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Review Article

Simulation-Based Nurse Education for Comorbid Health Problems: A Systematic Review

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KEYWORDS
simulation;
comorbidity;
nurse education;
high-fidelity patient simulators;
standardised patients

Abstract
Background: Comorbid physical and mental health problems pose risks for individuals and generate significant costs for services.
Methods: This study is a systematic review of simulation-based education (SBE) for comorbid health problems.
Results: Nine included studies indicate that SBE can develop nurses' knowledge and skills for the care of comorbid health problems. Methodological challenges limit the quality and generalizability of the findings.
Conclusions: Nurse educators can use the evidence in this review to guide development of educational practices. Further research is needed with larger samples and validated tools to assess the impact of SBE on patient outcomes and the extent to which learning can be sustained in practice.

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Background

Mental and physical health are interdependent facets of the human condition so that people with severe mental health problems often experience poor physical health, while those with a long-term medical condition have an increased likelihood of developing mental health difficulties (Attoe, Lillywhite, Hinchliffe, Bazley, & Cross, 2018; Naylor et al., 2016; Weiss, Haber, Andrews Horowitz, Stuart, & Wolfe, 2009). The consequences can be devastating for the individuals concerned and place a significant burden on health and social services including the need for more complex treatments that result in higher health care costs (Department of Health [DoH], 2011; Doherty & Gaughran, 2014). On average, the life expectancy of someone with a severe mental illness is 15 to 20 years less than it is among the general population, due in part to unrecognised and undertreated physical health problems including coronary vascular disease and diabetes (DoH, 2011; World Health Organisation [WHO], 2013). Conversely, someone with a long-term medical condition such as arthritis, asthma, or multiple sclerosis who develops a mental health problem is likely to suffer more complications of their primary physical condition and

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experience a poorer prognosis (Kolappa, Henderson, & Kishore, 2013; Naylor et al., 2012).

Forty-one million people die from chronic long-term conditions (LTCs) each year, which accounts for 71% of all deaths globally (WHO, 2018). A majority of these deaths are in low- to middle-income countries although high-income countries are also affected. In 2016, there were an estimated 15 million people in England who lived with one or more LTC, and this is set to rise to approximately 18 million people by 2025 (George & Martin, 2016). The serious health consequences and significant cost implications of comorbid health problems emphasise the importance of integrated physical and mental health care. However, this need is often unrecognised (Weiss et al., 2009) and there remains an ingrained separation of mind and body when planning health services (Doherty & Gaughran, 2014). This separation extends to the education of health care professionals including nurses (Attoe et al., 2018).

Key Points

- Physical and mental health comorbidities can be devastating for individuals, necessitating more complex treatments and resulting in higher health care costs.
- High-fidelity simulation-based education can develop nurses' knowledge and skills to provide integrated physical and mental health care.
- Further research needs to determine effects on practice, patient safety, related-health outcomes, and the extent to which any learning can be sustained in real-world contexts.

International and U.K. preregistration nurse education programmes have historically focused on either physical or mental health, which may limit a nurse's ability to provide holistic care, thereby contributing to the poorer outcomes associated with comorbid health problems. It is now recognised that care must be integrated to meet people's physical, mental, and social care needs with corresponding implications for professional education and training (Attoe et al., 2018; DoH, 2016). These concerns are addressed in the U.K. Nursing and Midwifery Council's (NMC, 2018) standards of proficiency for registered nurses. Care for people with comorbidities and complex needs is emphasised, with educators called on to create programs that support nursing students' learning across the physical/mental health interface (NMC, 2018). Contemporary nursing graduates need to be proficient in physical and psychosocial health care and possess competencies to assess and manage mental health needs (Kunst, Mitchell, & Johnston, 2016; Norman, 2012).

The Royal College of Nursing (RCN, 2017) in the United Kingdom has argued that existing education models do not make it possible to ensure adequate exposure for all students to complex clinical issues and corresponding skill sets. Against this backdrop, simulation-based education (SBE) can aid development of the knowledge and skills required of nurses to recognise and manage comorbid health problems. In these respects, standardized patients (SPs) who provide the nonverbal and verbal cues associated with mental health difficulties and high-fidelity patient simulators (HFPSs) that allow the replication of medical interventions may be particularly useful.

