Leadership Development in Postgraduate Medical Education: A Systematic Review of the Literature

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Abstract

Purpose

To evaluate and interpret evidence relevant to leadership curricula in postgraduate medical education (PGME) to better understand leadership development in residency training.

Method

The authors conducted a systematic review of peer-reviewed, English-language articles from four databases published between 1980 and May 2, 2017 that describe specific interventions aimed at leadership development. They characterized the educational setting, curricular format, learner level, instructor type, pedagogical methods, conceptual leadership framework (including intervention domain), and evaluation outcomes. They used Kirkpatrick effectiveness scores and Best Evidence in Medical Education (BEME) Quality of Evidence scores to assess the quality of the interventions.

Results

Twenty-one articles met inclusion criteria. The classroom setting was the most common educational setting (described in 17 articles). Most curricula (described in 13 articles) were isolated, with all curricula ranging from three hours to five years. The most common instructor type was clinical faculty (13 articles). The most commonly used pedagogical method was small group/discussion, followed by didactic teaching (described in, respectively, 15 and 14 articles). Study authors evaluated both pre/post surveys of participant perceptions (n = 7) and just postintervention surveys (n = 10). The average Kirkpatrick Effectiveness score was 1.0. The average BEME Quality of Evidence score was 2.

Conclusions

The results revealed that interventions for developing leadership during PGME lack grounding conceptual leadership frameworks, provide poor evaluation outcomes, and focus primarily on cognitive leadership domains. Medical educators should design future leadership interventions grounded in established conceptual frameworks and pursue a comprehensive approach that includes character development and emotional intelligence.

Leadership is increasingly becoming a vital competency expected of physicians. The ever-growing challenges facing health care systems across the world and the greater demand for accountability and efficient use of scarce resources necessitate effective physician leadership.[1,2] Physicians are working in more complex and interdependent teams, which demands an increasing ability to engage positively with others and inspire a common vision. In addition, research has shown that effective leadership of patient teams improves clinical outcomes, patient satisfaction, and provider satisfaction across a broad range of clinical settings.[3–6]

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Leadership development and training are particularly important for residents in postgraduate medical education (PGME). Residents require leadership skills to be effective in their day-to-day work including performing their clinical responsibilities, fulfilling administrative roles, leading teams, engaging allied-health professionals, overseeing the development of younger trainees, managing conflict, and making resource decisions.[7] Postgraduate trainees recognize the importance of leadership abilities for their future careers and desire more leadership training during their education.[8] Eighty-five percent of medical residents surveyed by Brouns and colleagues (2010)[9] reported a need for management training in negotiation, practice partnerships, knowledge of health care systems, and career planning.

Medical bodies and institutions have responded to the need for physician leadership by adopting recommendations and guidelines to encourage leadership development during medical training. In 2015, the Royal College of Physicians and Surgeons of Canada changed one of the six core roles that define a competent physician from "Manager" to "Leader," citing both that "leadership competencies are integral to a physician's practice" and that "the need for physicians to lead collaboratively in health care will continue to increase."[10] In the United States, the Institute of Medicine concluded that academic health centers must "develop leaders at all levels who can … [m]anage the organizational and systems changes necessary to improve health."[11] In the United Kingdom, the General Medical Council has adopted competencies relating to effective multiprofessional team functioning and leadership.[12]

While such educational policy reflects a growing awareness of the importance of leadership training in medical education, current practice regarding leadership development for residents is less clear—as is the extent to which any PGME leadership education is informed by theory. Therefore, we undertook a systematic review of the published literature that described specific interventions aimed at leadership development in PGME. In our review,

we assessed conceptual leadership frameworks used and classified interventions under different educational domains. The goal of this effort was to identify and analyze existing leadership training efforts in PGME to answer the following research question: What are the current trends, lessons learned, and gaps in leadership interventions aimed at developing leadership skills, attributes, or competencies in PGME training? We also planned, through our systematic review, to assess both the effectiveness of the interventions and the quality of the research evidence.

Method

Search strategy

Three of us (N.S., A.I., and H.I.) completed the initial literature search on June 24, 2016, after consulting with a Western University associate librarian, and we conducted an updated search on May 2, 2017. We have summarized our search in Table 1, which provides the following:

- the four databases searched,
- subject headings and keyword variants searched within databases, and
- macro keyword searches used to cast a bigger net and capture research reports that the subject heading searches may not have identified.

We limited our searches to peer-reviewed, English-language articles focusing on PGME published since 1980. We hand searched the reference lists of the articles we selected for full-text review to identify additional articles not discovered in the initial database search.

