Simulated Patients in Physical Therapy Education: Systematic Review and Meta-Analysis

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Background. Traditional models of physical therapy clinical education are experiencing unprecedented pressures. Simulation-based education with simulated (standardized) patients (SPs) is one alternative that has significant potential value, and implementation is increasing globally. However, no review evaluating the effects of SPs on professional (entry-level) physical therapy education is available.

Purpose. The purpose of this study was to synthesize and critically appraise the findings of empirical studies evaluating the contribution of SPs to entry-level physical therapy education, compared with no SP interaction or an alternative education strategy, on any outcome relevant to learning.

Data Sources. A systematic search was conducted of Ovid MEDLINE, PubMed, AMED, ERIC, and CINAHL Plus databases and reference lists of included articles, relevant reviews, and gray literature up to May 2015.

Study Selection. Articles reporting quantitative or qualitative data evaluating the contribution of SPs to entry-level physical therapy education were included.

Data Extraction. Two reviewers independently extracted study characteristics, intervention details, and quantitative and qualitative evaluation data from the 14 articles that met the eligibility criteria.

Data Synthesis. Pooled random-effects meta-analysis indicated that replacing up to 25% of authentic patient–based physical therapist practice with SP-based education results in comparable competency (mean difference=1.55/100; 95% confidence interval=−1.08, 4.18; P=.25). Thematic analysis of qualitative data indicated that students value learning with SPs.

Limitations. Assumptions were made to enable pooling of data, and the search strategy was limited to English.

Conclusion. Simulated patients appear to have an effect comparable to that of alternative educational strategies on development of physical therapy clinical practice competencies and serve a valuable role in entry-level physical therapy education. However, available research lacks the rigor required for confidence in findings. Given the potential advantages for students, high-quality studies that include an economic analysis should be conducted.

Health care education is designed to graduate caring and competent health care professionals.[1] Education in clinical environments provides students with supervised opportunities for interactions with people seeking health services through which students can consolidate knowledge, refine clinical skills, and enable attainment of competency to practice.[2] Traditional models of clinical education are experiencing unprecedented pressures, with a global push for more health care professional graduates to meet the growing demand for services.[2,3]

Simulation-based education (SBE) is increasingly being embraced as a substitute for traditional methods of clinical education across health care professions to increase clinical education opportunities.[3–5] *Simulation* in health care refers to "a technique—not a technology—to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner."[6(p126)] *Simulated patients* (SPs) (also referred to as *standardized patients*[7]) are people who are well and trained to portray a patient role.[4,8]

Simulating the authentic practice environment provides students with opportunities to apply cognitive knowledge; practice psychomotor skills; and learn communication, teamwork, and clinical decision-making skills in a way that is safe and low risk to patients and students.[6,9–11] In addition, education sessions can be scheduled to suit the student, reducing dependence on patient availability.[1,5,12,13] An SP's behavior can vary according to the educational context, be tailored to student needs and learning outcomes of the experience, and model authentic variation in human behavior.[7] Feedback from an SP's "authentic patient" perspective about an interaction also is considered valuable in facilitating development of patient-centered care.[7]

Simulation-based education is not new in physical therapy education. Students have long "acted" as patients for peer practice in preclinical activities. In addition, students learn with low-fidelity mannequins or part-task trainers to practice basic psychomotor skills.[5,14] Simulated patients have contributed to teaching sessions and assessments in musculoskeletal, cardiorespiratory, and neurological physical therapy education.[15–18] Specific SP scenarios have been created to facilitate development of knowledge, clinical reasoning,[17–19] professionalism,[12,15,19,20] and skills in communication[16] and physical examination.[21,22] There is general consensus that SBE is valuable in both professional (entry-level) and postgraduate education.[11,23,24] Simulated patients have been described as a valuable and effective resource for teaching and assessing communication and physical examination skills in medical students.[1,25–27]

The effects of SP practice in physical therapy education are not clear. In a systematic review of SPs in education across health disciplines (69 articles, 1996–2005), May et al[4] reported that 73% of studies were in medicine; 15% were in nursing; and the remaining 12% were in other areas such as dentistry, pharmacy, and dietetics; no research into SPs in physical therapy was identified. The authors of a narrative review on SBE in entry-level physical therapy curricula (23 articles, 1946–2013) concluded that SBE is usually well received by students and may improve skill attainment.[28] A narrative review exploring the potential impact of SBE on the clinical placement outcomes of physical therapy students concluded that opportunities exist for SBE, but evidence of effects on skill acquisition is sparse.[5]

There are substantial costs in setting up and running SP activities, and these costs are consistently identified as barriers to uptake.[1,25] In national surveys of SBE in Australian entry-level physical therapy curricula, major barriers to increasing simulation were lack of resources, lack of facilities, and lack of dedicated recurrent funding.[5]

The potential application and value of SPs to physical therapy education are significant. Implementation and resource allocation are increasing, although research that informs best practice is sparse. To our knowledge, no systematic review or meta-analysis evaluating the contribution of SPs to physical therapy education is currently available. Systematic review provides an in-depth analysis and summary of the best available evidence to a specific research question and is a valid method to seek and substantiate the effects of health profession education interventions.[29]

Given the substantial costs required to set up and run SP activities, it is timely to consolidate information regarding the potential merit of adopting such significant changes in learning environments for physical therapy students. With knowledge of effects, costs associated with SP-based education could be considered with respect to the likely benefits. This systematic review of SPs in physical therapy education was designed to inform current practice and guide future directions for physical therapy education research.

The primary aim of this review was to synthesize and critically appraise the findings of empirical studies (qualitative or quantitative) evaluating the contribution of SPs to entry-level physical therapy education. The secondary aim was to explore how SPs have been incorporated into entry-level physical therapy education.

The focused review question was: "What is known about the effects of SP interactions in entry-level physical therapy programs, on any outcome relevant to learning, compared with no SP interaction or an alternative education strategy?"

Method

Data Sources and Searches

The full holdings of 5 databases (Ovid MEDLINE, PubMed, AMED, ERIC, and CINAHL Plus) were searched to May 2015. The reference lists of systematic reviews, gray literature, and other relevant articles also were searched. Search terms were compiled in consultation with experts in SP methodology and from review of systematic reviews and high-quality articles on SPs. Terms were grouped (with truncation [*]) into 3 categories: (1) health profession (physiotherap*, physical therap*), (2) learning method (simulat*, patient simulat*, simulated patient*, standardi* patient*), and (3) outcome (educat*, learn*, curriculum*, skill* develop*, teach*, skill* practic*, feedback*, skill*). Terms within each category were searched in each database using the Boolean operator "OR" and then across categories using "AND." An example of the search strategy is provided in eAppendix 1 (available at ptjournal.apta.org).