Systematic reviews have demonstrated the potential for medium- to high-fidelity SBE, including SPs and HFPSs, to increase knowledge, confidence, and clinical and communication skills among nursing staff and to promote patient safety (Cant & Cooper, 2017; Lee & Oh, 2015; Norman, 2012; Shin, Park, & Kim, 2015). There is less available evidence to support SBE for the care of people with comorbid physical and mental health problems. In 2011, Hardy, White, Deane, and Gray considered educational interventions to improve the physical health of adults with severe mental illness, but their protocol yielded no SBE studies. In Cant and Cooper's (2017) systematic review and meta-analysis of medium- to high-fidelity simulation, only 2 of 72 included studies had a mental and physical health simulation scenario topic. More specifically, Goodman and Winter's (2017) systematic review into the use of SPs in psychiatric nursing noted their value as an educational tool but concluded that there was insufficient evidence to determine their effectiveness. Among other disciplines, a systematic review by Issenburg, McGaghie, Petrusa, Gordon, and Scalese (2005) of medical education found SBE to be an effective learning strategy that aided understanding of complex health care scenarios. Its use for comorbid mental and physical health care education was recommended.

No other systematic reviews that specifically examined the use of SBE to improve nurses' care of patients with comorbid mental and physical health problems have been identified. Given the increasing incidence of comorbidities and the potential for SBE to develop mental and physical health care knowledge and skills independently, further investigation is warranted into its use. Different mnemonics are used to generate focused questions for literature reviews that typically include a combination of population and/or problem (P), interventions (I), exposures (E), comparisons (C) (if applicable), outcomes (O), and type of study design (T) (Bettany-Saltikov & McSherry, 2016). A population and/or problem (P), exposure (E), outcome (O) and type of study design (T) analysis was conducted to formulate the research question for the review presented in this article (Table 1).

- How effective is SBE, using HFPSs and/or SPs, for improving the knowledge, skills, and confidence of nurses to assess and manage patients experiencing mental and physical health comorbidities?

Table 1 PEOT Analysis

Population and/or Problem	Exposure	Outcomes	Types of Study
All nurses caring/managing people with both mental and physical health comorbidities	Simulation-based education using medium- to high-fidelity simulation	Improved knowledge, skills, and confidence	All study types

Methods

The research was conducted as a narrative review with results reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009). PRISMA contains 27 items in a checklist of research methods that are deemed essential for reporting together with a flow diagram to

