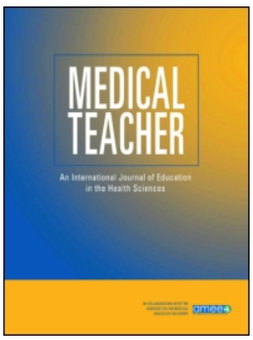

Medical Teacher

ISSN: 0142-159X (Print) 1466-187X (Online) Journal homepage: https://www.tandfonline.com/loi/imte20

A BEME realist synthesis review of the effectiveness of teaching strategies used in the clinical setting on the development of clinical skills among health professionals: BEME Guide No. 61

Cason Pierce, Janet Corral, Eva Aagaard, Ben Harnke, David M. Irby & Chad Stickrath

To cite this article: Cason Pierce, Janet Corral, Eva Aagaard, Ben Harnke, David M. Irby & Chad Stickrath (2020): A BEME realist synthesis review of the effectiveness of teaching strategies used in the clinical setting on the development of clinical skills among health professionals: BEME Guide No. 61, Medical Teacher, DOI: 10.1080/0142159X.2019.1708294

To link to this article: https://doi.org/10.1080/0142159X.2019.1708294

MEDICAL TEACHER
https://doi.org/10.1080/0142159X.2019.1708294

BEME GUIDE

A BEME realist synthesis review of the effectiveness of teaching strategies used in the clinical setting on the development of clinical skills among health professionals: BEME Guide No. 61

Cason Pierce[a], Janet Corral[a], Eva Aagaard[b], Ben Harnke[c], David M. Irby[d] and Chad Stickrath[a]

[a]Department of Medicine, University of Colorado Anschutz, Aurora, CO, USA; [b]Department of Medicine, Washington University School of Medicine, St. Louis, MO, USA; [c]Strauss Health Sciences Library, University of Colorado Anschutz, Aurora, CO, USA; [d]Department of Medicine, University of California, San Francisco, CA, USA

ABSTRACT

Background: Literature describing the effectiveness of teaching strategies in the clinical setting is limited. This realist synthesis review focuses on understanding the effectiveness of teaching strategies used in the clinical setting.

Methods: We searched ten databases for English language publications between 1 January 1970 and 31 May 2017 reporting effective teaching strategies, used in a clinical setting, of non-procedural skills. After screening, we used consensus to determine inclusion and employed a standardised instrument to capture study populations, methodology, and outcomes. We summarised what strategies worked, for whom, and in what settings.

Results: The initial search netted 53,642 references after de-duplication; 2037 were retained after title and abstract review. Full text review was done on 82 references, with ultimate inclusion of 25 publications. Three specific teaching strategies demonstrated impact on educational outcomes: the One Minute Preceptor (OMP), SNAPPS, and concept mapping. Most of the literature involves physician trainees in an ambulatory environment. All three have been shown to improve skills in the domains of medical knowledge and clinical reasoning.

Discussion/conclusions: Apart from the OMP, SNAPPS, and concept mapping, which target the formation of clinical knowledge and reasoning skills, the literature establishing effective teaching strategies in the clinical setting is sparse.

KEYWORDS
Effective clinical teaching; realist synthesis review; educational outcomes

Background

A substantial portion of health professions education occurs in clinical settings, yet how clinical skills are best taught within them is not well understood. Because of this knowledge gap and the challenge of providing health professions education in complex workplaces, educators and researchers have observed or devised numerous and varied approaches to foster learning in the clinical setting—generally based on educational and behavioural theories and the current understanding of knowledge and skills acquisition (Spencer 2003a; Kilminster et al. 2007; Ramani and Leinster 2008; Ende et al. 2010; Gaberson and Oermann 2010; Nilsson et al. 2010; Conn et al. 2012; Abdool and Bradley 2013). Although these approaches and theories certainly provide guidance for those engaged in clinical teaching, the most optimal, direct, and the specific application is not always apparent to frontline clinicians or health professions educators. In support of this argument is a body of literature filled with suggestions on strategies that teachers could use, with most of these publications failing to document efficacy on skills formation (Cunningham et al. 1999; Dave 1999; Roth et al. 2003; Wolpaw et al. 2003; Irby and Bowen 2004; Irby and Wilkerson 2008; Barrington and Street 2009; Certain et al. 2011; Back et al. 2013; Brown and Bush 2013; Stickrath et al. 2013; Chretien et al. 2014; Chamberland et al. 2015; Chew et al. 2016; King et al. 2016). To address this knowledge gap, several reviews have sought to establish the impact of general teaching methods on competency formation (Aspegren 1999; Issenberg et al. 2005; Veloski et al. 2006; Hammick et al. 2007; Colthart et al. 2008; Craig 2011; Birden et al. 2013; Reeves et al. 2016), while others have effectively summarised well-known clinical teaching strategies (Cayley 2011; Chinai et al. 2018). Unfortunately, neither of these more focused summaries (Cayley 2011; Chinai et al. 2018) took a systematic approach to identify potentially relevant literature, and both focused on a narrow learner group (physician only) in

Practice points

- The One-Minute Preceptor and SNAPPS are the only well-established teaching strategies consistently proven effective in the clinical setting.
- Concept mapping may be an effective strategy for teaching clinical reasoning in the clinical setting.
- There are no well-established, specific teaching strategies utilised in the clinical setting shown to improve skills in the domains of empathy, communication, or professionalism.

CONTACT Cason Pierce cason.pierce@dhha.org 601 Broadway, MC4000, Denver, CO 80203, USA

Supplemental data for this article can be accessed here.

a specific clinical setting. Recognizing that the effectiveness of instructional strategies is often dependent upon the context of the learning environment (Ramani and Leinster 2008) but that strategies used in one context or discipline could have applicability to other contexts or disciplines, this review seeks to expand upon this important prior work. It examines more broadly the topic of effective teaching strategies used in a clinical setting, including those studied in the training of non-physician health professionals. Specifically, this BEME realist synthesis review seeks to answer the unanswered question: Which clinical teaching strategies are effective in what contexts and among which health professional learners?

Methods

Rationale for using a realist synthesis review

A realist synthesis review is an interpretive review that seeks to synthesise the existing literature to determine how and why certain interventions were effective and for which individuals (Ellaway et al. 2016; Mertens et al. 2018). We elected to conduct this type of review for three reasons. First, the body of literature related to teaching in the clinical setting is expansive. Thus a focused search approach may miss important literature. Second, the clinical environment is complex, and interventions in one setting may or may not be generalizable to others. Third, based on our preliminary scoping review, the interventions, teacher and learner populations, the outcomes of interest, and the methodology used to assess impacts were highly variable. Consequently, to fully answer the question for the medical education community around what works in clinical education, for whom and when, the current literature required a realist synthesis approach of connecting the context of clinical bedside teaching, with the mechanism of teaching, and the learning outcomes. For guidance, the authors used the Realist Synthesis RAMESES training materials (Wong et al. 2013, 2017)

Development of an analytic framework, screening, and selection

The study populations of interest were trainees from across the health professions: medicine, nursing, occupational and physical therapy, speech-language, pharmacy, midwifery, dentistry, and veterinary medicine. These disciplines were selected because (1) they all involve learning and teaching in a clinical setting and (2) all seek to develop competency in most (if not all) of the outcomes of interest, which included clinical reasoning, medical knowledge, physical examination, professionalism, empathy, patient-centeredness, and communication.

Importantly, this review is limited to non-procedural skills teaching. While the optimal teaching of procedural skills often shares general elements with the teaching of non-procedural skills—for example, structured feedback and debriefing—procedural skills formation also typically relies upon cadavers, physical models, skills labs, video-recordings, or simulation centres (Hayden and Panacek 1999; Greif et al. 2010; McGaghie et al. 2010; DaRosa et al. 2013; Irvine and Martin 2014; Allavena et al. 2017; Soucisse et al. 2017; Causby et al. 2018). Furthermore, procedural skills have additional steps in the learning process that go beyond cognitive knowledge and involve psychomotor/haptic/sensory input and require repeated practice until automation is achieved (Lake and Hamdorf 2004; Grantcharov and Reznick 2008). These differences suggest that a teaching strategy oriented toward cognitive learning may not necessarily transfer to psychomotor skills learning. Separately, the initial scoping review suggested that expanding the literature search to include strategies for the teaching of procedural skills would yield too many publications to feasibly screen and review. For these reasons, this review is restricted to strategies used for teaching non-procedural skills.

