


REVIEW

Integrated simulation-based skills assessment for evaluating pharmacist competence: A scoping review

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Abstract

Background: Integrated assessment of health professional competence more closely represents performance of tasks in clinical practice, than assessment models that evaluate fragmented competencies. Simulation continues to expand the range of assessment methods available for training healthcare professionals, however, there is limited understanding of the potential use of integrated simulation-based assessments in pharmacy education.

Objective: To review the range of integrated simulation-based assessments used across the healthcare professions, and explore their applicability to pharmacy education.

Methods: Medline, International Pharmaceutical Abstracts (IPA), EMBASE, CINAHL, ERIC and Scopus were searched for articles in English published between January 1975 and May 2019, to identify studies that reported on the use of integrated simulation-based assessments in medicine, nursing, allied health and pharmacy.

Results: Searches identified 2, 440 records for screening; 59 full-text articles were screened for eligibility, with a total of 20 studies meeting the inclusion criteria for the review. The findings show evidence for a variety of simulation approaches to enable the evaluation of integrated competencies, however the validity and reliability of such approaches is less well documented. Most studies have been conducted in medicine, nursing and allied health with only two studies conducted in pharmacy. All studies used multidimensional assessment instruments but only fourteen were tested for reliability and validity.

Conclusion: Despite the limited number of published studies specifically pertaining to integrated simulation-based assessment in pharmacy, the current approach in other healthcare disciplines provides support for future application in pharmacy.

Keywords: *Integrated Skills Assessment, Simulation, Health Professionals, Pharmacy*

Introduction

Education providers are preparing pharmacy graduates for comprehensive clinical practice. Upon registration, pharmacists must be deemed competent to manage their patients to achieve optimal health outcomes in an individual context, team environment and as a

collaborator in a wider system (Aggarwal *et al.*, 2010). This requires a broad and increasingly complex range of knowledge and skills that must be integrated in a way that demonstrates planning, implementation and evaluation of patient management. Therefore, integrated assessment approaches should be considered when

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evaluating competence to deliver safe and effective outcomes in daily activities in pharmacy practice. In recent decades, the need for integrated assessment approaches which closely resemble the reality of the healthcare setting has been recognised (Bujack *et al.*, 1991). Simulation offers authentic and practice-orientated clinical scenarios during assessment tasks, and has been increasingly used in training and assessment as part of the education of competent and safe healthcare professionals (Scalise, Obeso & Issenberg, 2007; Ryall, Judd & Gordon, 2016). Given the potential impact of integrated assessment approaches for pharmacy students, educators and the wider healthcare community, review of contemporary literature in this topic is warranted. Therefore, this paper presents a scoping review of the literature pertaining to the current use of simulation-based, integrated assessment approaches in health professional education.

Background

Medicine dispensing, the process of preparing and providing medicine to a patient, is recognised as one of the vital elements in quality use of medicines, and represents a core activity of daily pharmacy practice (World Health Organisation [WHO], 2012). Medicine dispensing by pharmacists is commonly assumed to be a simple, routine process. However the dispensing process is underpinned by multiple, parallel steps that include interpreting and evaluating a prescription, retrieval and review of medication history, selection, preparation, packaging, labelling, record-keeping, and transfer of the prescribed medicine to the patient, including counselling as appropriate (WHO, 2012; Pharmaceutical society of Australia, 2017). The dispensing process may also incorporate other associated tasks such as communication with the prescriber, and provision of more complex advice to the patient (Pharmaceutical Society of Australia, 2017). In the practice environment, these tasks are most frequently performed concurrently, whereby a pharmacist performs two or more of these actions simultaneously (Douglas *et al.*, 2017). There are several examples of competency standards and frameworks that specify the individual knowledge, skills, and attitudes that entry level pharmacists require. For example, the Center for the Advancement of Pharmacy Education (CAPE) learning objectives provide a structured framework for measuring the outcomes of a degree programme in pharmacy, including those that are necessary for the safe and appropriate supply of medicines (Medina *et al.*, 2013). Although these frameworks emphasise the essential interpersonal and technical skills which ultimately become the focus of assessments, they are less useful for focusing on the integration of these skills as they translate to a single clinical process in patient management.

Currently, medicine dispensing skills are assessed using a variety of approaches that focus on specific domains of competence. For example, multiple choice questions

(MCQs) examine drug knowledge; viva voce/oral examinations assess clinical reasoning; objective structured clinical examinations (OSCEs) usually consist of stations that focus on specific components such as prescription review, history taking or patient counselling; and workplace-based assessments (WPBAs) often require a preceptor to observe and sign-off on specific tasks, often in isolation. Further, assessments are often administered to align with the specific requirements for a course or unit of study, and authors have stated that assessing across multiple domains of competence, it is extremely difficult for any individual course to achieve (Vyas, Bhutada & Feng, 2012). There are examples of capstone courses that attempt to provide a comprehensive and integrated review of the pharmacy curriculum and reflect this in student assessments as a preparation for clinical practice experiences, however, multiple separate assessment methods are often used to capture the range of graduate competencies *e.g.* OSCE at the end of the capstone course, written examinations and calculations assessments (Hirsch & Parihar, 2014). There is evidence that these assessment methods reliably assess basic skills, and core knowledge across a number of distinct competencies, but many of these approaches are limited because they do not assess all skills as they would occur during patient management.

Since its development, the OSCE has gained acceptance as the benchmark for the evaluation of clinical skills of undergraduate students of health professional programmes worldwide (Mitchell *et al.*, 2009; Smith, Muldoon & Biesty, 2012; Khan *et al.*, 2013). The OSCE can facilitate assessment across a wide range of clinical contexts, in a well-planned or structured way (Shirwaikar, 2015; Australian Pharmacy Council, 2017). The assessment process can be component-specific, or take on a more integrated approach. Traditionally the OSCE is viewed as an approach to the assessment of clinical competence in which the components of competence are assessed, with an emphasis on specific, well-defined skills (Mitchell *et al.*, 2009). The original OSCE model revolves around the basic principle of 'one competency-one-task-one station' and comprises a series of stations that are focused on the examination of a sub-component of patient assessment. This method of examination enables the rater/assessor to tease out deficiencies which provide feedback for the students' progress, particularly during the early stages of learning. One of the drawbacks of this approach is that it tends to compartmentalise candidates' skills and knowledge and fails to assess some important multidimensional domains of pharmacy practice including integration of core knowledge into practice, clinical reasoning, multi-tasking and time-management. Over time, this approach has been adapted to feature fewer, longer stations or case scenarios that would enable a more complete and holistic assessment. Indeed there are examples of a total patient format that comprises a single integrated assessment station, an approach that has been referred to by some authors as an objective structured clinical assessment (OSCA) (Bujack *et al.*, 1991; East *et al.*, 2014).

