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EFFECTIVENESS OF USING SIMULATION IN THE DEVELOPMENT OF CLINICAL REASONING IN UNDERGRADUATE NURSING STUDENTS: A SYSTEMATIC REVIEW

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Abstract

Aim/objective: This systematic review examines the effectiveness of undergraduate nursing students' using simulation to acquire clinical reasoning.

Background: Use of simulation to positively impact practice outcomes is an established method in nursing education. Clinical reasoning is a graduate capability that contributes to safe practice, so developing clinical reasoning requires explicit scaffolding in undergraduate contexts. While research has primarily evaluated specific clinical reasoning frameworks, variability in clinical reasoning definitions has obscured simulation efficacy for clinical reasoning acquisition.

Design: This review uses the Joanna Briggs Institute Systematic Reviews approach.

Methods: An electronic database search was conducted to identify studies published from May 2009 to January 2020 using a three-step search strategy. Selected papers were assessed by at least two independent reviewers for inclusion criteria, methodological validity, and data extraction. Ten studies using quasi-experimental designs involving 1532 students were included.

Results: Evidence regarding the effectiveness of simulation for undergraduate nursing students' acquisition of clinical reasoning was limited but of high quality. Review results showed no statistically significant gains in clinical reasoning with a single simulation exposure. Two emerging concepts, situation awareness and teamwork support the enhancement of clinical reasoning within simulation. In order to draw future conclusions on the efficacy of simulation to develop clinical reasoning, more research is warranted.

Conclusions: New insights about team-based simulations and situation awareness were identified as integral for development of clinical reasoning in the context of simulation. More consistent use of terminology in the context of simulation research is also recommended.

Highlights

- Simulation efficacy is obscured by imprecise definitions of clinical reasoning and inconsistent terminology in research
- Multiple simulation exposures are recommended as single exposure showed no statistically significant gains in clinical reasoning
- Focus on situation awareness and team-based simulations enhances development of clinical reasoning
- Further research is needed to draw conclusions on the efficacy of simulation for development of clinical reasoning

Keywords

Simulation; Clinical reasoning; Critical thinking; Undergraduate nursing education

1. Introduction

The pivotal role of simulation in developing clinical reasoning (CR) has been established (Lapkin et al., 2010). A decade has passed since Lapkin et al.'s systematic review (SR), and with exponential growth and diversity in simulation typologies and applications, it is timely to re-examine if contemporary simulation practices enable acquisition of clinical reasoning. This systematic review examines the efficacy of simulation for the acquisition of nursing students' clinical reasoning.

Simulation is recognized as a valuable learning approach in nursing education with efficacy and learning impact demonstrated in contexts such as decision making, role plays, recognizing deteriorating patients and end of life care (Cant and Cooper, 2017). Simulation is increasingly used across nursing education to develop and practice clinical reasoning (Forneris et al., 2015; Liaw et al., 2018). Clinical reasoning is a complex iterative process (Simmons, 2010). To appreciate the use of cognition and metacognition in nursing education requires systematic analysis of clinical reasoning, clinical judgment with critical thinking and clinical decision making. Clinical reasoning is a complex thinking process using formal and informal thinking strategies to collect and analyze patient information, interrogate this data and consider alterative actions (Simmons, 2010). Clinical reasoning is a valued capability for all registered nurses (Liaw et al., 2018). This systematic review acknowledges the significance of clinical reasoning acquisition for a learner. Extending the prior systematic review (Lapkin et al., 2010), critical thinking was included as a primary outcome, as was clinical judgement and clinical decision making.

Critical thinking is broadly related to clinical reasoning (Simmons, 2016) with Facione and Facione (2016) refining this relationship by stating that critical thinking is an integral cognitive process and disposition that facilitates progression through clinical reasoning (Forsberg et al., 2014). Best practice necessitates that students critically think during simulation (INACSL Standards Committee, 2016). There is, however, no evidence of a correlation between simulation and nursing students' development of critical thinking (Macauley et al., 2017), which threatens the assumption that simulation is effective for clinical reasoning acquisition.

Clinical judgment is a decision that requires calculation based on step-by-step analysis of a situation (Benner and Tanner, 1987). Clinical judgment is differentiated by level of nursing expertise. Clinical judgment is acquired with experience and development of expertise and is rapidly applied by an expert clinician to formulate a decision. Conversely beginner nurses lack expertise and default to protocols and clinical guidelines to direct decision making (Benner and Tanner, 1987; Tiffen et al., 2014). Delayed outcomes result as the inexperienced nurse or student struggles to incorporate conscious, iterative analytical thinking alongside ongoing data collection and analysis to reach an evidenced based clinical decision or action (Tiffen et al., 2014). Clinical decision making will be compromised if the continuous process of data gathering, and analysis is omitted or incorrectly undertaken.

Clinical reasoning is a primary skill required by nurses as it facilitates safe patient care (Menezes et al., 2015). In this systematic review, clinical reasoning is defined as a process through which nurses collect cues, process information, identify the patient problem, plan and implement interventions, evaluate care and reflect and learn from the process (Levett-Jones et al., 2010). Reflection is identified by Levett-Jones et al. (2010) as a distinct and critical component of clinical reasoning. This is a notable point of difference with Simmons (2010) definition and aligns with the pedagogy of simulation and translation to practice.

Lapkin et al.'s (2010) systematic review examined secondary outcome measures: critical thinking; clinical skill performance; knowledge acquisition; self-reported levels of confidence and student satisfaction with simulation experience. Likewise, in this review, we applied similar outcome measures. The review also assesses the quality of evidence (Joanna Briggs Institute, 2017) to determine if findings were reliable and robust.