To help ensure the reproducibility of our results, we applied two published frameworks to guide the protocol for this systematic review: (1) the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement,[13] along with the PRISMA checklist[13] and the PRISMA explanation and elaboration document[13]; and (2) the Best Evidence in Medical Education (BEME) guide no. 13, "Conducting a Best Evidence Systematic Review."[14]

Ethics approval was not required for this study.

Inclusion and exclusion criteria

We considered articles that included trainees at any point in their postgraduate medical training, even if they also included medical students and practicing/licensed physicians. To be included, the article had to describe or evaluate a leadership intervention, which we defined as curricula that included one or more interventions for which *developing* new leadership skills, attributes, or competencies was the *primary goal*.

We excluded studies that evaluated trainees' perceptions of leadership or assessed their leadership abilities but did not include an intervention. Other exclusion criteria included studies that included leadership skills as only a minor focus in a larger study or studies in which the term "leadership" indicated the achievement of excellence in some specific clinical context (e.g., leading a cardiac arrest team).

Title and abstract review

After we removed the duplicates, two of us (A.I. and H.I.) independently reviewed the titles and abstracts of all remaining articles. We selected articles for full-text review if they met the inclusion criteria and did not meet any obvious exclusion criteria. We collected the selected articles in an EndNote Group Set (version x7.7.1; EndNote, Thomson Reuters, Toronto, Ontario, Canada). Two of us (A.I. and H.I.) discussed any discrepancies in an attempt to reach consensus. If we could not reach consensus, another author (N.S.) independently reviewed the title and abstract, and the three of us discussed the abstract until we reached a consensus about whether to include or exclude the article from full review.

Full-text review and data extraction

One of us (N.S.) read each article thoroughly and captured all relevant information, using a data extraction tool, which we created according to BEME guidelines.[14] We collected the extracted data in an online, shared Google spreadsheet (Google Inc., Mountain View, California). Fields included but were not limited to the following: a description of the educational setting; curricular format; learner level; instructor type; pedagogical methods or approaches; conceptual leadership framework, including intervention focus or domain; and evaluation outcomes.

We classified educational settings as clinical, classroom, small-group, immersive, simulation, online, or off-site. Curricula taught in clinical settings took place in patient care environments. According to our classification, classroom settings included workshops, seminars, and lectures. We considered small groups to be interventions that incorporated exercises completed by and/or discussion among smaller cadres of residents. Immersive refers to interventions in which residents were placed in and spent time working within a nonclinical environment, such as hospital administration or a government agency, while simulation refers to interventions occurring in simulation centers. We defined online educational settings as those that took place virtually

Table 1

Subject Headings and Keywords Used to Search Databases for Studies on Leadership Training During Residency[a]

	Databases				
Concept	Medline	Embase	PsycINFO	ERIC	Keywords
Leadership	Leadership/	exp leadership/	SU.EXACT. EXPLODE("Leadership")	SU.EXACT("Leadership")	Leadership development, Leader*
PGME (postgraduate medical education)	education, medical, graduate/ or exp "internship and residency"/	exp residency education/	SU.EXACT. EXPLODE("Medical Education")	(SU.EXACT.EXPLODE("Medical Education") OR SU.EXACT. EXPLODE("Graduate Medical Education"))	Pgme OR postgraduate medical education OR internship* OR medical resident* OR fellow*

[a]The authors searched the literature from 1980 through to their search date, May 2, 2017.

through online platforms and did not involve face-to-face interactions, and we defined off-site settings as locations removed from all clinical sites or classroom settings (e.g., parks). Finally, we considered interventions occurring in mixed settings as any that used two or more of the above settings.

We stratified curricular format as either longitudinal or isolated. We defined longitudinal as a curriculum lasting at least one year with time between contact (e.g., between class sessions, small-group work, lectures). We defined isolated as a curriculum in which the intervention(s) occurred in a single session or over concurrent sessions for a period of less than one year (e.g., a weeklong retreat or a single-semester course).

We stratified learners into two levels: *junior* for trainees in their first or second year of PGME or if postgraduate year (PGY) 1, 2, and 3 were grouped together, and *senior* for trainees in or beyond their third year of PGME. We used the classification of *both* if both junior and senior trainees were involved (beyond PGY 1–3) or if the learner level was not specified.

We defined instructor type as clinical faculty, nonclinical faculty, institutional administrators, outside consultants, resident educators, not specified, and other. We defined clinical faculty as clinical instructors from within the institution and nonclinical faculty as small-group leaders, basic science faculty, or other faculty from within the institution. We defined institutional administrators as administrators from within the institution (e.g., hospital administrators), outside consultants as guest speakers or instructors from outside the institution, and resident educators as any postgraduate trainees involved in teaching all or part of the curriculum.