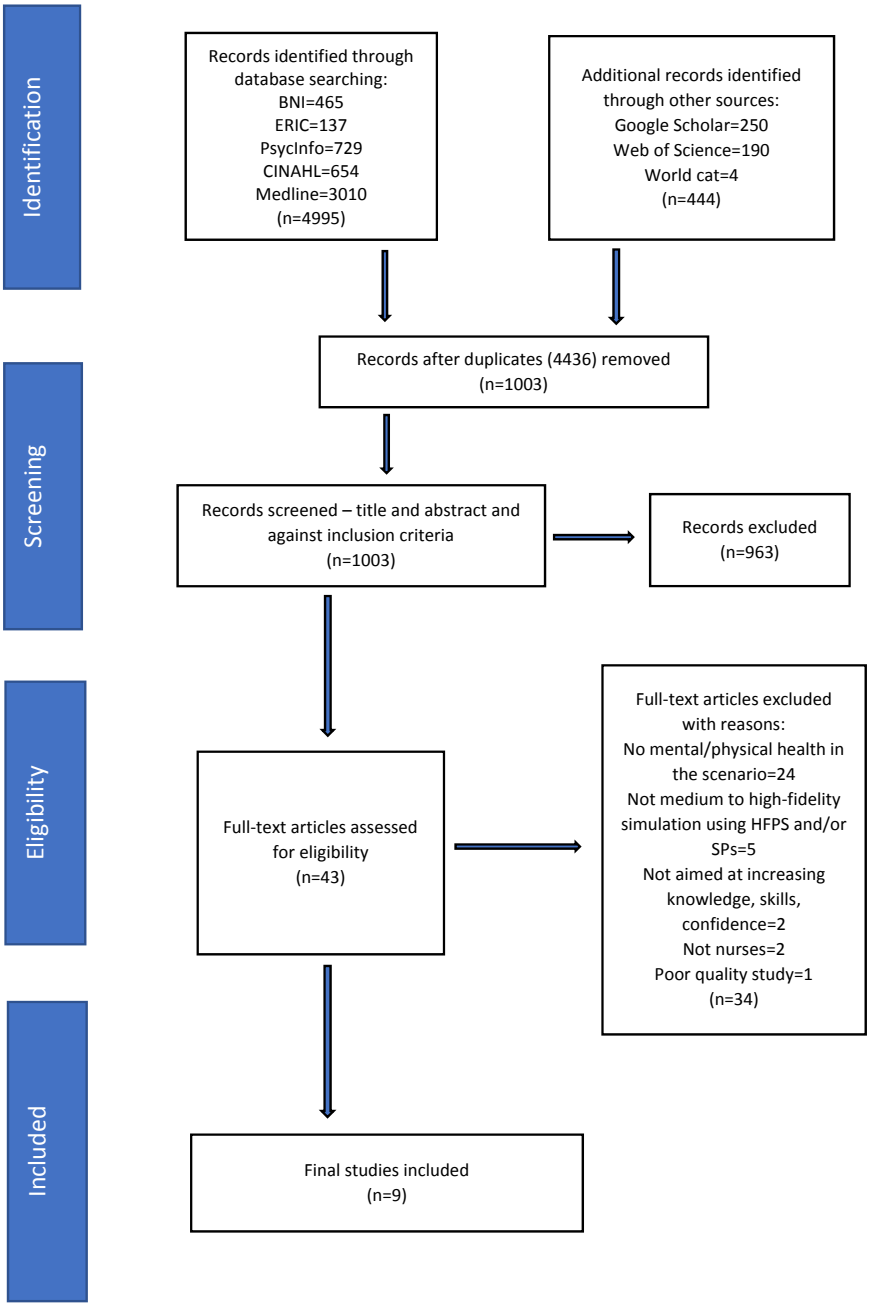

Figure PRISMA flow diagram. *Note*. HFPS, high-fidelity patient simulator; SP, standardized patient.

accurately represent the search, retrieval, and inclusion of review papers. PRISMA guidelines aim to ensure that review presentations are transparent and replicable.

Search Strategy

Five databases were searched from their inception to July 2018: CINAHL, BNI, PsycInfo, ERIC, and MEDLINE. The grey literature and Google Scholar were also searched over the same time period. Although no restrictions were placed on the years searched, it was anticipated, as reported by other authors, that combined mental and physical health SBE would be a recent phenomenon (Cant & Cooper, 2017; Hardy, White, Deane, & Gray, 2011). MESH and free-text terms were identified using the PEOT analysis to search for relevant literature. A total of 30 terms were used for ''problem'' providing different descriptions of physical/mental health and comorbidities. ''Exposure'' was captured by 11 search terms that described generic simulation and different types of HFPSs and SPs. ''Outcome'' was assigned seven search terms that included increases and improvements in knowledge, skills, confidence, and patient safety. Boolean operators and truncations were applied to the search terms to expand and combine necessary elements.

Study Selection

For inclusion in the review, eligible articles were those that reported empirical research of any methodology in the English language, were full-text articles in peer-reviewed journals, sampled nurses of any branch or level, used medium- to high-fidelity SBE using HFPSs and/or SPs, incorporated comorbid physical/mental health scenarios, and aimed to improve the knowledge, skills, and confidence of nurses. Against these criteria, the selection of articles followed a two-stage process. Initially, duplicates were removed and the titles and abstracts of each article were reviewed. The full text of the remaining articles was then read, and those that met the inclusion criteria were included in the review. The reference lists of included studies were also manually searched to ensure comprehensive coverage and retrieval. These selection processes were undertaken independently by two members of the research team who compared results and agreed any discrepancies through discussion to arrive at a final sample of nine articles for inclusion in the review (see Figure: PRISMA flow diagram).

Critical Appraisal

The quality of the included research studies was critically appraised using the Simulation Research Rubrics (SRR) (Fey, Glow, & Mariani, 2015). The tool was chosen because it emphasises the importance of certain features required within SBE, which are not recognised by other research appraisal tools, such as debriefing, simulation design, development, and implementation. Simulation-based research often lacks standardization, and studies of poor quality can occur with some frequency (Kardong-Edgren, Gaba, Dieckman, & Cook, 2011). The SRR allows these risks to be addressed with consistency (Fey et al., 2015).

