is used along with good research design (Hayden et al., 2014), paramedicine can initiate research to investigate the replacement of clinical time with SBE. With consideration of the current state of health care systems in many countries, it is essential to gather evidence to inform future practice for training paramedics more efficiently and effectively.

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