Study Selection

Articles were included in the review if they met specific criteria: an empirical study that reported quantitative or qualitative data evaluating the effect of SPs on any relevant learning outcome (eg, communication skills, clinical reasoning, safety, technical skills, assessment grades, student self-reported competency scores), study participants were students completing undergraduate or postgraduate entry-level physical therapy programs, simulated patients were defined as (or implied to be) a well person portraying the role of a patient, articles were published in English in a peer-reviewed journal, and full text was available for review. Articles were excluded if data specific to physical therapy students were not clearly reported, if only data where SPs were involved in high-stakes assessment were reported, or if SPs were physical therapy students (considered peer or near-peer role play).

One researcher (S.A.P.) screened titles and abstracts to discard clearly irrelevant articles. Two independent researchers (S.A.P. and J.L.K., F.C.B., or D.N.) reviewed full texts to determine eligibility for inclusion. Disagreements were discussed until consensus was achieved on included and excluded articles.

A randomized controlled trial (RCT) is the ideal research design to study the effects of interventions.[30] Including nonrandomized and single-cohort studies in a systematic review is likely to increase the influence of biases on study findings. We included all study designs in this review to enable a view of the available data. However, when considering quantitative data, we assessed studies for potential bias using the standards expected of a well-designed RCT to identify the influence that this factor may have on results.

Data Extraction and Quality Assessment

Study characteristics and educational intervention details were extracted. Data describing the effect of SPs on outcomes were arranged first by like comparisons and then by the construct measured. Means and standard deviations were extracted or, if unavailable, imputed from available data. In uncontrolled, observational studies, preintervention data were used as the best estimate of control data and labeled accordingly. Scale directions were reversed and expanded as required to align interpretation of results. Qualitative evaluation data (key themes with supportive or representative quotes) that enabled a view of the effect of learning with SPs were extracted. Authors of included studies were contacted if difficulties arose in interpreting or extracting data. One researcher (S.A.P.) performed data extraction, and one other independent researcher (J.L.K., F.C.B., or D.N.) confirmed accuracy of extracted data.

Two tools for assessing risk of bias were used. Studies reporting quantitative data on effects of SPs were assessed using the PEDro scale.[31] The PEDro scale has adequate validity[31] and reliability[32] for assessing method quality of clinical trials. Low scores for studies (eg, with no control group) would reflect the greater potential for biases to affect study results. Studies reporting qualitative data were assessed using our consensus-developed appraisal system (eAppendix 2, available at ptjournal.apta.org) that was based on a comprehensive review by 2 independent reviewers of methods used to assess the method quality of qualitative studies. This Quality Assessment for Qualitative Research Reports (QAQRR) scale has face validity for assessing key sources of bias that may influence study results. It differs from published scales in describing specified and unambiguous decision rules for each scale item that enable determination of whether threshold criteria were reported. Content validity of the scale is likely given its systematic derivation from existing instruments. A full report on the scale development is being finalized for publication. Studies containing quantitative and qualitative data were assessed using both scales. Two researchers independently assessed each study (S.A.P. and J.L.K., F.C.B., or D.N.). Disagreements were resolved with discussion.

Data Synthesis and Analysis

Study characteristics were summarized. Two researchers (S.A.P., D.N.) independently conducted thematic analysis according to the principles of Bearman and Dawson[33] on intervention details and other qualitative data. Results were assembled (with examples of supporting evidence) to illuminate key themes, relationships, and recurring reflections on incorporating SPs into physical therapy education.

Where possible, quantitative data were pooled across studies using Review Manager 5 meta-analysis software (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark) for each set of like comparisons. Otherwise, 2-tailed *t* tests (alpha level=.05) were conducted to test individual study outcomes for statistically significant differences between groups. In meta-analysis, heterogeneity between trials was assessed using the I^2 statistic. If I^2 was greater than 50%, a random-effects model was applied. Otherwise, a fixed-effects model was used.[34] Standardized mean differences (SMDs) were used where different outcome measures were used for comparable constructs across studies.

Results

Search Yield

The initial search identified 342 unique records. After screening on title and abstract of each article, 293 records were excluded. Four records were excluded because full texts could not be located despite extensive searching. Two independent researchers (S.A.P. and J.L.K., F.C.B., or D.N.) screened the full texts of 45 records for inclusion. Fourteen articles reporting on 16 studies met all criteria.[15–20,35–42] A PRISMA flow diagram[43] (Fig. 1) summarizes the pathway of included studies.

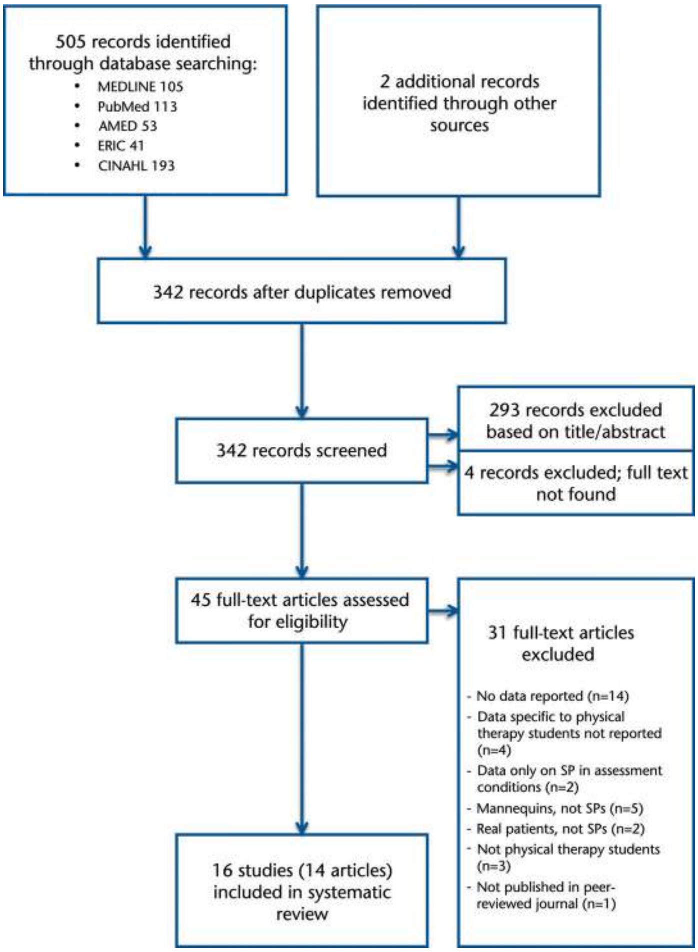

Figure 1.
PRISMA flow diagram summarizing pathway of included studies. SP=simulated patient.