Data Extraction and Synthesis

A data extraction template was used to capture key methodological detail for each article including the research aim, design, sample, intervention, data collection methods, findings, and study limitations. The heterogeneity of included studies necessitated a narrative approach to aid synthesis of the evidence (Popay et al., 2006). In addition to the use of a tabulation technique to capture methodological detail and the critical appraisal of studies, a grouping technique was also used. Studies were grouped according to one or a combination of the type of intervention, the setting or context for the intervention, the group under study, the study design, and the nature of the results being reported (Popay et al., 2006). As synthesis progressed, the researcher adapted these groupings to provide a meaningful and valid narrative of the evidence that answered the review question.

Results

Description of Studies

An overview of study characteristics is presented in Table 2. The nine studies were published between 2013 and 2018 and involved a total of 425 participants, of whom 310 were nurses, from the United States (six studies) and the United Kingdom (three studies), representing a mix of qualified and student health professionals. Five used quasiexperimental pre-post-test designs (Chadwick & Withnell, 2016; Fernando et al., 2017; Kameg, Cozzo Englert, Howard, & Perozzi, 2013; Lehr & Kaplan, 2013; Snow & Wynn, 2018), two were descriptive post-test only designs (Maruca & Diaz, 2013; Murray, 2014), and two were pilot studies (Felton, Holiday, Ritchie, Langmack, & Conquer, 2013; Le Page & Savoia, 2017). Methodologies included four quantitative studies (Chadwick & Withnell, 2016; Kameg et al., 2013; Lehr & Kaplan, 2013; Snow & Wynn, 2018), two qualitative studies (Felton et al., 2013; Maruca & Diaz, 2013), and three mix method studies (Fernando et al., 2017; Le Page & Savoia, 2017; Murray, 2014). Most studies surveyed participants with a questionnaire to collect quantitative or qualitative data and most of the instruments were designed by the research teams. Only two studies used validated tools (Kameg et al., 2013; Lehr & Kaplan, 2013). One study used prefocus/postfocus groups together with a postsimulation questionnaire (Felton et al., 2013). All postmeasurements were taken immediately after the SBE experience apart from the study by Kameg et al. (2013) which followed up

Table 2 Characteristics of Included Studies (n = 9)

Author, Year, Country	Aim/Purpose	Design	Sample	Intervention	Method and Measures	Key Findings	SRR Quality
Chadwick and Withnell (2016), UK	To evaluate a simulated intervention for developing mental health nursing students' confidence to recognise and manage physical health problems	Quasiexperimental pre-post-test	N = 95 mental health nursing students	High-fidelity patient simulation using two scenarios: (a) low mood and wrist cutting in an in-patient setting and (b) community setting psychotic episode with fall resulting in compound leg fracture	Prequestionnaire/ postquestionnaire using 4-point Likert scale based on the validated generalised self-efficacy scale, plus closed questions	90% reported improved confidence to recognise and manage deteriorations in physical health among patients with mental health problems	82%
Felton et al. (2013), UK	Evaluation of a new teaching approach that brought child and mental health nursing students together to share developing clinical expertise	Pilot study	N = 16: 8 child and 2 mental health students undertook the simulation with others observing	Workshop with young people to develop learning outcomes and scenarios: self-harm and paracetamol overdose. Simulations with young person actors.	Two focus groups and postsimulation questionnaire Nonvalidated	Overall positive response to the learning experience and opportunity to learn from each other. Child branch reported learning from mental health (MH) students, e.g., communication skills. Less recognition from MH students of learning physical health care skills. Being observed raised anxieties in some students.	79%
Fernando et al. (2017), UK	To evaluate a Simulation Workshop at the Mental-Physical Interface (SWAMPI) in terms of knowledge, attitudes, confidence, and changes to practice	Quasiexperimental pre-post-test	N = 63 mix of qualified doctors and nurses including RN = 18, RMN = 15, emergency nurse = 3	High-fidelity and standardized patients used in a one-day interprofessional workshop with 6 scenarios of physical/ psychiatric comorbidities	Self-evaluation form containing yes/no, Likert and open-ended questions Nonvalidated	Statistically significant improvements in knowledge, attitudes, and confidence 100% reported anticipated benefits to patient care, 98% to patient safety, 97% to communication skills	69%
Kameg et al. (2013), USA	To assess high-fidelity patient simulation effects on student knowledge, retention of knowledge, and their perceptions of the simulation.	Quasiexperimental pre-post-test	N = 37 BSc nursing students (35 completed full study protocol)	Three manikin-based scenarios of patients with alcohol withdrawal, trauma from partner violence, and postpartum depression. Actors played the role of relatives.	Pretest/post-test 30-item Health Education Systems Inc. (HESI) examination (12 weeks after intervention) plus Howard et al. (2010) 9-item postsimulation evaluation survey Both validated	Nonsignificant decrease in HESI scores postsimulation for whole sample. When stratified according to student performance statistically significant improvements for students who needed more teaching support. Students were highly satisfied with the simulation experience.	95%