OSCE approaches often incorporate simulation methodology into one or more stations, where each station is built around a specific task or component of the more extensive process. This generates information about several dimensions of competency, which may be integrated by combining stations where one builds on another. This blended simulation methodology has been used successfully in pharmacy education, most recently in a study evaluating patient care outcomes in first- and third-year undergraduate pharmacy students and postgraduate pharmacy residents (pharmacy interns) as an overall assessment of practice readiness (Benedict *et al.*, 2017). It is unclear, however, how well such blended assessment approaches represent a students' competency to perform the task as an integrated whole. An integrated skills assessment, which evaluates a candidate's ability to view the patient and dispensing process holistically, is more suitable during the advanced stages of training (Barman, 2005; Rushforth, 2007; van der Vleuten *et al.*, 2010; Smith *et al.*, 2012; Australian Pharmacy Council, 2017).

A recent development in the assessment of professional competence is the introduction of entrustable professional activities (EPAs), statements of specific task-related activities that require integration of multiple competencies (Pittenger *et al.*, 2016; Australian Pharmacy Council, 2017). For example, an EPA statement used in the pharmacy setting is 'gather a history and assess a patient's current medication regimen to ensure medications are indicated, effective, safe, and convenient' (Pittenger *et al.*, 2016: p.4). Such statements allow for consideration of the multiple elements that contribute to this task. There is increasing momentum for using EPAs to frame competency based assessment in pharmacy practice, such as the attainment of CAPE educational outcomes (Medina *et al.*, 2013; Pittenger *et al.*, 2016).

Workplace-based assessments (WPBAs) during clinical placements offer the opportunity for integrated assessment of pharmacy students, however WPBAs are usually longitudinal, and do not always require students to demonstrate competency while completing tasks in their entirety; and these assessments lack standardisation (Australian Pharmacy Council, 2017). Furthermore, there are challenges with obtaining and sustaining clinical placements which means that educators cannot rely on this approach for making competency-based decisions.

An emerging trend in simulation-based assessment has prompted a growing number of studies focussed on development of competency assessments and evaluation tools. Indeed there has been an increasing integration of simulation based activities in pharmacy education (Seybert, Kobulinsky & McKaveney, 2008; Bray *et al.*, 2011; Seybert, 2011; Smithburger *et al.*, 2012). The increased use of simulation for teaching and assessment in healthcare education has been driven by a range of factors, including increased student numbers and changes in the structure of both academic programmes and healthcare delivery. This has been compounded by an increase in demand for patients who are available for educational opportunities, and the need to standardise the

clinical situation faced by students for assessment purposes (Scalese *et al.*, 2007; Boulet, 2008; Ryall *et al.*, 2016). Simulation applications range from high fidelity, technical simulations with manikins to simple role-plays with simulated patients. In pharmacy, often lower fidelity simulation is adequate to achieve educational outcomes (Bray *et al.*, 2011; Seybert, 2011).

Understanding of the utility of simulation based assessments to offer an integrated skills assessment is increasing (Boulet, 2008). The most recent systematic review of simulation-based assessments in healthcare concluded that further comparative studies are required to evaluate the effectiveness of simulation for the assessment of competency as a stand-alone assessment tool, and in combination with other forms of assessment or more than one simulation scenario (Ryall *et al.*, 2016). This review focused on technical skills only which is indicative of a gap in the literature in relation to the use of simulation in the assessment of non-technical skills, including interpersonal communication, teamwork and clinical decision making (Ryall *et al.*, 2016).

The present review focuses on assessment of tasks of professional practice that require the integration of multiple competencies to safely and effectively manage all aspects of the patient encounter. A scoping review was deemed more appropriate than a systematic review for this purpose due to the relative lack of previous work exploring the underpinning research area to define the conceptual boundaries of the topic. The scoping review methodology enables a rigorous and transparent approach to data collection and analysis while including a range of study designs to construct a synthesis of the relevant literature which is both broad and deep. The aim of this scoping review is to identify previous studies reporting on integrated simulation-based assessments and explore their applicability to pharmacy education and training.

Methods

Search strategy

A scoping review was conducted using a systematic process and following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Figure 1). The Cochrane database of systematic reviews and other databases were initially searched to ensure that a review on this subject did not already exist or was in progress. Initial searches were conducted in Medline and Scopus. The returned articles were analysed to identify keywords and index terms to inform subsequent searches. The keywords identified were ("health care" OR "health professional(s)" OR "health professional student(s)" OR "allied health" OR "medicine" OR "medical education" OR "doctor(s)" OR "nursing" OR "nurse(s)" OR "pharmacy" OR "pharmacist(s)") AND ("assessment"; "competency assessment" OR "competency") AND ("simulation" OR "role-plays" OR "practical" or "oral" OR "technical skills" OR "non-technical skills" OR "soft skills" OR

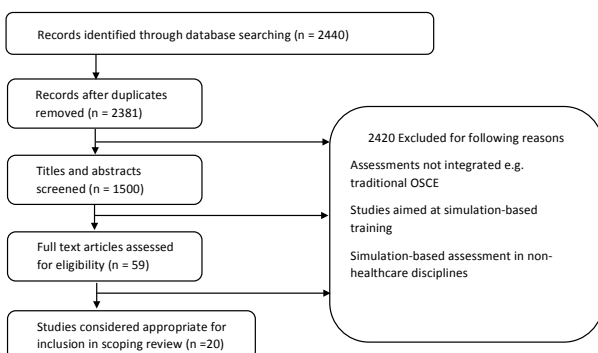
“humanistic skills” OR “communication” OR “patient centredness” OR “professionalism” OR “problem-solving” OR “clinical reasoning”).

A search was performed using all identified keywords and index terms across Medline, International Pharmaceutical Abstracts (IPA), EMBASE and CINAHL, ERIC and Scopus. The literature search was limited to articles published in English between January 1975 and May 2019 reporting on the use of simulation for competency assessment in healthcare education. This time period coincides with the use of simulation in OSCE format, and the increasing emphasis on outcomes-based education, and more recently an increase in the widespread use of simulation for teaching and testing doctors and many other healthcare professionals. It is noted that since the year 2000 there is a documented improvement in the quality of research published related to simulation, since observation from historical summaries is that much research before this lacks methodological rigour (McGaghie *et al.*, 2010). To complete the literature search, targeted searching was also included using the American Journal of Pharmaceutical Education; Journal of Simulation; Medical Education; and Currents in Pharmacy Teaching and Learning. Reference lists of all included studies were analysed to identify any additional studies that may be relevant.