2. Review method

This systematic review was conducted in accordance with the Joanna Briggs Institute methodology for reviews of quantitative evidence (Aromataris and Munn, 2020). The protocol for the review is registered with PROSPERO database (Prospective Register of Systematic Reviews) (CRDCRD42020169667).

2.1 Purpose

The purpose of this review is to examine the effectiveness of simulation on undergraduate nursing students' acquisition of clinical reasoning.

2.2 Inclusion criteria

2.2.1 Types of studies

All quantitative, qualitative, and mixed-method study designs assessing the effectiveness of simulation on undergraduate students' acquisition of clinical reasoning were considered. In the absence of randomized controlled trial studies, all non-randomized studies were examined, and qualitative and non-English studies were excluded.

2.2.2 Types of participants

The review considers studies in which participants were undergraduate nursing students enrolled in a Bachelor of Nursing program.

2.2.3 Types of interventions

The review focuses on the use of all fidelity simulation modalities to develop clinical reasoning in undergraduate nursing programs.

2.2.4 Types of outcome measures

The primary outcome measure was the acquisition of clinical reasoning.

Secondary outcome measures included: clinical skill performance, knowledge acquisition, self-reported confidence and student satisfaction with the simulation experience.

2.3 Search strategy

A three-step search strategy was utilized (Aromataris and Munn, 2020). The search strategy aimed to locate both published and unpublished studies and was limited to English language papers published from May 2009 – January 2020. Databases searched include: CINAHL, MEDLINE, PsycINFO, ERIC (EBSCOhost), Embase, JBI Database of Systematic Reviews and Implementation Reports, Web of Science and Mednar. Unpublished studies were searched through databases such as: ProQuest Dissertations and Theses, Mednar, Trove and Google Scholar. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles, were used to develop a full search strategy for MEDLINE and CINAHL and adapted for each included information source. For example, the search strategy for MEDLINE, combining all identified keywords and index terms using Boolean phrases, (i.e. “AND” “OR”) was MH "Clinical Decision-Making" OR clinical

N2 decision N2 making MH "Decision Making+" "clinical reasoning" MH "Clinical Competence" OR "clinical competence" "clinical judgement*" "critical N2 thinking" experiential learning" AND (MH "High Fidelity Simulation Training") OR "high fidelity simulation" (MH "Patient Simulation") OR human W3 patient W3 simulat*(MH "Manikins") OR manikin* OR mannequin* "clinical simulation*" "realistic simulation* "AND (MH "Students, Nursing") OR nursing N3 student* (MH "Education, Nursing+") OR "nursing education" (MH "Education, Nursing, Baccalaureate") (MH "Universities") OR university OR college OR "higher education" AND Limit – (Date Range 2009 – 2020). The reference list of all studies selected for critical appraisal was screened for additional studies.

Like Lapkin et al.'s (2010) systematic review, student satisfaction was not included in the initial search strategy, though student satisfaction was reported as a secondary outcome result. Self-reported levels of confidence, while not included in the search strategy, were also reported on as a secondary outcome result.

2.4 Study selection and critical appraisal

Two independent authors (KT/NT) screened the titles and abstracts of all papers for inclusion. A third and fourth author arbitrated any differences arising at any stage of the screening process (JR/SJ).

To appraise the methodological quality of non-RCT articles included in this review, a Critical Appraisal Checklist for Quasi-Experimental Studies (Joanna Briggs Institute, 2017) was utilized to independently review the articles. Each study included in the quality assessment was evaluated by two independent reviewers with any discrepancies mediated by a third and fourth reviewer.

2.5 Data extraction

The following characteristics were extracted from the included studies: author, year, country, study design/participant/setting, study aim(s), methods/interventions, outcome measures, and key findings. Data extracted were checked by two independent reviewers.

2.6 Data analysis and synthesis

Meta-analysis for pooled studies was unable to be performed due to variation in study interventions. Key findings from the review are presented as a narrative summary (Table 1).

<Insert Table 1 here>

3. Results

3.1 The search results

Searches identified 1641 publications and a further 17 were identified through other sources including reference lists and Google. Following removal of duplicates, the titles and abstracts were screened for inclusion. Of the 104 studies selected for full-text assessment, 10 met the inclusion criteria and were included in the review. Fig.1 presents an overview of the inclusion/exclusion process.

<Insert Prisma Flow Chart here>

3.2 Characteristics of included studies

The included studies reviewed were published between 2014 and 2018 and were conducted in the USA (Barnes, 2018; Coram, 2016; Shinnick and Woo, 2013; Weiler et al., 2018), Australia (Bogossian et al., 2014; Cooper et al., 2010; Kelly et al., 2014), China (Yuan et al., 2014) and South Korea (Shin et al., 2015). One study's country of origin was not stated (Levett-Jones et al., 2015).

The studies used quasi-experimental research designs including multi-site pre-test/post-test design (Bogossian et al., 2014; Shin et al., 2015), single-group, pre-test/post-test design (Shinnick and Woo, 2013; Yuan et al., 2014), post-test design (Barnes, 2018; Levett-Jones et al., 2015), quantitative descriptive design (Cooper et al., 2010; Kelly et al., 2014), quantitative experimental design (Coram, 2016), and randomized single factorial design (Weiler et al., 2018).

3.3 Participants

All studies use convenience sampling of undergraduate nursing students. The number of participants ranged from 43 (Coram, 2016) to 444 (Levett-Jones et al., 2015). Nursing students were described as at varying levels of education including prelicensure, junior-level baccalaureate, senior, and final year undergraduate students, with 1532 total participants. Three studies provided information on gender and age. The proportion of females ranged from 88.5% (Barnes, 2018) to 94.1% (Cooper et al., 2010), while the mean age ranged from 21 (Barnes, 2018) to 29.6 (Cooper et al., 2010) years.