One of the more challenging elements of this review was reaching a shared definition of 'teaching strategy.' Authors ultimately agreed upon a narrow definition of 'strategy' as a specific, clearly defined structure for the teacher/learner interaction. Strategies needed to be more than a mnemonic device, checklist, or worksheet. This decision necessarily excluded from the analysis a number of described approaches to diagnostic reasoning (Woods et al. 2014; Chew et al. 2016) and clinical precepting (Roth et al. 2003). It also excluded general teaching approaches taught in a variety of ways, including: 'reflection,' 'role-modelling,' 'learning contracts,' 'feedback,' and 'activated demonstration.' Fortunately, others have addressed, or are currently reviewing, many of these broader topics (Aspegren 1999; Issenberg et al. 2005; Birden et al. 2013; Passi et al. 2013; Reeves et al. 2016).

The strategy also needed to be consistently named throughout the literature, highly reproducible, and feasibly implemented with minimal written and/or in-person instructions, thereby excluding simulations and curricula offered on a larger scale (for example, full courses on communications training). The RIME framework and the mini-CEX were characterised as assessment tools, not teaching strategies, and therefore excluded.

Finally, 'structural' changes to the teacher-learner-patient interaction without utilisation of a specific teaching strategy fell outside the focus of this review. For example, teaching at the bedside versus removed from the patient (Gonzalo et al. 2010) and changes to teacher/learner pairings (Bell and Turner 2010; Clementz et al. 2015; Doumouras et al. 2015) were excluded.

Search strategy

A health sciences librarian (BH) conducted a literature search between the dates of August 29, 2017 and September 5, 2017. English language citations from 1970 to the present were retrieved from the following databases: Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily, Ovid MEDLINE and Versions(R); psychINFO via Ovid; Embase.com; CINAHL via EBSCO; ERIC via EBSCO; Web of Science; ProQuest Dissertations; Google Scholar; WorldCat (firstsearch.oclc.org); Library of Congress (loc.gov). Because of resource limitations that precluded translation, only articles published in English were reviewed.

The search had two phases. Phase 1 focused on (unknown) specific named strategies used in a clinical setting to teach non-procedural skills. Text words and their corresponding Medical Subject Headings (MeSH) and

Emtree (Embase controlled vocabulary) terms were identified by examining language associated with known named teaching strategies. Additional search terms were identified through expert content knowledge. In Phase 2, the search strategy focused on the basic structure: non-procedural skill + teaching (see Supplementary Appendix for full search strategy). This strategy was applied to all of the above databases, with simplified versions run in databases with limited search capabilities (WorldCat, Library of Congress, Google Scholar, ProQuest Dissertations). In non-medical databases (ERIC, Web of Science), additional search terms naming the medical personnel of interest (residents, junior physicians, etc.) were included to limit irrelevant results. The librarian (BH) uploaded these search results and additional hand searched citations to EndNote and then to the reference manager Covidence for review.

Upon completion of phase one, 153 named teaching strategies were identified. These were tested and refined to maximise specificity (highly relevant results). A second search was run for these named strategies in the primary medical databases of Ovid Medline and Embase.com on 29 March 2018 with no date or language restrictions. These results were combined with those generated from the first search.

Inclusion and exclusion

Through title review, two authors (CP and CS) made the initial determination about whether to potentially include or exclude articles based on all of the following: relevance to our topic, use of a named teaching method or strategy, study among a health professional population, the measurement of pre-specified outcomes of interest as defined in our protocol, and availability of full publication in the English language. We excluded letters and commentary. Following the title review, two authors (CP and CS) reviewed publication abstracts and, where necessary, full texts of publications to further determine the appropriateness for potential inclusion. From these identified texts, both specific, named strategies and more general themes (for example 'reflection' and 'activated demonstration') were extracted. The group (CS, JC, EA, DI, CS) then discussed in several conference calls each general teaching method and specific strategy. Determinations about final inclusion were made using the consensus definition of a 'teaching strategy.'

Protocol modifications

Three modifications to our original protocol were made. First, a planned search of MedEdPortal (www.mededportal.org) ultimately became a limited search of this database as our initial two-step search yielded more than 50,000 articles, suggesting our literature review was adequately comprehensive. The group also surmised that if there were strategies described in MedEdPortal with demonstrated effective educational outcomes, they would likely have been published elsewhere in the literature.

Second, although the initial plan was to have two independent investigators extract data for each included publication, there were very few discrepancies identified in comparing the initial independent data extractions made by the different authors. Moreover, because two members of the group (EA and DI) had authored candidate publications for inclusion in the final analysis, they were not assigned to review or extract data from publications they had authored. Thus, data extraction for the residual candidate publications was ultimately only done by one author (CP).

Third, although in the original protocol, the authors proposed start date of 1946 for the search period, it became apparent during our search implementation that identifying literature prior to 1970 in the electronic databases would be problematic, as would obtaining the manuscripts for screening any identified candidate publications. Thus, only literature from 1970 onwards was included.

Data extraction

Where necessary to fully inform our group decisions about inclusion or exclusion, all data on methodology, study populations, and outcomes were extracted from candidate publications into our standardised data collection tool (Pierce et al. 2017) (Appendix S1) using a REDCap (Research Electronic Data Capture) electronic data capture tool. This tool was adopted from previous published BEME data collections forms (Veloski et al. 2006; Reeves et al. 2016) based on the needs of this specific review.

Analysis and synthesis

To help answer the question of 'for whom' strategies worked, the authors determined the learner and teacher populations in which each strategy has been studied. As terminology for the level of the trainee can vary, general categories of pre-licensure, limited licensure (requiring supervised practice), and full licensure (able to practice independently) were used. The specific teacher population (faculty or other trainees more senior than the learners) was identified. The various clinical settings in which the strategies had been shown effective were also identified.

Next, the mechanism was identified based on whether learners or teachers were mostly responsible for its use. If effective strategy implementation required a learner orientation and that the learner initiates its use, it was classified as 'learner-led.' Conversely, if the teacher required orientation to the strategy and was primarily responsible for its application, it was classified as 'teacher-led.' If both parties required training and shared responsibility for implementation, it was classified as 'collaborative.' Lastly, the key outcomes each strategy impacted were extracted and noted as desirable (+), undesirable (−), or not significant (0).

The relative quality of evidence for a specific strategy was determined based on both the number of studies and their rigor. Studies lacking a comparison/control group were deemed relatively lower quality. High-quality studies included a comparison group, and those of the highest quality were randomised. Studies in which the outcomes were measured using direct observation of behaviour, video-recording, or standardised knowledge or skills tests were deemed higher quality than those using survey data or questionnaires.