Inclusion and exclusion criteria

Studies were included if they were English, original research articles, focusing predominantly on systematic reviews, primary research studies and meta-analyses, that had at least one primary outcome measure that (a) related to the use of a simulation modality for health professional or healthcare student competency assessment; and (b) reported on integrated assessment in an entire practice-based task/patient encounter using a combination of technical and/or non-technical skills using an integrated assessment approach. Any studies that focussed on assessing individual components of competence were excluded.

Figure 1: PRISMA flow diagram for the scoping review search (Moher et al, 2009)



No limitations were placed on healthcare setting, with both acute and primary healthcare included. Research focusing on the evaluation of simulation as a training rather than assessment modality were also excluded. No limitations were placed on the type of simulation modalities used and human patient simulation, virtual reality, and manikin/part task trainer tools were all included. The search strategy initially generated 2,440 records. After removing duplicates and refining the records against the inclusion and exclusion criteria, 59 studies were identified and obtained in full text for further assessment of eligibility. Twenty studies were ultimately included in the review (Figure 1).

Categorisation of studies

Included studies are summarised in according to author(s), year of publication, country, study participants, study objectives and methods. The type of simulation and outcomes are further described in Appendix A.

Characteristics of included studies

Fourteen of the studies were undertaken in the United States of America (USA), three in Australia, two in Canada and one in the United Kingdom (UK) (see Appendix A). Eleven of the studies were quantitative, one was qualitative and eight studies used mixed methods. Of the 20 articles included in the review, six of the assessments used only high-fidelity human patient simulation (HPS)/manikins; six used simulated patients (SPs) (see Appendix A). The dominant approach to simulation was a blended model containing more than one different simulation modality (*e.g.* SP plus high fidelity HPS/mannikin or part-task trainer) within the same assessment task ($n=8$). All but three of the of the simulation-based assessments were conducted in tertiary education institutions.

Participant characteristics

The studies included in the review involved integrated simulation-based assessments in the training of a variety of health professions, and most commonly included medical students, residents and physicians ($n=8$). Other professionals included surgical trainees ($n=1$), anaesthesia residents and anaesthesiologists ($n=1$); registered nurses and nursing students ($n=5$); paramedics ($n=2$); pharmacy students ($n=2$) and physiotherapy ($n=1$).

Outcome measures

Four main themes were derived from the reported outcomes in the included papers; 1) Integration of competencies to perform a complete patient/clinical task ($n=20$); 2) simulation for assessment of competence ($n=20$); 3) Type/combination of multidimensional assessment tool used for rating; and 4) assessment of validity and/or reliability of the instrument used ($n=14$).

Integration of competencies

All included studies presented an approach to assessment whereby assessment candidates were required to demonstrate multiple domains of competence to complete a given task/patient encounter in its entirety in a simulated context. Of these, all studies described the integration of both technical and non-technical ‘humanistic’ competency domains.

Ten studies emphasised the selection of simulation methodology for achieving integration of skills for competence assessment. The most prevalent approach was a combination of two different simulation modalities, including high-fidelity HPS/manikins and a variety of part task trainers (DeMaria *et al.*, 2013); SP and a variety of bench top anatomic and tissue part task models (Kneebone *et al.*, 2006; LeBlanc *et al.*, 2009; Isenberg *et al.*, 2011); and high-fidelity HPS manikins and simulated patients (Kneebone *et al.*, 2006; LeBlanc *et al.*, 2009; Isenberg *et al.*, 2011; Rizzolo, 2012). Other studies reported on designing simulation encounters that enabled a more integrated approach to patient care, including prolonged and more complicated patient encounters with simulated patients (Boulet *et al.*, 2003; Lammers, *et al.*, 2009; Lipner *et al.*, 2010; Vyas *et al.*, 2010; DeMaria *et al.*, 2013; Judd *et al.*, 2016;), and/or using multiple clinical scenarios (Purkerson *et al.*, 1996; McBride *et al.*, 2011).

Five studies were focused on the development of an assessment tool that was inclusive of multiple domains of competence (Gimpel, Boulet & Errichetti, 2003; Mikasa, Cicero & Adamson, 2013; Kesten, Brown & Meeker, 2015; Judd *et al.*, 2016; Mudumbai *et al.*, 2012). Two studies described pragmatic approaches to integrated assessment and proposed a new assessment model designed specifically to enable integrated clinical assessment and overcome deficiencies identified in OSCE-like approaches (Bujack *et al.*, 1991; East *et al.*, 2014). Bujack *et al.* (1991) implemented an intervention with nursing students participating in a new integrated assessment strategy, an OSCA, for the purpose of measuring the extent to which a student nurse can plan and deliver safe and effective comprehensive patient care. The OSCA experience was rated positively by students, who also perceived this to be an accurate reflection of their capacity to deliver nursing care. The statistical correlation between student OSCA results and other areas of assessment support the reliability and validity of this integrated assessment approach.

Two studies included pharmacy students. In an exploratory study, Purkerson *et al.* (1996) sought to develop one assessment exercise that would facilitate the measurement of four ability-based educational outcomes: group interaction, written communication, problem solving, and interpersonal communication. Statistically, the assessment instruments performed well with reliability coefficients all within the optimal range. Student participants’ reflective survey responses also indicated attitudinal perception toward the outcomes’ abilities assessment exercises. Subjects agreed that they had an increased awareness and understanding of how the

abilities assessed relate to each other in the overall performance of a healthcare professional; and the important interrelationship of the abilities in their overall development as a healthcare professional (Purkerson *et al.*, 1996). Vyas *et al.* (2012) evaluated pharmacy students in a series of practical simulation-based sessions and compared the assessment of these students with a group of students who undertook a traditional practicum in the community whereby students participate in a workplace experience. The practical experiences of students in both groups assessed ten core competency domains where students would interview a standardised patient, order pertinent laboratory work, conduct a physical examination, and ultimately develop a care plan based on the results of the interview. On the simulation-based approach 67% of students passed compared to 52% of students in the control group. Based on scores on the Perception of Preparedness to Perform (PREP) survey, students felt more prepared regarding ‘technical’ aspects after completing the simulation experience ($p < 0.001$). Also, 96% of respondents on a student confidence survey agreed they were more aware of their medication errors after completing the simulation experience (Vyas *et al.*, 2012).