(*continued on next page*)

Table 2 (*continued*)

Author, Year, Country	Aim/Purpose	Design	Sample	Intervention	Method and Measures	Key Findings	SRR Quality
Lehr and Kaplan (2013), USA	To describe implementation and debriefing processes and to evaluate a mental health simulation experience for student nurses	Quasiexperimental pre-post-test	N = 54 Baccalaureate nursing students	High-fidelity patient simulation using two scenarios: (a) emergency dept. presentation of patient with alcohol withdrawal after fall from a ladder and (b) post-op patient for CA prostate who was withdrawn and low in mood	Prequestionnaire/ postquestionnaire using the validated Medical Education Technologies, Inc. simulation effectiveness tool (METI—SET)	All METI—SET items yielded a positive response including confidence, knowledge, assessment skills, critical thinking, decision-making, learning from peers, and value of debriefing.	73%
Le Page and Savoia (2017), USA	To increase student nurses' knowledge and experience of integrating physical and psychological health in their delivery of patient care through simulation	Pilot study	N = 8 nursing students	Unfolding case study simulation with a standardized patient who has PTSD, alcohol use, and liver cirrhosis	Pre/post self-efficacy assessment and postsimulation knowledge assessment Nonvalidated	Statistically significant increases in self-efficacy Qualitative reports of enhanced, transformational learning through simulation	85%
Maruca and Diaz (2013), USA	To evaluate a high-fidelity simulation on alcohol withdrawal syndrome education	Post-test only	N = 120 undergraduate nursing students of which 38 completed the survey: response rate of 31.6%	High-fidelity simulation patient manikin portraying alcohol withdrawal	Open-ended questionnaire survey. Nonvalidated	Positive evaluation by students who reported that the simulation was effective in helping them practice what they had learnt in the classroom. The proximity of the simulation experience to classroom content was important in this respect. Four students did not feel confident using the alcohol withdrawal assessment tool and wanted more practice	51%

(*continued on next page*)

Table 2 (*continued*)

Author, Year, Country	Aim/Purpose	Design	Sample	Intervention	Method and Measures	Key Findings	SRR Quality
Murray (2014), USA	To describe the implementation of simulated high-fidelity clinical experiences and the experiential learning and reflective practice of students	Post-test only	N = 20 19 BSc nursing students 1 postgraduate nurse	SimMan full-body manikin, real-time communication/ feedback, four simulations: (a) alcohol withdrawal, (b) adolescent inhalant abuse, (c) hallucinogen overdose, (d) opioid overdose.	20 questions using Likert scale and 1 open-ended question. Nonvalidated	Highly rated simulation experience although some students expressed a preference for real patients Beneficial for knowledge, skills, therapeutic communication, medication administration, and critical thinking	78%
Snow and Wynn (2018), USA	To assess whether high-fidelity patient simulation equipped clinicians with the knowledge and skills to manage veterans with co-occurring PTSD and opioid use disorder (OUD)	Quasiexperimental pre-post-test	N = 12 qualified nurses RMN = 11 RN = 1	Three lessons over a six-week period on PTSD and OUD followed by high-fidelity simulated patient scenario portraying signs and symptoms of opioid withdrawal	Pre/post multiple-choice questionnaire for participants and postsatisfaction surveys for veterans who received care after simulation Nonvalidated	Statistically significant improvements in overall assessment and judgement skills After the intervention, all were able to recognise moderately severe withdrawal and self-rated their perception of clinical knowledge as improved	64%

Note. CA = cancer; PTSD = post-traumatic stress disorder; RMN = registered mental nurse; SRR = Simulation Research Rubrics.