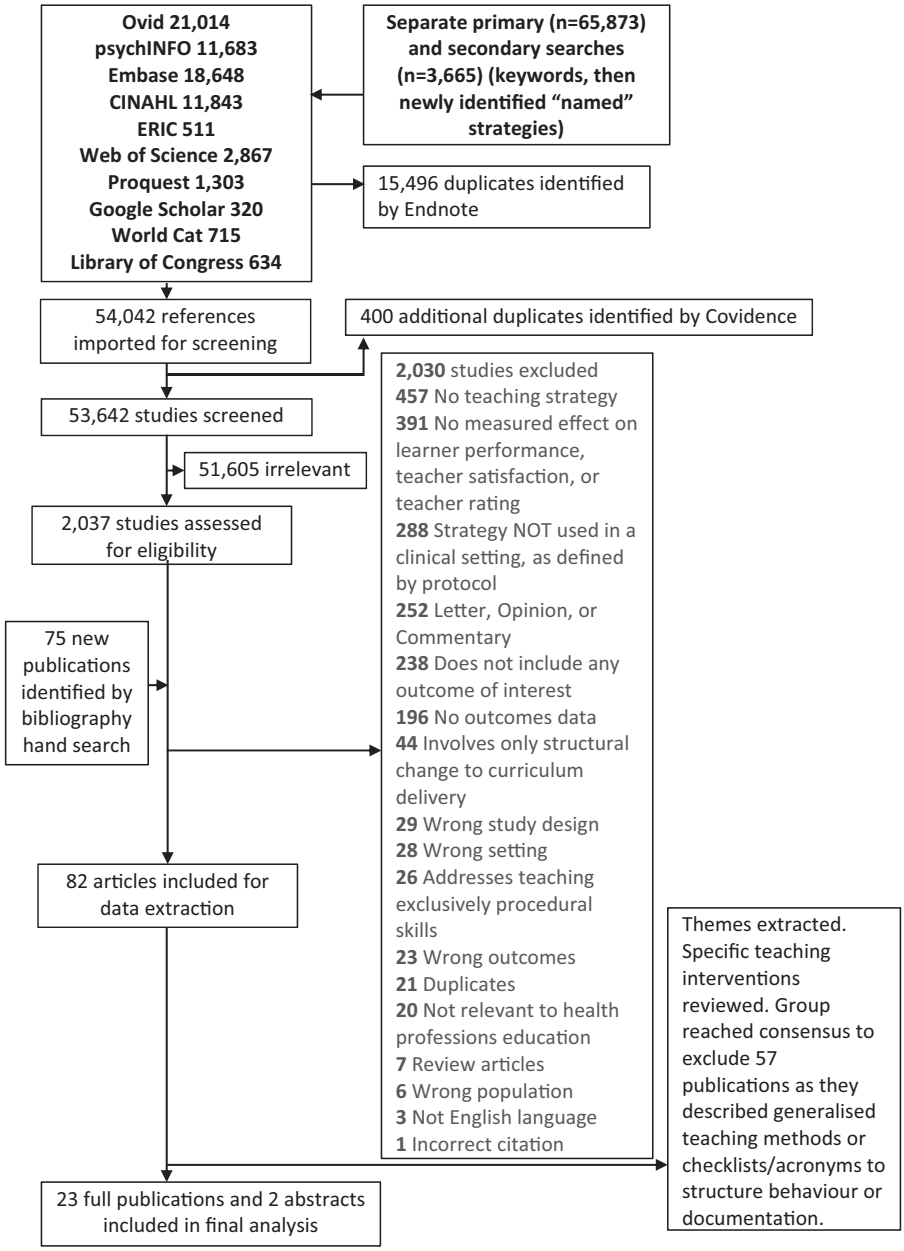

Figure 1. Inclusion and exclusion of search results.

Results

The search yielded 53,642 unique publications following de-duplication in EndNote and Covidence (Figure 1) that following title and abstract review and exclusions left 82 articles for data extraction. Following extensive group discussion, only 23 full publications and 2 abstracts of these met our strict inclusion criteria. These publications represented literature demonstrating outcomes of three different teaching strategies: the One Minute Preceptor (OMP) (Furney et al. 2001; Salerno et al. 2002; Aagaard et al. 2004; Irby et al. 2004; Teherani et al. 2007; Okubo et al. 2014; Schaye et al. 2015; Ong et al. 2017), SNAPPS (Wolpaw et al. 2003, 2009, 2012; Okubo et al. 2014; Sawanyawisuth et al. 2015; Barangard et al. 2016; Kapoor et al. 2017), and concept mapping (Wheeler and Collins 2003; Abel and Freeze 2006; Hinck et al. 2006; Atay and Karabacak 2012; Huang et al. 2012; Wahl and Thompson 2013; Kaddoura et al. 2016). Two abstracts (Dubey et al. 2013, 2015) examined the OMP and two publications evaluated modified versions of the OMP (Ottolini et al. 2010, Hu et al. 2015). Each strategy is briefly described below.

The OMP is a teacher-led strategy derived from Neher's five-step micro skills of effective clinical teaching (Neher et al. 1992). It builds upon principles that observational studies identified as correlating with effective clinical teaching (Stritter et al. 1983; Wolverton and Bosworth 1985). The five steps are: (1) get a commitment, (2) probe for supporting evidence, (3) teach general rules, (4) reinforce what was done right, and (5) correct mistakes (Neher et al. 1992). The OMP is designed to enable identification of learner knowledge gaps to target teaching, to prompt the teacher to provide specific and corrective feedback, and to help foster a positive learning environment. In general, the OMP requires an orientation of the teacher to the strategy and practice using it.

SNAPPS is a learner-led teaching strategy that provides structure to a learner's case presentation. Its 6 steps derive from cognitive activity rating scales (Connell et al. 1999) and include: (1) summarise information, (2) narrow the differential, (3) analyse the differential through comparing and contrasting, (4) probe the preceptor to clarify uncertainty, (5) plan management for the patient's medical

issues, and (6) select a case for self-directed learning. In general, SNAPPS involves teaching these steps to the learner in orientation but also requires the teacher to have some familiarity.

Concept mapping is a collaborative strategy, originally developed from the field of cognitive psychology with links to neurobiology. Novak was an early proponent of this method in science education (Novak 1990). Learners use it to graphically represent and provide structure to distinct, inter-related ideas and overarching concepts. Specifically, learners: (1) cluster information to foster the formation of associations between related concepts, (2) draw directional arrows to demonstrate causality and inter-dependence, and (3) graphically impose hierarchy to organise information around themes. Learners typically receive extended, formal instruction on the technique and practice it several times before applying in a clinical setting. Teachers need to be oriented to the strategy in order to comprehend concept maps and provide learners meaningful feedback.

Table 1 summarises where the studies on these strategies were conducted, the learner populations, and the number of studies showing impacts in each domain of interest. Most studies were conducted in the United States. Most, but not all, examining the OMP and SNAPPS involved physician trainees in a clinic setting. In contrast, concept mapping was studied in a variety of clinical settings exclusively with nursing trainees (although concept mapping has been studied in other disciplines, its use in these disciplines appeared to be limited to classroom learning (Chape 2006; Torre et al. 2007; Canasi et al. 2014)). No strategy was studied outside the physician, nursing, midwife, or dental professions. None of the included studies demonstrated impacts on outcomes in the domains of empathy, professionalism, or patient-centeredness.

In Supplementary Table 2, the specific strategies are listed, along with learner populations, teacher populations, clinical context, a brief summary of the most common study designs, and the specific outcomes studied. Full details for individual publications, including methods, outcomes measures, and strengths and limitations are shown in Supplementary Table 3. The results for each strategy are described separately below.

OMP and variants

Studies demonstrating the effectiveness of the OMP model involved teachers of pre-licensure (medical student) and limited-licensure (house officers) learners, mostly in the United States. We excluded one letter (Arya et al. 2018) and one non-English publication (Brand et al. 2011) describing use in other populations. In terms of teachers, both house officers and faculty have effectively utilised the strategy. Because teachers were primarily responsible for implementation, it was classified as 'teacher-led.'

Most of these studies oriented faculty with a single brief workshop, used a pre/post design with a control group or used randomisation, and combined direct observation or recording of precepting sessions with teacher and learner surveys to determine outcomes.

Measured, improved outcomes in studies among physician trainees included teaching effectiveness, teaching efficiency, feedback (both quantity and specificity), specific teaching points made by the teacher, and learner motivation for outside learning (Furney et al. 2001; Salerno et al. 2002; Irby et al. 2004; Teherani et al. 2007; Schaye et al. 2015). These mapped to the domains of clinical reasoning and medical knowledge. In contrast to physician trainees, dental trainees perceived no impact on quantity or quality of clinical teaching from faculty using the OMP (Ong et al. 2017). Use of the OMP did not seem to impact patient satisfaction or visit length (Salerno et al. 2002). The OMP, while developed as a strategy for teaching in the clinic, demonstrated effectiveness in the hospital setting as well (Furney et al. 2001; Schaye et al. 2015).

There were two related strategies derived from the OMP—the Eight Step Preceptor (ESP) (Ottolini et al. 2010) utilised in ambulatory paediatrics, and the Ten Minute Preceptor (TMP) (Hu et al. 2015) used in teaching nursing trainees. In the ESP study, the authors added to the traditional (five step) OMP model: (6) listening without interruptions, (7) providing teaching on experiences with previous 'like patients,' and (8) prompting the learner to generate learning objectives. Ottolini demonstrated that better adherence to the ESP model, as measured by third-party observers, correlated with higher student ratings of teaching effectiveness while average visit time was not different between control and intervention groups (Ottolini et al. 2010).

The TMP is classified as an OMP variant because the authors attribute its origin to the OMP, and it derives directly from an OMP adaptation to nursing education called the Five Minute Preceptor (Bott et al. 2011). The TMP instructs nurse preceptors to take 10 min at the beginning of each shift to—with the learner—set the day's learning goals, understand the physical and psychological conditions of the learner, and provide support and give feedback. Preceptors spend another 10 min at the end of each shift discussing what tasks were accomplished, providing positive and negative feedback, and setting the next day's learning goals (Hu et al. 2015). The study involving the TMP version demonstrated an improved workplace experience, less reported workplace stress, and a reduction in anticipated workplace turnover among nursing trainees (Hu et al. 2015). Learners reported significantly higher satisfaction scores (approximately 1 point higher on a 6-point Likert Scale) with the preceptors' ability to provide individualised learning, goal setting and periodic evaluations, provision of step-by-step instructions, and autonomy. The authors also assessed the effects on work stress and experience (quality of workplace environment). At 3 months, scores for workplace stress were 1.3 points lower among learners exposed to the TMP, 0.97 points higher for workplace experience, and 1.19 points lower on the turnover intention scale; these effects were durable for up to three months (Hu et al. 2015).