Quality Assessment

The PEDro scores ranged from 0/10 to 6/10. Only 5 of 13 studies reporting quantitative data allocated participants to intervention and control groups.[16–18] One of these studies did not randomly allocate participants to groups.[16] With no control group, the remaining 8 studies provided postintervention data that cannot be confidently attributed to the intervention.[15,35,36,38–42] No studies included student ("participant") or educator ("therapist") blinding, introducing potentially unavoidable performance and detection bias. Briefing students and educators on what to expect in simulation activities is commonplace in SP practice.[7] Considering this, the 4 RCTs that achieved scores of 6/10 were considered higher quality for the purpose of this review and pooled separately in meta-analysis.

The QAQRR scale scores ranged from 4/24 to 15/24. Most studies did not provide adequate information or justification about the study design or data collection and analysis methods, indicating that significant risk of reporting bias may have influenced conclusions.

Characteristics of Studies

Most studies (n=7) used a case series (single-cohort) study design, incorporating a posttest evaluation only (n=2) or a pretest-posttest evaluation (n=5). Three articles reported on 5 RCTs.[16–18] Two of these articles (each reporting on 2 separate RCTs) stemmed from the same national research project.[17,18] One article reported on a nonrandomized trial,[42] and 3 articles reported on qualitative studies.[19,20,37] Six included studies reported on SPs incorporated into undergraduate entry-level programs, 7 studies reported on SPs incorporated into postgraduate entry-level programs (master's, n=3; doctorate, n=4), and 3 studies did not specify the degree or year level of participants. Countries in which studies were conducted were the United States (n=9), Australia (n=5), and the United Kingdom (n=2). Characteristics of included studies are shown in Table 1.

Educational Intervention Details

Thematic analysis indicated substantially varied program foci, development, execution, and SP practices. Underreporting obscured analysis of elements in some educational interventions. A summary of extracted data is shown in Table 2.

The SP programs were designed to advance knowledge, skills, behaviors, or attitudes. Educational foci broadly targeted clinical reasoning, communication, professionalism, working in a multidisciplinary team, therapeutic technique, and ethical issues. Some interventions were designed for specialized areas, including gait retraining,[16] electrocardiogram (ECG) interpretation,[41] patient assessment and management in an intensive care unit,[40] and diabetes management.[35] Educational strategies in control or comparison groups included clinical placement without simulation,[17,18] simulation with high-technology mannequins,[41] and peer role play.[16] One article had no alternative strategy for the control group[42]; all other studies used a single-cohort design.

Of the 4 RCTs from the same national project,[17,18] 2 replaced clinical placement with SP interactions for 1 week of a 4-week placement (1 in the musculoskeletal domain, 1 in the cardiorespiratory domain); the other 2 studies replaced the equivalent of 1 week of clinical placement with SP interactions interspersed across 2 weeks (1 in the musculoskeletal domain, 1 in the cardiorespiratory domain). Two of these studies also provided detailed information on program design and integration and SP scenario development and training.

Other studies poorly described methods used to develop and implement SP programs or for curriculum or scenario

Table 1.
Characteristics of the 14 Included Articles Reporting 16 Studies[a]

Study	Study Design	Course and Year Level	Country of Study	PEDro Score	QAQRR Score
Black et al,[16] 2002	RCT	2nd year master of PT	US	3/10	8/24
Blackstock et al,[17] 2013	2 independent RCTs	Bachelor of PT	Australia	6/10	
Cahalin et al,[19] 2011	Qualitative	5th year doctorate of PT	US		4/24
Hale et al,[35] 2006	Single-cohort case series (pretest-posttest)	1st year master of PT	US	2/10	
Hayward et al,[20] 2006	Qualitative	5th year doctorate of PT	US		8/24
Hayward et al,[36] 2010	Single-cohort case series (pretest-posttest)	5th year doctorate of PT	US	1/10	12/24
Hensman and Conduit,[37] 2012	Qualitative	Master of PT	UK		13/24
Jensen and Richert,[38] 2005	Single-cohort case series (pretest-posttest)	Doctorate of PT	US	2/10	4/24
Ladyshewsky and Gotjamanos,[39] 1997	Single-cohort case series (posttest)	3rd year bachelor of science (major in PT)	Australia	0/10	
LaPier,[40] 1997	Single-cohort case series (pretest-posttest)	Undergraduate PT degree	US	0/10	6/24
Lewis et al,[15] 2008	Single-cohort case series (pretest-posttest)	2nd year undergraduate PT degree	UK	2/10	
Smith et al,[41] 2012	Single-cohort case series (posttest)	Bachelor of PT	US	1/10	15/24
Wamsley et al,[42] 2012	Nonrandomized trial	3rd year bachelor of PT	US	2/10	
Watson et al,[18] 2012	2 independent RCTs	Bachelor of PT	Australia	6/10	

[a] QAQRR=Quality Assessment for Qualitative Research Reports, RCT=randomized controlled trial, PT=physical therapy, US=United States, UK=United Kingdom.

development. From the limited available data, SPs generally received training prior to interacting with students (n=10). Training activities included instruction on giving feedback to students, observing real therapist-patient interactions, rehearsing with supervision and feedback, and receiving written information about a role. Three studies reported paying SPs.[36,38,41] Simulated patients were recruited from various backgrounds, including formally trained actors (n=9), community-dwelling adults (n=3), physical therapists (n=1), and medical students (n=1). Two studies did not specify the background of the SPs.

The cost of implementing SP programs was underreported. Black and Marcoux[16] reported a total cost of $1,760.60 for 19 students who each had a 90-minute interaction with an SP. Blackstock et al[17] acknowledged that implementation of SP programs with this design can be expensive and that comprehensive cost analyses were being conducted.

