OPEN ACCESS

Evidence-based medical leadership development: a systematic review

Oscar Lyons [1], Robynne George,[2] Joao R Galante,[3,4] Alexander Mafi,[5] Thomas Fordwoh,[5] Jan Frich [6], Jaason Matthew Geerts [7,8]

► Additional material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/leader-2020-000360).

[1]Nuffield Department of Surgical Sciences, University of Oxford, Oxford, UK
[2]Royal United Hospital Bath NHS Trust, Bath, UK
[3]Department of Medical Education, Oxford University Hospitals NHS Foundation Trust, Oxford, UK
[4]Cardiology Department, Buckinghamshire Healthcare NHS Trust, Amersham, UK
[5]University of Oxford Medical School, University of Oxford, Oxford, UK
[6]Department of Health Management and Health Economics, University of Oslo, Oslo, Norway
[7]Research and Leadership Development, Canadian College of Health Leaders, Ottawa, Ontario, Canada
[8]The Business School (formerly Cass), University of London, London, UK

Correspondence to
Dr Oscar Lyons, Nuffield Department of Surgical Sciences, University of Oxford, Oxford OX3 9DU, UK;
oscar.lyons@nds.ox.ac.uk

Received 6 August 2020
Revised 16 September 2020
Accepted 28 September 2020
Published Online First 16 November 2020

Check for updates

To cite: Lyons O, George R, Galante JR, *et al*. *BMJ Leader* 2021;**5**:206–213.

ABSTRACT

Health systems invest significant resources in leadership development for physicians and other health professionals. Competent leadership is considered vital for maintaining and improving quality and patient safety. We carried out this systematic review to synthesise new empirical evidence regarding medical leadership development programme factors which are associated with outcomes at the clinical and organisational levels. Using Ovid MEDLINE, we conducted a database search using both free text and Medical Subject Headings. We then conducted an extensive hand-search of references and of citations in known healthcare leadership development reviews. We applied the Medical Education Research Study Quality Indicator (MERSQI) and the Joanna Briggs Institute (JBI) Critical Appraisal Tool to determine study reliability, and synthesised results using a meta-aggregation approach. 117 studies were included in this systematic review. 28 studies met criteria for higher reliability studies. The median critical appraisal score according to the MERSQI was 8.5/18 and the median critical appraisal score according to the JBI was 3/10. There were recurring causes of low study quality scores related to study design, data analysis and reporting. There was considerable heterogeneity in intervention design and evaluation design. Programmes with internal or mixed faculty were significantly more likely to report organisational outcomes than programmes with external faculty only (p=0.049). Project work and mentoring increased the likelihood of organisational outcomes. No leadership development content area was particularly associated with organisational outcomes. In leadership development programmes in healthcare, external faculty should be used to supplement in-house faculty and not be a replacement for in-house expertise. To facilitate organisational outcomes, interventions should include project work and mentoring. Educational methods appear to be more important for organisational outcomes than specific curriculum content. Improving evaluation design will allow educators and evaluators to more effectively understand factors which are reliably associated with organisational outcomes of leadership development.

INTRODUCTION

Health systems invest significant resources in leadership development for physicians and other health professionals.[1] Competent leadership is considered vital for team effectiveness, for clinical and financial performance and for maintaining and improving quality and patient safety.[1–5] Clinical leadership development involves activities to promote leadership competencies among clinicians, while medical leadership development refers to activities centred on doctors.

Research suggests that medical leadership development can improve outcomes at individual, organisational and clinical levels.[6–11] Evidence backing medical leadership development activities has, however, been variable in quality.[1 7–10 12–15] There has been a particular lack of research and evaluation that goes beyond individual learner feedback and subjective outcomes.[6–9] One systematic review of 45 studies evaluating leadership development interventions for doctors found that effective interventions were characterised by the use of multiple learning methods, including seminars and group work, alongside action learning projects in multidisciplinary teams.[8] These findings were echoed in a recent study by Geerts *et al*,[9] who emphasised that plans need to be in place for transferring learning from the intervention into the working environment.

We undertook this systematic review to synthesise recent empirical evidence regarding medical leadership development programme factors associated with outcomes at the clinical and organisational levels. We specifically investigated links between aspects of programme design, delivery and evaluation and improved outcomes. Given the variable quality of studies highlighted in previous reviews,[7–9] we applied two validated critical appraisal instruments[16 17] to isolate higher reliability findings. This review is the first to apply both instruments in order to identify and synthesise the highest quality empirical evidence in medical leadership development.

METHODS

The design of this review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses[18] and the Best Evidence in Medical Education (BEME) guide for systematic reviews.[19] Our methods were based on the review conducted by Frich *et al*,[8] with methodological changes drawn from other reviews.[7 9 10 14 15 20] Following the BEME recommendations for systematic reviews,[19] we hand-searched references and citations of known reviews extensively to supplement our database search. In line with recommendations from Geerts *et al*[9] and Rosenman *et al*,[7] we assessed study quality using the Medical Education Research Study Quality Indicator (MERSQI), which is designed to measure the methodological quality of quantitative medical education research studies.[16] We added

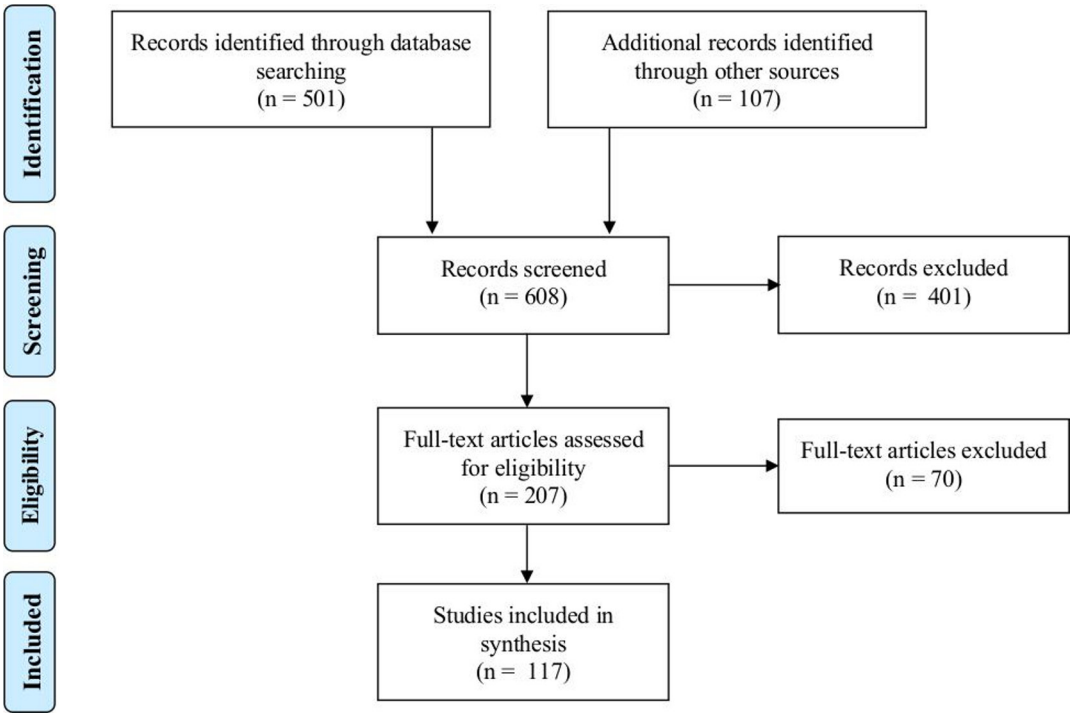

Figure 1 PRISMA diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

the Joanna Briggs Institute (JBI) Critical Appraisal Checklist,[17] which is designed for meta-aggregation of qualitative research and is well-established in healthcare research.[21]

Search strategy

We began this review by re-examining the data set identified in the review of leadership development for physicians by Frich *et al*.[8] With assistance from a specialist librarian at the University of Oxford, we then based our search strategy on Frich *et al*'s review.[8] Using the Ovid MEDLINE database, we conducted a search using both free text and Medical Subject Headings. The full search terms are listed in the online supplemental material. This search identified 501 unique publications. We then conducted an extensive hand-search of references and of citations in known healthcare leadership development reviews using Web of Science and Google Scholar. This identified an additional 107 studies for possible inclusion, for a total of 608 records for screening (figure 1).

Inclusion criteria

We included any peer-reviewed study published in English between January 2000 and January 2020 which:

1. Describes a leadership development intervention (programme, workshop, course and so on).
2. Includes physicians as learners (defined here as any practising doctor post-qualification).
3. Evaluates the leadership development intervention.

Qualitative, quantitative and mixed evaluations were included. We excluded studies where leadership development was a minor focus or where the proportion of physicians was lower than 10% of intervention participants.

Screening process

Two members of the review team (OL and TF) independently screened all study titles and abstracts for eligibility. Articles that were approved by either reviewer progressed to full-text review. Two members of the review team independently reviewed for inclusion the full text of all 207 articles that passed the title and abstract screen (TF and RG reviewed half each, OL reviewed all). Where there was disagreement about inclusion, all three reviewers (OL, TF, RG) reached consensus by discussion, with the third reviewer (TF or RG) arbitrating where required.

Data abstraction

After screening and reviewing for eligibility, 117 unique studies were included for abstraction and analysis. Data were abstracted and coded for educational setting, methods, content, evaluation methods and outcomes. Outcome data were categorised according to an adapted version of Kirkpatrick's Framework for evaluation of training programmes (see table 1).[19 22] One reviewer abstracted and coded all 117 included studies (OL). The second reviewers (RG/JRG/AM/TF) each abstracted and coded at least five studies in full to ensure consistency between reviewers. Data abstraction and coding for all 117 studies was then cross-checked by the second reviewers. Any differences were resolved by consensus, with a third reviewer arbitrating where required. Where possible, statistical tests performed in studies were replicated and checked for accuracy.

Study quality appraisal

Previous reviews have shown marked variation in the quality of studies of medical leadership development.[7 9 10 14 15 20] To isolate the most reliable evidence linking medical leadership programmes to improved outcomes, two researchers independently critically appraised each included study using the MERSQI and JBI Instruments.[16 21] Differences in MERSQI and JBI quality score were resolved by consensus, and a third researcher arbitrated where needed.

The MERSQI was applied to all 117 studies. The MERSQI is a validated appraisal tool consisting of 10 items in six domains which relate to design, sampling, type of data collected, validity of evaluation methods, analysis and outcomes.[16] Each domain is

Table 1 Kirkpatrick's Framework for evaluation of training programmes, with adaptations from Frich *et al*[8]

Kirkpatrick level	Description
Level 1 Reaction	Participants' satisfaction with the learning experience, its organisation, presentation, content, teaching methods and quality of instruction
Level 2A Change in attitudes	Changes in the attitudes or perceptions among participant groups towards leadership, management and/or administration
Level 2B Change in knowledge or skills	For knowledge, this relates to the acquisition of concepts, procedures and principles; for skills, this relates to the acquisition of thinking/problem-solving, psychomotor and social skills
Level 3A Behavioural change (self-reported)	Transfer of learning to the workplace and changes to professional practice, as noted by participants themselves
Level 3B Behavioural change (observed)	Transfer of learning to the workplace and changes to professional practice, as noted by a third party or by promotions
Level 4a Results (self-reported)	Organisational outcomes perceived by respondents and group effectiveness perceived by subordinates
Level 4b Results (observed)	Tangible organisational outcomes, such as reduced costs, improved quality and safety, impact of projects

scored to a maximum of 3, for a total score of 5–18. In line with Geerts *et al*,[9] studies with scores of 12 or higher were categorised as higher reliability studies (see the Data analysis section).

The JBI Checklist for Qualitative Studies was also applied where a study used mixed methods (k=53) or qualitative methods (k=10). Fundamental differences in study design, sampling, evaluation instruments and analysis preclude summative comparison of mixed-methods or qualitative studies to quantitative studies using the MERSQI.[16 21 23 24] The JBI Checklist is considered the most appropriate qualitative critical appraisal tool for use in pragmatic meta-aggregation of qualitative research.[24] It includes 10 items which regard the study's research questions, methods, analysis and reporting, for a total score of 0–10. Following recommendations from the JBI Reviewers' Manual,[17] a cut-off score for higher reliability studies was predetermined at 6/10. This score was chosen as studies obtaining six or more points included most key elements of high-quality design.