3.4 Interventions

The use of simulation technology in the form of High Fidelity Patient Simulation (HFPS) mannequins (Bogossian et al., 2014; Cooper et al., 2010; Coram, 2016; Kelly et al., 2014; Shin et al., 2015; Shinnick and Woo, 2013; Weiler et al., 2018; Yuan et al., 2014) was the most common intervention used. Three of these studies specifically described using either a Laerdal SimMan (Shinnick and Woo, 2013), SimMan3G (Coram, 2016) or SimMan ALS (Cooper et al., 2010).

One study observed video recorded simulation scenarios involving nurse educators role modelling a case study (Barnes, 2018) while another study set up tag team simulation scenarios involving role modelling where the participants took on roles of actor and audience (theatre critic observer) (Levett-Jones et al., 2015).

4. Review of simulation and the acquisition of clinical reasoning

4.1 Primary outcome – clinical reasoning

In this systematic review, critical thinking has been included as a primary outcome due to the interplay between critical thinking and clinical reasoning (Facione and Facione, 2016). Seven studies (Barnes, 2018; Cooper et al., 2010; Coram, 2016; Kelly et al., 2014; Levett-Jones et al., 2015; Shin et al., 2015; Yuan et al., 2014) report on the application of clinical reasoning based on Tanner's clinical judgement model (Tanner, 2006) and Lasater's clinical judgment rubric (Lasater, 2007). Critical thinking as defined by Facione and Facione (2006) and based on the Health Sciences Reasoning Test (HSRT) was used as an alternative measure in place of clinical reasoning in a further study (Shinnick and Woo, 2013).

In one study (Weiler et al., 2018), a researcher developed a tool to measure critical thinking based on existing recognized critical thinking measurement tools. One study (Bogossian et al., 2014) reported on clinical decision making from the perspective of clinical performance, teamwork and situation awareness, while another (Cooper et al., 2010) measured the relationship between knowledge, situation awareness and skill performance.

Eight studies (Barnes, 2018; Cooper et al., 2010; Coram, 2016; Kelly et al., 2014; Shin et al., 2015; Shinnick and Woo, 2013; Weiler et al., 2018; Yuan et al., 2014) directly examined the effectiveness of simulation for acquisition of clinical reasoning, clinical judgement or critical thinking in undergraduate nursing students.

Two studies (Bogassian et al., 2014; Levett-Jones et al., 2015) examined clinical reasoning from the perspectives of clinical decision making and student satisfaction. Students who took on the role of tag team actors were more satisfied than observers of simulation with the effect of simulation on clinical reasoning; however, this difference was not statistically significant (Levett-Jones et al., 2015). Bogassion et al. observe that simulation can expose potential gaps in students' decision making capability rather than tacitly enhance this requisite skill.

One study (Barnes, 2018) compared the effectiveness of simulation video-recorded scenarios to a written case study and found no statistically significant difference in clinical judgement scores between the experimental and control groups. Statistical significance was, however, present in clinical judgement scores between first and second semester participants, the latter having higher scores. A study using video-based review (Cooper et al., 2010) reported that students' clinical reasoning appeared to be flawed due to anxiety, lack of education and experience.

Another study (Coram, 2016) used a role modelling intervention during simulation pre-brief and measured impact of this on clinical judgment. Students' self and peer rated scores (Lasater Clinical Judgement Rubric -LCJR) did not demonstrate statistically significant differences between the control and treatment groups. However, faculty reviewer ratings demonstrated statistically significant increases in mean scores between control and treatment group clinical judgement scores (LCJR).

One study investigated the contribution of 11 specific high fidelity patient simulation components to the enhancement of clinical judgment (Kelly et al., 2014) and found the three components that received the highest ratings for contributing to clinical judgment were facilitated debriefing, post-simulation reflection and guidance by the academic. The components rated by participants as least beneficial to clinical judgment were the patient case notes and participating in a role. Statistically significant differences in mean ratings occurred in two simulation component areas. In post-simulation reflection (p = 0.003) specifically, the 3-year program students' mean score was lower than the 2-year graduate entry students. The second statistically significant difference was viewing of the simulation recording (p = 0.008), with the 3-year program students having a lower mean score compared to the 2-year graduate entry students.

Another study (Yuan et al., 2014) reports an increase in clinical judgment over five simulation sessions. Second-year students achieved higher clinical judgement scores as experience of simulation progressed through second to fifth simulation exposures. The same pattern was not evident for third-year students and researchers inferred that second-year students had better knowledge and preparation for the simulation experience than the third-year students.

A study that recruited senior nursing students from three universities enrolled in a pediatric practicum examined the effects of an integrated pediatric nursing simulation on students' critical thinking abilities (Shin et al., 2015). The effects of the number of simulation exposures on critical thinking abilities were measured using Yoon's critical thinking disposition tool (Yoon, 2008). The study found that amount of simulation exposure did not increase critical thinking scores.

A study examining knowledge and critical thinking (Shinnick and Woo, 2013) used a validated critical thinking tool (Health sciences reasoning test – 33 items) to identify the predictors of higher critical thinking scores and found a mean improvement in knowledge scores, showing evidence of learning. However, there was no statistically significant change in the critical thinking scores, and thus one dose does not appear to increase critical thinking.