SNAPPS and variants

SNAPPS has been shown effective within and outside the United States (Sawanyawisuth et al. 2015; Barangard et al. 2016; Kapoor et al. 2017). Studies have been limited to faculty teaching physician trainees in outpatient clinics only.

Most studies of SNAPPS included control groups for comparison or were randomised (Wolpaw et al. 2009, 2012; Sawanyawisuth et al. 2015; Barangard et al. 2016; Kapoor

Table 1. Data from extracted studies by location, health discipline, clinical setting, and outcomes domain.

	OMP[a] ($n = 12$[b])	SNAPPS[a] ($n = 7$)	Concept mapping ($n = 7$)
Location			
USA	9[c,f]	3	5
Taiwan	1[#]	0	1
India	0	1	0
Iran	0	1	0
Thailand	0	1	0
Singapore	1	0	0
Japan	1[a]	1[a]	0
Turkey	0	0	1
Health disciplines			
Physicians	10[c,f,a]	6[a]	0
Nursing	1[d]	0	7
Midwifery	0	1	0
Dentistry	1	0	0
Clinical settings			
Clinic	9[a,c,f]	7[a]	1
Hospital	3[#]	0	5
Not specified	0	0	1
Outcomes[e]			
Clinical reasoning	8[a]	5[a]	7
Knowledge	1[a]	3[a]	0
Empathy	0	0	0
Communication	0	0	0
Patient centeredness	0	0	0
Professionalism	0	0	0
Effective teaching	8	4	0
Presentation time	1	3	0
Patient satisfaction	1	0	0
Learner satisfaction	3[f]	1	1
Workplace stress	1[d]	0	0
Workplace experience	1[d]	0	0

Total unique full text publications = 23, Abstracts = 2. [a]Includes one study examining a combined intervention with OMP and SNAPPS. [b]Includes Eight Step Preceptor (ESP) and Ten Minute Preceptor (TMP), both derivatives of OMP, a study combining OMP/SNAPPS, and two abstracts. [c]Includes Eight Step Preceptor (ESP). [d]Ten Minute Preceptor (TMP) variant. [e]Numbers do not sum to total as studies could have multiple outcomes. [f]Includes two abstracts.

et al. 2017). Outcomes measures frequently involved recordings or third party observations and mapped primarily to the domains of medical knowledge and clinical reasoning. Some studies captured total case discussion and visit times (Wolpaw et al. 2009; Sawanyawisuth et al. 2015; Kapoor et al. 2017).

In terms of clinical reasoning outcomes, learners who were instructed to use SNAPPS (with trained faculty) provided on average 1.27 more items in the differential diagnosis (2.08 SNAPPS versus 0.81 comparison group) and 1.04 more total justification reasons for items in the differential diagnosis (1.26 versus 0.22) (Wolpaw et al. 2012). Students also were far more likely to seek information by asking questions or acknowledging uncertainties (84.38% SNAPPS versus 10.77% comparison), discuss patient management (84.84% versus 53.72%), and initiate reading selections for self-study (51.61% versus 0%) (Wolpaw et al. 2009).

Two important SNAPPS studies were conducted outside the United States. One involved a population of Thai medical students using SNAPPS, which generated similar findings as the original Wolpaw study (Sawanyawisuth et al. 2015). Another involving an Iranian population of midwife students found that students instructed on SNAPPS received higher scores on their ability to take histories and to generate differential diagnoses on final course examinations (Barangard et al. 2016).

When measured, presentations generally took longer with SNAPPS relative to the comparison groups (Wolpaw et al. 2009; Kapoor et al. 2017). In the Wolpaw study, total presentation length was 5.65 min in the SNAPPS group and 4.66 min in the comparison group, although the difference was borderline statistically significant ($p = 0.05$). In the Kapoor study, case presentation time did not change, but the total case discussion time increased by 1.73 min; the difference was statistically significant.

For completeness, we reviewed two other SNAPPS-related publications. These are not included in Supplementary Table 2 because they were essentially 'proof of concept' studies. One described the use of SNAPPS among limited-licensure learners in a child psychiatry clinic (Connor and Pearson 2017) and a second examined a modified version of SNAPPS for use in the inpatient setting (Nixon et al. 2014). Learners in the former were highly satisfied with SNAPPS (Connor and Pearson 2017). Nixon added to the standard SNAPPS approach an 'educational prescription' that included a written PICO (Population, Intervention, Comparison, Outcomes) template and termed it 'SNAPPS-Plus.' The authors instructed prelicensure physician trainees to formulate a clinical question according to PICO for six case presentations, complete the educational prescription, investigate the answer to each question, and present the answer on rounds the next day. They determined the technique was easily integrated into a standard clerkship and that it led to well-formulated questions and answers, which conformed to the PICO rubric.

Concept mapping

The third strategy, concept mapping, has been used mostly in nursing. In order to master this model, extensive learner (and less so faculty) orientations are required, often up to 8 h or more. This is a collaborative approach as it requires extensive scaffolding for learners to use the model and

teacher training on how to accurately score concept maps and provide meaningful feedback to learners.

Most studies on concept mapping were not randomised, and not every study included control groups. Only one randomised study (Huang et al. 2012) was identified. Authors generally measured outcomes with a standardised instrument designed to assess clinical reasoning skills or scores on the concept maps themselves.

Concept mapping, when applied in a clinical setting, impacts clinical reasoning outcomes among nursing trainees (Wheeler and Collins 2003; Abel and Freeze 2006; Hinck et al. 2006; Atay and Karabacak 2012; Huang et al. 2012; Wahl and Thompson 2013; Kaddoura et al. 2016). Nearly all of these studies involved nursing trainees prior to licensure (Wheeler and Collins 2003; Abel and Freeze 2006; Hinck et al. 2006; Atay and Karabacak 2012; Huang et al. 2012; Kaddoura et al. 2016). One involved recently graduated nurses (Wahl and Thompson 2013).

Discussion

In this realist synthesis, we identified only three specific teaching strategies used in the clinical setting that have been shown to impact important educational outcomes: the OMP, SNAPPS, and concept mapping. The OMP and SNAPPS have the highest quality of evidence and have been studied among the broadest ranges of teacher and learner populations. In line with the realist synthesis, we discuss differential characteristics of the three strategies that may influence a preference for one or the other.

The OMP is the most widely studied and has been shown effective in both ambulatory and hospital-based settings. It is teacher-led. SNAPPS, slightly less well studied, is a learner-led strategy that has consistent evidence of efficacy, although only in the ambulatory setting. Compared to OMP and SNAPPS, studies involving concept mapping involved less robust methodology and learner populations were limited to nursing trainees. Because not all studies involving concept mapping included a control group, it was not clear if clinical reasoning improved because of the teaching strategy or whether clinical reasoning skills would have developed equivalently over time using an alternative strategy (Wilgis and McConnell 2008; Wahl and Thompson 2013; Kaddoura et al. 2016). Additionally, the publication methodologies did not consistently describe the type of concept mapping. While several different versions of concept mapping exist—hierarchical representations, flow charts, and webs (Taylor and Littleton-Kearney 2011)—the literature appears inadequate to determine if one particular type of concept map might be relatively more efficacious.

Concept mapping appears to be a time-consuming strategy—both in terms of orientation and application. Orientation typically required multiple large group instructional sessions, often several hours in duration each. Then, learners created several practice concept maps and received direct feedback before implementing them in the clinical setting. This orientation process contrasts with that of SNAPPS and OMP, which generally required short orientations that could be achieved in as little as a lunch conference, and at most a half-day workshop.

Examining in more detail the mechanisms by which these three strategies impact outcomes, OMP and SNAPPS uniquely structure the conversation between teacher and learner and deliberately incorporate steps that foster collaborative dialogue and provision of feedback—seeking to improve learning climate and guiding learners to take specific actions. All three harness a reproducible and consistent structure to improve the communication between learners and teachers of the learner's: (1) data gathering, (2) organisation of knowledge, and (3) understanding of causality. Consequently, teachers are better able to identify learner gaps in knowledge and understanding and can better focus on teaching to these areas. Learners thus perceive teachers as being more effective. Although similar in these broad strokes, the three strategies differ in how specifically teachers identify and then address identified gaps.