Data analysis

MERSQI and JBI Scores were used to establish which studies presented more reliable evidence of outcomes. Summary statistics were calculated for all 117 studies. In line with Geerts *et al*,[9] studies with a final MERSQI Score of 12/18 or higher were also analysed separately to isolate the most reliable evidence, as were qualitative and mixed-methods studies which achieved the pre-determined JBI Score of 6/10 or higher. As there was substantial methodological heterogeneity, study characteristics and outcomes were synthesised using a meta-aggregation approach.[25] All study quality appraisal scores are presented in the Online supplemental table 1, and full data extraction tables are available on request.

RESULTS

Study reliability (MERSQI and JBI)

Twenty-eight of 117 studies (25%) were categorised as higher reliability. Two studies were categorised as higher reliability by both the MERSQI and the JBI tool,[26 27] 14 studies (12%) by the MERSQI only and 12 studies (10%) by the JBI tool only. The median critical appraisal score according to the MERSQI was 8.5 (range 5–16 from possible range of 5–18) and the median critical appraisal score according to the JBI was 3 (range 0–9 from possible range of 0–10). Online supplemental table 1 includes the MERSQI and JBI Scores for all included studies.

Study design showed considerable room for improvement, as shown in online supplemental tables 2 and 3. Nearly half the of studies (46%) relied on post-programme evaluations only, and 92% did not include a control group. Of the nine studies that did include control groups, most had substantial methodological flaws in their selection of control groups. One common method for control group recruitment was to use unsuccessful course applicants.[28–30] In terms of evaluation design, the median evaluation instrument score was 0 (range 0–3). The majority of studies (59%) did not fulfil any of the MERSQI requirements for evaluation instruments, including reporting questionnaire design, wording and content. Objective outcome measures were used in only a minority of studies, with 60% relying solely on self-reported measures.

Data analysis and reporting likewise showed considerable limitations. Only one in five studies (20%) met criteria for comprehensive analysis and reporting of data. Few studies analysed their data beyond descriptive statistics to consider the generalisability and implications (13%). In many cases, studies omitted basic statistical significance tests.

Many studies did not contain key reporting elements for qualitative research as outlined in the JBI tool (see online supplemental table 3). There was clear congruity between research methodologies chosen and the research objectives and methods employed in 60% of studies. A minority of studies adequately reported their analysis (28%) and interpretation of data (25%), the potential for the researcher to have influenced data collection and interpretation (23%) and the researcher's cultural or theoretical orientation (15%). Participant voices were clearly represented through quotes in only 16/53 (30%) of mixed-methods studies and 5/10 (50%) of qualitative studies. There was a statement of ethical approval or ethics exemption in only 26 of 63 studies (40%) which used qualitative methods. No study included a statement of philosophical perspective (normally expected for qualitative research).[17]

Programme design

There was considerable heterogeneity in leadership development intervention design. It was often unclear whether established good practice for development of medical education interventions was followed, as shown in figure 2.[9 31] Only 52 studies (44%) reporting having conducted a needs assessment before

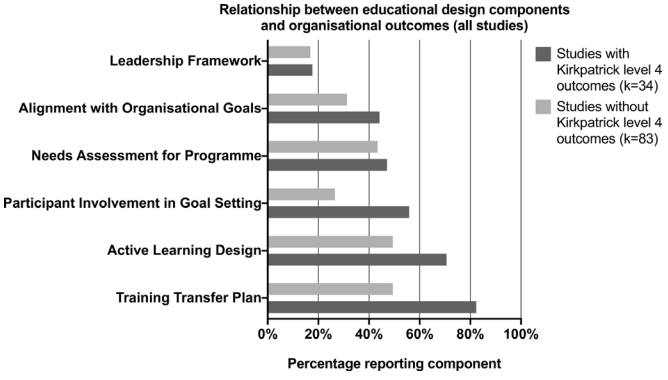

Figure 2 Educational design components: studies which reported Kirkpatrick level 4 outcomes (k=34) compared with studies that did not report Kirkpatrick level 4 outcomes (k=83).

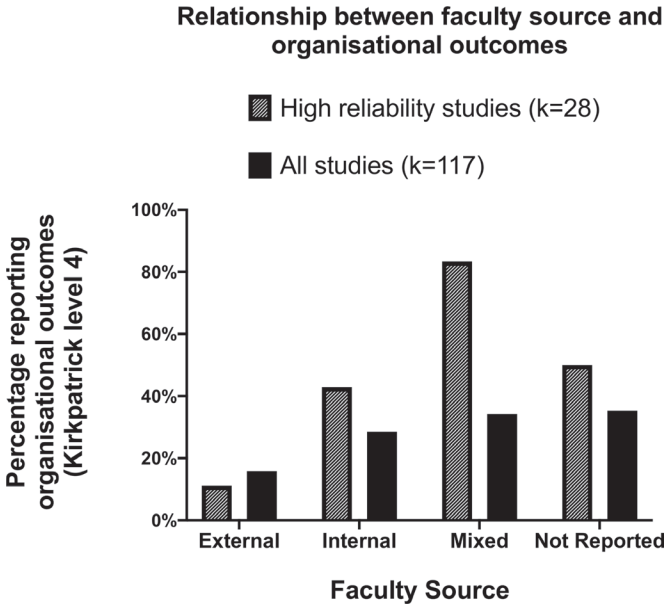

Figure 3 Relationship between faculty source and programme outcomes. Higher reliability studies were those with Medical Education Research Study Quality Indicator Score of at least 12/18 or Joanna Briggs Institute Score of at least 6/10. NR, not reported.

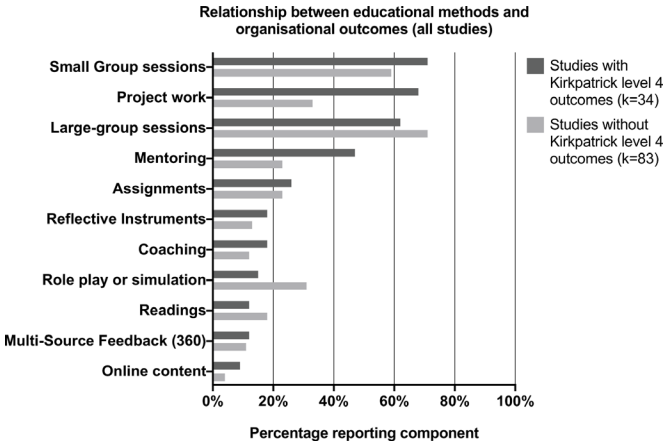

Figure 4 Educational methods: studies which reported Kirkpatrick level 4 outcomes (k=34) compared with studies that did not report Kirkpatrick level 4 outcomes (k=83).

their intervention, and only 20 studies (17%) explicitly reported using an established capability or competency framework to inform leadership programme goals and objectives. There was, however, a plan for training transfer reported or built into 68 of 117 interventions (59%).

The majority of interventions were carried out in a single hospital department (27%), single hospital (22%) or a single university (12%). Just under a quarter (23%) of interventions were conducted in multiple healthcare centres. A further 15% of studies were conducted within a specialty training programme outside healthcare centres.

Most of the studies took place in the USA (67%) or the UK (16%). The remainder of studies were in other European countries (7%), Canada (4%) or Australia (3%), with a single study each from Africa,[32] India,[33] Israel[34] and Qatar.[35]

Programmes ranged in length from 2 hours to 4 years. The median intervention length was 6 months, and the most common length was 1 year (19%). Only 18 interventions (15%) lasted longer than 1 year. Five interventions (4%) were shorter than 1 day.

Programme faculty

Programmes were predominately delivered by either in-house faculty (36%) or a mix of in-house and external faculty (32%). Programmes delivered by mixed faculty were most likely to show organisational outcomes, as shown in figure 3. The professional backgrounds, qualifications and experience of faculty were generally not reported.

Participants

The majority of programmes included doctors only (76%). Physician learners ranged from residents (60%) to full specialists (30%) and academic medical faculty (19%). Only nine studies of 117 involved doctors from more than one category. Behavioural outcomes were reported in a similar percentage of higher reliability studies for each category (85%–92%), while organisational outcomes were more commonly reported in programmes with academic medical faculty (50%) or full specialists (44%) than in programmes with only residents (20%). The 26 studies (24%) reporting multidisciplinary programmes included a combination of nurses (12%), managers (15%) and allied health professionals (9%). Most studies did not report the gender of participants (74%) or the age of participants (87%).

In terms of participant selection criteria, the majority of interventions included participants who volunteered (27%), were nominated (19%) or who applied to the programme (16%). In some cases the application process was highly competitive. Interventions were mandatory in one-fifth of studies (20%). A considerable proportion of all studies (23%) did not report the selection process for their learners, including one quarter (25%) of the studies categorised as higher reliability by MERSQI criteria.

Educational methods

A wide range of educational methods were employed in various combinations across the reviewed studies, as shown in figure 4. Most interventions included lectures (68%) and small group work (61%). Project work was included in the majority of studies with organisational outcomes (68%), but only in a minority of studies which did not report organisational outcomes (33%). Individual or team mentoring was also more prevalent where organisational outcomes were reported (47% vs 23%).

Educational content

Educational content varied considerably among interventions. The most consistent content area was leadership theory (reported in 65% of interventions). The other common content areas were performance management (44%), self-management (41%), change management (39%), communication (36%), teamwork (33%), quality improvement (30%), healthcare policy (27%), healthcare finance (26%) and leadership behaviours (20%). There were no notable educational content differences in higher reliability studies or in studies which reported organisational outcomes (Kirkpatrick level 4).

Evaluation methods

A wide range of evaluation methods were employed across the included studies. Nearly half used quantitative methods only for their evaluation (46%). Of the remainder, most studies used mixed methods (45%), with 10 studies (9%) using purely

qualitative methods. These proportions were similar in the higher reliability studies (41% quantitative, 48% mixed methods, 10% qualitative).

Four out of every five studies (82%) used questionnaires in their evaluation. Almost all of these employed Likert Scale items (92%) and one-third included open questions (34%). Only 8% used content or construct validated questionnaires. The proportion of higher reliability studies using validated questionnaires was slightly higher at 20% (MERSQI) and 18% (JBI). An additional six studies (6%) had conducted an expert review of their questionnaire for content validity only.

More than two-thirds of the included studies relied solely on self-ratings (69%). A minority of studies included ratings from subordinates (3%), peers (7%), superiors (12%) or experts (20%). The proportion of higher reliability studies which relied on self-ratings was lower (39%), with increased use of ratings from peers (14%), superiors (25%) or experts (39%).

The majority of studies (72%) included the collection of outcome data regarding behavioural changes (Kirkpatrick level 3, 57%) or organisational outcomes (Kirkpatrick level 4, 24%). Only three studies relied solely on Kirkpatrick level 1 outcomes (reaction).[36–38]

Nearly half of the studies used single group post-programme only designs (46%), with most of the other half using single group pre-programme and post-programme designs (46%). Most studies included a post-programme evaluation completed immediately at the end of the programme (90%). Only 18 studies (15%) included a longer-term evaluation. In higher reliability studies, longer-term evaluations were associated with increased reporting of organisational outcomes (56%) when compared with immediately-post designs (31%). All 16 higher reliability studies as assessed by the MERSQI used pre and post designs. Six of these included a non-randomised control group (38%), and one study included a randomised control group (6%). This was the only randomised control group used in any of the 117 studies.

Behavioural and organisational outcomes in higher reliability studies

A full summary of outcomes from all 117 studies is provided in online supplemental table 1.

There was a range of behavioural (Kirkpatrick level 3) and organisational (Kirkpatrick level 4) outcomes demonstrated in higher reliability studies.

Behavioural changes were objectively demonstrated in higher reliability studies through observed changes in behaviour,[26 27 39–43] promotions,[44 45] increased responsibilities or titles[28 46–49] and project completion.[50–52] Subjective changes in behaviour included improved communication,[39] influence,[50] delegation,[27] collaboration,[53] involvement in service improvement[47] and application of skills learnt or improved leadership in general.[39 40 54–57] These changes were indicated through interviews, free text questionnaire responses and behavioural self-assessments.