Simulation methodologies

There was evidence for the use of high- and mixed-fidelity simulation, standardised patients and part task trainers for technical skill assessments. These studies reinforced that simulation is a valid and reliable way of assessing competency in technical skills. These include, but are not limited to, acute care management involving resuscitation and airway management; minor surgical skills; medical image interpretation; patient physical examination; and orthopedic manipulation (Boulet *et al.*, 2003; Isenberg *et al.*, 2011; Mudumbai *et al.*, 2012).

There is evidence that standardised patients can assess integration of non-technical skills such as oral communication, problem solving, decision making, professionalism, time management, ethics and values, and clinical knowledge. Twelve included studies successfully evaluated interpersonal communications between healthcare professionals and the patient and/or other healthcare providers using standardised patients (Bujack *et al.*, 1991; Gimpel *et al.*, 2003; Kneebone *et al.*, 2006; Panzarella & Manyon, 2007; LeBlanc *et al.*, 2009; Lipner *et al.*, 2010; Isenberg *et al.*, 2011; Rizzolo, 2012; DeMaria *et al.*, 2013; Mikasa *et al.*, 2013; East *et al.*, 2014; Judd *et al.*, 2016). Standardised patients have been used successfully to assess competency in clinical reasoning for nursing students while managing complex clinical cases (Rizzolo, 2012). Similarly, high-fidelity human patient simulation (HPS) manikins have also been used to assess non-technical skills of advanced practice nurses and medical students (Isenberg *et al.*, 2011; Kesten *et al.*, 2015). Measurement instruments used in these two evaluations focused on healthcare behaviours such as leadership, professionalism, prioritisation, identification of patient safety issues, and use of evidence-based guidelines (Kesten *et al.*, 2015).

Eight studies reported using more than one blended simulation methodology. The most common model of this approach is the integrated procedural performance instrument (IPPI) consisting of clinical scenarios in which bench top inanimate medical models are combined with SPs for the purpose of evaluating two domains of practice – communication and technical skills – in an integrated manner, rather than in isolation (Kneebone *et al.*, 2006; LeBlanc *et al.*, 2009).

Type/combination of multidimensional assessment tool used for rating

Amongst the high fidelity manikin, standardised patient and part task trainer literature, analytic (checklist) and holistic (global) scoring metrics are the two prevailing approaches used to provide a set criteria against which technical and non-technical skills are assessed by raters in an integrated fashion (Gimpel *et al.*, 2003; Isenberg *et al.*, 2011; Mudumbai *et al.*, 2012).

Of the 20 studies included in the review, there were a variety of rating scales used. Some studies assessed competence using a checklist alone (n=3) or global rating scale (GRS) alone (n=3). The most common approach was to use a combination of checklist criteria and an overall global rating scale (n=11). In one study, the IPPI approach combined three previously validated instruments: a task-specific checklist and a five-item (each item anchored by five-point behavioural descriptors) global rating scale for the evaluation of technical skills; combined with a communication scale. In another study conducted with pharmacy students, Vyas *et al.* (2012) assessed student performance in a standardised patient encounter across ten core competency domains in the advanced pharmacy practice curriculum using the combination of a checklist and a global rating 'pass or fail' completed by a faculty observer upon student completion of the assessment. In another study researchers explored the use of a new tool developed specifically for integrated assessment. The Integrated Standardised Patient Examination (ISPE) is a performance assessment tool that can measure clinical competence as defined through integration, and was developed by an interdisciplinary team of medicine, health-related and education faculty (Panzarella & Manyon, 2007). The ISPE is scored in three sections: i) history taking measured against a binary checklist (met expectations/below expectations); ii) specific measurable attributes of integration evaluated; and iii) quality of student interaction with SP, with both ii) and iii) measured using a four-point rubric.

For high fidelity patient simulators, there is the added ability to obtain simulator metrics for rating, either alone or in combination with other assessment methods. Some high-fidelity patient simulation studies used inbuilt simulation metrics (n=3) (Lammers *et al.*, 2009; Lipner *et al.*, 2010; DeMaria *et al.*, 2013) and combination of inbuilt simulation metrics and checklist (n=3) (Boulet *et al.*, 2003; McBride *et al.*, 2011; Mudumbai *et al.*, 2012).

Validity and reliability of instrument for assessing competence

Of the 20 studies included in this scoping review, 14 reported validity and/or reliability measures for their assessment. Validity evidence was presented in several ways, and all studies that reported on validity and reliability suggested that further work is necessary. Some studies reported validity measures by obtaining evidence on the assessment experience such as the realism (fidelity) of the simulated clinical interaction and the 'correctness' of diagnostic cues provided (Bujack *et al.*, 1991; East *et al.*, 2014; Judd *et al.*, 2016).

Alternatively, validity was reported in relation to the assessment tool and how the results were interpreted to make a decision on the students' performance (Purkerson *et al.*, 1996). In their OSCA assessment with undergraduate nursing students, East *et al.* (2014) examined how individual assessors rated students. Their study found that there was significant variation in pass rates between assessors (range 39% to 66%, $p=0.004$), and qualitative findings reported that rather than using the objective assessment criteria, assessors were predominantly relying on subjective views of competence based on personal clinical knowledge and experiences. Preliminary psychometric data on the IPPI-based assessments of performance are presented in two studies. A study by LeBlanc *et al.* (2009) demonstrated that performance scores on the two assessments of technical skills (the checklist and the GRS) correlated strongly with each other overall ($r=0.760$, $p=0.000$). However, performance on the communication scale was not correlated significantly with other scores on the assessment of technical skills ($r=0.06$, $p=0.47$). This suggests that technical and communication skills vary independently of each other. The four-scenario IPPI assessment also showed good internal consistency for the assessment of global aspects of technical skills and the communication skills, but it had less than desirable internal consistency on the checklist scores (LeBlanc *et al.*, 2009).

The reliability of the newly developed ISPE was established in a pilot study that required raters (n=20) to view and score two videotaped ISPE cases. The integration component and overall encounter sections of the ISPE were found to be somewhat less reliable than dichotomous checklist ratings, based on inter-rater correlations. Content validity evidence for the ISPE was gathered during a rigorous development process.