We captured any aspects of each intervention's methodology, approach, or delivery that the study authors deemed novel or innovative. Recognizing that the definitions of some of these constructs are dynamic and debatable, even within the education literature, we defined these fairly generically for our purposes.

One of us (N.S.) assessed all leadership intervention studies for any underlying pedagogical methods. We categorized pedagogical approaches into the following: experiential (assuming responsibility for leadership roles, or a direct placement in a leadership setting); mentorship/coaching (being assigned a mentor/coach to provide guidance and feedback); work based (reflecting and learning within one's normal work environment); theoretical learning (including didactic instruction and independent reading); interactive/discussion (engaging in small groups or workshops); reflection (experiencing a process of self-reflection); project based (being responsible for working on a project-based deliverable, typically with a team); other; and not specified.

We also classified the leadership interventions according to three common leadership development domains: character, emotional intelligence, and cognitive skills. Our reasoning for doing this derived from increasing evidence in the broader literature which demonstrates not only that developing character and emotional intelligence is just as important to leadership success as the development of cognitive knowledge and skills but also that the best results occur when development occurs holistically across multiple domains.[15–25] Although we recognized that these three leadership domains are not exhaustive, they have been increasingly adopted in leadership research, particularly in the business literature.[16–18,21–23] We believed that they formed a useful perspective from which to assess the present medical education literature on leadership development, as well as underlying trends and potential gaps.

We classified leadership interventions in the character domain if they were connected to personal/internal moral, ethical, or character development (e.g., integrity or trust building). We classified interventions under the emotional intelligence domain if they were directly connected to one of the broad domains of emotional intelligence: self-awareness, self-management, social awareness, and/or relationship management. Finally, we selected the cognitive skills domain if the learned element was characterized by specific knowledge or skills related to intellectual competencies (e.g., organizational behavior, strategic planning, time management, financial management).

Data synthesis and analysis

We systematically assessed each curriculum's evaluation strategy using the Kirkpatrick[26] model. The Kirkpatrick model, a recognized standard for evaluating teaching effectiveness and assessing curriculum outcomes, is well established in the context of health professions education scholarship.[27–31] It is a four-level training evaluation model. The four levels are as follows: (1) changes in learners' attitudes, (2) modification of skills and/or learning, (3) changes in behavior as a result of learning, and (4) evidence of tangible results. We added a level of "0" for articles that did not evaluate outcomes. We assessed each study and scored the effectiveness of each intervention according to the Kirkpatrick model.

To score the quality of the evidence presented in the studies, we assessed each curriculum using the sample classification scale included in BEME guide no. 13.[14] This quality of evidence hierarchy ranges from 1, indicating that results are not clear/not significant, to 5, which indicates that results are unequivocal.

Results

Excluding duplicates, our initial search identified 1,259 articles, which we included in the title and abstract review (see Figure 1). Of these, 36 articles met the full-text review inclusion criterion of describing a curriculum with one or more interventions to develop leadership skills/abilities in postgraduate medical trainees. We identified 5 additional articles by hand searching the reference lists of these 36 articles. After reviewing the full text of these 41 articles, we excluded 20, which brought the final number of studies included in the systematic review to 21 studies.[32–52] We have summarized key features of the studies in Appendix 1.

Educational settings and curricular formats

Of the 21 curricular interventions, 19 (90%) took place in the United States,[32–36,38–42,44–52] 1 (5%) in Canada,[37] and 1 (5%) in the United Kingdom.[43] Over three-quarters of the studies (n = 17; 81%) reported the number of participants.[32,34,36–45,47,49–52] The number of participants ranged from 2[32] to 125,[47] and the average number of participants was 22.

Varied medical educational settings were represented. The classroom setting was the most common, represented in 17 of the 21 studies (81%).[32,34,36–42,44,46–52] Five