The 4 RCTs substituting placement with SPs used simulation strategies such as time in/out (where students, educators, or SPs may pause the interaction), rewind for repetition, and accelerated progression. Feedback was included for students in most studies (n=12) from various sources (faculty, SPs, peers) in various formats (written, audiovisual, verbal). Audiovisual recording was used in some studies to encourage student reflection (n=5). Students worked in groups with the SP (n=11) and individually (n=5).

Synthesis of Quantitative Data

Figures 2, 3, and 4 present summary data, effect estimates, and confidence intervals for data pooled in meta-analysis. Table 3 presents results of tests for significant differences between groups for individual articles that could not be pooled with other studies.

Comparison 1: clinical placement with 25% SP substitution compared with usual clinical placement (no SPs). Pooled analysis of 4 RCTs comparing substitution of 25% of clinical

Table 2.
Educational Intervention Details[a]

Study	Intervention Group	Control Group	SPs	Intended to Support	Domain of Physical Therapy
Black et al,[16] 2002	One student-SP interaction observed by 4 others	Peer role play exercises in pairs using same scenarios as intervention group	Trained professional actors Gave feedback to students	Gait retraining skills	Nonspecific
Blackstock et al,[17] 2013 – RCT 1	First week of 4-wk clinical placement (25%) replaced with SP interactions for each student	4-wk clinical placement	Trained professional actors Gave feedback to students	Clinical competency in professional behavior, communication, assessment, analysis and planning, intervention, evidence-based practice, and risk management	Cardiorespiratory
Blackstock et al,[17] 2013 – RCT 2	First 2 wk of 4-wk clinical placement (25%) substituted with ½ day placement, ½ day SP interactions for each student				
Cahalin et al,[19] 2011	One student-SP interaction observed by a group of students via video link, followed by feedback and online debrief	No control	Trained community dwellers Gave feedback to students	Clinical reasoning and professional skills	Nonspecific
Hale et al,[35] 2006	One student-SP interaction for all students	No control	Trained professional actors (for subjective examination) 2nd year medical students (for physical examination)	Attitudes, confidence, and perceived skills in treating patients with diabetes	Diabetic management
Hayward et al,[20] 2006	One student-SP interaction observed by a group of students via video link, followed by feedback and online debrief	No control	Trained community dwellers	Professional skills	Nonspecific
Hayward et al,[36] 2010	One student-SP interaction observed by a group of students via video link, followed by feedback and online debrief	No control	Trained community dwellers Gave feedback to students	Clinical reasoning and professional skills, confidence to enter workplace	Nonspecific
Hensman and Conduit,[37] 2012	Two SP interactions in multidisciplinary groups (one student was a physical therapist)	No control	Trained actors Gave feedback to students	Interprofessional skills (working in a team environment)	Cardiorespiratory
Jensen and Richert,[38] 2005	Two SP interactions for all students (1:1)	No control	No data reported	Skills navigating ethical issues typical in practice	Nonspecific
Ladyshewsky and Gotjamanos,[39] 1997	One SP interaction with an SP (4 possible cases)	No control	Trained actors	Communication skills	Nonspecific
LaPier,[40] 1997	One SP interaction for a group of 6 physical therapy students	No control	Faculty were trained as the SP	Cardiorespiratory physical examination and treatment techniques in the ICU	Cardiorespiratory ICU
Lewis et al,[15] 2008	Two SP interactions per pair of students	No control	Trained actors	Perceived interpersonal skills	Nonspecific

(Continued)

Table 2.
Continued

Study	Intervention Group	Control Group	SPs	Intended to Support	Domain of Physical Therapy
Smith et al,[41] 2012	One interaction with SP combined with printed ECG strips, followed by one interaction with computerized mannequin with ECG displayed on monitor	Same as intervention group except in reverse order–mannequin then SP	SP trained to recite standardized script with verbal prompts	Ability to recognize and interpret ECGs	Cardiorespiratory–recognize and interpret ECGs
Wamsley et al,[42] 2012	One SP interaction in group of 5 students (1 was a physical therapist), all interacted with SP individually	No additional intervention	Trained actor	Interprofessional skills–knowledge of other health care professionals' roles, attitude toward collaborative care, communication skills	Nonspecific
Watson et al,[18] 2012 – RCT 1	First week of 4-wk clinical placement (25%) replaced with SP interactions for all students	4-wk clinical placement	Trained actors Gave feedback to students	Clinical competency as a physical therapist in professional behavior, communication, assessment, analysis and planning, intervention, evidence-based practice, and risk management	Musculoskeletal
Watson et al,[18] 2012 – RCT 2	First 2 weeks of 4-wk clinical placement (25%) replaced with ½ day placement, ½ day SP interactions for all students				

[a] SP=simulated patient, RCT=randomized controlled trial, ICU=intensive care unit, ECG=electrocardiogram.

placements with SP interactions with usual clinical placements (no SPs) indicated that there were no significant differences on educator-assessed competency to practice[17,18] (Fig. 2). The Assessment of Physiotherapy Practice, a validated measure of competence in physical therapist practice with high interrater reliability,[44] was administered in all 4 RCTs at the conclusion of the clinical placement. Data reported in the studies with a 0–4 scale were converted to a 0–100 scale to facilitate interpretation. No significant differences were found between groups on student-assessed competency to practice (Fig. 2), assessed using a self-report questionnaire (5-point Likert scale, higher score indicating more competent) designed for standardizing assessment of this construct in the 4 included RCTs and not tested for validity or reliability. All studies were reasonably well protected against bias (PEDro score 6/10). Scores on the questionnaire also were converted to a 0–100 scale for meta-analysis.

Comparison 2: SPs compared with peer role play. One RCT comparing SP interactions with peer role-play interactions (PEDro score 3/10) reported on self-administered questionnaires (no validity or reliability data provided) completed within 2 weeks of interactions for student-assessed competency to practice (clinical skills), satisfaction with the experience, value of the experience, and anxiety of the experience.[16] No significant differences were found for student-assessed competency to practice or satisfaction with the experience (Tab. 3). Statistically significant differences were found favoring the SP group for the value of the experience and anxiety felt by students (Tab. 3).

Comparison 3: SPs compared with no SPs. One nonrandomized trial comparing SP interactions with no additional intervention (PEDro score 2/10) showed no significant difference between groups on student-assessed competency to practice (interprofessional skills) assessed using a self-administered questionnaire[42] (time of administration unspecified, no validity or reliability data provided) (Tab. 3).