Validity evidence was reported in other studies by how the assessment tool can distinguish between standards of performance, including novice-expert comparisons (Kneebone *et al.*, 2006; DeMaria *et al.*, 2013). In another study conducted with ambulance paramedics in the UK, non-technical skills such as situational awareness, history gathering and decision making were assessed on a seven dimension global rating scale (GRS) that demonstrated evidence of validity and reliability (Tavares *et al.*, 2014). This study compared the findings from simulation-based

assessment to WPBA, and provided validity evidence for extrapolating observations collected in a simulated environment to enable inferences to be drawn about future clinical practice (Tavares et al., 2014).

For technical skill assessment more recent developments have included high-fidelity simulators and virtual reality simulators, which allow for metrics to be extracted from the simulator computer, thus providing an objective measure of technical skill (DeMaria et al., 2013). However, psychometric testing of high-fidelity human simulator assessments to date has not shown adequate reliability for high stakes summative assessment, and further research into the development of appropriate simulator models and valid and reliable assessment frameworks for this assessment modality is necessary.

Discussion

The advantages, disadvantages, feasibility, reliability and validity of commonly used assessment methods in Pharmacy education is well documented, including MCQs, viva voce/oral exams, OSCEs and WPBA methods. These current assessment approaches are limited, however, because they tend to emphasise one dimension of competence and do not integrate all skills necessary for comprehensive patient management (Epstein & Hundert, 2002; Epstein, 2007). This scoping review has identified studies reporting on integrated skills assessments using simulation and explored their applicability to pharmacy education and training.

We reviewed 20 studies spanning multiple health disciplines, all supporting the potential for integrated skills assessment experiences using a variety of simulation-based tasks that differ from traditional approaches. These approaches continue to expand the range of valid and reliable assessment methods throughout the course of health professional training. Our current understanding however, of the potential of simulation-based assessments in pharmacy education remains limited, and results of this review both highlight an opportunity, and point towards the need for further research and development to generate valid and reliable simulation-based assessment methods that assess the candidates' ability to manage the patient holistically. To our knowledge, this review is the first to examine integrated simulation-based assessments for evaluation of health professional competency, and to identify the role for integrated simulation-based assessment in pharmacy education. Due to the diversity in study designs and the variability in outcome measures reported, generalisability of results is limited, however several key findings can be highlighted.

Assessments that evaluate skills in an isolated manner and within a short timespan have become commonplace. This does not happen in a real-life scenario where a clinician must perform all their skills in an integrated manner, with the ultimate aim to optimise patient outcomes. Modern educational theory also stipulates that integration of tasks facilitates learning (van der Vleuten

& Schuwirth, 2005). It is thus imperative that OSCE-style examinations are complimented by and/or move towards integrated assessment (Gupta, Dewan & Singh, 2010). For example, history taking, medicine supply and counselling can be integrated into a single scenario. This review shows evidence for a variety of approaches to achieving an integrated and simultaneous assessment of competencies, including the selection of the most appropriate simulation modality, including blended approaches, development and/or modification of existing assessment instrument that incorporates multiple domains of competence and consideration of the assessment model including the duration, complexity number of clinical cases.

The prevailing approach in this review was to use a combination of simulation modalities in the one 'simulated' clinical encounter with several examples of the simultaneous use of simulated patients and bench top anatomical models, part task trainers or high fidelity mannikins providing a 'composite' picture of the learners' ability to contextualise their various skills. This is not surprising given that the intention is to create an authentic scenario requiring application and integration of multiple domains of competence, and employing measurement techniques that evaluate the comprehensive performance of the student. This is in contrast to other simulation-based assessments where the focus is on just one performance dimension (Auffermann et al., 2015). Role-plays using simulated patients and practical assessments that require students to dispense a medicine are commonplace in schools of pharmacy but tend to focus on the 'deconstructed' components of the overall task such as patient counselling, medication history taking, prescription checking, often delivered in an OSCE-style examination. Previous studies have encouraged opportunities for health professionals to be given the opportunity to perform their clinical task in a comprehensive manner and there is evidence of assessment models that are facilitators of this such as the OSCA and prolonged complicated clinical simulations (Bujack et al., 1991; Boulet et al., 2003; Lammers et al., 2009; Lipner et al., 2010; D. Vyas et al., 2012; DeMaria et al., 2013; East et al., 2014; Judd et al., 2016). This is based on the idea that if we break down competencies into smaller units and evaluate them separately, we cannot assume that the sum of the parts leads to competence of the integrated whole. While performance feedback is almost always a component of simulation activities and training, studies in pharmacy focusing on simulation as a formal assessment methodology are limited. This has been found in other reviews that show although the majority of USA colleges and schools of pharmacy use simulation-based teaching methodologies to some extent in the pharmacy curricula, the role of simulation for assessment of competency-based skills could be expanded (Deepti Vyas, Bray & Wilson, 2013).

For integrated assessment there is a need for instruments that enable a measure of performance across multiple constructs and capture the holistic nature of the task. All the assessment instruments used to evaluate performance in the simulation-based assessment tasks included in this

review were multidimensional, designed to evaluate multiple domains of a health professional's competency. It appears that integrated skills assessments rely heavily on checklist criteria and global rating scales, consistent with the evidence that evaluation of student skills and clinical competence is reliant on the grading criteria as well as the professional judgement of the assessor (East *et al.*, 2014). Tertiary institutions often aim for an objective approach to assessment to ensure equity and consistency for students. Despite the provision of an objective marking criteria in many studies, the inherent subjectivity has been highlighted in qualitative findings which suggest assessors were openly subjective in their evaluation of performance (East *et al.*, 2014). The challenge is in ensuring the marking criteria is robust and transparent, and that steps are taken to minimise any assessor bias which can create inconsistency among student outcomes. These steps may include assessor training, and avoiding dual roles such as standardised patient and assessor.