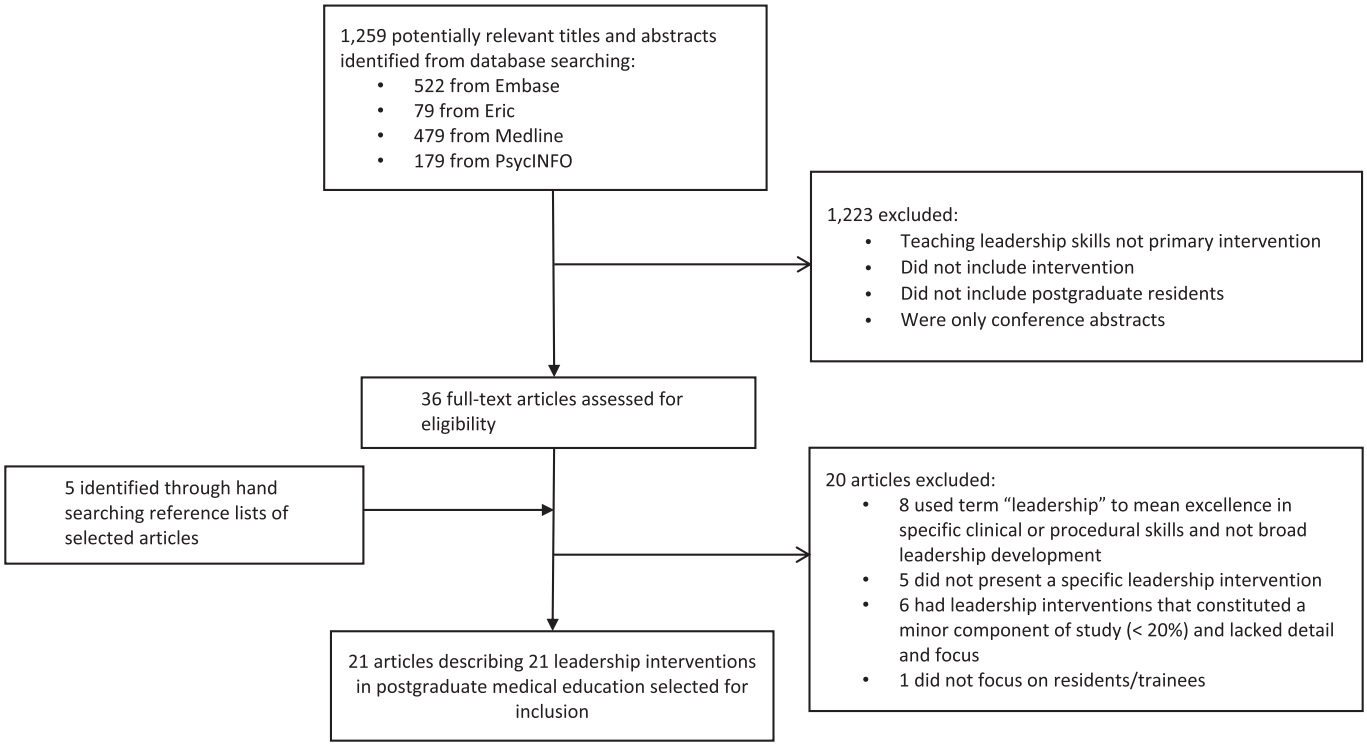

Figure 1 Flowchart illustrating the process of identifying 21 studies used in a 2017 review of literature examining leadership training in postgraduate medical education.

(24%) curricular interventions used a small-group setting.[38,39,41,49,51] Ten studies (48%) described curricula in which trainees learned and applied leadership skills in multiple environments.[32,37–41,49–52] An immersive setting, in which trainees were embedded within a medical or hospital administrative unit, was used in 4 (19%) studies.[32,43,50,51] Finally, 2 (10%) studies[41,45] occurred at an off-site retreat setting. No studies described simulation or online settings.

Leadership curricula and interventions were delivered in a wide variety of formats. Most of the classroom interventions did not provide opportunities for students to practice leadership skills. Interventions included discussion, small-group work, and reflection. Residents rated discussion and small-group interventions favorably, especially when the former were led by respected physician mentors.[32,40,41,50] Trainees also rated reflection-based interventions favorably.[34,42–44]

Some programs implemented nontraditional leadership interventions. For example, Gurrera and colleagues (2014)[36] had trainees develop and present project proposals to faculty who evaluated their proposals in a format resembling the popular reality television program *Shark Tank* (American Broadcasting Company, 2009–present). Stoller and colleagues (2004)[45] implemented a "reef survival exercise" at an off-site leadership retreat during which teams vied to devise an effective survival strategy. Johnson and Stern (2014)[39] used video vignettes from the television show *ER* (National Broadcasting Company, 1994–2009) to display examples of emotional intelligence—or lack thereof—in action. Participants evaluated these nontraditional approaches to leadership training favorably.