Table 3 Simulation Research Rubrics Quality Assessments

Author	Chadwick & Withnell, 2016	Felton et al., 2013	Fernando et al., 2017	Kameg et al., 2013	Lehr & Kaplan, 2013	Le Page & Savoia, 2017	Maruca & Diaz, 2013	Murray, 2014	Snow & Wynn, 2018
Element of study									
Introduction background rationale	4	4	4	4	4	4	3	4	4
Literature review	4	2	2	4	4	4	3	3	4
Problem statement, study objective research Qu.	3	3	3	4	4	4	1	4	4
Guiding conceptual or theoretical framework	1	0	0	4	0	4	3	4	3
Study design	3	3	3	4	3	4	2	4	2
Strength of study design: quantitative	1	0	1	4	1	4	0	2	3
Strength of study design: qualitative	0	4	2	4	1	4	1	2	0
Sample and setting	3	3	3	3	4	4	2	4	2
Simulation development	4	3	4	4	2	4	2	4	3
Description of simulation implementation	4	3	3	4	4	4	1	4	3
Description of simulation feedback debriefing	3	3	4	3	4	4	1	3	1
Study instrument: quantitative	4	0	2	4	4	1	0	2	1
Study instruments: qualitative	0	4	2	4	0	1	1	2	0
Results	4	4	3	4	4	2	3	4	1
Discussion	4	4	4	3	4	3	2	4	1
IRB approval exemption: ethics	4	4	4	4	4	4	4	0	4
Total	46/56	44/56	44/64	61/64	47/64	55/64	29/56	50/64	36/56
Total percentage	82%	79%	69%	95%	73%	85%	51%	78%	64%

4 = excellent, 3 = very good, 2 = good, 1 = poor, 0 = unsatisfactory.
Highest possible score is 64 for mixed quantitative and qualitative studies and 56 if either quantitative or qualitative.

participants 12 weeks after the simulation intervention. The quality of studies, as rated by the SRR (Fey et al., 2015), ranged from 51% to 95%. Six studies achieved a quality rating of 70% or more, indicating that overall, the studies were of good quality. Full details of the SRR quality assessments are presented in Table 3. One study that had met eligibility criteria was excluded from the review because of a poor quality rating, achieving an SRR score of 11% (Oliver, Ambrose, & Wynn, 2011).

Simulation Implementation

As indicated in Table 2, a range of mental and physical health comorbidity scenarios were applied to improve the knowledge, skills, and confidence of participants. Most were conducted in a university simulation centre although detail of the specific environments was generally lacking. All studies used either HFPSs or SPs with one study using both simulation techniques. Each study incorporated essential simulation elements such as debriefing and the use of authentic scenarios but differed in their specific application and timings, although this detail was not always described. Due to the heterogeneity of the simulation interventions and missing detail, it is difficult to draw firm conclusions about the benefits of one approach over another. However, based on the available evidence, no one application of SBE appeared to produce significantly better results than others.

Impact on Knowledge and Skills

Six of the nine studies explored the impact of simulation-based learning on participants' knowledge and skills. The use of different questionnaires and survey instruments made it difficult to draw direct comparisons although all studies reported some knowledge and skill improvement after simulation. Three of the six studies undertook univariate (Fernando et al., 2017; Snow & Wynn, 2018) or multivariate statistical analyses of their data (Kameg et al., 2013). Snow and Wynn (2018) identified a statistically significant difference in participants' knowledge between premeasures and postmeasures using the t-test ($p < .001$). This finding was supported by Fernando et al. (2017) who also identified a statistically significant difference in participants' attitudes ($p < .001$). Conversely, Kameg et al. (2013) reported a mean Health Education Systems, Inc. (HESI) custom Examination score that decreased at 12 weeks after their simulation intervention although an ANOVA calculated the change as nonsignificant ($p = .297$). The research team then considered presimulation HESI scores and categorised the student group as "at risk" or "nonrisk" based on a benchmark HESI score of 850 or above for the nonrisk group. Presimulation and postsimulation HESI scores were then calculated for both groups using the chi-squared test that demonstrated a significant improvement in knowledge for the at-risk group ($p < .05$).

Five of the six studies elicited participant perceptions about the impact of the simulation-based learning (Felton et al., 2013; Fernando et al., 2017; Lehr & Kaplan, 2013; Murray, 2014; Snow & Wynn, 2018). In all five studies, students believed the simulation had helped improve their knowledge and skills in the assessment and management of patients with mental and physical health comorbidities. Each study also drew a distinction between the improvement of nontechnical and technical skills. Nontechnical skills included clinical decision-making, which participants rated as having improved in studies by Fernando et al. (2017), Lehr and Kaplan (2013), and Murray (2014) in which 80% of participants strongly agreed with the statement *"I was challenged in my thinking and clinical decision-making skills."* These ratings were supported by qualitative data such as *"the simulations were helpful in activating critical thinking and decision-making"* (Murray, 2014, p. 9).