Overall, this scoping review has demonstrated the potential for integrated simulation-based assessments to be used to measure health professional competency. What is less clear, is what is required in measurement models to enable assessors to move from using inferences obtained from simply observing the actions and behaviours of students, to having clear evidence for a student's skill, strategies and proficiencies, based on a valid and reliable framework, as outlined in the Accreditation Council for Pharmacy Education (ACPE) standards for professional degree pharmacy programmes. Although a systematic review by Ryall *et al.* (2016) demonstrated that simulation-based assessments for technical-based skills can be considered both reliable and valid, only 14 of 20 studies included in the present review used rating scales that presented evidence of reliability and validity. Further, even though studies did gather validity and/or reliability evidence, none offered a complete suite of such evidence and all authors acknowledged that further work was needed. Future research examining validity and reliability of integrated simulation-based assessments, particularly for the assessment of non-technical skills such as communications, could benefit from more rigorous study designs that may include blinding of assessors and participants (Ryall *et al.*, 2016). Across the included studies, internal consistency of global rating tools was more desirable than checklist scores. This is consistent with previous research indicating that checklists have lower reliability than global ratings of performance (Ilgen *et al.*, 2015). Our review demonstrates that communication skills are not correlated with technical skills. Training someone to have superior communication skills will not necessarily result in them having strong technical skills, and vice versa, suggesting that it is important to assess both types of skills (LeBlanc *et al.*, 2009). Assessing these types of skills separately, however, will fail to demonstrate the ability of a student to apply these skills adequately in clinical situations.

Studies which focused on simulation primarily for training purposes were not included in the present review, and this may have excluded some integrated simulation activities which also have an assessment component. There were no randomised controlled trials, and most studies were observational in design, *e.g.* cohort studies. This is likely because of some of the ethical challenges in implementing an educational intervention to some students and not others. There was also a lack of published studies specifically pertaining to the integrated skills assessment of pharmacists or pharmacy students' competence. We acknowledge there may be integrated assessment approaches being used in pharmacy education that have not been published. Our literature review methodology searched for articles from 1975, however it is only in the last two decades that many education approaches have been actively published. Despite these limitations, this scoping review provides a comprehensive picture of the use of integrated assessment in health professional education. Important findings of the review can be applied to future developments for the pharmacy field.

Conclusion

The demanding nature of healthcare requires health professional assessment to provide an accurate reflection of competence. It is not known if competence be broken into elements for assessment without losing meaning. Integrated assessment approaches offer information about one's ability to deliver safe and effective comprehensive patient care. Perhaps the greatest value of this review is to highlight opportunities for integrated simulation approaches to closely resemble the nuances of clinical practice and evaluate students' performance-based abilities, avoiding an artificial spilt between technical skill and the wider components of patient care.

The results of this review highlight different models for integrated assessment used in healthcare professions. Some of these models differ from those assessment approaches reported in pharmacy literature; this provides opportunity for further exploring this approach in assessing competency of future pharmacists. It is recognised that there is a need to incorporate integrated assessments into competence evaluations, and studies have demonstrated that the selection of simulation modality and clinical scenario(s), along with the considered development of a multidimensional assessment instrument, underpin this approach. However our review highlights the validity and reliability of such approaches is less well documented and further research required. This review provides a guide for pharmacy educators to consider different models of assessment, and adapt existing instruments for competence assessment in pharmacy education.

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Appendix A: Description of the included studies in the scoping review mapped to each category

Author(s), Year of Publication	Country, study participants	Study objectives and methods	Type of simulation	Outcomes and key findings related to simulation-based assessment approach	Evidence of assessing integration of competencies	Validity, reliability testing of assessment tool reported (Yes/No) Example of role for this approach to pharmacy
(Bujack <i>et al.</i> , 1991)	Australia Undergraduate nursing students	To determine the validity and reliability of the use of the OSCA as an integrated assessment tool; and to provide feedback on the students' perceptions of their experience with the OSCA Mixed methods - Quantitative assessment scores and qualitative data	Simulated patients (SPs)	Strong agreement that the OSCA assessment was a good example of the reality of nursing practice and even stronger agreement on the effectiveness of the use of simulated patients	New assessment model (OSCA) measures the extent to which a student nurse can plan and deliver safe and effective nursing care. Most students perceived the assessment as representative of the integration of all course units.	Yes Simulated patients can be used to create prolonged and integrated pharmacy practice scenarios in competency assessments
(Boulet <i>et al.</i> , 2003)	USA, medical students & emergency medicine/ surgery residents	To develop and test simulation exercises and associated scoring methods that could be used to evaluate acute care technical skills. 40 medical students participated in 10 simulated acute care situations. Quantitative assessment scores	High fidelity patient simulator (manikin)	Acute care skills can be validly and reliably measured using a high-fidelity simulator and checklist ratings but require multiple and a variety of simulation encounters.	Trainees' skill in acute diagnosis was integrated with the need to manage a variety of surgical and medical conditions. Prolonged and complicated encounters were used to evaluate technical (e.g. auscultate chest) and behavioural skills (decision to administer medicines, request pathology; communication)	Yes High fidelity patient simulators can create scenarios involving pharmacists, such as focusing on patient management for the deteriorating patient e.g. anaphylaxis; including inter-professional collaboration opportunities
(DeMaria <i>et al.</i> , 2013)	USA Anaesthesiologists	To incorporate simulator-based education, to help determine technical skills competency in licensed and previously licensed anaesthesiologists before return to practice. 20 physicians evaluated by the authors' centre undergo an adaptable 2-day simulation-based assessment. Quantitative assessment scores	High fidelity patient simulator (manikin) and a variety of part-task trainers including virtual fiberoptic bronchoscope, a neuraxial anaesthesia part-task trainer, a central-line part-task trainer, and an IV arm part-task trainer. Standardised patient/ role-player	Simulated environment provides an effective means by which to assess baseline competency in technical skills and a way to retrain physicians, using a combination of checklist rating tools and global rating scales	2-day assessment incorporating six anaesthesiology cases with integration of technical skills using anaesthesia machine, manikin) and non-technical skills using standardised role plays (as family member, nurse, surgeon) for each case	No Hybrid simulated activities using part-task trainers with SPs can provide opportunities for integrated assessment of processes such as vaccine administration consultations
(East <i>et al.</i> , 2014)	Australia Undergraduate nursing students	To gain insight into how assessors determine Objective Structured Clinical Assessment (OSCA) result and whether individual perceptions and characteristics have an impact on results Qualitative data	Standardised patient/ role-player and high-fidelity manikin	OSCA is a suitable approach for assessment of however there was significant variation in pass rates between assessors and subjectivity in ratings was identified through qualitative data	Students were required to demonstrate completion of a preoperative checklist including technical skills such as measurement of vital signs and medicine administration	Yes Combining multiple simulation methods enables a more seamless integration of technical and non-technical aspects of patient management in assessment of daily activities of pharmacy practice, e.g. wound dressing, clinical monitoring