The majority of curricula (described in 13 studies [62%]) approached leadership training in an isolated fashion without longitudinal integration. These more isolated interventions ranged from three hours in duration to six months.[33,34,36,37,39,41,43–46,48,49,52] Of the 8 studies (38%) with longitudinal interventions,[32,35,38,40,42,47,50,51] 4 (19%) lasted more than one year,[32,40,50,51] and 1 program (5%) spanned all five years of residency training.[51]

Learner levels

Leadership curricula were available to residents at various levels of their education. Ten interventions (48%) focused on the residents in their junior PGYs of training (PGY 1–3),[32,34,36,40,45–50] while 5 (24%) interventions focused on the senior years of training (PGY 3–5).[35,37–39,52] Four (19%) studies focused on both junior and senior years (PGY 1–5).[33,41,42,51] Of the interventions that took place during trainees' junior years, 3 focused on PGY 1,[45,47,48] 3 on PGY 2,[34,36,49] 3 on PGYs 1–3,[32,40,50] and 1 on PGYs 2–3.[46] Of the interventions that occurred during residents' senior years of training, 4 addressed PGYs 3–5[37-39,52] and 1 addressed trainees beyond PGY 5.[35] Two studies did not specify the training level of the participants.[43,44]

Types of instructors

Leadership curricula were taught by a variety of instructors. The most common instructors were clinical faculty (named in 13 studies [62%]); these faculty represented a range of clinical specialties.[34–41,43–45,47,50] Four (19%) interventions employed outside consultants with leadership expertise,[37,38,43,47] while another 3 (14%) engaged hospital or medical administrators from within their institution as instructors.[32,36,50] One (5%) study involved nonclinical faculty members—specifically a psychologist, an improvement specialist, and a graduate

studies faculty member—from within the institution.[36] One (5%) study used resident educators as instructors.[40] Eight (38%) studies employed a mix of instructors including two or more of the above,[32,36–38,40,43,47,50] and in 7 (33%) of these studies, clinical faculty were among the instructors.[32,36,38,40,43,47,50] Seven (33%) studies did not report on the instructors.[33,42,46,48,49,51,52]

Pedagogical methods

The vast majority of interventions (19 studies [90%]) applied at least two or more approaches.[32,34,36–52] The most commonly used pedagogical method was small-group work and discussion (15 studies [71%]).[34,37–42,44–49,51,52] These studies included small-group, case-based learning, as well as interactive workshops and seminars. The next most common pedagogic method used was didactic teaching and independent reading/learning (described in 14 studies [67%]).[32,36–44,47,49–51] The third most common pedagogical approach was experiential learning (described in 8 studies [38%]).[32,35,36,40,43,45,50,51] In these interventions, residents took on new leadership roles (e.g., chief resident or junior consultant) within their clinical contexts, or they took on roles within new contexts (e.g., hospital or government administrative units). Seven studies (33%) incorporated a project-based learning approach during the intervention,[32,38,40,41,43,50,51] 7 studies (33%) incorporated mentorship,[32,36,40,41,43,50,51] and another 7 (33%) applied reflection as a learning tool for residents.[34,40,42–44,46,48] Other pedagogical approaches included multimedia viewing and analysis,[39] work-based learning,[32] gaming,[36,45,52] simulation,[46,48] and multisource feedback.[40]

Conceptual leadership frameworks

Nearly half of the studies (9 studies [43%]) provided an explicit conceptual leadership framework as the basis of the intervention design.[34,35,42–46,49,52] One set of investigators used three frameworks in their study.[34] Three studies[42,49,52] applied two frameworks. The remaining 5 studies[35,43–46] used one framework each.

In accordance with the multiple intelligences theory of leadership, we categorized all the leadership interventions into character, emotional intelligence, or cognitive domains. The vast majority of leadership interventions (19 studies [90%]) taught knowledge and skills related to the cognitive domain.[32–38,40–43,45–52] These included a wide array of different skills and abilities that were analytical, conceptual, or theoretical in nature. Some of these included business, financial, strategic, communication, and team-building skills. They also included knowledge on quality improvement, technology management, organizational behavior, informatics, negotiations, and critical thinking. Eight of the studies (38%) involved the character domain.[33,34,43–45,47–49] Concepts under the character domain included integrity, trust, authentic leadership, responsibility, accountability, wisdom, courage, humanity, justice, temperance, transcendence, modeling one's values, and setting personal vision. Finally, another 10 interventions (48%) included emotional intelligence.[34,39,40,42–45,47–49] Concepts taught under the emotional intelligence domain included reflection, understanding emotional intelligence and its relationship to leadership, self-awareness, and self-management. Only 4 studies incorporated elements from all three domains into their leadership development curriculum.[34,43,47,49]