OMP guides the teacher to: (1) 'probe' the learner with verbal questioning to elucidate missing facts and/or causal linkages, (2) teach 'general rules' to promote the learner's formation of factual hierarchy and causal linkages, (3) verbally reinforce learner's existing knowledge structure (where it is correct), and (4) verbalise to the learner how to restructure incorrectly classified or associated knowledge. SNAPPS prompts the learner to: (1) verbalise an organised representation of a subset of many potential facts, (2) 'narrow' (limit) the focus of conversation to specific topical domains, (3) 'analyse' (highlight) key elements that distinguish different disease representations, and (4) ask the teacher to fill in missing facts, linkages, or mechanisms. OMP and SNAPPS share in that both rely upon verbal representation of ideas, force learners to generate an organised representation of complex and numerous facts, and create opportunities for the teacher to restructure and refine knowledge. Concept mapping, in contrast, relies on a visual representation of facts and inter-relatedness of concepts, from which teachers can identify gaps in knowledge or understanding. In doing so, it allows the teacher to focus attention to areas that need restructuring and refinement.

In regard to specific outcomes, these three strategies all focus primarily on improving medical knowledge and clinical reasoning. Importantly, we did not identify any specific strategies that have been used in the clinical setting and have shown positive impacts on communication skills between health professionals and patients, positive impacts on the creation of empathy, professionalism, or consistent improvement in physical exam skills.

We proceed to summarise the implications of these findings for three audiences—health professions educators and administrators, front-line teachers, and health professions education researchers.

Health professions educators and educational administrators

Educators and administrators of training programs looking to improve teaching in the clinical setting should take into consideration both the applicability of the data to their environment and the relative ease of teacher or learner development to support widespread implementation. Since SNAPPS is predominantly learner-led, it shows potential for use in geographically dispersed programs. Learners, who are encouraged to take the initiative in clinical presentations using SNAPPS, can be trained centrally in 30–90 min.

Teachers at dispersed sites still require an orientation but they only need to encourage or be receptive to the use of the strategy. On the other hand, the OMP is teacher-led and thus requires teacher training to be successful (1–4 h). However, it does not require training of learners, nor is it dependent on learner self-motivation.

Concept mapping seems a reasonable approach to teaching and assessing clinical reasoning skills. However, it requires more extended orientation for the learners (usually 9–12 h) and several practice sessions before it can be realistically applied to the clinical setting. Teachers also require more than cursory familiarity with concept mapping in order to provide learners appropriate feedback. Finally, creating concept maps de novo remains time intensive. Therefore, using this strategy may only be reasonable for a small subset of patient encounters—especially where a teacher needs detailed information about a learner's clinical reasoning and organisation of medical knowledge. However, given the strategy's effectiveness in general education and that some medical schools have positive outcomes with a type of pre-set and peer-reviewed cognitive map, called schemes, cognitive maps may be more useful and efficient to adopt when both teacher and learner use a pre-set scheme as a tool in the patient encounter (Nesbit and Adesope 2006). With increasing movement in medical education towards integrated basic and clinical sciences for advanced clinical training (Kulasegaram et al. 2013; Brauer and Ferguson 2015), concept mapping in the specific form of pre-set schemes may be an essential tool for facilitating efficient teacher-learner interactions at the bedside and result in larger learning outcomes. More study is needed.

In terms of the level of training, limited literature suggests more advanced trainees may have a preference for SNAPPS (Seki et al. 2016).

Front-line teachers

SNAPPS and OMP are both accessible, effective strategies individual teachers can learn to implement with attendance at a brief workshop. Although very limited data exists directly comparing them (Seki et al. 2016) (and more robust studies comparing the two are needed), the literature suggests some important differences. Consequently, clinical teachers should reflect on their practice and teaching environments and determine which of these is most appropriate—paying attention to the level of learners with which they work, their practice setting, and patient volumes. The OMP has fewer steps and, in contrast to SNAPPS, learners generally require less orientation to its process. Although the data does not show a tremendous impact on case discussion time, an average of 1.7 additional minutes per patient visit, as documented with SNAPPS use among prelicensure students (Kapoor et al. 2017) may be significant in busy clinical settings. Thus, it may be preferable to limit this strategy to a subset of patient encounters. Teachers should also recognise that these strategies impact primarily cognitive outcomes; they may need to employ alternative methods to teach communication, physical examination, empathy, and professionalism skills.

Health professions education researchers

Our authorship team noted a considerable amount of variability in reporting of study design and outcomes. The effectiveness of teaching strategies would improve with better standardisation of study methods reporting. Future studies should include the following: description of teaching strategy, description of the teacher and learner orientation process to the strategy (including the format of orientation, duration, and frequency), the frequency of use of the strategy, the duration of exposure to the strategy, the number of teachers delivering the strategy, the number of learners receiving the strategy, and the number of learners and teachers for which outcomes data are collected.

Strengths and limitations

Our review has several strengths. First, our search strategy was extremely broad and thorough and involved two steps. Rather than focusing only on literature describing well-known strategies, we sought to identify strategies unknown to the author group while also reviewing the literature on well-known strategies. In contrast to many prior reviews (Pascoe et al. 2015; Farrell et al. 2016; Chinai et al. 2018), ours was not limited to literature from a single health discipline. Last, we developed a useful framework for assessing the effectiveness and the practicalities of implementation for any new or existing teaching strategy.

As with any review, we possibly failed to identify some important and innovative teaching strategies. The potential for exclusionary bias was minimised by conducting a two-stage search strategy. Additionally, a hand search of references of key articles describing important strategies was performed to identify residual publications of potential relevance. Finally, literature from the 1970s onward was included to ensure we captured strategies that may have been studied previously but were poorly disseminated and thus never adopted widely. As an additional measure, comparing the final inclusion list to an existing review, no additional strategies with associated outcomes data met our criteria for inclusion (Chinai et al. 2018). There were some publications (unpublished dissertations) that seemed potentially relevant to our topic, but they were not available for us to review in detail (Roop 2002; Studley 2005) and were not included.

With all reviews, decisions in the initial screening process and regarding inclusion of specific studies impact significantly the conclusions. Although we pre-identified reasons for exclusion in our protocol prior to the screening of search results, the process inevitably involves some subjectivity and thus has a potential for bias. Several of the authors (EA, DI, CS) have publications on teaching strategies that can be used in a clinical setting, and some of these publications were included in the final analysis. In order to minimise this risk of bias, the authors with several key publications related to our topic (EA and DI) were excluded from the initial screening process, which was conducted by two authors—the first (CP) and senior author (CS), neither of whom has published on the OMP. Final decisions regarding inclusion for analysis were made at the group level, with the first author (CP) serving as the tie-break. We notably excluded from our results and discussion a specific strategy created by two of the authors (EA and

CS) because its impact on our pre-identified outcomes has not been assessed (Stickrath et al. 2013). Although two authors in our group (EA and DI) have heavily studied the OMP and some of these publications are included in the analysis, this specific teaching strategy is widely known, frequently used, and often cited in the literature by others (Heidenreich et al. 2000; Spencer 2003b; Brand et al. 2011; Cayley 2011; Farrell et al. 2016; Chinai et al. 2018). This review would be remiss in not discussing it. Importantly, none of the author group has published on SNAPPS or concept mapping, and literature supporting the effectiveness of both of these strategies is included in this review; SNAPPS was felt to demonstrate similar effectiveness to the OMP.

The goal of this review was to identify teaching strategies that an individual teacher could reasonably implement in an actual clinical setting with a learner, without the teacher needing to undergo extensive training. We recognise that checklists, formative assessments, and feedback are critical teaching tools, but we felt they fell outside of the scope of this review. Specifically, they are facilitators of a teaching strategy rather than a clinical teaching strategy per se and have been extensively reviewed elsewhere (Veloski et al. 2006; Espey et al. 2007; Thomassen et al. 2014; Treadwell et al. 2014; Le Grand Rogers et al. 2015). The Stanford Faculty Development Program in Clinical Teaching (Skeff 1988; Berbano et al. 2006), although well known and studied, requires individual teachers to participate in an extensive course. Thus it was not included in this review.