(Gimpel et al., 2003)	USA, Osteopathic medical students	To gather data to support the use of a performance-based assessment of osteopathic clinical skills. 121 fourth-year osteopathic medical students given 12 SP encounters and tested using the Comprehensive Osteopathic Medical Licensing Examination-USA performance-based clinical skills examination (COMLEX-USA-PE) prototype Quantitative assessment scores	Standardised patient (SP)	Reliable and valid scores can be obtained using simulation-based assessment with SPs using the current checklist rater prototype.	Evaluates the integration of both technical (physical examination, manipulative treatment techniques) and non-technical (history taking, problem solving) skills	Yes Simulated patients can be used to create prolonged and integrated pharmacy practice scenarios – standardised approaches enable consistency in assessment
(Isenberg et al., 2011)	USA, Medical students	To evaluate the use of simulation to assess skills related to rectal examination, suturing, and inserting intravenous lines and nasogastric tubes. Quantitative assessment scores	Simulated patients in conjunction with anatomic and tissue part task-training models	Integrated use of simulated patients and simulation models yielded reliable scores and evidence of validity related to clinical ratings.	Student scores were based on their ability to gather data (SPs) and perform procedures (models) integrated into a single clinical encounter, rated by faculty using combination of checklist and global rating scales.	Yes Combining multiple simulation methods enables a seamless integration of technical and non-technical aspects of patient management in pharmacy practice, e.g. assessment of skin condition, clinical monitoring, use of medicinal devices
(Jude et al., 2016)	Australia Physiotherapists	To evaluate the validity of a comprehensive practice tool (Assessment of Physiotherapy Practice – APP) for student assessment in simulation settings. Mixed methods – Quantitative assessment scores and qualitative data	Standardised patient (SP)	Longitudinal assessment over one week of simulation and a single simulation scenario were used. Outcomes showed the APP was a valid assessment tool when used in longitudinal simulation formats. A revised APP may be required for assessment in short-form simulation scenarios.	Professional competence measures across seven domains of practice which include professional behaviour, communication, patient assessment, analysis and planning of interventions, performing the intervention, evidence-based practice and risk management	Yes Longitudinal simulation formats using SPs can be used to create prolonged and integrated pharmacy practice scenarios, providing opportunity to explore simulation for supplementing clinical placement hours
(Kesten et al., 2015)	USA, Advanced Practice Registered Nurse (APRN)	To determine the effectiveness of using simulation to assess APRN student competence in managing complex cases, in the simulation laboratory at four separate intervals; two independent reviewers used the APRN Competency Evaluation Tool to review the simulation Quantitative assessment scores	Standardised patients (SPs)	Simulation provides a suitable method for evaluation of competence in managing complex patient cases	The APRN Competency Evaluation Tool provides a framework for evaluating integration of competencies related to patient safety, leadership, prioritisation, delegation, collaboration, communication, and professionalism	No Simulated patients can be used to create prolonged and integrated pharmacy practice scenarios – standardised approaches enable consistency in assessment
(Kneebone et al., 2006)	Canada Medical student trainees and experienced medical practitioners	To explore the feasibility of an Integrated Procedural Performance Instrument (IPPI) for assessing clinical procedural skills in trainee and experienced clinicians Mixed methods – Quantitative assessment scores and qualitative data	Blended approach to simulation which combines simulated patients with inanimate models or items of medical equipment	Offers an innovative approach to assessing clinical procedural skills over a spectrum of clinical scenarios without risk to patients; resource intensive; realism was rated highly from qualitative data	The IPPI assessment approach evaluates technical elements of the skills with communication and other professional skills	Yes Blended simulation models enable integrated evaluation of communication skills while performing technical roles e.g. taking blood pressure, administering vaccine, performing clinical tests such as for glucose, iron or INR

(Lammers et al., 2009)	USA, Paramedics	To identify the most common performance deficiencies in paramedics' (n=212) management of three simulated paediatric emergencies assessing technical skills (resuscitation) and non-technical skills in a prospective, observational study. Quantitative assessment scores	High fidelity paediatric simulators (manikins).	Scores from manikin-based simulations objectively rated performance of technical paediatric resuscitation skills	Each assessment required paramedics to provide appropriate paediatric care within a 12-minute time limit, that required integration of skills in appropriate decision-making in patient assessment (e.g. diagnosis, calculating administration of fluids and medicines) and resuscitation skills	No High fidelity patient simulators can create scenarios involving pharmacists, such as focusing on patient management for the deteriorating patient e.g. anaphylaxis; including inter-professional collaboration opportunities
(LeBlanc et al., 2009)	Canada, Medical students, surgical residents	To determine whether an Integrated Procedural Performance Instrument (IPPI) could discriminate between different levels of trainees in the management of 4 clinical scenarios Quantitative assessment scores	Blended approach to simulation whereby bench top models (e.g. simulated skin pad, urinary catheterisation anatomic model) are positioned with simulated patients	Preliminary psychometric properties of an IPPI examination show acceptable levels of inter-rater reliability for both technical and communication components; and was able to discriminate between student's and resident's technical and communication skills.	Trainees are required to perform technical skills while engaging with the patient, and are evaluated against a checklist of technical skills, a global rating scale of technical skills and a communication scale while performing their skills concurrently	Yes Blended simulation models enable integrated evaluation of communication skills while performing technical roles e.g. taking blood pressure, administering vaccine, performing clinical tests such as for glucose, iron or INR
(Lipner et al., 2010)	USA, Physicians	To determine whether it is feasible to develop a valid and reliable evaluation approach using medical simulation to assess technical and non-technical (cognitive) skills of physicians performing coronary interventions. Physicians (n=115) at three levels of expertise (novice, skilled, or expert) completed a questionnaire, one practice case and six test cases Quantitative assessment scores	High fidelity simulation - SimSuite simulator (Medical Simulation Corporation, Denver).	High-fidelity medical simulation to assess technical and non-technical (cognitive) skills of physicians performing interventional cardiology procedures can be used as an evaluation approach for physician performance and differentiate between physicians with different levels of experience.	Assessment approach integrated technical skills (e.g. stent positioning) and non-technical skills (e.g. knowledge of procedure, communication) which were rated using checklists.	Yes High fidelity patient simulators can create scenarios involving pharmacists, such as focusing on patient management for the deteriorating patient e.g. anaphylaxis; including inter-professional collaboration opportunities. Simulator metrics enable an objective assessment for some elements of the performance.
(McBride et al., 2011)	USA, Paediatric residents	To develop an inventory of simulated paediatric scenarios and determine if the resident scores could be used to establish the reliability and validity of a multiple-scenario assessment. Paediatric residents (n=29) participated in 10 scenarios that were scored by 2 independent raters using an action-item checklist and a global score. Quantitative assessment scores	High fidelity human patient simulation (manikin simulator)	When exposed to multiple scenarios scores in the simulation-based assessment were found to be valid and reliable measure of ability and discriminate between skill levels that examined both non-technical and technical diagnostic and management skills.	Diagnostic and management skills were integrated to obtain measures of ability across multiple clinical scenarios	Yes Simulations can provide information about performance that can differentiate between level of competence enabling application to such areas as the advanced pharmacy practice framework, and for obtaining evidence of performance in tracking progress towards entrustment using EPAs at all levels of pharmacy training