Organisational outcomes in higher reliability studies (Kirkpatrick level 4) were defined prospectively and in most cases were objectively demonstrated through leadership project impact evaluations. Projects achieved a range of outcomes, including reduced waiting times,[50] improved patient care[46 50] and cost savings.[27 46 47 50] By assessing the financial impact of projects completed during the intervention and relating this to programme costs, one higher reliability study reported a 364% financial return-on-investment (ROI).[27] Other objective outcomes included reduced organisational turnover of participants,[28] improved departmental working climate,[39] reduced sick leave[44] and increased promotion of women.[45] Organisational outcomes were subjectively indicated through reports of increased staff retention[56] and improvement in organisational effectiveness.[27] One study reported that 'intangible benefits' resulted in a 106% financial ROI.[51]

Organisational outcomes in higher reliability studies were reported more frequently from programmes delivered by a mix of internal and external faculty than from programmes delivered by only external faculty (83% vs 11%), as shown in figure 2. Organisational outcomes were also more frequently reported from interventions conducted in a whole hospital (57%) or multiple hospitals (40%), compared with interventions conducted in a single specialty (conference or outside-hospital training programme) (33%), single university (25%) or in a single department (0%). There were no notable differences in outcomes related to specific educational content.

Higher reliability studies that reported organisational outcomes were more likely have included project work (70% vs 44%), mentoring (50% vs 22%), coaching (22% vs 11%) and reflective instruments such as personality type assessments (22% vs 6%) than higher reliability studies that did not report organisational outcomes. Organisational outcomes were reported less frequently in higher reliability studies that included simulation or role play (10% vs 33%).

DISCUSSION

The aim of this review was to synthesise recent empirical evidence and explore factors associated with higher level outcomes in physician leadership development.

We found a substantial increase in the number of studies which evaluate medical leadership development interventions compared with previous reviews.[6–10 14 15] In many studies, it is still not clear whether best practices for design, delivery and evaluation are being followed.[31] It is also not clear whether there are sufficient behavioural and organisational outcomes to justify the considerable and increasing investments in medical leadership development.

Compared with previous reviews, we found an increase in the proportion of studies which report the use of active learning methods such as project work, simulation, discussions and reflections, which are widely accepted to be a vital component of leadership development[58] and which were associated in our review with increased Kirkpatrick level 4 outcomes.

No single leadership development content area was particularly associated with improved outcomes. With respect to educational methods, however, there was an association between the inclusion of individual or group project work and of mentoring with organisational outcomes. This may support the established position that educational methods are more important than specific curriculum content for leadership development.[1 58] Simulation and role play were less common in higher reliability studies which reported organisational outcomes that those that did not report organisational outcomes. This unexpected finding could result from these studies being situated in a training environment rather than a working environment. Alternatively, it could result from the evaluation process and study designs rather than from a lack of organisational impact. Studies which included simulation and role play tended to focus their evaluations on objective changes in behaviour at the expense of evaluating organisational outcomes (see online supplemental table 1). Interestingly, lacking a leadership development framework did not seem to impede programmes from reporting organisational

outcomes. This may indicate that programmes which are designed as bespoke solutions to local needs are more likely to achieve organisational impact than pre-packaged approaches to leadership development.

There was an additional association of more senior participant level with organisational outcomes. This may be related to the wider scope of influence or practice of senior physicians compared with resident physicians. It could also indicate that there is a longer post-programme development period before residents are able to have an impact on organisational outcomes. This would align with the finding that programmes which evaluated longer-term outcomes were more likely to report organisational outcomes.

Importantly, our findings indicated that leadership development interventions which used a combination of internal and external faculty were most likely to report organisational outcomes, and those interventions which used external faculty only were least likely. This could have significant implications for procurement and design of leadership development interventions across healthcare, particularly as courses run internally are associated with significantly reduced costs.[59 60]

As in previous physician leadership development reviews that used critical appraisal instruments,[7 9] we found that studies frequently did not meet criteria for high reliability. Many studies failed to report important methodological features, which restricts readers' ability to appraise studies and learn from their findings. This was particularly notable in terms of questionnaire design, with fewer than one in 10 studies using validated questionnaires or reporting their questionnaire content in detail. Most studies also did not report or analyse outcome evaluation data comprehensively. Many study designs were biased towards obtaining positive results, particularly in terms of the absence of control groups, having stringent or undisclosed selection criteria, including leading questions on questionnaires and relying solely on self-ratings. This is likely to have resulted in improved reported outcomes. The lack of evaluation quality seems to indicate perfunctory attention paid to evaluation design and precludes confident conclusions from these studies. Future studies could benefit from consulting study quality appraisal checklists such as the MERSQI and JBI in advance, in order to effectively design their evaluations.

This review does indicate that certain recommendations for improved programme evaluation are beginning to be applied into research. Whereas only 29% of the studies reviewed by Frich *et al*[8] included qualitative components, 63 (54%) of the 117 studies included in our review used mixed or qualitative methods. In a nascent and complex field such as medical leadership development research,[1 8 9 61] qualitative methods can have value in terms of establishing effective programme design features to achieve desired outcomes,[21 25 31] as well as helpful nuances of how, for whom, to what extent or in what circumstances interventions are effective or not.[9 10 62]

Additionally, many studies in this systematic review evaluated outcomes at Kirkpatrick level 3 behavioural change (57%) or level 4 organisational outcomes (24%). This is a significant improvement from previous reviews.[7 8 14] Changes in behaviour (level 3) and organisational outcomes (level 4) are more closely associated with transfer of learning to the working environment than participant reaction (level 1) and learning (level 2).[63–65]

Limitations and strengths

This review was limited by the reliability of the studies included. We attempted to control for study reliability using critical appraisal tools with cut-off scores for higher reliability studies. To the best of our knowledge, this is the first systematic review of healthcare leadership development interventions to use the JBI critical appraisal tool to critically appraise qualitative studies. The JBI tool enabled us to identify 12 additional higher reliability qualitative and mixed-methods studies which were not identified using the MERSQI. Marked heterogeneity of studies and evaluations precluded a formal meta-analysis, therefore, we adopted a meta-aggregation approach. This enabled us to highlight design components that are correlated with behavioural and organisational outcomes in higher reliability studies.

A substantial majority of studies reported only positive outcomes, which could represent a publication bias, and we limited our review to English language peer-reviewed studies. In line with Frich *et al*,[8] our database search was limited to MEDLINE, however, we augmented our database search with an extensive hand-search of reference lists and citations using Web of Science and Google Scholar. The hand-search revealed that many relevant empirical studies were absent from recent reviews despite some of those reviews searching a greater range of research databases. This could indicate flaws in healthcare leadership development literature tagging and filing procedures within medical and educational databases.

CONCLUSION

Our review has practical implications for those commissioning, designing and evaluating medical leadership development programmes in healthcare. No specific area of curriculum content and no particular leadership development framework were clearly associated with behavioural or organisational outcomes. While relevance and appropriateness of educational content is important,[31] this systematic review has more clear implications for leadership development methods than for specific content. Where possible, interventions should include projects and individual or group mentoring. Transfer of learning from the programme into learners' daily work and their organisations should be planned into the programme and where possible active learning educational designs should be employed, including opportunities for learners to set their own goals for development. External faculty should be judiciously used to supplement in-house faculty, not as a replacement for in-house expertise.

In terms of evaluation design, efforts should be made to ensure that evaluations are cost-effective and produce data that is useful for both practitioners and researchers.[66 67] Effective mixed-methods evaluation strategies should be integrated into evaluation designs. Study quality checklists such as the MERSQI and JBI could be consulted in the programme design phase to help build high quality quantitative and qualitative evaluation methods into programmes. At the minimum, evaluation design should include consideration of assessment at multiple time points, inclusion of control groups and collection of objective data, as well as collection of qualitative data from interviews, focus groups, questionnaires or observations. Programme goals and intended organisational outcomes should be explicitly considered during evaluation design[67] so that measures of organisational outcomes (including project outcomes) can be incorporated into the evaluation design. Improving study design and building robust evaluation methods into programmes will allow evaluators and educators to more effectively understand factors which are reliably associated with high level programme outcomes. This could both inform the improvement of individual programmes and

contribute to the medical leadership literature as a whole. It is only through more considered and thorough evaluation of physician leadership development programmes that we will be able to justify the investment they represent.

Twitter Oscar Lyons @oscarlyonsnz, Jan Frich @J_Frich and Jaason Matthew Geerts @jaasongeerts

Acknowledgements We would like to thank Tatjana Petrinic, University of Oxford Health CareHealthcare Librarian, for her invaluable assistance and advice in the search process.

Contributors OL, RG and JRG planned the review. OL, RG and TF screened studies for inclusion. OL, RG, JRG, AM and TF abstracted and coded studies. OL, RG, JRG, AM, TF, JF and JMG contributed to analysis, writing and editing the manuscript.

Funding Oscar Lyons was supported during this work by a Rhodes Scholarship, a Goodger and Schorstein Research Scholarship (University of Oxford) and the Shirtcliffe Fellowship (Universities New Zealand)

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

ORCID iDs
Oscar Lyons http://orcid.org/0000-0001-5809-7173
Jan Frich http://orcid.org/0000-0001-9079-7508
Jaason Matthew Geerts http://orcid.org/0000-0001-6672-3859