Another study (Weiler et al., 2018) used critical thinking and self-efficacy assessments (The California CT Disposition Inventory [CCTDI], Watson-Glacier Critical Thinking Appraisal [WGCTA], and the CT Process Test [CTPT]) pre- and post-simulation. Found were the students who undertook three of the five simulation participant roles and were more involved, demonstrated a statistically significant increase in critical thinking.

Simulation requires cognitive, affective, and psychomotor skills, which, when combined with clinical reasoning, replicate clinical practice. Secondary outcomes in this review are reported next.

4.2 Secondary outcomes

4.2.1 Clinical skill performance and knowledge acquisition

Four studies (Bogossian et al., 2014; Cooper et al., 2010; Shinnick and Woo, 2013; Yuan et al., 2014) evaluated the effectiveness of high fidelity patient simulation on clinical skill performance and knowledge and supports the evolution from measuring skill and knowledge separately.

A multi-site study (Bogossian et al., 2014) measured performance using an objective structured clinical examination and clinical knowledge measured by multiple choice questions and found that higher knowledge was significantly correlated with overall teamwork, overall situation awareness and clinical performance in two (cardiac and shock) of three high fidelity patient simulation scenarios. Overall, measures of clinical performance, teamwork and situation awareness indicated that students achieved half the possible total scores that were indicative of ideal performance. Students achieved a level of performance consistent with the experts' identified pass level in only nine (of 97) student team simulation experiences. Higher knowledge was significantly associated with overall teamwork, overall situation awareness and clinical performance in two (cardiac and shock) of three scenarios.

In one study (Cooper et al., 2010), skill performance was notably lower than knowledge scores and was not influenced by age or experience. Skill performance, however, improved significantly between the two high-fidelity patient simulation scenarios perhaps indicating the benefits of simulation as an educational model. However, skill performance declined and participant anxiety increased as the condition of the patient in the simulation deteriorated. Further in two studies (Bogossian et al., 2014; Cooper et al., 2010), a knowledge and skill performance assessment questionnaire was adapted from previously validated instruments (Smith and Poplett, 2002; Endacott et al., 2010). This supports the view that these variables are being increasingly researched together.

A clinical knowledge test, developed to focus on symptom management (Shinnick and Woo, 2013) found statistically significant gains in knowledge following simulation (p = 0.001), thus showing evidence of learning.

Another study (Yuan et al., 2014) reports that students’ perception of their theoretical knowledge level and understanding of the simulation scenario and salient issues in this was strengthened, with second-year students valuing and applying new knowledge more than third-year students.

4.2.2 Self-reported levels of confidence

Three studies (Shin et al., 2015; Shinnick and Woo, 2013; Weiler et al., 2018) report on the effectiveness of self-reported levels of confidence with high fidelity patient simulation.

A multi-site study (Shin et al., 2015) using a series of pediatric simulation experiences measured critical thinking abilities pre and post-test using the critical thinking disposition tool (Yoon, 2008). In the sub-category of critical thinking self confidence there was no significant difference related to amount of simulation exposure.

One study (Shinnick and Woo, 2013) used a tool developed by Ravert (2008) to define confidence as interchangeable with self-efficacy. Use of logistical regression in this study found “age” (older students), “baseline heart failure knowledge” (higher pre-test knowledge scores) and “low self-efficacy in managing a patient's fluid levels” (low confidence) to be predictive of higher critical thinking.

Another study (Weiler et al., 2018) reported self-confidence in the context of self-efficacy and clinical decision making using the Nursing Anxiety and Self-Confidence with Clinical Decision Making Scale (NASC-CDM). This instrument is a self-report, six-point Likert-type scale with 27 questions with subscales in anxiety and self-confidence. Role assignment within simulation had a statistically significant difference on self-efficacy. An improvement in participant self-efficacy was reported as most likely due to a participant pre-simulation preparation assignment that increased confidence.

4.2.3 Student satisfaction with simulation experience

Only two studies (Levett-Jones et al., 2015; Shin et al., 2015) report on self-reported student satisfaction with the simulation experience.

Shin et al. (2015) used a simulation effectiveness tool developed by Elfrink et al. (2012) to measure student satisfaction during high fidelity patient simulation and described the overall simulation experience as producing critical thinking gains in the prudence, systematicity, healthy skepticism, and intellectual eagerness subcategories. Student satisfaction was not significantly different among the three university groups.

Levett-Jones et al. (2015) applied a novel tag team approach to an acute pain simulation and aimed to evaluate students' satisfaction using the self-developed Satisfaction with Simulation Experience Scale. A 'debriefing and reflection' subscale measured satisfaction with facilitator debriefing, provision of feedback, and the opportunity for reflection. A 'clinical reasoning' subscale measured satisfaction with learning about clinical reasoning and clinical decision-making. Finally, a 'clinical learning' subscale measured satisfaction with the overall clinical learning experience and knowledge gained. No significant differences between audience observers and participants in any of the three subscales were reported.

Two additional secondary outcome measures were identified during data extraction and analysis of relevant studies. These new outcome measures were situation awareness and teamwork.

4.2.4 Situation awareness

Three studies measured situation awareness (Bogossian et al., 2014; Cooper et al., 2010; Weiler et al., 2018). Of note, all three studies used the Situation Awareness Global Assessment Technique (SAGAT tool). Bogossian et al. (2014) measured situation awareness scores of simulation scenario team leaders and these were low overall and significantly correlated with student knowledge. Cooper et al. (2010) similarly found that situation awareness scores were low but were not influenced by age or experience. Participants identified physiological indicators of deterioration but had low comprehension scores. In the third study (Weiler et al., 2018), participants completed the SAGAT after a simulation and found that role assignment did not have a statistically significant difference on situation awareness skills in team-based high fidelity patient simulation scenarios.