(Mikasa et al., 2013)	USA Undergraduate nursing students	To determine if an assessment tool that integrates competencies and course objectives provides an effective method for consistent outcome-based evaluation of student performance in simulation experiences. Mixed methods - Quantitative assessment scores and qualitative data	High fidelity human patient simulation (manikin simulator)	The simulation-based assessment approach strengthened achievement of clinical course objectives. The tool was efficient, descriptive and visual; provided objective data to determine clinical grades; was useful for feedback	Assesses multiple competencies including patient assessment, critical thinking, patient care, communication and professionalism in a single simulated clinical encounter using high fidelity simulation	Yes A useful approach to ensuring assessment of integrated skills is to develop a suitable tool that enables consistent approach to evaluation.
(Mudumbai et al., 2012)	USA, Third-year anaesthesia residents	To test hypothesis that technical and non-technical performance in the simulated environment are related to other various criterion measures. Residents (n=12) participated in a series of 6 short scenarios (measured technical skills) and 1 longer scenario (focused on nontechnical skills). Two independent raters scored subjects using analytic and holistic ratings. Mixed methods - Quantitative assessment scores and qualitative data	High fidelity patient simulator (manikin)	When assessing both technical and non-technical (team working, situation awareness, task management and decision making) skills the associations between simulator performances provide evidence to support the validity of the scores from the simulation-based assessment.	Measures technical and non-technical performances in a simulated environment	Yes High fidelity simulation can assess performance in complex clinical encounters involving pharmacists and medicines management in a collaborative environment, e.g. identification of medication-related problems in a deteriorating patient.
Panzarella and Manyon, 2007)	USA, Medical Students	To develop and evaluate the Integrated Standardised Patient Examination (ISPE) performance assessment tool that could measure clinical competence defined through integration Mixed methods - Quantitative assessment scores and qualitative data	Standardised patients	The results for the simulation based assessment show this approach may be used for demonstration of integrated skills, shows acceptable reliability; and the integration sections (unique component of the ISPE) showed a great deal of content validity.	The assessment tool was specifically designed to measure the ability to integrate scientific knowledge and communication skills, utilizing a scoring rubric that quantifies attributes of clinical competency.	Yes Simulated patients can be used to create prolonged and integrated pharmacy practice scenarios – standardised approaches enable consistency in assessment
(Purkerson et al., 1996)	USA, Pharmacy Students	To develop a process to assess four outcome abilities (collaboration; problem solving; written and inter-personal communication skills) in one assessment exercise. Mixed methods - Quantitative assessment scores and qualitative data	Simulated patient	Simulated pharmacist/patient role plays provide an effective means by which to enable sampling of students integrated skills.	The students completed four exercises that each had embedded the use of more than one ability. In addition, the exercises were integrated by drawing upon the same scenario for collaboration and written communication. Also, qualitative responses show positive response to understanding how skills can be integrated in patient management.	No Simulated patients can be used to create prolonged and integrated pharmacy practice scenarios – standardised approaches enable consistency in assessment
(Rizzolo et al., 2015)	USA, Registered nurses (RN)	To explore the feasibility of using simulation for high-stakes assessment in student RN programs. Simulation scenarios were developed by experts to assess students at the end of their program. Scenarios were piloted and refined, then student performances on video recordings were scored Quantitative assessment scores	High fidelity simulation (manikins) and human patient simulation (standardised patients (SPs))	Well-designed and facilitated scenarios, delivered in the controlled environment of the simulation centre, can be a reliable and valid tool for evaluating the technical skills of students	RNs were assessed in clinical scenarios that required integration of multiple competency domains related to: professional practice, provision of patient care, critical thinking and collaborative practice; as required by RNs on entry to practice	Yes Integrated simulations may form the basis of high-stakes summative assessments e.g. pharmacist registration, particularly if they integrate multiple competency domains.

(Tavares <i>et al.</i>, 2014)	England, Paramedic trainees	To use a comparative, observational study to compare simulation-based assessment measures of clinical competence in non-technical skills, with workplace-based assessment measures obtained with real patients Quantitative assessment scores	High fidelity patient simulator (manikin) with standardised patient (SP)	Contributes validity evidence to support simulation-based assessment used to infer clinical competence and predict future performance	Assessment task integrated a range of non-technical skills including situation awareness, history gathering, patient assessment, decision making, and communication using a seven-dimension global rating scale	Yes Opportunities for translational research exploring if performance of pharmacists in an integrated simulated encounter can predict performance in a similar situation in practice
(Vyas <i>et al.</i>, 2012)	USA Pharmacy Students	To assess pharmacy students' core domain abilities prior to beginning advanced pharmacy practice experience (APPE). Mixed methods - Quantitative assessment scores and qualitative data	Standardised patients in simulated setting - mock community pharmacy incorporated pharmacy technology, simulated medications, and online resources. The mock hospital pharmacy incorporated 4 intravenous (IV) preparation hoods, prescription medications, IV medications, aseptic technique attire, IV syringes, and chemotherapy drugs.	The simulation experience was divided into 3 sections (case preparation, patient encounter, and debrief session). The scenarios were dynamic in that the patient's status changed during the encounter based on the student's therapy recommendations and disease progression. Study concluded that simulation is an effective method for assessing the abilities of pharmacy students, preparing them for real clinical encounters, and increasing awareness of medication errors and other patient safety issues.	Assessment across 10 domains of competence in a practical examination that required students to interview a standardised patient, order pertinent laboratory work, conduct a physical examination, and finally develop a care plan based on the results of the interview.	No Mock simulated pharmacy environments are versatile for enabling assessment in a range of clinical scenarios and are suitable for preparing students before attending hospital.