Study or Subgroup	Placement With 25% SPs X̄	SD	Total	Placement With No SPs X̄	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Educator-assessed competency to practice								
Blackstock et al,[17] 2013-RCT 1	64	16	162	65.25	15.75	161	24.0%	−1.25 (−4.71, 2.21)
Blackstock et al,[17] 2013-RCT 2	75.5	16.25	170	70	15.5	152	23.9%	5.50 (2.03, 8.97)
Watson et al,[18] 2012-RCT 1	68.25	13.75	186	67	13.5	185	28.2%	1.25 (−1.52, 4.02)
Watson et al,[18] 2012-RCT 2	65.25	16.25	171	64.5	16.5	172	23.9%	0.75 (−2.72, 4.22)
Subtotal (95% CI)			**689**			**670**	**100.0%**	**1.55 (−1.08, 4.18)**
Heterogeneity: tau²=4.40; χ²=7.74, *df*=3 (*P*=.05); I²=61%								
Test for overall effect: Z=1.15 (*P*=.25)								
Student-assessed competency to practice								
Blackstock et al,[17] 2013-RCT 1	79.5	9.75	162	78.25	8.25	161	27.3%	1.25 (−0.72, 3.22)
Blackstock et al,[17] 2013-RCT 2	79.25	11	170	80.75	9.5	152	26.5%	−1.50 (−3.74, 0.74)
Watson et al,[18] 2012-RCT 1	80.25	16	186	80.25	13.5	185	24.1%	0.00 (−3.01, 3.01)
Watson et al,[18] 2012-RCT 2	80.75	17	171	73	17	172	22.1%	7.75 (4.15, 11.35)
Subtotal (95% CI)			**689**			**670**	**100.0%**	**1.66 (−1.60, 4.91)**
Heterogeneity: tau²=9.10; χ²=18.79, *df*=3 (*P*=.0003); I²=84%								
Test for overall effect: Z=1.00 (*P*=.32)								

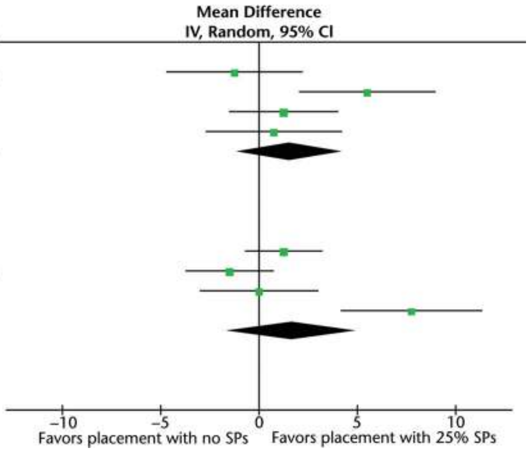

Figure 2.

Meta-analysis forest plot of clinical placement with 25% SP substitution compared with usual clinical placement (no SPs). SP=simulated patient, IV=inverse variance, RCT=randomized controlled trial.

Study or Subgroup	Post-SPs X̄	SD	Total	Pre-SPs X̄	SD	Total	Weight	Standardized Mean Difference IV, Fixed, 95% CI
Hale et al,[35] 2006	3.61	0.75	29	2.57	0.98	29	33.3%	1.18 (0.62, 1.74)
Hayward et al,[36] 2010	4.22	0.52	47	3.86	0.59	47	60.7%	0.64 (0.23, 1.06)
LaPier,[40] 1997	8.2	2.01	6	5.21	2.01	6	6.0%	1.37 (0.06, 2.69)
Total (95% CI)			**82**			**82**	**100.0%**	**0.86 (0.54, 1.19)**
Heterogeneity: χ²=2.86, *df*=2 (*P*=.24); I²=30%								
Test for overall effect: Z=5.24 (*P*<.00001)								

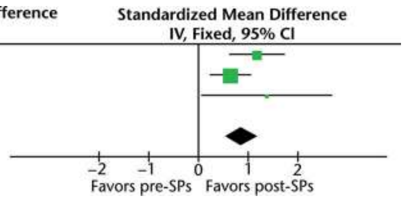

Figure 3.

Meta-analysis forest plot of pre- and post-SP interaction scores on student-assessed clinical skills. SP=simulated patient, IV=inverse variance, RCT=randomized controlled trial.

Study or Subgroup	Post-SPs X̄	SD	Total	Pre-SPs X̄	SD	Total	Weight	Standardized Mean Difference IV, Random, 95% CI
Hayward et al,[36] 2010	4.09	0.43	47	3.47	0.57	47	51.7%	1.22 (0.78, 1.66)
Lewis et al,[15] 2008	12.02	1.75	31	10.95	1.87	34	48.3%	0.58 (0.09, 1.08)
Total (95% CI)			**78**			**81**	**100.0%**	**0.91 (0.29, 1.53)**
Heterogeneity: tau²=0.14; χ²=3.50, *df*=1 (*P*=.06); I²=71%								
Test for overall effect: Z=2.87 (*P*=.004)								

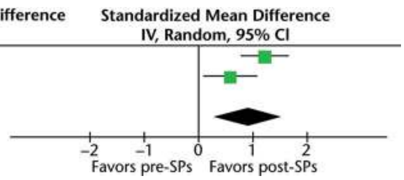

Figure 4.

Meta-analysis forest plot of pre- and post-SP interaction scores on student-assessed confidence. SP=simulated patient, IV=inverse variance, RCT=randomized controlled trial.

Comparison 4: before and after SP interaction. Several studies implemented SP interactions for a single cohort and assessed students before and after interaction. One study (PEDro score 2/10) reported student-assessed competency to practice (interprofessional skills) using self-report questionnaires (time of administration unspecified, no validity or reliability data provided) and reported significantly higher postintervention scores[35] (Tab. 3).