Conclusions

In summary, SNAPPS and the OMP are currently the most-evidence based mechanisms for teaching in the clinical setting, and their effectiveness extends beyond physician trainees. SNAPPS is learner-led and OMP is teacher-led. These differences have implications for their application to specific clinical teaching contexts. Mechanistically, OMP and SNAPPS (1) provide a structure for teachers and learners to verbalise and refine organisation of facts and causal linkages and (2) invite both parties to participate in a dialogue that includes the opportunity for specific feedback. Concept mapping, in contrast, uses a visual representation of knowledge and concept linkages to guide teaching and does not provide a specific structure to guide the learner-teacher interaction. We postulate that, because these strategies operate via specific mechanisms that promote structuring of knowledge, the positive outcomes are largely limited to the domains of clinical reasoning and medical knowledge. We did not identify effective teaching strategies that can foster skills in the competency domains of professionalism, empathy, and patient-centeredness in the clinical setting, potentially because more complex mechanisms are involved in their teaching, and/or measuring related outcomes is relatively more challenging.

Acknowledgments

The authors would like to thank Douglas Myhre, MD, Professor of Medicine, at University of Calgary, Paul Worley, Ph.D., MBBS, MBA and Professor of Medicine at Flinders University, and Jan Illing, Ph.D., MPhil and Professor of Medical Education Research at Newcastle University for their extremely valuable contributions to the development of this review topic, creation of the review protocol, and thoughtful input during the literature search process.

Disclosure statement

Dr. Stickrath and Dr. Aagaard developed the MiPLAN teaching strategy for use in a hospital-based clinical setting. Dr. Pierce and Dr. Stickrath have conducted a study on the use of MiPLAN in the inpatient setting. Dr. Aagaard and Dr. Irby have conducted several studies evaluating the One Minute Preceptor. Dr. Corral and Ben Harnke report no declarations of interest.

Glossary

One Minute Preceptor (OMP): A structured teaching strategy used and studied in the clinical setting based on Neher's five microskills, employed by the preceptor. The steps are (1) get a commitment, (2) probe for supporting evidence, (3) teach general rules, (4) reinforce what was done right, and (5) correct mistakes.

SNAPPS: A mnemonic outlining a structured teaching strategy used and studied in the clinical setting, employed by the learner. Its 6 steps derive from cognitive activity rating scales and include: (1) summarize information, (2) narrow the differential, (3) analyse the differential through comparing and contrasting, (4) probe the preceptor to clarify uncertainty, (5) plan management for the patient's medical issues, and (6) select a case for self-directed learning.

Concept mapping: A collaborative strategy, originally developed from the field of cognitive psychology with links to neurobiology. Learners use it to graphically represent and provide structure to distinct, interrelated ideas and overarching concepts. Specifically, learners: (1) cluster information to foster the formation of associations between related concepts, (2) draw directional arrows to demonstrate causality and interdependence, and (3) graphically impose hierarchy to organize information around themes.

Notes on contributors

Cason Pierce, MD, MA, is a full-time clinician and medical educator. He is a graduate of the Teaching Scholars Program at the University of Colorado Anschutz and has presented workshops at national meetings on curriculum development and published on the teaching of high-value care principles in the inpatient clinical setting.

Janet Corral has a Ph.D. in Education, has international medical education administrative experience, and brings prior experience with literature reviews, and mixed methods and qualitative analysis skills. She has reviewed one BEME review submission for BEME in 2015.

Eva Aagaard, MD, is a medical education leader and investigator. She developed the Academy of Medical Educators at the University of Colorado, which provides support and faculty development in curriculum, education research, and educational leadership. She is now the Senior Associate Dean at the Washington University School of Medicine in St. Louis.

Ben Harnke, MLIS, works in the field of library science and brings the expertise needed to conduct a robust literature search. He has published four systematic reviews, including one involving mixed-methods.

David M. Irby, PhD, MDiv, is an international leader in medical education, serving many years as Vice Dean of Education and Director of the Office of Medical Education at the University of California, San Francisco. He is an active committee member for the Association for Medical Education in Europe and the Josiah Macy Foundation.

Chad Stickrath, MD, serves as the Assistant Dean for Education at the Colorado Springs Branch of the University of Colorado. He has published an approach to maximizing clinical learning during bedside teaching rounds, has overseen the development of a longitudinal integrated clerkship, and oversees the University of Colorado Academy of Medical Educators curriculum.

ORCID

Cason Pierce http://orcid.org/0000-0002-0359-5607
Janet Corral http://orcid.org/0000-0001-8576-6192
Eva Aagaard http://orcid.org/0000-0002-5773-0923
Ben Harnke http://orcid.org/0000-0002-7386-4462
David M. Irby http://orcid.org/0000-0001-5753-8918
Chad Stickrath http://orcid.org/0000-0002-9246-4990

References

Aagaard E, Teherani A, Irby DM. 2004. Effectiveness of the one-minute preceptor model for diagnosing the patient and the learner: proof of concept. Acad Med. 79(1):42–49.

Abdool MA, Bradley D. 2013. Twelve tips to improve medical teaching rounds. Med Teach. 35(11):895–899.

Abel WM, Freeze M. 2006. Evaluation of concept mapping in an associate degree nursing program. JNE. 45(9):356–364.

Allavena RE, Schaffer-White AB, Long H, Alawneh JI. 2017. Technical skills training for veterinary students: a comparison of simulators and video for teaching standardized cardiac dissection. J Vet Med Educ. 44(4):620–631.

Arya V, Gehlawat VK, Verma A, Kaushik JS. 2018. Perception of One-Minute Preceptor (OMP) Model as a teaching framework among pediatric postgraduate residents: a feedback survey. Indian J Pediatr. 85(7):598–598.

Aspegren K. 1999. BEME guide no. 2: teaching and learning communication skills in medicine-a review with quality grading of articles. Med Teach. 21(6):563–570.

Atay S, Karabacak Ü. 2012. Care plans using concept maps and their effects on the critical thinking dispositions of nursing students. Int J Nurs Pract. 18(3):233–239.

Back A, Arnold R, Edwards K, Tulsky J. 2013. Teaching communication skills in real- time encounters (P3). J Pain Symptom Manage. 45(2): 319.

Barangard H, Afshari P, Abedi P. 2016. The effect of the SNAPPS (summarize, narrow, analyze, probe, plan, and select) method versus teacher-centered education on the clinical gynecology skills of midwifery students in Iran. J Educ Eval Health Prof. 13:41.

Barrington K, Street K. 2009. Learner contracts in nurse education: interaction within the practice context. Nurse Educ Pract. 9(2): 109–118.

Bell J, Turner R. 2010. The use of small-group bedside teaching to promote critical thinking in clinical problem solving among critical care nursing students. South Afr J Crit Care. 26(2):59.

Berbano EP, Browning R, Pangaro L, Jackson JL. 2006. The impact of the Stanford Faculty Development Program on ambulatory teaching behavior. J Gen Intern Med. 21(5):430–434.

Birden H, Glass N, Wilson I, Harrison M, Usherwood T, Nass D. 2013. Teaching professionalism in medical education: a Best Evidence Medical Education (BEME) systematic review. BEME guide no. 25. Med Teach. 35(7):e1252–e1266.

Bott G, Mohide EA, Lawlor Y. 2011. A clinical teaching technique for nurse preceptors: the five minute preceptor. J Prof Nurs. 27(1): 35–42.

Brand PL, Boendermaker PM, Venekamp R, Snoek JW. 2011. [Supervising students according to the STAMPPOT method: efficient integration of patient care and clinical teaching]. Ned Tijdschr Geneeskd. 155(18):A2702.

Brauer DG, Ferguson KJ. 2015. The integrated curriculum in medical education: AMEE guide no. 96. Med Teach. 37(4):312–322.

Brown S, Bush C. 2013. Teaching to teach: techniques for teaching in a busy emergency department. Ann Emerg Med. 62(4):S159.

Canasi DM, Amyot C, Tira D. 2014. Evaluating meaningful learning using concept mapping in dental hygiene education: a pilot study. J Dent Hyg. 88(1):20–29.

Causby RS, Reed L, McDonnell MN, Hillier SL. 2018. Teaching of manual clinical skills in podiatric medicine theory and recommendations. J Am Podiatr Med Assoc. 108(2):158–167.

Cayley WE. Jr. 2011. Effective clinical education: strategies for teaching medical students and residents in the office. WMJ. 110(4):178–181.

Certain LK, Guarino AJ, Greenwald JL. 2011. Effective multilevel teaching techniques on attending rounds: a pilot survey and systematic review of the literature. Med Teach. 33(12):e644–e650.

Chamberland M, Mamede S, St-Onge C, Setrakian J, Bergeron L, Schmidt H. 2015. Self-explanation in learning clinical reasoning: the added value of examples and prompts. Med Educ. 49(2):193–202.