REFERENCES

1 West M, Armit K, Loewenthal L, *et al*. Leadership and leadership development in health care: the evidence base. *Kings Fund* 2015;19022015:1–36.
2 Goodall AH. Physician-Leaders and hospital performance: is there an association? *Soc Sci Med* 2011;73:535–9.
3 Falcone RE, Satiani B. Physician as Hospital chief executive officer. *Vasc Endovascular Surg* 2008;42:88–94.
4 Spurgeon P, Long P, Clark J, *et al*. Do we need medical leadership or medical engagement? *Leadersh Health Serv* 2015;28:173–84.
5 Tasi MC, Keswani A, Bozic KJ. Does physician leadership affect Hospital quality, operational efficiency, and financial performance? *Health Care Manage Rev* 2019;44:256–62.
6 Husebø SE, Akerjordet K. Quantitative systematic review of multi-professional teamwork and leadership training to optimize patient outcomes in acute hospital settings. *J Adv Nurs* 2016;72:2980–3000.
7 Rosenman ED, Shandro JR, Ilgen JS, *et al*. Leadership training in health care action teams: a systematic review. *Acad Med* 2014;89:1295–306.
8 Frich JC, Brewster AL, Cherlin EJ, *et al*. Leadership development programs for physicians: a systematic review. *J Gen Intern Med* 2015;30:656–74.
9 Geerts JM, Goodall AH, Agius S. Evidence-based leadership development for physicians: a systematic literature review. *Soc Sci Med* 2020;246:112709.
10 Steinert Y, Naismith L, Mann K. Faculty development initiatives designed to promote leadership in medical education. A BEME systematic review: BEME guide No. 19. *Med Teach* 2012;34:483–503.
11 Stoller JK. Developing physician-leaders: a call to action. *J Gen Intern Med* 2009;24:876–8.
12 Clark J, Armit K. Attainment of competency in management and leadership: no longer an optional extra for doctors. *Clin Gov* 2008;13:35–42.
13 Leslie LK, Miotto MB, Liu GC, *et al*. Training young pediatricians as leaders for the 21st century. *Pediatrics* 2005;115:765–73.
14 Straus SE, Soobiah C, Levinson W. The impact of leadership training programs on physicians in academic medical centers: a systematic review. *Acad Med* 2013;88:710–23.
15 Sadowski B, Cantrell S, Barelski A, *et al*. Leadership training in graduate medical education: a systematic review. *J Grad Med Educ* 2018;10:134–48.
16 Reed DA, Cook DA, Beckman TJ, *et al*. Association between funding and quality of published medical education research. *JAMA* 2007;298:1002–9.
17 Aromataris E, Munn Z. *JBI Reviewer's Manual*. Joanna Briggs Institute, 2019.
18 Liberati A, Altman DG, Tetzlaff J, *et al*. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ* 2009;339:b2700.
19 Hammick M, Dornan T, Steinert Y. Conducting a best evidence systematic review. Part 1: from idea to data coding. BEME guide No. 13. *Med Teach* 2010;32:3–15.
20 Husebø SE, Olsen Øystein Evjen, Olsen OE. Impact of clinical leadership in teams' course on quality, efficiency, responsiveness and trust in the emergency department: study protocol of a trailing research study. *BMJ Open* 2016;6:e011899.
21 Lockwood C, Munn Z, Porritt K. Qualitative research synthesis. *Int J Evid Based Healthc* 2015;13:179–87.
22 Kirkpatrick DL. Techniques for evaluating training programs. *Train Dev J* 1979:178–92.
23 Côté L, Turgeon J. Appraising qualitative research articles in medicine and medical education. *Med Teach* 2005;27:71–5.
24 Hannes K, Lockwood C, Pearson A. A comparative analysis of three online appraisal instruments' ability to assess validity in qualitative research. *Qual Health Res* 2010;20:1736–43.
25 Munn Z, Porritt K, Lockwood C, *et al*. Establishing confidence in the output of qualitative research synthesis: the ConQual approach. *BMC Med Res Methodol* 2014;14:108.
26 Cooper S. Developing leaders for advanced life support: evaluation of a training programme. *Resuscitation* 2001;49:33–8.
27 Orme D, Campbell C. How leadership training saves money 'service line leadership' at Nottingham University Hospitals. *Leader* 2019;3:29–36.
28 Fassiotto M, Maldonado Y, Hopkins J. A long-term follow-up of a physician leadership program. *J Health Organ Manag* 2018;32:56–68.
29 Berkenbosch L, Muijtjens AMM, Zimmermann LJI, *et al*. A pilot study of a practice management training module for medical residents. *BMC Med Educ* 2014;14:107.
30 Day DV, Sin H-P, *et al*. Longitudinal tests of an integrative model of leader development: charting and understanding developmental trajectories. *Leadersh Q* 2011;22:545–60.
31 Thomas PA, Kern DE, Hughes MT. *Curriculum development for medical education: a six-step approach*, 2016.
32 Nakanjako D, Namagala E, Semeere A, *et al*. Global health leadership training in resource-limited settings: a collaborative approach by academic institutions and local health care programs in Uganda. *Hum Resour Health* 2015;13:87.
33 Gulati K, Singh AR, Kumar S, *et al*. Impact of a leadership development programme for physicians in India. *Leadersh Health Serv* 2019;33:73–84.
34 Maza Y, Shechter E, Pur Eizenberg N, *et al*. Physician empowerment programme; a unique workshop for physician-managers of community clinics. *BMC Med Educ* 2016;16:269.
35 Al-Mutawa N, Elmahdi H, Joyce P. The implementation of a practice management programme for family medicine residents in Qatar. *Educ Prim Care* 2016;27:380–5.
36 Ringdahl EN, Tarwater KD, Lindbloom EJ. A longitudinal curriculum to address the gender gap in physician leadership. *J Grad Med Educ* 2014;6:361–2.
37 Johnson JM, Stern TA. Teaching residents about emotional intelligence and its impact on leadership. *Acad Psychiatry* 2014;38:510–3.
38 Bhatia K, Morris CA, Wright SC, *et al*. Leadership training for residents: a novel approach. *Physician Leadersh J* 2015;2:76–80.
39 Boyle DK, Kochinda C. Enhancing collaborative communication of nurse and physician leadership in two intensive care units. *J Nurs Adm* 2004;34:60–70.
40 Ruston A, Tavabie A. Fostering clinical engagement and medical leadership and aligning cultural values: an evaluation of a general practice specialty trainee integrated training placement in a primary care trust. *Qual Prim Care* 2010;18:263–8.
41 Cole DC, Giordano CR, Vasilopoulos T, *et al*. Resident physicians improve Nontechnical skills when on operating room management and leadership rotation. *Anesth Analg* 2017;124:300–7.
42 Ten Have ECM, Nap RE, Tulleken JE. Quality improvement of interdisciplinary rounds by leadership training based on essential quality indicators of the interdisciplinary rounds assessment scale. *Intensive Care Med* 2013;39:1800–7.
43 Gilfoyle E, Gottesman R, Razack S. Development of a leadership skills workshop in paediatric advanced resuscitation. *Med Teach* 2007;29:e276–83.
44 von Vultée PJ, Arnetz B. The impact of management programs on physicians' work environment and health. A prospective, controlled study comparing different interventions. *J Health Organ Manag* 2004;18:25–37.
45 Dannels SA, Yamagata H, McDade SA, *et al*. Evaluating a leadership program: a comparative, longitudinal study to assess the impact of the executive leadership in academic medicine (ELAM) program for women. *Acad Med* 2008;83:488–95.
46 Agius SJ, Brockbank A, Baron R, *et al*. The impact of an integrated medical leadership programme. *J Health Organ Manag* 2015;29:39–54.

47 McKimm J, Hickford D, Lees P, *et al*. Evaluating the impact of a national clinical leadership fellow scheme. *Leader* 2019;3:37–42.
48 Tsoh JY, Kuo AK, Barr JW, *et al*. Developing faculty leadership from 'within': a 12-year reflection from an internal faculty leadership development program of an academic health sciences center. *Med Educ Online* 2019;24:1567239.
49 Haftel HM, Swan R, Anderson MS, *et al*. Fostering the career development of future educational leaders: the success of the association of pediatric program directors leadership in educational academic development program. *J Pediatr* 2018;194:5–6.
50 Hopkins J, Fassiotto M, Ku MC, *et al*. Designing a physician leadership development program based on effective models of physician education. *Health Care Manage Rev* 2018;43:293–302.
51 Throgmorton C, Mitchell T, Morley T, *et al*. Evaluating a physician leadership development program - a mixed methods approach. *J Health Organ Manag* 2016;30:390–407.
52 Levine SA, Chao SH, Brett B, *et al*. Chief resident immersion training in the care of older adults: an innovative interspecialty education and leadership intervention. *J Am Geriatr Soc* 2008;56:1140–5.
53 Pradarelli JC, Jaffe GA, Lemak CH, *et al*. A leadership development program for surgeons: first-year participant evaluation. *Surgery* 2016;160:255–63.
54 Wurster AB, Pearson K, Sonnad SS, *et al*. The patient safety leadership Academy at the University of Pennsylvania: the first cohort's learning experience. *Qual Manag Health Care* 2007;16:166–73.
55 Bergman D, Savage C, Wahlstrom R, *et al*. Teaching group dynamics--do we know what we are doing? An approach to evaluation. *Med Teach* 2008;30:55–61.
56 Monkhouse A, Sadler L, Boyd A, *et al*. The improving global health fellowship: a qualitative analysis of innovative leadership development for NHS healthcare professionals. *Global Health* 2018;14:69.
57 Cohen D, Vlaev I, McMahon L, *et al*. The Crucible simulation: behavioral simulation improves clinical leadership skills and understanding of complex health policy change. *Health Care Manage Rev* 2017;44:246–55.
58 Rabin R. *Blended learning for leadership: the CCl approach*. 12, 2014.
59 MacPhail A, Young C, Ibrahim JE. Workplace-based clinical leadership training increases willingness to lead: appraisal using multisource feedback of a clinical leadership program in regional Victoria, Australia. *Leadersh Heal Serv* 2015;28:100–18.
60 Gagliano NJ, Ferris T, Colton D, *et al*. A physician leadership development program at an academic medical center. *Qual Manag Health Care* 2010;19:231–8.
61 Frye AW, Hemmer PA. Program evaluation models and related theories: AMEE guide No. 67. *Med Teach* 2012;34:e288–99.
62 Kwamie A, van Dijk H, Agyepong IA, *et al*. Advancing the application of systems thinking in health: realist evaluation of the leadership development programme for district manager decision-making in Ghana. *Health Res Policy Syst* 2014;12:29.
63 Klein KJ, Kozlowski SWJ. *Multilevel theory, research, and methods in organizations: foundations, extensions, and new directions*. San Francisco: Jossey-Bass, 2000.
64 Saks AM, Burke LA. An investigation into the relationship between training evaluation and the transfer of training. *Int J Train Dev* 2012;16:118–27.
65 Kennedy PE, Chyung SY, Winiecki DJ, *et al*. Training professionals' usage and understanding of Kirkpatrick's level 3 and level 4 evaluations. *Int J Train Dev* 2014;18:1–21.
66 Patton MQ. *Utilization-focused evaluation*. 4th ed. Thousand Oaks, Calif, London: SAGE, 2008.
67 Edmonstone J. Healthcare leadership: learning from evaluation. *Leadersh Health Serv* 2013;26:148–58.

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
Higher Reliability Studies (MERSQI)										
Boyle, 2004 [1]	Two US ICUs	10	3 Physicians 7 Nurses	8 months	6 externally provided modules, total 23.5hrs	Learning activities, small group skill practice, problem-solving sessions, feedback and reinforcement of skills, assignment, assessments, feedback	Leadership, communication, coordination, problem solving/conflict management, and team culture	3a. Leaders reported increased satisfaction with their own communication and leadership skills 3b. Communication skills of ICU nurse and physician leaders improved significantly in simulation (from 57 to 75/100). Relationship skills remained high (77-78/100). 4b. Reported increased problem-solving between groups and decreased personal stress in one of the sites.	n/a	16
Parsons, 2018 [2]	Single US hospital residency	14	Residents (Emergency Medicine)	4 days	4 days of simulation scenarios	Introductory didactic presentation followed by a series of 6 simulation scenarios and structured debriefs.	Crew Resource Management (CRM)	2b. Each team showed an overall gradual improvement in CRM skills compared to the preceding teams, suggesting that observational learning of CRM was effective in this setting. 3b. Large but not significant increases in all objective measures of leadership, problem solving, situational awareness, resource utilisation, communication, and overall crisis resource management score (overall 2.75/7 to overall 6.0/7). Very low number of teams (4) caused lack of significance (4)	n/a	14.5
Cooper, 2001 [3]	UK advanced life support course	35	Mixed seniority doctors, nurses and technicians	3 day resuscitation course	75-min leadership development seminar	Lectures, videos and discussion groups, home reading	Importance of leadership, behaviours of effective leadership, introversion/extroversion	1. Appraisal of the leadership seminar was very positive (mean 4/5) 2a. Reported increased confidence in role as a leader 3b. Significant improvement over the control group 9/10 items on the leadership observation. Mean increase of 4.53(/40) (cf. 2.23 in the control group)	6	14
Malling, 2009 [4]	Single educational region in Denmark	28	Consultants (Responsible for education)	6 months	Two three-day residential modules and a follow-up day.	Residential modules and followup day. Mandatory assignments.	Pedagogical knowledge, organization of specialist training, educational culture evaluation and quality assurance, planning specialist training in the department, supervision of supervisors, implementation strategies, personal development, leadership in specialist training, research in medical education	1. Participants rated the course as beneficial and meeting their expectations (3.2-3.3/4) 2b. Technical, administrative and human skills feedback did not improve or differ from the control group. 3b. Citizenship behaviours did not improve or differ from the control group	n/a	14
von Vultée, 2004 [5]	University hospitals in Sweden	52	Specialists, senior physicians, heads of departments	1 year	Three programs, including mentor programs, management networks, and lectures held across 1 year; no details on number, duration, or allocation to programs	Mentoring/Networking/Lectures	NR	2a. No significant differences in self-reported well-being, self- esteem, mental energy, influence, authority, efficiency, assessed using elements of the quality, work, competence tool (data not provided) 2b. No significant differences in self-reported skills development, self-esteem, mental energy or work-related exhaustion 3a. No significant differences in influence, authority, participation, feedback, goal clarity or efficiency 3b. No significant difference in senior management positions between program and control 4b. Sick leave increased by 6.9 days per year fewer in intervention group compared to reference group (1.3 days vs 8.2 days), p<0.05	n/a	14
Fassiotto, 2018 [6]	Single US hospital	131	Assistant/associate/full professors	9 months	6 x 1.5 day sessions over 9 months	Interactive teaching methods based on adult earning principles, action learning projects	Personal development as a leader managing people and relationships managing groups and projects managerial finance and accounting understanding the organizational system	1. Positive qualitative feedback about the course 2a. Increased perceived institutional support (no Bonferroni) 2b. Self-reported increased understanding of organisational structure esp. Finance 3b. Participants more likely to hold regional or national leadership titles and to have taken on new leadership titles. No significant difference in promotions 4b. Increased retention of female participants	3	13.5
Levine, 2008 [7]	Single US academic medical centre	47	Residents (Chief residents, medicine and surgery)	1 year	Two-day offsite immersion training, project work	Small-group discussions, evidence-based mini-lectures, interactive seminars, one-on-one project mentoring	Management of complex older patients, geriatric principles, giving feedback, approaching the reluctant learner, conflict resolution	1. Effectiveness of programme rated at 3.69/5 2b. Reported increased confidence in skills and knowledge in role of chief resident. Knowledge test significantly increased in 2 of 3 years. Significantly increased self-assessed knowledge 3a. Reports of heightened sensitivity to the unique needs of older patients 3b. Eight individuals accomplished 100% of their projects, 20/27 completed at least half of the project.	0	13.5
Hopkins, 2018 [8]	Single US hospital network	113	Senior medical leaders and academic faculty. 19 administrators, 94 doctors.	9 months	Six 1.5 day sessions spaced over 9 months	Baseline assessments of their leadership competence, Multi-Source Feedback, Myers Briggs Type Indicator and the Thomas-Kilmann Conflict Mode Instrument. Reading materials, assignments, case study, role-play, discussions in dyads, brief reflection and writing assignments, responses to video vignettes, brainstorming, and small group problem-solving assignments, with minimal emphasis on didactic lectures. Project work	Personal development as a leader Managing people and relationships Managing groups and projects Managerial finance and accounting Understanding the organizational system	1. Programme rated 4.5/5 overall 2a. Significant improvements in self-reported attitudes 2b. Significant improvements in self-reported knowledge and skills 3a. Self-reported significant improvement in effectiveness as a leaders and power and influence 3b. 100% of participants completed their projects. 4b. 58% of projects achieved IHI level 3 (moderate improvement in process measures) with 22% of these attaining level 4 (significant improvement in outcomes measures).	n/a	13.5
Dannels, 2008 [9]	Single US university executive education programme	78	Female academic medical faculty (associate or full professor level)	1 year	Executive leadership development program for senior female faculty	Executive leadership education	Not specified	2a. Aspiration to higher leadership position inside an academic health centre decreased; 2b. In all eight leadership composites, the exposure group mean (based on a seven-point scale) was slightly but significantly greater than the means in both the control groups. (average 0.2/7 increase) 3b. A higher percentage of participants have achieved leadership positions 4b. Promotion of increased number of female graduates achieved	n/a	13
Orme, 2019 [10]	Single UK hospital trust	425	Consultants and senior healthcare professionals and managers	12 months	12 months with 5 workshop days spread over 6 months	Five face-to-face delivery days, ongoing tele-phone coaching and the use of a benchmarked 360-degree profile. Project work. Interactive sessions. 3 days, then 1 day after 3 months, then 1 day after 6 months. Support via coaching between. 360 repeats at 12	Not well reported: influence, behaviours, team behaviours, finances. From website: execution, people management, evaluation and feedback	1. Evaluation using the net promotor score gave 92% score (promotors-detractors/total) 2a. Reports of improved confidence 2b. Reports of improved skills and techniques, self-awareness and other-awareness. 3a. Reports of improvement in delegation skills, trust. Corroboration with interview questionnaire 3b. Multi source feedback showed statistically significant improvement in clarifying purpose, with several other categories approaching significance. 4a. Reports of improved team effectiveness. 4b. Savings of £3.3 million were identified through the delivery of 11 separate initiatives for a	6	12.5