The effect of SP interactions on student-assessed clinical skills was reported in 3 pretest-posttest studies[35,36,40]; fixed-effects meta-analysis determined a significantly higher postinteraction score (Fig. 3). Two studies reported significantly higher postinteraction scores for student-assessed confidence[15,36] (Fig. 4). One study specified that data were collected 2 weeks prior to SP interaction and 1 week after the interaction[15]; other studies did not specify when preinteraction or postinteraction data were collected.[36,40]

Some study outcomes could not be synthesized in this review. No clear construct was apparent for data reported by Hale et al.[35] Ladyshewsky and Gotjamanos[39] did not report standard deviations and or sufficient data to enable us to impute or estimate standard deviations. Standard deviations also could not be imputed for the survey results of Hayward et al[20] or for results reported by Jensen and Richert,[38] and raw data were requested but not available from Smith and colleagues.[41]

Table 3.
Individual Study Statistical Significance Testing[a]

Study	Intervention	Measure of Effect	Control	Construct	Participants	QA Score	Findings of 2-Tailed *t* Test
Black et al,[16] 2002	SP interactions	Not significantly different	Peer role-play interactions	Student-assessed competency to practice (clinical skills) 0–10 scale, higher score=more competent	39 (intervention group, n=19; control group, n=20)	2/10	Mean difference=0.71 (95% CI=−0.29, 1.71), P=.16 Effect size=0.46 (95% CI=−0.19, 1.09)
Black et al,[16] 2002	SP interactions	Not significantly different	Peer role-play interactions	Satisfaction with the experience 0–10 scale, higher score=more satisfaction	39 (intervention group, n=19; control group, n=20)	2/10	Mean difference=0.56 (95% CI=−0.16, 1.28), P=.12 Effect size=0.51 (95% CI=−0.14, 1.14)
Black et al,[16] 2002	SP interactions	Significantly more effective	Peer role-play interactions	Value of the experience 0–10 scale, higher score=more value	39 (intervention group, n=19; control group, n=20)	2/10	Mean difference=1.94 (95% CI=0.97, 2.91), P<.001 Effect size=1.30 (95% CI=0.58, 1.96)
Black et al,[16] 2002	SP interactions	Significantly more effective	Peer role-play interactions	Anxiety of the experience 0–10 scale, higher score=more anxious	39 (intervention group, n=19; control group, n=20)	2/10	Mean difference=1.95 (95% CI=0.33, 3.57), P=.02 Effect size=0.78 (95% CI=0.11, 1.41)
Wamsley et al,[42] 2012	SP interactions	Not significantly different	No additional intervention	Student-assessed competency to practice (interprofessional skills), 1–6 scale, higher score=more competent	16 (intervention group, n=7; control group, n=9)	2/10	Mean difference=0.18 (95% CI=−0.51, 0.87), P=.59 Effect size=0.28 (95% CI=–0.73, 1.26)
Hale et al,[35] 2006	Post-SP interaction	Not available; no independent control group	Pre-SP interaction	Student-assessed competency to practice (interprofessional skills), 1–5 scale, higher score=more competent	29	2/10	Mean difference=0.52 (95% CI=0.12, 0.92), P=.01 Effect size=0.69 (95% CI=0.15, 1.21)

[a] SP=simulated patient, QA=quality assessment, CI=confidence interval.

Thematic Analysis of Qualitative Data

One major theme (learning with SPs is valuable) and one minor theme (learning with SPs can be challenging) emerged from thematic analysis of qualitative evaluation data. Themes for studies with SP interactions were compared with those of studies without SP interactions.

Students consistently reported that learning with SPs was valuable for learning. Simulation felt more "real" than role play and was perceived as useful for developing competencies, and the feedback from SPs and educators was valuable:

> I really think this is a great way to learn. Working with each other is good, but we tend to be a little more lax with each other.[16]

> I think the feedback from a variety of sources with different backgrounds (academic, patient, peers) is very helpful to give us a very well-rounded view of what we do well and what we need to improve.[36]

Practice with simulation enabled gaps in knowledge to be identified, improved student perceptions of clinical skills, and contributed to higher self-perceived clinical readiness and confidence for practice. Students considered the simulation environment to be realistic, which enabled learning:

> I believe I learned a great deal about myself during these experiences. I found some areas of weakness that I can address, as well as strengths I can continue to enhance.[38]

> This experience aided in the preparation for our first clinical affiliation in that it forced me to truly think in the therapist's shoes, think about the sequence of what I was going to say, do, examine, test.[36]

Simulated patient interactions were not always better than optional education: learning ECG monitoring with SPs who recited a standardized script was considered by students to be not as valuable as use of a mannequin with real-life ECG monitoring.[41]

Clinical educators noted that the clinical performance of students who had worked with SPs appeared to be no different from that of students who had not worked with SPs.[36] Some students also expressed that learning with SPs is challenging because it induces anxiety and can be stressful. Particularly challenging aspects of learning with SPs were being observed by peers and receiving feedback from clinical educators.

Discussion

This review indicates that SPs appear to have an effect comparable to that of alternative educational strategies on development of physical therapy clinical practice competencies for entry to practice. However, it may be that the time allocated to SP practice has not been sufficient to enable a full view of effects (if indeed they are present). It also may be that methods used to assess learning outcomes are inadequately sensitive to small differences in performance that might occur. In any case, under the conditions reported in current literature, there are no obvious effects (detrimental or positive) associated with replacing optional educational approaches with education involving SPs. Students consider that learning with SPs is valuable. However, methodological weaknesses in studies investigating the contribution of SPs to physical therapy education make it difficult to arrive at unequivocal conclusions about their value. Empirical studies assessed as having a low risk of bias demonstrated that 25% of a 4-week clinical placement substituted with SP interactions enabled similar levels of clinical competence over 7 key domains of physical therapist practice (professional behavior, communication, assessment, analysis and planning, intervention, evidence-based practice, and risk management). Substitution of authentic practice with SP practice may expand the practical learning opportunities available to learners.

In this review, evidence from lower-quality empirical studies supported the finding that SPs make a positive contribution to physical therapy education. Students reported that learning with SPs was valuable for their sense of clinical readiness, confidence, and other skills. This learning was thought to be the product of a realistic replication of an authentic clinical environment, structured feedback, and debriefing with educators. Learning with SPs may be more valuable than peer role play or no SP exercises. Immediate pre- and post-SP interaction data indicated that students perceive clinical skills and interprofessional skills, and confidence improved as a result of interactions with SPs. Without comparison data, it is not possible to determine whether pre-existing (and potentially cheaper) physical therapy curricula content already achieves similar outcomes for students. Due to methodological weaknesses of the included single-cohort studies, it also is not possible to conclude whether the magnitude of observed effects in self-assessed skills would have occurred with time alone, other educational interventions, or no SP practice. Simulated patients challenged students because the interactions induced anxiety and stress. Anxiety and stress are also common for students working with real patients on clinical placements.[45] An area for further investigation is whether learning to deal with anxiety and stress in preclinical SP interactions reduces anxiety and stress that might occur early in real practice.