Chape EA. 2006. Improving clinical reasoning of physical therapist assistant students: a comparison of concept mapping and discussion in case-based learning [Doctoral dissertation]. Minneapolis (MN): Capella University.

Chew KS, Durning SJ, van Merrienboer JJ. 2016. Teaching metacognition in clinical decision-making using a novel mnemonic checklist: an exploratory study. Singapore Med J. 57(12):694–700.

Chinai SA, Guth T, Lovell E, Epter M. 2018. Taking advantage of the teachable moment: a review of learner-centered clinical teaching models. West J Emerg Med. 19(1):28–34.

Chretien KC, Swenson R, Yoon B, Julian R, Keenan J, Kheirbek R. 2014. Storytelling with inpatients. J Gen Intern Med. 29:S534–S535.

Clementz L, Dolansky M, Lawrence RH, Rusterholtz A, Singh S, Heilman A, Singh MK. 2015. Dyad teams: interprofessional collaboration and learning in the ambulatory setting. J Gen Intern Med. 30: S493–S494.

Colthart I, Bagnall G, Evans A, Allbutt H, Haig A, Illing J, McKinstry B. 2008. The effectiveness of self-assessment on the identification of learner needs, learner activity, and impact on clinical practice: BEME guide no. 10. Med Teach. 30(2):124–145.

Conn JJ, Lake FR, McColl GJ, Bilszta JL, Woodward-Kron R. 2012. Clinical teaching and learning: from theory and research to application. Med J Aust. 196(8):527.

Connell KJ, Bordage G, Chang RW, Howard BA, Sinacore J. 1999. Measuring the promotion of thinking during precepting encounters in outpatient settings. Acad Med. 74(10):S10–S12.

Connor DF, Pearson GS. 2017. Feasibility and implementation of SNAPPS in an outpatient child psychiatry clinic. Acad Psychiatry. 41(2):299–300.

Craig S. 2011. Direct observation of clinical practice in emergency medicine education. Acad Emerg Med. 18(1):60–67.

Cunningham AS, Blatt SD, Fuller PG, Weinberger HL. 1999. The art of precepting: Socrates or aunt Minnie? Arch Pediatr Adolesc Med. 153(2):114–116.

DaRosa DA, Zwischenberger JB, Meyerson SL, George BC, Teitelbaum EN, Soper NJ, Fryer JP. 2013. A theory-based model for teaching and assessing residents in the operating room. J Surg Educ. 70(1): 24–30.

Dave AL. 1999. Socrates or Aunt Minnie? [Letter]. Arch Pediatr Adolesc Med. 153(8):893.

Doumouras A, Rush R, Campbell A, Taylor D. 2015. Peer-assisted bedside teaching rounds. Clin Teach. 12(3):197–202.

Dubey S, Hirten R, Schlair S. 2013. The resident as preceptor: incorporating supervision of medical students in the ambulatory setting into a residency curriculum. J Gen Intern Med. 28:S483–S484.

Dubey S, LeFrancois D, Schlair S. 2015. Developing a learner centered multimodal ambulatory teaching program for senior housestaff: three-year follow-up. J Gen Intern Med. 30:S490–S491.

Ellaway R. H, O'Gorman L, Strasser R, Marsh D. C, Graves L, Fink P, Cervin C. 2016. A critical hybrid realist-outcomes systematic review of relationships between medical education programmes and communities: BEME guide no. 35. Med Teach. 38(3):229–245.

Ende J, Stratos GA, Dewitt DE, Alguire PC, Skeff KM, Pinsky LE. 2010. Teaching medicine series. Washington (DC): American College of Physicians.

Espey E, Nuthalapaty F, Cox S, Katz N, Ogburn T, Peskin T, Goepfert A, Hammoud M, Casey P, Emmons S, et al. 2007. To the point: medical education review of the RIME method for the evaluation of medical student clinical performance. Am J Obstet Gynecol. 197(2):123–133.

Farrell SE, Hopson LR, Wolff M, Hemphill RR, Santen SA. 2016. What's the evidence: a review of the One-Minute Preceptor Model of clinical teaching and implications for teaching in the emergency department. J Emerg Med. 51(3):278–283.