4.2.5 Teamwork

Three studies evaluated teamwork as a process and outcome (Bogossian et al., 2014; Levett-Jones et al., 2015; Weiler et al.,2018). Two studies used a team-based scenario (Bogossian et al., 2014; Weiler et al., 2018) and evaluated this in the simulation experience whereas teamwork was an innovation in the Levett-Jones et al. (2015) study. Specifically, this study (Levett-Jones et al. 2015) used large teams to actively engage all participants and observers by allocating set roles within a scripted simulation scenario. While all three studies reported benefits of working in teams, two (Bogossian et al., 2014; Weiler et al., 2018) advocated for teamwork practice and reminding participants to work together during preparation for future simulations. Further investigation that captures this outcome and valued dimension of nursing practice is required.

4.3 Critical appraisal and rating of the included evidence

An assessment of quality was made using the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies (2017) and studies were categorized as low, medium, or high quality (Supplementary e-component file I). No studies met all the JBI critical appraisal checklist categories (100%). One study met all but one criterion, (Coram, 2016); one study met all but two criteria (Shin et al., 2015), and no studies met three or more criteria. The main quality issue was the lack of control groups (Q4); however, this shortcoming is not surprising given that only quasi-experimental studies were included. Of the studies, 80% used appropriate statistical analysis, thus limiting statistical inference error. Most of the studies were high quality (80%) and only two studies were medium to low quality (Cooper et al., 2010; Bogossian et al., 2014).

5. Discussion

As far as we know this is the only study to review and appraise the existing evidence related to simulation effectiveness for acquisition of clinical reasoning since the original systematic review conducted by Lapkin et al. (2010). Of interest is the shift in study methodologies used by researchers in the intervening period. An additional but not surprising finding was the expansion in concepts of interest (situation awareness and teamwork) from the original study. These concepts are deemed critical for the success of clinical reasoning development within a simulated and real-world context.

Our review identified a small number of quasi-experimental studies examining the effectiveness of using simulation in the development of clinical reasoning in undergraduate nursing students. We did not find any randomized control trials that addressed our primary outcome of acquisition of clinical reasoning. The majority of studies explored high fidelity patient simulation while two studies used role modelling in simulation scenarios.

The reviewed studies identify a plethora of tested simulation instruments used to evaluate outcomes such as clinical reasoning or clinical judgement or critical thinking, clinical skills performance, knowledge acquisition, self-reported confidence, or self-efficacy and student satisfaction with simulation experience. These constructs continue to be examined 10 years on from Lapkin et al.'s original systematic review and two new outcome measures, situation awareness and teamwork, should be included in any future systematic reviews.

Differing definitions and application of primary outcomes (clinical reasoning/judgment/decision making and critical thinking) in simulation research hindered examination of the effectiveness of simulation to acquire clinical reasoning. Confounding this examination further is the role of critical thinking within clinical reasoning. This merging of concepts may contribute to the lack of clarity regarding the efficacy of simulation in the acquisition of clinical reasoning.

Findings in this review consistently demonstrated that there were not statistically significantly gains in clinical reasoning or critical thinking with a single simulation exposure. However, one study found that three exposures produced a statistically significant increase in critical thinking (Shin et al., 2015).

Secondary outcome measures regarding clinical skill performance and knowledge acquisition used interchangeably within the evidence studied suggest that knowledge and skill enhancement are not perceived as separate entities, rather as total performance that includes knowledge, skill and attributes and thus moves the concepts on from Lapkin et al's (2010) prior review. Tacit knowledge and skill are different from clinical reasoning. Students can demonstrate skill competence without having developed clinical reasoning. Sequencing learning outcomes from simulation could start with clinical competence and, once there is basic mastery, there is ‘cognitive room’ to develop the higher order thinking implicit within clinical reasoning.

When simulation participants improve their clinical skill and knowledge, confidence is gained (Cant and Cooper, 2017). This increase in self-efficacy can be enhanced by educators’ providing an emotionally safe environment, frequent feedback and scaffolded learning (Cant and Cooper, 2017); self-confidence then provides ongoing motivation for learning. Limited value from self-reported confidence and self-efficacy coupled with no definitive evidence of improvement in efficacy using simulation (Olsen et al., 2018) contests ongoing inclusion of these outcomes in similar studies.

An additional outcome, situation awareness, was measured in three studies using a validated Situation Awareness Global Assessment Technique (SAGAT) (Bogossian et al., 2014; Cooper et al., 2010; Weiler et al., 2018). Situation awareness is identified in the literature as the first step in decision making, allowing individuals to understand a situation, interpret information and predict what will occur next (Australian Commission on Safety and Quality in Health Care, 2019). The three levels of situation awareness (perception, understanding and prediction) can be measured in a simulated environment using previously validated Situation Awareness Global Assessment Technique (SAGAT) software (SA Technologies, 2007). Situation awareness is critical to patient outcomes and where reported, were found to be low (Bogossian et al., 2014; Cooper et al., 2010).

New insights about role assignment involving multiple participants (Weiler et al., 2018) were found in high fidelity patient team-based simulation scenario use and reported a statistically significant difference on critical thinking but not on situation awareness skills. Innovative approaches to teaching teamwork in simulation improved participant and observer engagement. Given the emphasis of preparation in interprofessional learning for nursing students, more attention should be given to team-based roles in simulation (Bogossian et al., 2014; Brown, Howard, Morse, 2016).

The total number of studies included in this review while small, were of high quality. Ten years on from the initial review (Lapkin et al. 2010), it is surprising that there is not a consistent approach to simulation and its integration of clinical reasoning in this pedagogy. While the use of higher order thinking is essential in delivery of safe nursing care, uptake of measuring these cognitive skills is largely lacking.