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
						months		Return On Investment of 364%. Quality improvements were observed.		
Cole, 2017 [11]	Single US hospital department	10	Residents (Anaesthesiology PGY3/4)	2 weeks	2 week operating room management and leadership elective rotation	Action learning literature reflective learning	Non-technical skills	3a. Increased "re-evaluates and debriefs"; "gathers and actively seeks out information"; "anticipates changing environment" 3b. Increase across a range of metrics measuring teamwork, task management, clinical decision making, situational awareness, as measured by "anaesthetists' non-technical skills" (ants) questionnaire	n/a	12.5
Haftel HM, 2018 [12]	Single US specialty association, 45 sites	49	Paediatric academic faculty	10 months	3 sessions focussing on the individual, their training programme and interaction with others	"highly interactive format", peer mentorship	Professional development, leadership training, administrative skill development.	3b. Statistically significant increase in leadership of national committees, production of national workshops and presentation at national platforms.	n/a	12.5
Ten Have, 2013 [13]	Four Dutch ICUs (in Single hospital)	9	Exposure: intensive care fellows Control: experienced intensivists	23 months	1 day simulation, group feedback on videoed interdisciplinary rounds. (unclear when this was offered - before or after post-training video)	Multiple learning activities including simulation; small group skill practice and problem-solving sessions; performance feedback and reinforcement of newly learned skills; and a planning assignment for on the job applications.	Leading an interdisciplinary ward round	3b. Participants increased significantly in their performance of 7 of the 10 tasks on the interdisciplinary ward round leadership assessment tool. Post-test, the participants performed these behaviours significantly more frequently than an experienced control group.	n/a	12.5
Gilfoyle, 2007 [14]	Single Canadian residency program (paediatrics)	29	Residents (Paediatrics, PGY1–PGY4)	1/2 day	Half-day workshop	Plenary session followed by two simulated resuscitation scenarios	Tasks required of a leader, effective communication skills within a team, and avoidance of fixation errors	2b. Significantly increased knowledge of tasks and fixation errors, "greater understanding of the concepts of effective leadership and team functioning" 3b. Residents' performance significantly improved from scenario 1 to scenario 2 (63% vs. 82%, p< 0.05). Residents' scores were better during the first scenario of the initial workshop than those during the 6-month workshop who had never previously participated (control). (63% vs. 50%, p< 0.05).	n/a	12
LoPresti, 2009 [15]	Four US residency programs	6	Residents (Family Medicine, PGY2)	2 years	60 hours of education in 20 modules.	Lectures, project work, in class exercises.	Leadership, quality improvement, policies, strategy and markets, insurance, finances, professional success, negotiation	1. Mean attendance of 66% 2b. Significant but small increase in test scores compared with control group	n/a	12
Wurster, 2007 [16]	Single US department of surgery	42	Surgical fellows	6 months	Long weekend of didactic study; teamwork on patient safety-related project; monthly conferences; 2 days for lectures and project presentations	Didactic study, group projects with monthly conferences and project presentations and capstone lectures	Ability to understand cognitive processes and group dynamics underlying medical decision making; communication across patient care continuum; implementation of systems approach to patient care	1. Reported leadership academy programme was more valuable than other patient safety initiatives 2a. Improved attitudes towards leadership roles 2b. Increased perceived leadership capability and knowledge across multiple skills and abilities 3a. Increased perceived functional skills in 5/8 areas. Increased preparedness to take a leadership role 4b. 1 out of 6 projects fully implemented	n/a	12
Higher Reliability Studies (JBI tool)										
Pradarelli, 2016 [17]	Single US hospital department	21	Academic surgeons from assistant to full professor grade	8 months	1 full day per month	Didactic and experiential learning. Case studies, team improvement projects, multi-source feedback, debriefing with executive coach	Leadership, team building, business acumen, and health care context	1. Participants reported high levels of satisfaction with the programme, ranked a 8.7/10 (10 being excellent use of their time) 2a. Participants felt "not only enabled but also capable of effecting change in their local environments" 2b. Participants reported increased self-awareness and increased team-building skills, and improvement of leadership knowledge 3a. Participants reported improved ability to foster collaborative relationships, and general improvement of interactions and networks.	9	8
Throgmorton, 2016 [18]	US Regional healthcare system	21	Physicians across a range of specialties	10 months	2.5h meetings/month +/- 2-3h of additional learning opportunities	Behavioural style assessment, multisource feedback, coaching, online discussions, online learning resources, team project in small groups	Intra/interpersonal effectiveness; resiliency; coaching; communication; teamwork; change management; business acumen; quality focus	1. Ratings of 4/5 for evaluation of eight content sessions (lowest average 4.3) 2a, 2b. Completing disc assessment, 360 feedback and coach supported development plan 3a. 16/21 participants completed individual development plan; 21/21 completed the everything disc workplace profile 3b. Team presentations completed 4B: 106% return-on-investment calculated from "intangible benefits"	8	11.5
Bergman, 2009 [19]	Single Swedish hospital	53	Managers (9 physicians, 33 nurses, and 11 other health personnel)	7 week vs 17 months	1: One week intensive course 2: Long-term support group (previously completed intensive) 3. Long-term support group (had not completed intensive)	A one-week course and a long-term support group. The intensive course consisted of modules using reflection and metre reflection supported by theoretical frameworks. The long term support group met half a day once a month for 1 to 2 years, to discuss problems that arise in the everyday work.	Group dynamics, communication, leadership theories	1. Participants emphasise the importance of the group as a "protected zone" 2a. Participants felt that they dared to be clearer. Both groups had improved attitude to leadership roles 3a. Participants from all groups reported using techniques in their workplace and personal lives, participants in the support groups reported exploring ways to handle changes in their work	8	10
Monkhouse, 2018 [20]	National UK programme	111	Doctors (secondary and primary care), nurses, public health professionals, allied health professionals, managers	3-9 months	3-9 month placement in a resource-poor country	Formal training, identification of learning needs, mentoring, project work with overseas partner	NHS healthcare leadership model, not otherwise specified	1. All interviewees agreed that the experience was valuable 2a. Increased percentage considering themselves to be leaders after the programme (78% after, 32% before), interviewees reported increased confidence. 2b. Increased self-awareness and leadership skills reported in questionnaire. Interviewees reported increased awareness of the leadership styles of others. 3a. 73% reported using their new skills. 18% reported not being able to use their skills. Interviewees reported changes in the way they relate to others. 4a. Several respondents noted they had planned to leave the NHS and decided to stay after the programme.	8	8.5
Tsoh JY, 2019 [21]	Single US academic healthcare centre	136	Faculty members perceived to have leadership potential	20 weeks	10 leadership modules over 20 weeks (75 Programme Hours)	Experiential learning NOS	Self-awareness, critical thinking, effective communication, inclusion, collaboration, empowered professionalism	1. Programme completion rate is 97.8% 2a. 76.4% of respondents said they developed an improved attitude towards their role and/or job at the university. Qualitative comments indicated improved confidence and aspiration. 2b. 98.6% of respondents reported noticeable changes in leadership skills 3a. 91.7% of respondents reported changes in leadership attitudes or behaviours. 62.5% reported seeking new leadership opportunities.	8	8.5