Child branch nursing students in the study by Felton et al. (2013) particularly valued input from the mental health branch students in terms of communication skill development. They benefited from observing others and valued the opportunity to learn new skills from each other. In contrast, the mental health branch students had not gained as much learning about physical health—related skills from the child branch students. However, the potential for learning between participants was supported by Lehr and Kaplan's (2013) study in which 78% of their participants reported learning as much from observing as they did from participating in the simulation experience.

Participants in the Fernando et al. (2017) and Lehr and Kaplan (2013) studies reported technical skill improvement, especially skills not often practiced or those traditionally regarded as belonging to other professional groups. Lehr and Kaplan (2013) and Snow and Wynn (2018) specifically noted improvements in participants' assessment skills. The latter study focused on use of the clinical opioid withdrawal scale, and although participant scores differed, all were able to recognise moderate to severe withdrawal signs and symptoms.

Impact on Confidence and Future Practice

Eight of the nine studies investigated participant's post-simulation confidence to care for patients with mental and physical health comorbidities; the exception being the study by Snow and Wynn (2018). Five of the studies reported that simulation-based learning would impact positively on participants' future practice indicating benefits to their confidence (Chadwick & Withnell, 2016; Fernando et al., 2017; Kameg et al., 2013; Lehr & Kaplan, 2013; Le Page & Savoia, 2017). All five studies asked slightly different questions which participants were asked to grade in different ways, making it impossible to combine the results.

Fernando et al. (2017) used seven 5-point Likert scale questions that focused on confidence in assessing,

managing, and treating patients with comorbid health problems, giving scores that ranged from 5 to 35. A *t-test* identified significant increases in total confidence scores between presimulation and postsimulation ($p < .001$). Chadwick and Withnell (2016) used one question that explicitly focused on the student's perception of confidence linked to mental and physical health; *"I can deal effectively with unexpected physical health deterioration whilst assessing a patient with a mental health problem"* (p. 28). Overall, 90% of students reported an improvement in confidence to manage and recognise physical deterioration.

Lehr and Kaplan's (2013) study contained three questions on the validated Medical Education Technologies, Inc. simulation effectiveness tool that assessed confidence. Most participants felt that HFPSs had increased their confidence to care effectively. Le Page and Savoia (2017) quantified similar reports in an analysis of their participants' self-efficacy scores which showed a statistically significant increase at postsimulation (presimulation score 4.08 to postsimulation score of 4.73, $p = .0028$). In contrast, Kameg et al. (2013) used a customised validated survey with one question linked to confidence; *"because of the simulation, I will be less nervous in the clinical setting when providing care for similar patients"* (p. 898). The responses were based on a Likert scale, from 1 (strongly disagree) to 5 (strongly agree), which resulted in a mean score of 3.52, indicating they neither strongly disagreed nor strongly agreed with this statement.

As noted earlier, all ratings of practice confidence and reports of impact on future practice were ascertained immediately after the simulation experience except in the study by Kameg et al. (2013). They represent proxy or instrumental outcomes rather than actual or ultimate measures of performance. It is also important to note that although an infrequent finding, some participants in the studies by Felton et al. (2013) and Murray (2014) found that the simulations made them nervous, increased their anxiety, and were not a true representation of how they would perform in actual practice.

Discussion

Although there is much evidence to support SBE for physical health care among medical and nursing students, there is less evidence to support its use for mental health problems or for comorbid mental and physical health problems (Vandyk et al., 2018; Williams, Reddy, Marshall, Beovich, & McKarney, 2017). This study is therefore of importance as the first to systematically review the available literature on SBE for comorbidities. From the nine studies included in the review, there is evidence that SBE using HFPSs and/or SPs can support nurses to assess and manage patients with comorbid health problems. However, there is some variability to the findings and methodological challenges that limit their generalisability.

Knowledge, Skills, and Confidence

Improved knowledge, skills, and confidence were reported in all nine studies, specifically clinical reasoning and assessment, communication skills, and confidence from the opportunities SBE provided to practice specific skills. These findings are supported in Harder's (2010) review, which found HFPSs developed clinical skills and practice confidence, and in the review by Kunst et al. (2016) which found HFPSs to benefit clinical ability, skill acquisition, clinical reasoning, and decision making in undergraduate nurses' management of mental health problems. Collectively, these systematic reviews indicate the potential value of SBE as an effective teaching and learning strategy.