Most studies in this review provided some information about the methods used to implement an SP program into entry-level physical therapy education. A common practice was to formally train SPs prior to interactions with students, using activities such as supervised rehearsal and instruction on how to give feedback. These are widely accepted and endorsed practices.[7,25] It also was common to draw on the SPs' experiences to provide feedback to students on their performance, and this feedback was considered valuable. In most studies, insufficient detail was provided to enable direct replication or integration of methods used in SP programs into current practice. An exception was Blackstock et al,[17] who provided information on program design, integration, SP scenario development, and SP training.

The high cost of SPs in physical therapy education has previously been documented as a major barrier to uptake.[5,46] Other studies have concluded that simulation programs with high-fidelity mannequins were considered too costly to justify their use as alternatives to clinical placement.[12,47] Simulated patient program costs were mostly underreported in this review; few data are available to provide an economic evaluation of the effects of substituting traditional clinical placement with reduced clinical placement plus SPs. The cost of implementing SP programs consistent with the protocol of Watson et al[18] was flagged as a potential barrier to future replication of the program, and Blackstock et al[17] acknowledged that implementation of SP programs to the level reported in their study could be expensive. Detailed evaluations of the costs involved to set up and sustain these programs matched against effects on student outcomes using long-term follow-up studies would be beneficial. A systematic review of economic analyses of SBE in health care professions (59 articles, pre-2011) showed that cost reporting in SBE is essential but infrequent and incomplete.[48] These results informed the development of a framework for accounting and reporting costs of SBE. If implementing an SP program, educators may need to conduct pilot interventions that include economic evaluations, think strategically about the target skills, and consider the nature of the simulation that best serves learning needs for physical therapy students to ensure the program is viable for clinical education budgets.

Four studies in this review demonstrated that it was feasible to determine the effect of SPs on educator-assessed physical therapy student competency and suitability for independent practice using the RCT.[17,18] Due to robust study designs, use of valid outcome measures, and transparent reporting of procedures and results, these data can influence future policy regarding funding directives for SBE projects in physical therapy. Future research in this area could target comparable investigation standards. Several factors, including but not limited to the use of weak study designs (single-cohort or nonrandomized trials), nonvalidated and nonspecific outcome measures (purpose-designed self-report questionnaires), and the significant underreporting of statistical methods, training of SPs, and educational intervention details, limited the potential for published work to influence current practice. Furthermore, all studies included in this review investigated the short-term outcomes of learning with SPs; follow-up data collection ranged from immediately after intervention to up to 2 weeks after intervention. No study, to our knowledge, has investigated the impact of learning with SPs on long-term student outcomes (eg, later in their physical therapy training, after graduation as clinicians) or patient outcomes. Longer-term effects of SP education might justify the expense.

Strengths and Weaknesses

Independent data sorting, bias assessment, and data extraction and the inclusion of both quantitative and qualitative evaluation data strengthen this review. Pooling individual survey items across the construct that they were evaluating enabled synthesis of all available data from varied methods and sources. However, assumptions were made to enable pooling data, and the results, at best, can serve as indicators of possible outcomes from employing SPs in physical therapy education. Review findings need validation with empirical data. The search strategy was limited to work published in English. Additionally, we cannot be sure all possible literature has been accessed using this search strategy. One of the review authors led one of the included studies[17] and was a coinvestigator on another study.[18] This author did not participate in the quality assessment or data extraction of either of these articles. We used a quality assessment method for qualitative studies that has not been validated. However, we have provided the items and decision rules for reader consideration, and we prefer the transparent and unambiguous nature of the item set to other published approaches.

Insufficient evidence is available to unequivocally determine the effect of SP interactions in entry-level physical therapy programs compared with no SP interaction or an alternative education strategy on learning outcomes. However, no detrimental outcomes have been reported, and no harms associated with substitution are apparent. Lower strength evidence suggests that SP practice has the potential to be a valuable addition to skill development, although sources of bias inherent in pretest-posttest studies exclude this as a definitive conclusion. Future research with robust study designs, transparent reporting, and cost analyses that report effects on short- and long-term student outcomes are needed to determine whether implementing SP programs is a viable education strategy.

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References

1 Motola I, Devine LA, Chung HS, et al. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. *Med Teach.* 2013;35:e1511–e1530.

2 Williams B, Brown T, Scholes R, et al. Can interdisciplinary clinical DVD simulations transform clinical fieldwork education for paramedic, occupational therapy, physiotherapy, and nursing students? *J Allied Health.* 2010;39:3–10.

3 Weller JM, Nestel D, Marshall SD, et al. Simulation in clinical teaching and learning. *Med J Aust.* 2012;196:1–5.

4 May W, Park JH, Lee JP. A ten-year review of the literature on the use of standardized patients in teaching and learning: 1996–2005. *Med Teach.* 2009;31:487–492.

5 Jull G, Wright A, McMeeken J, et al. *National Simulated Learning Project Report for Physiotherapy*. Adelaide, South Australia, Australia: Health Workforce Australia; 2010.

6 Gaba DM. The future vision of simulation in healthcare. *Simul Healthc.* 2007;2:126–135.

7 Nestel D, Bearman M. Introduction to simulated patient methodology. In: Nestel D, Bearman M, eds. *Simulated Patient Methodology: Theory, Evidence, and Practice*. Sussex, United Kingdom: John Wiley & Sons Ltd; 2015:1–4.

8 Barrows HS. An overview of the uses of standardised patients for teaching and evaluating clinical skills. *Acad Med.* 1993;68:443–452.

9 Lasater K. High-fidelity simulation and the development of clinical judgement: students' experiences. *J Nurs Educ.* 2007;46:269–276.

10 Dreifuerst KT. The essentials of debriefing in simulation learning: a concept analysis. *Nurs Educ Perspect.* 2009;30:109–114.

11 Nestel D, Groom J, Eikeland-Husebø S, O'Donnell JM. Simulation for learning and teaching procedural skills. *Simul Healthc.* 2011;6:S10–S13.

12 Jones A, Sheppard L. Use of a human patient simulator to improve physiotherapy cardiorespiratory clinical skills in undergraduate physiotherapy students: a randomised controlled trial. *Internet Journal of Allied Health Sciences & Practice.* 2011;9(1). Article 12.