Evaluation outcomes

All but 2 of the interventions included an evaluation component (19 studies [90%]).[33–49,51,52] As assessed according to the Kirkpatrick[26] scale (see Table 2), most studies (16/21 [76%]) scored just 1 (Reaction: Change in learner's attitude). Of these studies, 7 (33% of the 21) evaluated participants' perceptions of the leadership intervention using pre/post surveys,[33,35,37,40,41,44,45] and 10 studies (48%) evaluated only postintervention surveys.[34,36,39,42,43,46,48,49,51,52] One study (5%) used case study methods in addition to survey data.[43] Three studies (14%) scored 2 (Learning: Modification of knowledge or skill), providing pre/post data on participants' tested knowledge.[38,41,44] In addition, 1 (5%) study used a comparison cohort analysis.[44] No study demonstrated a Kirkpatrick score of 3 (Behavior: Change in behavior as a result of learning) or 4 (Results: Tangible as observed by objective outcome results).

We used the BEME guide to assess the quality of the 21 included studies[14]; the mean effectiveness score was 2 and the median was also 2. Nine studies (43%) scored 1 (No clear conclusion can be drawn, or the conclusions are not significant).[32,33,36,38,39,46,50–52] Three studies (14%) scored 2 (Results are ambiguous, but there appears to be a trend).[35,40,48] Nine studies (43%) scored 3 (Conclusion can probably be based on results) given their more robust curriculum and evaluation design.[34,37,41–45,47,49] None of the study assessments reached the highest quality scores of 4 (Results are clear and very likely to be true) or 5 (Results are unequivocal), as all studies were limited in scope and lacked rigorous outcome data.

Discussion

Through this review, we sought to evaluate and interpret leadership development interventions in PGME. Our results reveal that interventions lack grounding conceptual frameworks, employ varied curricular formats, lack longitudinal integration, provide evaluation outcomes of poor quality, and focus primarily on cognitive leadership domains. Both the lack of theoretical grounding and the narrow focus on cognitive domains are particularly troubling.

More than half of the curricula in our review (n = 12 [57%]) were not grounded in an explicit conceptual leadership framework. The authors of the remainder of the studies did not explain their criteria for selecting frameworks, nor did they discuss the pedagogical implications of those frameworks. In addition to providing intellectual rigor, the use of conceptual frameworks provides clarity in classifying interventions, facilitates the application of leadership efforts in different contexts and environments, and aids in evaluating the effectiveness of previous efforts. An explicit description of grounding frameworks encourages educators to reflect on the varied approaches to leadership development and make a reasoned choice in their context.

The majority of studies focused solely on cognitive and intellectual-related leadership competencies and neglected to address the domains of character and emotional intelligence[15–25]—despite accumulating evidence of the importance of a more comprehensive approach to leadership development.[53,54] Leaders who can influence, inspire, and empower those around them require more

Table 2

Classification of 21 Studies of Postgraduate Medical Education Leadership Curricula[a] Based on Kirkpatrick Effectiveness Score and the Best Evidence in Medical Education Guide's Quality of the Evidence Score

Score	Definition	No. (% of 21) curricula
Kirkpatrick: Effectiveness of the intervention[26]		
0	None: Outcomes not evaluated	2 (10)
1	Reaction: Change in learner's attitude	16 (76)
2	Learning: Modification of learning and/or skills	3 (14)
3	Behaviour: Change in behaviour as a result of learning	0
4	Results: Tangible, as observed by change in system/organization practice, reduced cost, improved quality, efficiency, etc.	0
BEME: Quality of evidence[14]		
1	No clear conclusion can be drawn, not significant	9 (43)
2	Results ambiguous, but there appears to be a trend	3 (14)
3	Conclusions can probably be based on the results	9 (43)
4	Results are clear and very likely to be true	0
5	Results are unequivocal	0

[a]The 21 articles were reviewed in a 2017 review of the literature.

than skill; they must manifest strong character and emotional intelligence to gain the trust and commitment of their followers.[53,54] Failure of most PGME leadership interventions to incorporate character and emotional intelligence is a significant gap.

Although this gap is significant, it may not be surprising. In today's competency-centric medical education culture, even topics such as ethics and professional identity are routinely described, taught, and practiced from a competency lens that stresses a rationalist, didactic approach focused on rules, skills, charters, and logic-based problem solving.[55–58] A competency-focused culture may encourage medical educators to emphasize cognitive and knowledge-based leadership competencies.[56] In doing so, the medical education community may not only lose sight of the critical domains of character and emotional intelligence in leadership development but also lose a tradition of educational discourse on leadership that stresses purpose, empathy, and commitment to values.[59,60]

Our results are consistent with previous systematic reviews of leadership interventions in different populations, including medical students, as well as practicing physicians.[31,61,62] These reviews have similarly demonstrated a lack of objective outcomes, a lack of theoretical grounding, and a much greater emphasis on skill-based cognitive competencies. This consistency points to a wider cultural approach to leadership development in physicians and physicians-in-training that may be in need of reform.