Situation awareness is considered essential in the recognition and interpretation of clinical cues, thereby enabling accurate clinical reasoning (Fischer et al., 2017). For simulation to be effective in the acquisition of clinical reasoning, situation awareness must be considered in both simulation design and delivery. The incorporation of a debrief with a skilled facilitator provides an instructional opportunity to enhance situational awareness where learners can contribute to discussion, identify how issues during the simulation were addressed and reflect on the roles and responsibilities during simulated experience (Weiler et al., 2018).

5.1 Implications for further research

Well-conducted randomized controlled trials with larger samples are warranted to further identify the effectiveness of using simulation in the development of clinical reasoning in undergraduate nursing student programs. The inclusion of situation awareness when searching for evidence on the efficacy of simulation in the acquisition of clinical reasoning is essential, as lone observation of practice during simulation may provide data on the nursing students' decisions, but not on their understanding of a patient's situation (Lavoie, et al., 2016). Teamwork is a promising contributor to developing clinical competence and clinical reasoning by fostering engagement. Inclusion of this construct in future studies and systematic review is recommended.

5.2 Limitations

Studies that included self-reported outcomes can contribute to personal bias, and a lack of RCT studies reduces data arising from clear comparison of groups. Data pooling was not possible due to the lack of homogeneity of the evidence and study design. A further limitation of the study is that the term 'clinical reasoning' covers a variety of different definitions, connotations, and applications. Different terms such as clinical judgement, critical thinking and clinical reasoning were used interchangeably without making clear distinctions between the meanings of the terminology used. It is therefore possible that other studies and literature sources exist that we did not identify in our review. Inclusion in the initial search strategy of student satisfaction and self-reported levels of confidence, contrary to Lapkin et al.'s (2010) systematic review, may have yielded additional articles for consideration in this systematic review. Also, only full text articles were reviewed so pertinent studies from other sources may have been missed which could have contributed to analysis.

6. Conclusion

Despite the methodological flaws in some of the studies, this systematic review provides updated evidence on the efficacy of simulation in the acquisition of clinical reasoning. There is insufficient evidence to draw conclusions about the effectiveness of simulation to acquire clinical reasoning based on the available studies. Despite the high quality of studies included in this systematic review, future research is needed, ideally with randomized control trials, to confirm validity of primary and secondary outcome measures. It appears that more can be done to consistently produce desired outcomes in simulation-based learning. More universal application of consistent terms when referring to clinical reasoning in simulation is also warranted.

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References

Aromataris E., Munn Z., 2020. Chapter 1: Joanna Briggs Institute Systematic Reviews, in: Aromataris, E., Munn, Z. (Eds.), Joanna Briggs Institute Manual for Evidence Synthesis. Accessed July 20, 2021. https://doi.org/10.46658/JBIMES-20-02

Australian Commission on Safety and Quality in Health Care. 2019. The national safety and quality health service standards. Accessed July 20, 2021. https://www.safetyandquality.gov.au/

Barnes, S.P., 2018. The effect of a video-based simulation vs. case study on clinical judgment of baccalaureate prelicensure nursing students. Doctoral thesis, Widener University.

Benner, P., & Tanner, C. 1987. Clinical Judgment: How Expert Nurses Use Intuition. The American Journal of Nursing, 87(1), 23–31. https://doi.org/10.2307/3470396

Bogossian, F., Cooper, S., Cant, R., Beauchamp, A., Porter, J., Kain, V., Bucknall, T., Phillips, N.M., 2014. Undergraduate nursing students' performance in recognising and responding to sudden patient deterioration in high psychological fidelity simulated environments: An Australian multi-centre study. Nurse Education Today 34, 691-696.

Brown, C.W., Howard, M., Morse, J. 2016. The use of trauma interprofessional simulated education (TIPSE) to enhance role awareness in the emergency department setting. 30 (3), 388-390.

Cant, R. P. & Cooper, S. J., 2017 Use of simulation-based learning in undergraduate nurse education: An umbrella systematic review. Nurse education today 49, 63-71. doi: 10.1016/j.nedt.2016.11.015.

Cooper, S., Kinsman, L., Buykx, P., McConnell-Henry, T., Endacott, R., Scholes, J., 2010. Managing the deteriorating patient in a simulated environment: Nursing students' knowledge, skill and situation awareness, Journal of Clinical Nursing 19, 2309-2318.

Coram, C., 2016. Expert role modeling effect on novice nursing students' clinical judgment. Clinical Simulation in Nursing 12, 385-391.

Elfrink, V.L., Leighton, K., Ryan-Wenger, N., Doyle, T.J., Ravert, P., 2012. History and development of the simulation effectiveness tool (SET). Clinical Simulation in Nursing 8 (6), 199-210.

Endacott, R. et al., 2010. Final-year nursing students' ability to assess, detect and act on clinical cues of deterioration in a simulated environment. Journal of advanced nursing. 66 (12), 2722–2731.

Facione, N., Facione P., 2006. Health Sciences Reasoning Test (HSRT): A test for critical thinking skills for health care professionals. Test manual, The California Academic.

Fischer, M. A., Kennedy, K. M., Durning, S., Schijven, M. P., Ker, J., O'Connor, P., Doherty, E., Kropmans, T. J., 2017. Situational awareness within objective structured clinical examination stations in undergraduate medical training-a literature search. BMC Medical Education 17(1), 1-10.

Forneris, S. G. et al. 2015 Enhancing clinical reasoning through simulation debriefing: A multisite study. Nursing Education Perspectives. 36 (5), 304–310.