13 Kneebone R, Nestel D, Wetzel C, et al. The human face of simulation: patient-focused simulation training. *Acad Med.* 2006;81:919–924.

14 Blackstock FC, Jull GA. High-fidelity patient simulation in physiotherapy education. *Aust J Physiother.* 2007;53:3–5.

15 Lewis M, Bell J, Asghar A. Use of simulated patients in development of physiotherapy students' interpersonal skills. *Int J Ther Rehabil.* 2008;15:221–227.

16 Black B, Marcoux BC. Feasibility of using standardized patients in a physical therapist education program: a pilot study. *J Phys Ther Educ.* 2002;16:49–56.

17 Blackstock FC, Watson KM, Morris NR, et al. Simulation can contribute a part of cardiorespiratory physiotherapy clinical education. *Simul Healthc.* 2013;8:32–42.

18 Watson K, Wright A, Morris N, et al. Can simulation replace part of clinical time? Two parallel randomised controlled trials. *Med Educ.* 2012;46:657–667.

19 Cahalin LP, Markowski A, Hickey M, Hayward L. A cardiopulmonary instructor's perspective on a standardized patient experience: implications for cardiopulmonary physical therapy education. *Cardiopulm Phys Ther J.* 2011;22:21–30.

20 Hayward LM, Blackmer B, Markowski A. Standardized patients and communities of practice: a realistic strategy for integrating the core values in a physical therapist education program. *J Phys Ther Educ.* 2006;20:29–37.

21 Ladyshewsky R, Baker R, Jones M, Nelson L. Reliability and validity of an extended simulated patient case: a tool for evaluation and research in physiotherapy. *Physiother Theory Pract.* 2000;16:15–25.

22 Ladyshewsky R, Baker R, Jones M, Nelson L. Evaluating clinical performance in physical therapy with simulated patients. *J Phys Ther Educ.* 2000;14:31–37.

23 McGaghie WC, Issenberg SB, Cohen ER, et al. Does simulated-based medical education with deliberate practice yield better results than traditional clinical education? A meta-analytic comparative review of the evidence. *Acad Med.* 2011;86:706–711.

24 Issenberg SB, McGaghie WC, Petrusa ER, et al. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. *Med Teach.* 2005;27:10–28.

25 Cleland JA, Abe K, Rethans JJ. The use of simulated patients in medical education: AMEE Guide No. 42. *Med Teach.* 2009;31:477–486.

26 Boulet JR, Smee SM, Dillon GF, Gimpel JR. The use of standardized patient assessments for certification and licensure decisions. *Simul Healthc.* 2009;4:35–42.

27 Lane C, Rollnick S. The use of simulated patients and role-play in communication skills training: a review of the literature to August 2005. *Patient Educ Couns.* 2007;67:13–20.

28 Mori B, Carnahan H, Herold J. Use of simulation learning experiences in physical therapy entry-to-practice curricula: a systematic review. *Physiother Can.* 2015;67:194–202.

29 Sharma R, Gordon M, Dharamsi S, Gibbs T. Systematic reviews in medical education: a practical approach: AMEE guide 94. *Med Teach.* 2015;37:108–124.

30 *How to Review the Evidence: Systematic Identification and Review of the Scientific Literature.* Canberra, Australia: National Health and Medical Research Council; 1999.

31 de Morton NA. The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *Aust J Physiother.* 2009;55:129–133.

32 Maher CG, Sherrington C, Herbert RD, et al. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther.* 2003;83:713–721.

33 Bearman M, Dawson P. Qualitative synthesis and systematic review in health professions education. *Med Educ.* 2013;47:252–260.

34 Higgins J, Thompson S, Deeks J, Altman D. Measuring inconsistency in meta-analyses. *BMJ.* 2003;327:557–560.

35 Hale LS, Lewis DK, Eckert RM, et al. Standardized patients and multidisciplinary classroom instruction for physical therapist students to improve interviewing skills and attitudes about diabetes. *J Phys Ther Educ.* 2006;20:22–27.

36 Hayward LM, Blackmer B. A model for teaching and assessing core values development in doctor of physical therapy students. *J Phys Ther Educ.* 2010;24:16–26.

37 Hensman M, Conduit J. Exploring lessons learnt: reflections of physiotherapy students participating in interprofessional clinical skills simulations. *Int J Ther Rehabil.* 2012;19:317–325.

38 Jensen GM, Richert AE. Reflection on the teaching of ethics in physical therapist education: integrating cases, theory, and learning. *J Phys Ther Educ.* 2005;19:78–85.

39 Ladyshewsky R, Gotjamanos E. Communication skill development in health professional education: the use of standardised patients in combination with a peer assessment strategy. *J Allied Health.* 1997;26:177–186.

40 LaPier TK. Preparing physical therapy students to evaluate and treat cardiopulmonary patients in the intensive care unit. *Acute Care Perspectives.* 1997;5:1.

41 Smith N, Prybylo S, Conner-Kerr T. Using simulation and patient role play to teach electrocardiographic rhythms to physical therapy students. *Cardiopulm Phys Ther J.* 2012;23:36–42.

42 Wamsley M, Staves J, Kroon L, et al. The impact of an interprofessional standardized patient exercise on attitudes toward working in interprofessional teams. *J Interprof Care.* 2012;26:28–35.

43 Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement. *PLoS Med.* 2009;6:e1000097.

44 Dalton M, Davidson M, Keating JL. The Assessment of Physiotherapy Practice (APP) is a valid measure of professional competence of physiotherapy students: a cross-sectional study with Rasch analysis. *J Physiother.* 2011;57:239–246.

45 Alzayyat A, Al-Gamal E. A review of the literature regarding stress among nursing students during their clinical education. *Int Nurs Rev.* 2014;61:406–415.

46 Paparella-Pitzel S, Edmond S, DeCaro C. The use of standardized patients in physical therapist education programs. *J Phys Ther Educ.* 2009;23:15–23.

47 Shoemaker MJ, Beasley J, Cooper M, et al. A method for providing high-volume interprofessional simulation encounters in physical and occupational therapy education programs. *J Allied Health.* 2011;40:e15–e21.

48 Zendejas B, Wang AT, Brydges R, et al. Cost: the missing outcome in simulation-based medical education research: a systematic review. *Surgery.* 2013;153:160–176.