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
								3b. 9.6% of graduates reported a new leadership position; 12.4% of female graduates, 33.3% of underrepresented minority graduates.		
Bearman, 2012 [22]	Single Australian residency program (surgery)	12	Residents (Surgical trainees, midlevel across all specialties)	2 days	Two day simulation course	Simulation, peer observations, multi-source feedback, reflection, lectures, videos, scenarios	Patient-centred communication, inter-professional communication, teamwork, leadership and professionalism	1. All participants rated the course as good or very good. One third of participants described the communication scenario as "less than useful". All other aspects of the course were considered useful or highly useful. 2a. Increased awareness of the broader situation and the value of high-quality communication and teamwork 2b. Self-reported achievement of learning objectives including increased knowledge	8	7.5
Carney, 2015 [23]	12 US Primary Care residencies (4 locations)	33	Faculty (Family medicine, internal medicine, Paeds)	6 months	2.5day session with followup over 6 months	Didactic small-group sessions webinars conference calls visits by core faculty	Leadership change management teamwork population management clinical microsystems competency assessment patient-centredness and patient-centred-medical-home principles	1. Participants satisfied 51.5%-97%, useful 42.5%-84.8% on 7 topics 2a. 50%-96.7% report intention to implement	8	7.5
Cooper, 2011 [24]	Single US academic medical centre	108	Physicians, nurses, allied health professionals, administrators, managers	1 day	Workshop	Seminar simulation review of data from safety climate survey team project	Teamwork, patient safety, communication, individual and collective leadership, recognizing difference in perspectives between managers and clinicians, how to speak up to voice concerns, specifically	1. Scores for relevance and quality of simulations on questionnaire and free-text comments rated >5/10. 2a. The simulation helped participants recognize problems with speaking up. 2b. Gained understanding about shifting from blame to learning oriented leadership, facilitating communication and teamwork, being welcoming rather than defensive, and other self-reflections.	8	6.5
Agius, 2015 [25]	Single UK deanery	8	Specialty trainees (psych, renal, GUM, ENT)	4 years	Four-year part-time programme to Master's level with academic and vocational components	Diploma/MSc modules Action learning sets Workplace-based projects Shadowing placements Leadership development tools (self-reflection)	MLCF competencies Leadership, policy, organisational development, governance	1. Participants were happy with the course 2a. Participants reported improved confidence and judgement skills 2b. Participants reported improved leadership skills 3a. Participants reported taking new approaches to their roles 3b. Participants reported new roles 4b. Projects had significant system impact including organisational changes, improved patient experiences, cost savings.	7	10.5
McKimm J, 2019 [26]	National UK programme	145	Residents (Specialty and GP doctors in training)	1 year	Immersive internship out of practice with the most senior personnel in national and healthcare-related organisations	Immersive internship, visits to other host organisations and Parliament, teaching on leadership and management, and action learning sets	Policy development, project management, research and analysis, writing and publishing, professional networking skills.	1. Participants overwhelmingly endorse the programme and would recommend it to other trainees. 2a. Increased self-confidence as leaders (87% of respondents) and willingness to speak up 2b. Increased understanding of health systems, policy, team working skills with diverse groups, networking 3a. 60% of graduates report being actively involved in service improvements post-programme 48% of graduates reported difficulties transferring their training back to their clinical practice. 3b. 63% of graduates had gone on to further leadership/management development as a result of the programme 4b. Host organisations describe a range of benefits and examples of the impact of fellows' work on their organisations, including financial impact (e.g. Income generation, cost savings) and a range of deliverables (e.g. Reports, publications, research studies).	7	10.5
Cohen, 2017 [27]	Multiple UK health care organizations (London)	69	Consultants (32), Registrars (35), Grade not identified (2)	1 day	Workshop	Lecture-style presentations policy leadership simulation	Background of NHS reform healthcare challenges	1. All measures above 4/5 on Likert scales including "I recommend this simulation to colleagues at my professional stage" (4.50) and "I would like to take part in similar simulation events in future". 2a. Self-reported "learning from the simulation will help me deliver better long term care to my patients" (4/5) 2b. Self-reported increase in understanding of healthcare organisation (4.55/5) in all seven knowledge areas (regulation of health care providers, role of patient organizations, organizational accountability, role of local authorities, financial climate, roles and responsibilities of commissioners and care providers), there was a significant improvement in perceived knowledge scores. 3a. Capability was the only construct that showed a large and significant change post-simulation. There was a moderate but significant change in behavioural intentions, attitudes and subjective norms postsimulation, although there was no significant change detectable in opportunity in the short time between the simulation and feedback, 22 clinicians stated that their experiences in the crucible simulation had directly influenced their leadership practice increase in perceived self-efficacy postsimulation (mean score presimulation, 3.87 to postsimulation, 4.08).	7	10
Ruston, 2010 [28]	Single UK deanery	3	Residents (General Practice Specialty Trainees)	4 months	2 days per week for 4 months	Peer learning sets, meetings, project work, reflective diaries	Strategic and contextual issues, commissioning, design and delivery of health care, service redesign, public health agenda, leadership, management and partnership skills.	1. All respondents were positive about the value and success of the programme 2b. "evidence indicated that the [trainees] had met their core curriculum competencies at the level expected.". Trainees reported gaining an understanding of how good leaders hold a vision of the future and motivate people. All respondents, including observers, reported a marked increase in the trainee knowledge. Increased self-awareness 3a. Trainees reported using the skills learned during their project work 3b. Observers reported change in trainee behaviour, use of language, and use of skills. Supervisors also reported cultural barriers and organisational silos being broken down.	6	10.5
Other Included Studies										
Hackworth J, 2018 [29]	Single US hospital	99	Medical faculty members with supervisory or team leader responsibility	10 months	68 hours of learning over 10 month course. Two one-day seminars, one two-day off-site session, seven monthly four hour meetings, reading assignments.	Seminars, experiential activities, small group discussions, multisource feedback, teambuilding activities, reading	Emotional intelligence, leadership behaviours, leadership foundation skills	1. 94% of participants would recommend the programme to others, training rated as worthwhile investment (6.7/7) 2a. Statistically significant increased confidence in leadership ability 2b. Statistically significant improvement in 25/26 leadership measure 3a. Statistically significant increase in seeking ways to maximise application of leadership strengths and to overcome leadership limitations 3b. Statistically significant improvement in communication of leadership strengths and in confidence as seen by managers	3	11.5

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
Al-Mutawa, 2016 [30]	Family medicine residency programme Qatar	39	Residents (family medicine year 1-4)	5 days	5 day practice management workshop	Didactic teaching case studies small group discussions team exercises	Professionalism interpersonal skills practice-based learning and improvement system-based practice	2a. Increased confidence 2b. Increased self-assessed risk management, conflict management, communication skills, time management, ability to write objectives 3b. Supervisor-reported increase in effective use of hospital resources, coordination of patient care, patient communication skills	n/a	11.5
Fernandez, 2016 [31]	Single US college (O&G)	37	Obstetricians (Junior fellows, young physicians, senior fellows, not otherwise specified)	3.5 days	3.5 day national intensive leadership development for O&G physician leaders	Interactive skills-building workshops, series of leadership and psychological assessment tools, including a 360-degree assessment. Formal coach debrief of assessment, small and large group sessions	Organisational culture, leading and empowering, communication, motivation, advocacy, media, negotiation skills, health policy	1. 100% of respondents indicated that they would recommend the course to colleagues 2b. Posttest scores were significantly and meaningfully higher than pretest at the p< .0001 level in all 10 targeted leadership skills, both immediately following completion of the course and at 6 months post completion. Mean differences ranged from 0.8 to 1.81 (5 point scale from unskilled to highly skilled) 3a. Respondents reported having used skills learned in their day to day job. 3b. 9/26 respondents had expanded leadership responsibilities in a new role.	4	11
Chang, 2019 [32]	Three US healthcare organisations in 24 US states	65	49 Physicians (46 Geriatrics) 1 Dentist 3 Nurses 6 Pharmacists 1 Psychologist 1 Social Worker 1 Speech Pathologist	9 months	55hrs	Orientation, large-group workshop, two in-person meetings, monthly small group videoconferences disc personality type instrument, 1:1 coaching, structured networking, independent reading and reflection individual leadership project	Adaptive leadership managing reactivity courage and generosity mission, vision, goals disc(r)assessment motivation and resilience managing transitions influence and persuasion intrinsic and extrinsic rewards stories and advice presentation skills messaging and marketing strategy and stakeholders evaluation design scaling up business case and budget measuring impact project management	1. Mean satisfaction score of 4.86/5 2a. Significant increases in confidence in all sub-domains: self-awareness self-management empathy communication planning and execution (overall mean increased from 5.8/9 to 8.0/9) 2b. Some scholars stated that they gained confidence and skills from the program. 3a. Scholars reported intentionally continuing as a sustaining community of national colleagues after the conclusion of the program, offering peer mentoring, sharing speaking opportunities, and co-authoring manuscripts 3b. Scholars gave 85 presentations and published 63 manuscripts, and reported accepting local and national leadership positions as a result of the programme. 4b. Scholars received 21 awards, in addition to receiving funding and program cost savings from their training and practicum.	1	11
Day, 2010 [33]	Single US specialty association (orthopaedics)	100	Orthopaedic surgeons	1 year	Mentoring by established orthopaedic leader	Mentoring	Unclear	2b. Significant increase in 3/8 leadership domains: knowledge of theory, tolerance for demands of leadership, and leadership positioning. 3b. Significant increase in the number of national committee chairs (22% pre, 62% post-programme, p < 0.001). 48% of alumni advanced in academic rank vs 21% of controls (p = 0.005).	n/a	11
Korschun, 2007 [34]	Single US academic medical centre	70	Physicians (29), nurses, and a wide range of administrators	5 months	Five three-day sessions over five months	Lectures, seminars, case studies, experiential exercises, individual assessment, executive coaching, including a 360° assessment, mentoring, team project work	Strategic thinking and personal awareness, Leadership qualities, Leadership best practices, negotiating tactics and managing conflict Human resources and talent management, Building collaboration and influence skills, Marketing, development and public policy, Leadership in changing times, Communications, media relations, crisis management	1. Participants reported positive experiences with the program. Attendance was at a rate of 95% or higher. 24% of respondents disagreed that the mentoring process had helped them with their professional growth. 2a. 98% increased their commitment to and support of the vision and strategies of the organisation 2b. All respondents agreed to some degree that they had improved their interpersonal skills related to team leadership and that they had improved their approach to functioning in a team setting. Participants reported increased knowledge of the organisation. 3a. 93% reported the programme has made them more effective leaders. 85% report that they have become advocates for the organisation's strategy. Graduates reported being more effective in committees within their school or the university. 3b. 15% of graduates were promoted within the followup period. 76% reported taking on additional leadership responsibilities. 4a. Fellows stated that the leadership academy allowed them to establish a strong network of friends and colleagues from other disciplines, and after the program was over, they found it much easier to seek advice or establish collaborations with peer leaders in other parts of the organisation. 96% of respondents reported being more likely to stay with the organisation. 4b. Successful adoption of most projects into the organisation.	n/a	11
McDade, 2004 [35]	Multiple US and Canada Academic Medical Centres (AMCs)	79	Associate or full professor	7 months	Three 1-week meetings across 7 months	Leadership skill development, mentoring, and networking	The curriculum focuses on building knowledge and skills in seven domains: paradigms of corporate, government, and academic leadership; financial management; strategic planning and organizational transformation; emerging issues in academic medicine; communication; personal dimensions of leadership; and career advancement strategies.	2a. Increase confidence in applying conflict resolution strategies, and with public speaking. 2b. Significant increases (p<0.001) in knowledge of organization, management, and leadership theory, financial management, environmental scanning, job negotiations, risk management, life balancing 3a. Increase in reports of having a mentor 3b. No clear effect on career progression. 4b no significant increase in tangible benefits from projects.	n/a	11
Edmonstone, 2011 [36]	UK National programme (Scotland)	117 (from total 5 cohorts)	Senior strategic leaders in NHS Scotland: hospital doctors, primary care doctors, nurses, AHPs, pharmacists, psychologists, dentists, paramedics	12 months	A three-day residential development centre followed by nine two-day residential events held every six weeks.	Coaching, Mentoring, Action Learning, Change Management Project, Masterclasses/Workshops, After Dinner Speakers, Shadowing, Organisational Visits, Chief Executive Sponsorship, multi-source feedback, psychometric tools, Development Centre, Personal Development Plan	Self-leadership, leading others, collaborative working, delivering excellence through others, managing complex change, improving patient experience, political awareness, strategic dexterity, aligning agendas/creating culture	1- all elements of the programme were positively rated by participants with ratings becoming more positive as the programme progressed. 2a - increased self-awareness and insight, greater personal resilience and improved motivation. 2b - participants "appear to have gained tremendous personal benefit" which focused on confidence to operate outside their initial comfort zone; greater clarity about their leadership role; greater assurance about their own leadership capability and sense of empowerment; greater awareness and knowledge of policy issues and the need to develop skills in the areas of strategic influence. 3a - improved relationship-building and networking skills and the development of improved influencing ability. 3b - positive feedback was also offered by those around the participants in their employing organisations. In responding to telephone interviews and questionnaires, these colleagues, managers and staff of participants reported significant behaviour change. 4b- successful completion of significant service development through leadership projects had made significant impact locally and nationally.	5	10.5
MacPhail, 2015 [37]	Single Australian Hospital Department (Geriatrics, Rehabilitation and Palliative Care)	39	Non-executive middle or senior level medical, nursing and allied health professionals	9-10 months	2-hour monthly sessions, group projects, site visits	Guest speakers and discussions external site visit, project, presentation	Organisational structure, healthcare context, leadership and patient safety, quality of care and clinical errors, complex systems, communication, engagement with patients, conflict, negotiation, change management	1. Participants reported almost unanimously (86-100%) for all measures including that the course was relevant and valuable 2a. Participants reported increased willingness to take on leadership roles 3a. Participants reported in comments that they benefited from increased networking and relationships across silos. 3b. 4 of 17 participants from the first cohort had been promoted 18 months after the programme (no control group available)	5	10.5