Forsberg, E. et al. 2014 Clinical reasoning in nursing, a think-aloud study using virtual patients – A base for an innovative assessment. Nurse Education Today. 34 (4), 538–542.

INACSL. 2016. INACSL standards of best practice: SimulationSM debriefing. Clinical Simulation in Nursing 12, S21–S25. https://doi.org/10.1016/j.ecns.2016.09.008

Joanna Briggs Intitute, 2017. JBI critical appraisal checklist for quasi-experimental studies (non-randomized experimental studies). Joanna Briggs Institute, Adelaide, 1-6. Accessed July 23, 2021. https://jbi.global/sites/default/files/2019-05/JBI_Quasi-Experimental_Appraisal_Tool2017_0.pdf

Kelly, M.A., Hager, P., Gallagher, R., 2014. What matters most? Students' rankings of simulation components that contribute to clinical judgment. Journal of Nursing Education 53, 97-101.

Lapkin, S., Fernandez, R., Levett-Jones, T., Bellchambers, H., 2010. The effectiveness of using human patient simulation manikins in the teaching of clinical reasoning skills to undergraduate nursing students: A systematic review. JBI Library of Systematic Reviews 8 (16), 661-694.

Lasater, K., 2017. Clinical judgment development: Using simulation to create an assessment rubric. Journal of Nurse Education 46, 496 – 503.

Lavoie, P., Cossette, S., Pepin, J., 2016. Testing nursing students' clinical judgment in a patient deterioration simulation scenario: Development of a situation awareness instrument. Nurse Education Today 38 61-67.

Levett-Jones, T., Hoffman, K., Dempsey, J., Jeong, S., Noble, D., Norton, C., Roche, J.,Hickey, N., 2010. The 'five rights' of clinical reasoning: An educational model to enhance nursing students' ability to identify and manage clinically 'at risk' patients. Nurse Education Today 30, 515-520. https://doi.org/10.1016/j.nedt.2009.10.020

Levett-Jones, T., Andersen, P., Reid-Searl, K., Guinea, S., McAllister, M., Lapkin, S., Palmer, L., Niddrie, M., 2015. Tag team simulation: An innovative approach for promoting active engagement of participants and observers during group simulations. Nurse Education in Practice 15, 345-352.

Liaw, S. Y., Rashasegaran, A., Wong, L.F., Deneen, C.C., Cooper, S., Levett-Jones, T., Goh, H.S., Ignacio, J., 2018. Development and psychometric testing of a Clinical Reasoning Evaluation Simulation Tool (CREST) for assessing nursing students' abilities to recognize and respond to clinical deterioration. Nurse education today 62, 74–79.

Macauley, K., Brudvig, T.J., Kadakia, M., Bonneville, M.,2017. Systematic review of assessments that evaluate clinical decision making, clinical reasoning, and critical thinking changes after simulation participation. Journal of physical therapy education. 31 (4), 64–75.

Menezes, S., Correa, C., Silva, R., Lopes da Cruz, D.,2015. Clinical reasoning in undergraduate nursing education: a scoping review. Revista da Escola de Enfermagem da U S P. 49 (6), 1037–1044.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., The PRISMA Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. PLoS Med 6(7): e1000097.https://doi.org/10.1371/journal.pmed.1000097

Olson, J. K., Paul, P., Lasiuk, G., Davidson, S., Wilson-Keates, B., Ellis, R., Marks, N., Nesari, M., Svard, W.,2018. The state of knowledge regarding the use of simulation in pre-licensure nursing education: A mixed methods systematic review. International Journal of Nursing Education Scholarship. 15 (1), https://doi: 10.1515/ijnes-2017-0050 .

Ravert, P., 2008. Patient simulator sessions and critical thinking. The Journal of Nursing Education 47 (12), 557-562.

Shin, H., Ma, H., Park, J., Ji, E.S., Kim, D.H., 2015. The effect of simulation courseware on critical thinking in undergraduate nursing students: Multi-site pre-post study. Nurse Education Today 35, 537-542.

Shinnick, M.A., Woo, M.A., 2013. The effect of human patient simulation on critical thinking and its predictors in prelicensure nursing students. Nurse Education Today 33, 1062-1067.

Simmons, B., 2010. Clinical reasoning: concept analysis. Journal of Advanced Nursing, 66, 1151-1158.

Smith, G. B. & Poplett, N.,2002. Knowledge of aspects of acute care in trainee doctors. Postgraduate Medical Journal. 78 (920), 335–338.

Tanner, C.A., 2006. Thinking like a nurse: A research-based model of clinical judgment in nursing. Journal of Nursing Education 45, 204-211.

Tiffen, J., Corbridge, S. J., & Slimmer, L., 2014. Enhancing clinical decision making: Development of a contiguous definition and conceptual framework. Journal of Professional Nursing, 30 (5), 399–405. https://doi.org/10.1016/j.profnurs.2014.01.006

Weiler, D.T., Gibson, A.L., Saleem, J.J., 2018. The effect of role assignment in high fidelity patient simulation on nursing students: An experimental research study. Nurse Education Today 63, 29-34.

Yoon, J., 2008. The degree of critical thinking disposition of nursing students and the factors influencing critical thinking disposition. Journal of Korean Academy of Nursing Administration 14 (2), 159-166.

Yuan, H.B., Williams, B.A., Man, C.Y., 2014. Nursing students' clinical judgment in high-fidelity simulation based learning: A quasi-experimental study. Journal of Nursing Education and Practice 4 (5), 7-15.