Developing leadership interventions that address character and emotional intelligence alongside cognitive competence may seem daunting, but such interventions have already occurred in both business and psychology. Medical educators should become familiar with these various approaches, many of which have the potential to be adapted to the medical setting. One noteworthy approach to holistic leadership development has been put forward by the Ivey Business School of Western University. Upon identifying failure of character as a root cause of the 2008 financial crisis, Ivey researchers argued that business schools have a moral responsibility not only to educate learners, helping them become competent in the knowledge and skills of business, but also to nurture character development to support that competence.[63] The group embarked on an ambitious plan to develop a "character-based leadership" program within the graduate school of business. Their efforts resulted in a character-based curriculum and conceptual leadership framework, a validated character assessment tool applicable to multiple organizational settings, and a number of impactful scholarly publications.[64,65] In medicine, the focus of any inquiry into failures of the system has been on transactional issues: organization, licensing, duty hours, and competence[66–69]—not character. But medicine is not immune to the character failures of the business world,[70] and we contend that our medical community would benefit from a similar focus on character. By learning from robust, evidence-based disciplines outside of medicine, medical educators can develop effective leadership development programs that will serve the growing need for effective physician leadership in today's world.

We acknowledge that any literature review may not thoroughly represent the state of existing leadership curricula. Although we took care to cast a wide net in seeking literature on leadership interventions in PGME, we may have missed some relevant articles. This limitation may be particularly acute in reviews of the medical education literature, as many curricular interventions are described in the gray literature of online repositories and other non-peer-reviewed sources. Thus, an institution or group may have developed an effective curriculum for holistic leadership in PGME that has not been published in a peer-reviewed journal and was, therefore, not identified in this review.

In addition, we made decisions regarding the classification of each curriculum intervention (e.g., format, learner level, instructor type) according to the information provided in each article, which at times lacked clarity and offered multiple possible interpretations. As such, the classifications reflect our analytical inferences and may not always accurately capture the dimensions of the respective curricula.

Lastly, we set out to synthesize, not to provide a meta-analysis of, included leadership interventions. With few studies available and diversity amongst study designs, we do not believe that a meta-analysis would be either appropriate or meaningful.

Conclusions

Given the changing environment of health care, it is imperative that medical educators nurture the leadership abilities of the next generation of

physicians. We encourage leaders and faculty to design future leadership intervention studies that are grounded in established conceptual leadership frameworks and include measurable outcomes. As conceptualizations of physician leadership have shifted from the positional (leadership as a role or title) toward, instead, the dispositional (leadership as a capacity), educators should develop new curricular interventions. Educators should incorporate broad evidence-based leadership attributes including those related to character and emotional intelligence in their curricular design. They should also integrate leadership development longitudinally throughout residency training. These steps are likely to result in greater effectiveness in PGME leadership training.

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Appendix 1

Description of 21 Peer-Reviewed, English-Language Studies on Leadership Training During Residency[a]