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
Cerrone, 2017 [38]	Large US integrated health care organization	80	Residents (Incoming Chief Residents)	1 day	9hrs	Emotional intelligence inventory three weeks prior to course didactic sessions simulated teaching encounters	Leadership, managing, and core feedback skills, interpretation of emotional intelligence inventory, interpersonal and communication skills and professionalism	1. 92% agreed that the program met their learning needs. Participants reported considering the OSTEs useful. 3b. OSTE scores (out of 100) increased from mean = 47.92, SD = 7.8 to mean = 51.22, SD = 6.9); t (68) = 1.99, p = 0.006	1	10.5
Patel, 2015 [39]	Single US hospital	30	Residents (PGY2-4)	2 years	2 year healthcare leadership in quality residency track	Core curriculum (120 hours over 3 weeks including lectures, readings, videos, small group activities, online modules, facilitated discussions), integration into a quality improvement leadership team, capstone qi project, mentorship	Methods and tools of quality improvement and patient safety, human factors engineering and safety culture.	1. The core curriculum has been rated as highly valuable and necessary (mean 4.95 and 4.96/5 respectively) 2b. Mean improvement of quality improvement knowledge assessment was 3 points for cohort 1 (SD 3), 4 points for cohort 2 (SD 1.6). Improvements were marked by the track directors. No significance reported 3a. Graduates reported that they intend to pursue quality/safety leadership positions (13 strongly agree, 1 agree) 3b. All graduates have completed their projects. 12 posters presented at national conferences regarding capstone qi projects. 4b. "most of the capstone projects have resulted in improvements in health care delivery" - not otherwise specified.	n/a	10.5
Nakanjako, 2015 [40]	Four African and 4 US universities	15	Unclear	1 year	1 year fellowship	8 weeks of didactic teaching, with two 4.5 month experiential trainings at health organisations. Also 4 online modules. Mentoring (weekly meetings, monthly mentoring team meeting). Logbook for learning.	Leadership, communication, monitoring and evaluation, health informatics, research methodology, grant writing, implementation science, and responsible conduct of research.	2b. Participants reported improved skills and knowledge 3a. Participants reported use of new knowledge and skills in both current and new leadership roles 3b. All graduates have remained in health leadership positions in Uganda. 86% (13/15) have opted to take on new responsibilities. 4b. Individual projects completed on the programme had a range of positive outcomes. These amounted primarily to official recommendations and initiation of new pathways, but several of the projects are reported to have improved patient care.	2	10
Kuo, 2010 [41]	Single US residency program	16	Residents (Paediatrics PGY1-3)	3 years	Bespoke residency programme	Small-group seminars, project work, and mentoring	Themes of leadership, critical thinking, and community engagement. Topics include policy making, project management, decision making and communication	1. Satisfaction with programme 3.73/4 ±0.46 2a. Positive impact on plans to influence population health and health policy 3.53±0.64 and to serve minority or underserved populations 3.47±0.74 2b. Improvement of competence as a leader 3.40±0.74 3b. Participants have received both local and national awards recognizing their leadership and commitment to the community. Nine graduates are in positions of leadership such as medical directorships 4b. 9/16 graduates have received grants to support their projects. Multiple projects have achieved sustainable funding and impact across advocacy, health programme development and policies.	1	10
Brandon, 2013 [42]	Single US residency program (radiology)	44	Residents (Radiology)	1 year	7x 90min modules	lectures and case-based group discussions	Finances, quality improvement, employment, organisational dynamics, healthcare policy and economics, negotiation and conflict management	2a. Significant improvement in participants' knowledge for all modules (p<.001) 2b. Significant improvement in participants' self-assessed confidence scores for all modules (p<.001)	n/a	10
Green, 2002 [43]	US network of community- owned health care providers and physicians	26	26 Teams from eight organizational units	2 years	Coaching and leadership initiative	Faculty coaching Quality improvement projects Team meetings, with team learning sessions and planning for six-month action period following the meetings. Teams from subsequent waves overlapped	Diffusion of innovation, Strategic goal-setting, engaging others, PDSA, barrier-busting and infrastructure-building, project management, reflective thinking and learning, conceptual thinking, summarizing and communicating, coaching, and building further organizational capacity for spread	4b. 17 of 26 teams reported significant clinical improvements in targeted areas, improvement work has become easier with each cycle (improved from 50% of projects within 3 weeks in cycle 1, to 100% in cycle 3)	n/a	10
Hemmer, 2007 [44]	Single US residency/ fellowship program (pathology)	16	Residents and fellows (Pathology)	1 year	6 x 1-2 day workshops (average 10hrs per workshop)	Pre-reading, didactic lectures, interactive sessions, case scenarios, team- building exercises, project	Leadership and management basics, managing change and interpersonal skills, personnel issues, quality, informatics, finance, and a capstone seminar	1. Participants evaluated (five-point scale) the content and speakers (scores from 4.4 to 5.0). 2b. Participants showed significant improvement in their leadership and management test scores (61/62 % to 88% in two different cohorts)	n/a	10
McCurdy, 2004 [45]	Single US academic medical centre	22	Faculty members (who were, at the time of the course, in a leadership position or likely to move into a leadership position soon)	12 months	Eight 3-hour sessions in two 2-day blocks 6 months apart and 2 evening small group discussions	Workshops, evening sessions, Project with poster or a short oral presentation	Setting goals, leadership, change, emotional intelligence, organisational dynamics, mediation and negotiation, quality improvement	2b. Post-program self-assessments significantly and meaningfully different from pre-programme using both traditional and retrospective measurement. 3b. 14 projects completed	n/a	10
Hadley, 2014 [46]	Single UK training deanery	30	Residents (PGY2 doctor/s paired with a management trainee)	6-9 months	Paired quality improvement project with a management trainee and a PGY2 doctor	Project work, mentoring, action learning sets	No formal curriculum	1. Continued engagement from 24/30 participants for the programme 2a. Participants felt empowered to start service improvement projects 2b. Statistically significant increase in self-reported understanding of several domains (statistics and data not reported) 3b. Projects presented by 9 of 14 teams	3	9.5
Revere, 2015 [47]	Single US hospital network	50 "approximately"	Senior physicians "chairs and near-chairs"	6 months	Fortnightly full-day sessions, project work	Lectures, discussions, projects	Strategy, finance and accounting, organizational performance measures, including clinical quality, human resources and customer experience management, organizational behaviour and team building and leadership skills.	1. Course rated 4.69/5. 71% rated topics as relevant 2a. Participants reported changed perspectives 2b. Participants reported learning from the lectures 3a. Participants reported being more engaged in their conversations, and applying learning day-to-day 4b. 40 per cent of the course projects have been funded by and implemented within the participant's respective institution. Senior sponsors have continued to be satisfied with project and programme outcomes and continue to send participants	3	9.5
Osborn, 2004 [48]	Ten US Paediatric Association locations	32 (total 2 cohorts)	Paediatricians from AMCs	2-3 years	Three 2-day workshops during first 12 months, then 2 advanced workshops annually (only one for cohort 2)	Workshops, project	3 Clusters: 1) institutional leadership concepts; institutional leadership skills; management skills (very good table in the paper with details of each).	2b. Reported increased knowledge and skills in all areas related to giving workshops 3a. Participants reported that they incorporated into their workshops knowledge and skills gained in 1) mission, vision, and values; 2) how to approach organisational change; 3) mission-based management; 4) net- working and team building; and 5) workshop development 3b. Across a 2-year follow-up period: 13/30 (43%) conducted a workshop, 2/30 (7%) were promoted, 18/30 (60%) participants assumed a leadership position participants conducted 57 local workshops and 33 regional or national workshops that were attended by 1082 participants.	2	9.5

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
								4b. Across a 2-year follow-up period 8/30 (27%) obtained a peer-reviewed grant		
Wichman, 2009 [49]	Single US hospital department	6	Residents (Psychiatry PGY3)	8 months	Weekly seminars (8 modules x 4 sessions each), with projects and mentoring	Lectures, discussions, projects, mentoring	Financial management, Human resources management, Planning and marketing, Information management, Risk management, Governance and organizational dynamics, Business and clinical operations, Professional responsibility.	1. All respondents said course met or exceeded their expectations. 3b. Multiple projects completed during programme 4b. One project resulted in decreased non-attendance by new patients by 50% across 12 months	n/a	9.5
Monaghan, 2018 [50]	Single UK hospital trust	12 (6 doctors)	Residents (non-training clinical development and clinical teaching fellows, managers of various departments)	6 months	6 month paired learning doctors/managers	6-month paired learning matching doctors with managers. Shadowing, conversations, reflections	Nr	2a. Physician participants reported feeling more prepared for a range of leadership requirements, including understanding decisions and working in teams and with managers 4b. Two pairs collaborated to successfully implement a lasting organisational change in the form of a trainee management forum	4	9
Voogt, 2016 [51]	Six Dutch teaching hospitals	NR (~50)	Residents (mixed specialties and levels)	1 year	Four 1hr meetings to discuss and plan projects	Facilitated discussions, project work	Quality improvement and leadership, not otherwise specified	2a. Interviewees reported feeling empowered 2b. Interviewees reported increased awareness of organisational aspects of healthcare delivery. 4a. Outcomes of projects e.g. Development of new handover guidelines to ensure the attending physician is present at handovers	3	9
Heitkamp, 2017 [52]	Single US hospital department	98	Residents (radiology)	NR (variable, journal club)	One hour lunchtime Journal club meeting every fortnight	Journal club, projects, mentoring, leadership role placement	Leadership (topics chosen by the group on an ad hoc basis)	2a. Participants felt better prepared for their careers 2b. Self-reported increased understanding of the business of radiology 3a. Self-reported improved communication, interaction with referring physicians, career development team building, group dynamics, and interactions with hospital administration 3b. 35% had assumed leadership roles within three years. Publication of 27 articles in core radiology journals, completion of multiple projects 4b. New external collaboration for residents	0	9
Pearson, 2018 [53]	UK leadership fellowship	12	Residents (senior, medicine, general practice, surgery, obstetrics and gynaecology, paediatric surgery and psychiatry.	1 year	1 year out-of-programme fellowship in a host organisation	Symposia and conferences, one-to-one coaching sessions, action learning sets, shadowing opportunities and reflective practice including completion of a portfolio. Project work for host organisations	Minimally reported. Communication, working styles and leadership framework mentioned	1. Most participants reported that all components of the course were very or slightly useful. 75% did not access multi-source feedback component. 2a. Most participants reported improved attitudes towards leadership and their ability to make changes in their organisation. Reports of increased confidence. 2b. Reports of increased awareness of other working styles and characteristics of good leadership. 3a. Reports of adjusting behaviour towards other working styles	0	9
Crites, 2004 [54]	Single US residency program (internal medicine and paediatrics)	13	Residents (PGY1-4)	1 year	Monthly seminar series	Interactive lectures	Coding, finances, group dynamics, human resources, risk management	1. Participants rated the course effectiveness 4.13/5 2a. The residents' views towards practice management education in general had mean scores of 4.67 (/5) 2b. Participants scored significantly higher on a self-assessed management skill, from 2.62 to 3.65 (/5). Average score on knowledge test significantly increased from 74% to 91%	n/a	9
Dickey, 2014 [55]	Single US hospital	Unclear (3 leadership projects described)	Residents (Psychiatry PGY1-4)	4 years	Modular leadership programme over 4 years with mostly voluntary components	Seminars, with voluntary simulations, action teams work, electives, mentoring	Philosophy of leadership, healthcare delivery systems, quality assurance, risk management, qualities of exceptional leaders	3b. Three projects undertaken as part of voluntary elective 4b. One project resulted in a reduction of admission time of 65 minutes	n/a	9
Foster, 2008 [56]	Single US medical centre	12	Residents	2 years	3 week intensive orientation, 11 month MPH degree and leadership coursework, weekly 1/2 day didactic sessions, monthly journal club, monthly open evening sessions	MPH degree, leadership coursework change project, mentoring	Leadership of small systems in health care Measurement of illness burden in individuals and populations Measurement of the outcomes of health service interventions, Leadership of change for improvement of quality, value, and safety of health care of individuals and populations Reflection on personal professional practice enabling personal and professional development.	3b. Projects completed 4b. 8 projects completed with patient and organisational benefits e.g. Decreased procedure and hospitalisation times	n/a	9
Freeman, 2018 [57]	Single US training programme	30	Cardiology fellows-in-training and early career professionals	2 years	2 year cardiology leadership academy	Mentoring, not otherwise clear	Conflict management, team leadership, influencing others, navigating challenging conversations, and how to achieve work-life balance.	2b. Participants reported increased confidence across a range of key curriculum areas 3a. Participants reported the programme had helped them to gain new leadership roles, and that they had applied learning from the programme in their new leadership roles; 4a. Of those that acquired a new leadership opportunity, 100% of respondents reported participating in the leadership academy program had an impact on their success within the newly acquired leadership role(s).	n/a	9
Saravo, 2017 [58]	Single German university hospital	50	Residents (PGY1-4 across specialties)	4 weeks	Weekly 2.5hr sessions after clinical duties (x4)	Didactic module, standardised simulations, one-on-one feedback on recorded simulations, "practicing communication techniques"	"Full Range Leadership Model" (Bass); transactional and transformational leadership, simulation of critical incidents, communication techniques	2a. No change in knowledge in exposure or control. No difference in self-assessed change in self-assessed leadership scores compared with control (both had small increases in mean scores). 3b. Increase in observed performance on bespoke transactional and transformational scales (based on video recorded simulations, no control group)	n/a	9
Schulz, 2013 [59]	US surgical department specialty	9	Residents (ENT)	6 months	Virtue strength assessments (VIA); mentorship meetings; 'thought of the day'; internal and external faculty training and development; leadership basic training course	Mentoring, interactive sessions mixed with reading, individual character assessment	Virtue Leadership, curriculum not otherwise specified	1. 100% agree that project was a valuable learning experience (up from 56%) 2a. No significant change in attitude towards leadership 2b. Increased knowledge of the leadership values of the organisation (94% up from 47%)	n/a	9
Stoller, 2007 [60]	Single US hospital network	Unclear (roughly 400)	Emerging physician-leaders	9 months	Eight sessions offered roughly once monthly on Fridays at an off-site retreat centre, Longitudinal project	Seminars, business case project	Marketing in healthcare, Healthcare finance, Writing a business plan, Emotional intelligence, situational leadership, conflict resolution and negotiation, Medicolegal issues	3b. 49 business plans were submitted over 13 courses. 4b. 30 of 49 business plans have been implemented	n/a	9