Furney SL, Orsini AN, Orsetti KE, Stern DT, Gruppen LD, Irby DM. 2001. Teaching the one-minute preceptor. A randomized controlled trial. J Gen Intern Med. 16(9):620–624.
Gaberson K, Oermann M. 2010. Clinical teaching strategies in nursing. New York (NY): Springer publishing company.
Gonzalo JD, Chuang CH, Huang G, Smith C. 2010. The return of bedside rounds: an educational intervention. J Gen Intern Med. 25(8): 792–798.
Grantcharov TP, Reznick RK. 2008. Teaching procedural skills. BMJ. 336(7653):1129–1131.
Greif R, Egger L, Basciani RM, Lockey A, Vogt A. 2010. Emergency skill training–a randomized controlled study on the effectiveness of the 4-stage approach compared to traditional clinical teaching. Resuscitation. 81(12):1692–1697.
Hammick M, Freeth D, Koppel I, Reeves S, Barr H. 2007. A best evidence systematic review of interprofessional education: BEME guide no. 9. Med Teach. 29(8):735–751.
Hayden SR, Panacek EA. 1999. Procedural competency in emergency medicine: the current range of resident experience. Acad Emergency Med. 6(7):728–735.
Heidenreich C, Lye P, Simpson D, Lourich M. 2000. The search for effective and efficient ambulatory teaching methods through the literature. Pediatrics. 105(1):231–237.
Hinck SM, Webb P, Sims-Giddens S, Helton C, Hope KL, Utley R, Savinske D, Fahey EM, Yarbrough S. 2006. Student learning with concept mapping of care plans in community-based education. J Prof Nurs. 22(1):23–29.
Hu YC, Chen SR, Chen IH, Shen HC, Lin YK, Chang WY. 2015. Evaluation of work stress, turnover intention, work experience, and satisfaction with preceptors of new graduate nurses using a 10-minute preceptor model. J Contin Educ Nurs. 46(6):261–271.
Huang YC, Chen HH, Yeh ML, Chung YC. 2012. Case studies combined with or without concept maps improve critical thinking in hospital-based nurses: a randomized-controlled trial. Int J Nurs Stud. 49(6): 747–754.
Irby DM, Aagaard E, Teherani A. 2004. Teaching points identified by preceptors observing one-minute preceptor and traditional preceptor encounters. Acad Med. 79(1):50–55.
Irby DM, Bowen JL. 2004. Time-efficient strategies for learning and performance. Clin Teach. 1(1):23–28.
Irby DM, Wilkerson L. 2008. Teaching when time is limited. BMJ. 336(7640):384–387.
Irvine S, Martin J. 2014. Bridging the gap: from simulation to clinical practice. Clin Teach. 11(2):94–98.
Issenberg SB, McGaghie WC, Petrusa ER, Lee Gordon D, Scalese RJ. 2005. Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Med Teach. 27(1):10–28.
Kaddoura M, VanDyke O, Cheng B, Shea-Foisy K. 2016. Impact of concept mapping on the development of clinical judgment skills in nursing students. Teach Learn Nurs. 11(3):101–107.
Kapoor A, Kapoor A, Kalraiya A, Longia S. 2017. Use of SNAPPS Model for pediatric outpatient education. Indian Pediatr. 54(4):288–290.
Kilminster S, Cottrell D, Grant J, Jolly B. 2007. AMEE guide no. 27: effective educational and clinical supervision. Med Teach. 29(1): 2–19.
King KM, Caraballo H, Zhuang C, Stewart TE. 2016. The use of "synthesis shifts" to teach medical decision making to third-year medical students. Acad Emerg Med. 23:S278.
Kulasegaram KM, Martimianakis MA, Mylopoulos M, Whitehead CR, Woods NN. 2013. Cognition before curriculum: rethinking the integration of basic science and clinical learning. Acad Med. 88(10): 1578–1585.
Lake FR, Hamdorf JM. 2004. Teaching on the run tips 5: teaching a skill. Med J Aust. 181(6):327–328.
Le Grand Rogers R, Narvaez Y, Venkatesh AK, Fleischman W, Hall MK, Taylor RA, Hersey D, Sette L, Melnick ER. 2015. Improving emergency physician performance using audit and feedback: a systematic review. Am J Emerg Med. 33(10):1505–1514.
McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. 2010. A critical review of simulation-based medical education research: 2003-2009. Med Educ. 44(1):50–63.
Mertens F, de Groot E, Meijer L, Wens J, Gemma Cherry M, Deveugele M, Damoiseaux R, Stes A, Pype P. 2018. Workplace learning through collaboration in primary healthcare: a BEME realist review of what works, for whom and in what circumstances: BEME guide no. 46. Med Teach. 40(2):117–134.
Neher JO, Gordon KC, Meyer B, Stevens N. 1992. A five-step "microskills" model of clinical teaching. J Am Board Fam Pract. 5(4): 419–424.
Nesbit JC, Adesope OO. 2006. Learning with concept and knowledge maps: a meta-analysis. Rev Educ Res. 76(3):413–448.
Nilsson MS, Pennbrant S, Pilhammar E, Wenestam CG. 2010. Pedagogical strategies used in clinical medical education: an observational study. BMC Med Educ. 10(1):9.
Nixon J, Wolpaw T, Schwartz A, Duffy B, Menk J, Bordage G. 2014. SNAPPS-Plus: an educational prescription for students to facilitate formulating and answering clinical questions. Acad Med. 89(8): 1174–1179.
Novak JD. 1990. Concept mapping: a useful tool for science education. J Res Sci Teach. 27(10):937–949.
Okubo Y, Nomura K, Saito H, Saito N, Yoshioka T. 2014. Reflection and feedback in ambulatory education. Clin Teach. 11(5):355–360.
Ong MM-A, Yow M, Tan J, Compton S. 2017. Perceived effectiveness of one-minute preceptor in microskills by residents in dental residency training at National Dental Centre Singapore. Proc Singapore Healthcare. 26(1):35–41.
Ottolini MC, Ozuah PO, Mirza N, Greenberg LW. 2010. Student perceptions of effectiveness of the eight step preceptor (ESP) model in the ambulatory setting. Teach Learn Med. 22(2):97–101.
Pascoe JM, Nixon J, Lang VJ. 2015. Maximizing teaching on the wards: review and application of the One-Minute Preceptor and SNAPPS models. J Hosp Med. 10(2):125–130.
Passi V, Johnson S, Peile E, Wright S, Hafferty F, Johnson N. 2013. Doctor role modelling in medical education: BEME guide no. 27. Med Teach. 35(9):e1422–e1436.
Pierce C, Corral J, Aagaard E, Harnke B, Irby D, Myhre D, Stickrath C. 2017. Protocol: a BEME review of the effectiveness of teaching strategies used in the clinical setting on the development of clinical skills among health professionals. [accessed 2019 Sep 16]. https://beme collaboration.org/downloads/2802/Effectiveness%20of%20Teaching% 20Strategies%20protocol%20May%202017.pdf.
Ramani S, Leinster S. 2008. AMEE Guide no. 34: teaching in the clinical environment. Med Teach. 30(4):347–364.
Reeves S, Fletcher S, Barr H, Birch I, Boet S, Davies N, McFadyen A, Rivera J, Kitto S. 2016. A BEME systematic review of the effects of interprofessional education: BEME guide no. 39. Med Teach. 38(7): 656–668.
Roop KM. 2002. Effect of concept mapping as a learning strategy on cetificate practical nursing students' academic achievement and critical thinking development. New Castle (DE): Wilmington College.
Roth CS, Fagan MJ, Griffith JM, Nelson D, Zhao Y. 2003. Evaluation of a worksheet to structure teaching and learning outpatient internal medicine. Med Teach. 25(3):296–301.
Salerno S M, O'Malley P G, Pangaro L N, Wheeler G A, Moores L K, Jackson J L. 2002. Faculty development seminars based on the one-minute preceptor improve feedback in the ambulatory setting. J Gen Intern Med. 17(10):779–787.
Sawanyawisuth K, Schwartz A, Wolpaw T, Bordage G. 2015. Expressing clinical reasoning and uncertainties during a Thai internal medicine ambulatory care rotation: does the SNAPPS technique generalize? Med Teach. 37(4):379–384.
Schaye V, Volpicelli F, Bui L, Schwartz MD, Dembitzer A. 2015. Training hospitalists to use micro skills and small group teaching strategies can improve confidence and performance in ward round teaching. J Gen Intern Med. 30:S284.
Seki M, Otaki J, Breugelmans R, Komoda T, Nagata-Kobayashi S, Akaishi Y, Hiramoto J, Ohno I, Harada Y, Hirayama Y, et al. 2016. How do case presentation teaching methods affect learning outcomes?–SNAPPS and the One-Minute Preceptor. BMC Med Educ. 16(1):12.
Skeff KM. 1988. Enhancing teaching effectiveness and vitality in the ambulatory setting. J Gen Intern Med. 3(S1):S26–S33.
Soucisse ML, Boulva K, Sideris L, Drolet P, Morin M, Dube P. 2017. Video coaching as an efficient teaching method for surgical residents-a randomized controlled trial. J Surg Educ. 74(2):365–371.
Spencer J. 2003a. ABC of learning and teaching in medicine: learning and teaching in the clinical environment. BMJ. 326(7389):591–594.
Spencer J. 2003b. Learning and teaching in the clinical environment. BMJ. 326(7389):591–594.

Stickrath C, Aagaard E, Anderson M. 2013. MiPLAN: a learner-centered model for bedside teaching in today's academic medical centres. Acad Med: J Assoc Am Med Colleges. 88(3):322–327.

Stritter FT, Baker RM, McGaghie WC. 1983. Congruence between residents' and clinical instructors perceptions of teaching in outpatient care centres. Med Educ. 17(6):385–389.

Studley HL. 2005. The effect of concept mapping on critical thinking skills of baccalaureate nursing students. New Haven (CT): Southern Connecticut State University.

Taylor LA, Littleton-Kearney M. 2011. Concept mapping: a distinctive educational approach to foster critical thinking. Nurse Educ. 36(2): 84–88.

Teherani A, O'Sullivan P, Aagaard EM, Morrison EH, Irby DM. 2007. Student perceptions of the one minute preceptor and traditional preceptor models. Med Teach. 29(4):323–327.

Thomassen O, Storesund A, Softeland E, Brattebo G. 2014. The effects of safety checklists in medicine: a systematic review. Acta Anaesthesiol Scand. 58(1):5–18.

Torre DM, Daley B, Stark-Schweitzer T, Siddartha S, Petkova J, Ziebert M. 2007. A qualitative evaluation of medical student learning with concept maps. Med Teach. 29(9–10):949–955.

Treadwell JR, Lucas S, Tsou AY. 2014. Surgical checklists: a systematic review of impacts and implementation. BMJ Qual Saf. 23(4):299–318.

Veloski J, Boex JR, Grasberger MJ, Evans A, Wolfson DB. 2006. Systematic review of the literature on assessment, feedback and physicians' clinical performance: BEME guide no. 7. Med Teach. 28(2):117–128.

Wahl SE, Thompson AM. 2013. Concept mapping in a critical care orientation program: a pilot study to develop critical thinking and decision-making skills in novice nurses. J Contin Educ Nurs. 44(10): 455–460.

Wheeler LA, Collins SK. 2003. The influence of concept mapping on critical thinking in baccalaureate nursing students. J Prof Nurs. 19(6):339–346.

Wilgis M, McConnell J. 2008. Concept mapping: an educational strategy to improve graduate nurses' critical thinking skills during a hospital orientation program. J Contin Educ Nurs. 39(3):119–126.

Wolpaw T, Cote L, Papp KK, Bordage G. 2012. Student uncertainties drive teaching during case presentations: more so with SNAPPS. Acad Med. 87(9):1210–1217.

Wolpaw T, Papp KK, Bordage G. 2009. Using SNAPPS to facilitate the expression of clinical reasoning and uncertainties: a randomized comparison group trial. Acad Med. 84(4):517–524.

Wolpaw TM, Wolpaw DR, Papp KK. 2003. SNAPPS: a learner-centered model for outpatient education. Acad Med. 78(9):893–898.

Wolverton SE, Bosworth MF. 1985. A survey of resident perceptions of effective teaching behaviors. Fam Med. 17(3):106–108.

Wong G, Greenhalgh T, Westhorp G, Buckingham J, Pawson R. 2013. RAMESES publication standards: realist syntheses. BMC Med. 11(1): 21.

Wong G, Westhorp G, Greenhalgh J, Manzano A, Jagosh J, Greenhalgh T. 2017. Health services and delivery research. Quality and reporting standards, resources, training materials and information for realist evaluation: the RAMESES II project. Southampton (UK): NIHR Journals Library.

Woods R A, Trinder K, D'Eon M, McAleer S. 2014. Teaching the RAPID approach at the start of emergency medicine clerkship: an evaluation. Canad J Emerg Med. 16(04):273–280.