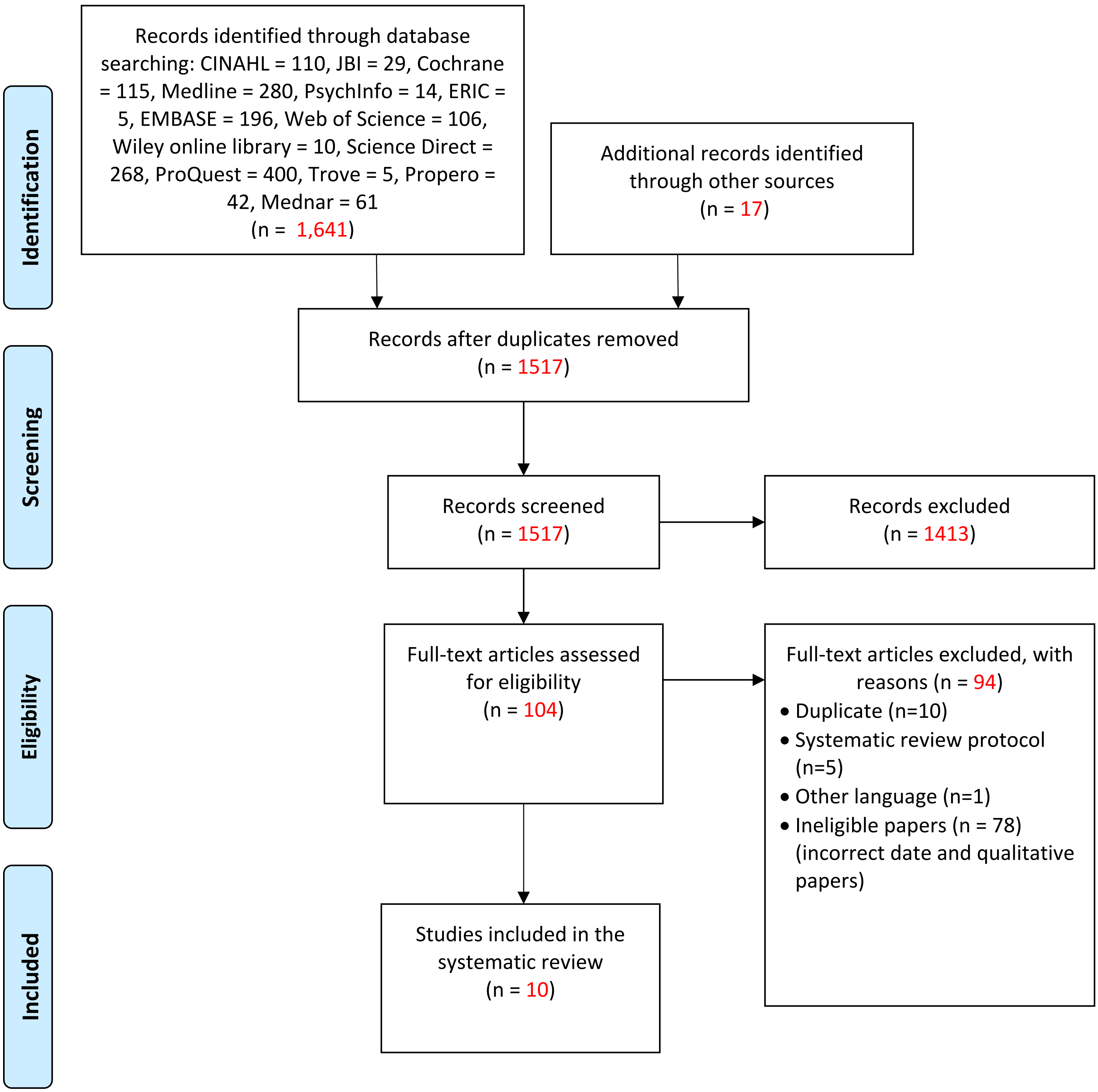

Fig 1: Flow Chart Literature Search (Moher et al., 2009)

Supplementary e-component file I:

Summary of methodological quality (Modified from JBI Critical Appraisal Checklist for Quasi-Experimental Studies)

Study	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Researchers Score** (KT/NT) Y = 3 N = 2 U = 1 N/A = 0
Barnes (2018)	Y	U	U	N	N	Y	Y	N	Y	20 74% (High)
Bogossian et al. (2014)	N	NA	NA	N	NA	NA	NA	U	Y	8 30% (Low)
Cooper et al. (2010)	U	N	N	N	NA	NA	NA	U	Y	11 41% (Medium)
Coram (2016)	Y	Y	Y	Y	N	Y	Y	Y	Y	26 96% (High)
Kelly (2014)	Y	U	U	N	N	N	Y	U	Y	18 67% (High)
Levett-Jones et al. (2015)	Y	U	Y	N	N	U	Y	Y	Y	21 78% (High)
Shin et al (2015)	Y	U	Y	N	Y	Y	Y	Y	Y	24 89% (High)
Shinnick & Woo (2013)	Y	Y	Y	N	U	N	U	U	Y	19 70% (High)
Weiler et al. (2018)	Y	Y	N	N	Y	N	U	U	U	18 67% (High)
Yuan et al. (2014)	N	Y	U	N	N	U	Y	Y	U	18 67% (High)

Reference: Joanna Briggs Institute, 2017. JBI Critical Appraisal Checklist for Quasi-Experimental Studies (non-randomized experimental studies). Joanna Briggs Institute, 1-6. Accessed July 23, 2021 https://jbi.global/sites/default/files/2019-05/JBI_Quasi-Experimental_Appraisal_Tool2017_0.pdf

Researchers' methodological quality classification score: Low = 0–33%, Medium = 34–66%, and High 67–100%