However, three of the studies in this review found that some participants experienced increased anxiety when participating in the simulations (Felton et al., 2013; Maruca & Diaz, 2013; Murray, 2014). This finding was reported in a review by Weaver (2011) who also questioned the value of recording confidence levels immediately after simulation rather than at a later stage in clinical settings. Students may only perceive increased confidence in a controlled, simulated setting where they can do no harm, or they may lack confidence because of an awareness of not having applied learned skills in a real-world context (Weaver, 2011). More research is therefore required to investigate the impact of simulation on practice confidence and patient outcomes within clinical environments.

Impact on Patient Safety and Sustainability of SBE Interventions

None of the studies measured actual changes in the clinical practice of participants and only one captured participant perceptions of changes at a time point that was not immediately after an SBE intervention. It is not possible therefore to deduce the impact of SBE on patient safety or the sustainability of any learning in the longer term. This is an important area for further research and several authors have called for longitudinal, practice-based measurements of SBE effects that take account of both participant and patient outcomes (Cant & Cooper, 2017; Kunst et al., 2016; Williams, Reddy, Marshall, Beovich, & McKarney, 2017).

Simulation Implementation

Although it has not been possible to draw firm conclusions about the relative benefits of the different SBE techniques used in this review, descriptions in Table 2 provide a useful resource for nursing and other educators to support their own development of SBE for comorbid health problems. Further research is needed to compare different types of simulation for this subject area, including those not included in this review such as Mask-Ed and role-play, and to consider the necessary and sufficient conditions

that develop the knowledge, skills, and confidence of students (Cant & Cooper, 2017; Kunst et al., 2016).

Limitations of the Review

All included studies were uncontrolled, most used quasiexperimental designs with small, self-selected samples, and most used unvalidated measurement tools. Although an overall SRR rating of ''good'' was attained, individual scores ranged from 51% to 95% with only six articles achieving greater than 70%. The results of the review should therefore be considered as tentative and interpreted with caution. Other reviews have reported similar limitations while also finding that medium- to high-fidelity SBE can increase knowledge, confidence, and clinical and communications skills among nursing staff (Cant & Cooper, 2017; Lee & Oh, 2015; Norman, 2012). This may be indicative of a positive publication bias for the simulation studies and for this systematic review method. Studies with positive results are more likely to be published than those with neutral or negative results, which has an impact on the pooled summaries contained in systematic reviews (Catalogue Of Biases, 2017). Song et al. (2010) have argued that systematic reviews should incorporate all relevant studies including those from the grey literature, non-English language texts, and unpublished studies, as well as reporting statistical sensitivity analyses that take account of anticipated biases. The fact that the literature in this review is from the United Kingdom and United States only is a further important limitation that may contribute toward bias.

Implications for Further Research

More rigorous research designs with larger sample sizes that use validated tools are important requirements of future research. So too is the need to advance simulation research beyond the measurement of changes in knowledge, confidence, and anticipated practice skills. The impact of SBE in clinical practice, particularly its effects on patient safety, related health outcomes, and the extent to which simulated learning can be sustained in the longer term are important matters. Resource use and the costs of simulation are also key to fully understanding the benefits of this teaching method. A related matter is the tendency for some participants to feel anxious in SBE contexts which can interfere with their performance. This needs further exploration including any strategies that can be used to support these students.

Conclusions

Findings from this review suggest that SBE using HFPSs and/or SPs to improve the knowledge, skills, and confidence of nurses in their assessment and management of patients with comorbid health problems is an effective teaching strategy, although the evidence base is not robust. Methodological challenges have been identified and associated recommendations made for future research. The occurrence of comorbid health problems is growing rapidly because of increased life expectancy and lifestyle and other behavioural factors. It is now estimated that almost 25% of the population in developed countries have more than one LTC, typically involving mixed mental and physical health symptoms (WHO, 2016). Yet the preparation of nurses remains delineated into physical and mental health education streams. This now appears far from appropriate and is unlikely to adequately equip nurses with the knowledge and skills necessary for the realities of contemporary practice. It is beholden on nurse educators to recognise these realities and to consider the use of SBE as one strategy to support the preparation of nursing students. In these respects, the evidence presented in this review can help guide the development of such educational practices.

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