Author (year)	Learner level	Duration	Setting	Pedagogical method	Brief study description	Outcome		Leadership domains included
						Effectiveness	Quality	
Ackerly et al[32] (2011)	PGY 1–3	3 years	Cls, clin, imm	Didactic instruction, experiential learning, mentorship, project-based learning, work-based learning	Project-based rotations focusing on finance, patient safety, health systems operations, and strategy	0	1	Competency
Awad et al[33] (2004)	PGY 1–5	6 months	N/A	N/A	Communication and integrity development with focus on patient care and time management	1	1	Character, competency
Blumenthal et al[34] (2014)	PGY 2	1 month	Cls	Discussion, reflection, small-group work	Case studies addressing leadership styles, emotional intelligence, and leading clinical teams	1	3	Character, competency, EI
Doughty et al[52] (1991)	Chief (senior) residents	3 days	Cls, ws	Discussion, gaming, small-group work	Structured, 3-day experiential workshop based on organization development techniques and human interaction training modules to develop leadership skills	1	1	Competency
Edler et al[35] (2010)	Clinical subspecialty	1 year	Clin	Experiential learning	Developing decision-making and leadership skills under a team leader and team member roles	1	2	Competency
Gurrera et al[36] (2014)	PGY 2	5 months	Cls	Didactic instruction, experiential learning, gaming, mentorship	Developing business plans incorporated into a psychiatry training curriculum	1	1	Competency
Hanna et al[37] (2012)	PGY 3+	1 day	Cls, ws	Didactic instruction, interactive learning, small-group work	Management seminar, interactive lectures and case-based discussions	1	3	Competency
Hemmer et al[38] (2007)	Senior residents	1 year	Cls, smgp, ws	Didactic instruction, interactive learning, project-based learning, small-group work	Designed a course exploring leadership and management topics including interpersonal skills, market and finance, event management and informatics skills	2	1	Competency
Johnson and Stern[39] (2014)	Senior residents	1 day	Cls, smgp, ws	Didactic instruction, multimedia viewing and analysis, small-group work	Educational workshop including emotional intelligence teaching and leadership scenario role-playing	1	1	EI
Kasuya and Nip[48] (2001)	PGY 1	1 day	Cls	Reflection, simulation, small-group work	Evaluation of parental satisfaction of interactions with residents, effectiveness of parents' written feedback on the rate at which residents' parental satisfaction scores improve	1	2	Character, competency, EI
Kuo et al[40] (2010)	PGY 1–3	3 years	Cls, clin	Didactic instruction, experiential learning, mentorship, multisource feedback, project-based learning, reflection, small-group work	Educational curriculum designed for leadership, critical thinking, and community engagement development; focused domains: purpose, people, process; and personal, small-group seminars	1	2	Competency, EI
Levine et al[41] (2008)	PGY 1–5	2 days	Cls, os, smgp, ws	Didactic instruction, mentorship, project-based learning, small-group work	Educational curriculum with objectives to foster collaboration between disciplines, increase knowledge of geriatrics principles and enhance leadership skills	2	3	Competency
Moore et al[47] (2016)	PGY 1	1 year	Cls	Case-based learning, didactic instruction, small-group work	Learning modules on team decision making/ bias, leadership styles, and authentic leadership. Included resident evaluation of leadership interest and capacity	1	3	Character, competency, EI
Mygdal et al[49] (1991)	PGY 2 (chief resident candidates)	Not stated	Cls, smgp, ws	Didactic instruction, discussion, small-group work	Educational conference, including large- and small-group discussion, to develop better stress management and leadership skills	1	3	Character, competency, EI

(*Appendix continues*)

Appendix 1

(Continued)

Author (year)	Learner level	Duration	Setting	Pedagogical method	Brief study description	Outcome		Leadership domains included
						Effectiveness	Quality	
Paller et al[50] (2000)	PGY 1–3	3 years	Cls, imm	Didactic instruction, experiential learning, mentorship, project-based learning	Leadership and technical skills development, career mentoring	0	1	Competency
Pettit et al[42] (2011)	PGY 1–5	1 year	Cls	Didactic instruction, reflection, small-group work	Educational program designed to develop competency of interpersonal and communication skills; topics included leadership style, conflict management, effective feedback, team building, team leadership, motivation	1	3	Competency, EI
Ruston and Tavabie[43] (2010)	Not specified	4 months	Imm	Experiential learning, independent reading/learning, mentorship, project-based learning, reflection	Integrated training program to develop leadership skills and knowledge of general practice specialty trainees	1	3	Character, competency, EI
Schulz et al[44] (2013)	Not specified	6 months	Cls	Independent reading/ learning, interactive learning, reflection, small-group work	Use of virtue-based validated assessment tool; forums focused on virtues of initiative, integrity, responsibility, self-discipline, and accountability	2	3	Character, EI
Sims and Darcy[51] (1997)	PGY 1–5	5 years	Cls, imm, smgp, ws	Didactic instruction, experiential learning, mentorship, project-based learning, small-group work	Focused leadership/ management curriculum including a dedicated 2-month rotation supported with mentorship	1	1	Competency
Stoller et al[45] (2004)	PGY 1	1 day	Os	Discussion, experiential learning, gaming, small-group work	Experiential learning regarding teamwork and leadership; table discussions; enhance the interaction and teamwork dimensions	1	3	Character, competency, EI
Wipf et al[46] (1995)	PGY 2–3	1 day	Cls	Reflection, simulation, small-group work	Integrating residents as teacher/team managers, generating constructive discussions and problem solving, open-discussion format	1	1	Competency

Abbreviations: PGY indicates postgraduate year; cls, classroom; clin, clinical; imm, immersive (hospital administration); smgp, small-group; os, off-site; ws, workshop; character, character based; competency, competency/cognitive based; EI, emotional intelligence based; N/A, not applicable.

[a]The 21 articles were reviewed in a 2017 review of the literature.