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
Wulfert, 2017 [61]	German Master's Degree (Leadership in Medicine)	17	Varied (2 senior consultants, 8 consultants, two senior residents, one pharmacist, one financial controller)	>100 days teaching time over a master's degree	Master's degree	Project work, didactic teaching, discussions, thesis	Leadership and management, quality management and legal aspects, medical ethics, project management, empirical research methods, communication/dialogue skills, change management, diversity management, management accounting, health economics, medical engineering and computer science, education and didactics, educational management	1. 14/17 participants completed the masters in full 3b. More than 30 projects implemented over the course of the masters. 4b. Projects successfully integrated into existing structures	n/a	9
Blumenthal, 2014 [62]	Single US hospital	16	Residents (PGY2 Internal Med)	4 weeks	2-3hrs a week for 4 weeks, work between	Large-group discussions case-studies, videos, role-plays small-group meetings homework/required readings	Clinical leadership Goleman's leadership types and emotional intelligence authentic leadership effective team leadership	1. Sessions perceived to be relevant 2a. Increased confidence, feeling more prepared for team challenges 2b. Self-reported learning, better understanding of personal strengths and weaknesses as a leader	4	8.5
Sanfey, 2011 [63]	Single US university	143	Academic faculty members who had demonstrated leadership potential within the school of medicine.	10 weeks	3 to 7 hour weekly training sessions over a 10-week period for an approximate total of 40 hours.	Instructional sessions, self-analysis using MBTI and the leadership skills inventory 360	Managing organizational change, making strategic decisions, assessing the dynamics of successful leaders, financial management, and finding life balance in a growing career.	Immediately post: 2a. 50% of participants indicated that their perspectives on leadership had changed as a result of the programme. 2b. For each leadership skill surveyed, the majority of participants agreed that it was improved by programme participation 3a. 81% of participants indicated that they had changed their professional behaviour as a result of the programme. 3b. 66% of respondents were invited to apply for or offered positions post-programme. 1-4 years post: 2a. Some respondents reported increased insight into others/self/job/leadership. 2b. Respondents reported increased ability to recognize weaknesses and strengths, and a range of other increased leadership skills. 3a. Only 27% of respondents reported changes in their behaviour, though 31% reported that they had been very successful in achieving their career goals.	2	8.5
Edler, 2010 [64]	Single US residency programme (paediatric anaesthetics)	Unclear	Residents (first year paediatric anaesthetics residents)	1 year	1 year administrative resident programme	Reading, experiential learning, feedback, self-assessment, mentoring	Organisation culture, human factors, quality assurance (QA) and continuous quality improvement (CQI), operating room scheduling, and resident selection, decision making, technical planning, interpersonal or professional actions, and conflict resolution	1. Qualitative report of satisfaction with the programme 2b. Report of improved conflict-management 3b. Observed application of leadership skills in programme improvement	1	8.5
Richman, 2001 [65]	US/Canada executive education in academic medicine	200	Midcareer female faculty at medical or dental schools at associate or full professor rank	1 year	Two week-long residential sessions (in September and April), annual conference, numerous assignments	Lectures, panel discussions case studies, computer simulations, role playing, small group work, individual interviews and projects, extensive individual assessment, coaching	"mini-MBA, contemporary leadership issues, personal professional development (individual assessment tools, conflict management and negotiation skills, team-building skills)	2a. Reports of improved confidence in addressing and resolving conflict situations. Insight and confidence into "how the game is played". 2b. Reports of improved knowledge in addressing and resolving conflict situations. Assessment showed significant and large increase in all curricular areas. (p<0.0001) reports of increased knowledge of career possibilities, new insights into how to advance their own careers, and understanding of a greater range of options open for their pursuit. Increased awareness of educational and medical issues and development of strategies to be informed, resolve problems, and advance projects. Understanding of new leadership and management strategies, allowing fellows to conceptualise, introduce, and implement ideas with greater effectiveness and confidence 3b. Fellows have been successful in advancing to higher leadership roles	0	8.5
Farver, 2016 [66]	Single US hospital	105	Residents (New Chief Residents)	2 days	2 day Chief Residents' Leadership Workshop	Pre-workshop readings Workshop Post-workshop readings	Teambuilding Conflict Resolution Negotiation Emotional Intelligence Physician Health Mentoring	1. All workshops rated highly 2a. Confidence in team building increased 2b. Increased perceived ability to locate areas of need. Increased familiarity with workshop concepts. 3a. Self-reported increased ability to resolve conflict effectively	n/a	8.5
Gregg, 2016 [67]	Single US trauma centre	20	Residents (Trauma, y3-5)	6-30 months	Evaluation of communication skills and weekly discussion at meetings	Evaluation and feedback	Communication	3b. Increase in observed communication/professionalism, systems-based practice, medical knowledge, practice-based learning, patient care	n/a	8.5
Hill, 2018 [68]	Single US hospital	7	Residents (senior surgery)	3 weeks	3 week course with senior residents giving 5 presentations a week to juniors. Timing and frequency not specified	Presentations by participants to junior residents reflecting on readings from the course reading book	Weekly readings from the book "the founding fathers on leadership"	3a. No statistically significant changes in survey results relating to behaviour with Bonferroni correction applied.	n/a	8.5
Pugno, 2002 [69]	US residency director program	"more than 300"	Residency directors (family practice). Numbers not specified	9 months	A three-day conference and two one-day sessions. Project work, mentoring	Didactic and small-group sessions, project	Leadership skills, personnel management and team building, program management, communication skills, negotiation skills, program finances, educational guidelines for family practice	1. 99% of participants rated the programme valuable (15%) or very valuable (84%); 2a. Enhanced job satisfaction, reduced job stress, and an expanded network of educational contacts and resources. 4a. 76 % reported that the program lowered the level of stress. Participants reported enhanced job satisfaction, reduced job stress, and an expanded network of educational contacts and resources. 83% said they were more likely to continue as a program director for the next few years after the programme. The average tenure of family practice program directors has increased from 3 to 4 years before the programme, to more than 6 years after the programme had been running for 5 years.	n/a	8.5
Denney, 2019 [70]	Single UK deanery (South East Scotland)	89	Residents General Practice Specialty Trainee, Year 1)	6 months	Single session on leadership, recommended menu of possible experiences	Guidance, formative feedback, encouragement to seek out specific leadership activities	Recommendations: chairing a meeting, "fresh pair of eyes" exercise NOS, running an educational session, practice leaflet project, clinical protocol, website design, mini-quality improvement project	2a. All trainees who completed the survey reported that development of leadership skills is either "quite important" or "very important" for a trainee's future career. 51% of trainees felt more involved in their GP practice as a result of their leadership activity. 2b. There was no significant change in the self-rated confidence in leadership skills or team working skills when compared pre-post. 3a. 83% of respondents reported having undertaken a voluntary leadership activity, particularly quality improvement projects and running educational sessions. Those who did not, frequently reported time and service delivery pressures as a reason.	5	8

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
McAlearney, 2005 [71]	Single US hospital	52	Physicians (two cohorts)	2 years	1hr monthly morning sessions, 1 half day session each 6 months	Adult learning. Interactive questions, case-based scenarios.	Decision making, problem solving, strategy, change, situational leadership, communication, negotiation, coaching and mentoring, conflict, finances	1. Mean score (/5) 4.7 for satisfaction, 4.8 for quality of information 2a. Mean score (/5) for perceived applicability 4.6. Mean confidence in strategic direction of the organisation 4.1 2b. Participants reported increased awareness of leadership resources(4.1), motivation to be involved in their community (3.7) 3a. Participants self-reported increased leadership effectiveness (4.2/5), teamwork (4.0) and team leading (4.3), as well as new roles (4.0). Participants reported using skills learned; 4a. Improved organisational collaboration towards strategic initiatives	5	8
Shah, 2013 [72]	Single UK specialty training	40	Consultant ophthalmic surgeons	2 days	2x full day interactive sessions	Gaming, team challenges, meta-planning, role play and professional actors, interactive presentations, and self-analysis	Admitting vulnerability and uncertainty, taking responsibility for managing risk, being self-aware and reflexive, internalising authentic leadership	2a. Participants reported increased self-awareness 2b. Demonstrated increased knowledge of authentic leadership concepts 3a. Self-reported long term (4 years) application of skills learned into clinical practice 4a. Participants reported improved performance for them and their teams as a result of the programme	2	8
Clapp, 2018 [73]	Single US hospital department	36	Residents and faculty (Department of Anaesthetic and Critical Care)	1 year (presumed)	2x 2hr evening skills session, 1 half-day session and 1 2.5hr evening session "capstone"	Capstone: presentation on relevant topic small-group discussions presentations back to large group	Feedback supporting colleagues during tough times clinical pedagogy	1. 31% excellent, 44% very good, 25% good; 4a. "the frankness of the discussions between residents and attendings in these sessions has paved the way for a broader departmental initiative designed to facilitate more effective leadership and teamwork among individuals in all departmental roles—attendings, residents, nurse anaesthetists, administrative staff—through identifying the strengths and deficiencies of the ways in which they interact.	1	8
Pettit, 2011 [74]	Single US hospital department	11 (9 responses)	Residents (Neurosurgery)	1 year (academic)	Monthly 1hr sessions	Interactive lectures, self-assessment activities, case studies, self-reflection, discussions, and reading materials	Leadership style, conflict management, effective feedback, team building, team leadership, motivation, moving from peer to leader.	2a. Qualitative comments indicate more open attitude towards leadership roles 2b. Significant self-assessed increase in leadership knowledge.	1	8
Donnelly, 2016 [75]	Single US residency programme	Unclear	Residents (radiology, PGY1-4)	4 years	4 year residency programme in leadership fundamentals and leadership tracks.	Monthly lectures for first 2 years, research work with imaging scientists, mentoring, project work	Research, education, business/management, quality care/service, and information technology	1. "universal praise" from participants for the mandatory first 2 years, 100% opted into the optional years 3-4. 3b. 4 participants have worked on projects as part of the programme, with one having submitted academic manuscripts resulting from her project	0	8
Gruver, 2006 [76]	Single US health system	17	Physicians and non-physicians (finance, IT, nursing, public relations)	8 months	Monthly seminars over dinner (2-2.5hrs)	Case-based leadership discussions during two-hour sessions	Managing vs. Leading, forming a vision, predefining a person's moral compass, risk-taking and transactional leadership	1. High ratings for the course 4.63/5 for comparison to other leadership and education programmes experienced. 2a. Improved self-confidence in leadership, intended changes to leadership style 2b. Increased knowledge of desirable leadership characteristics in the organisation 3a. Several of the participants reported experimenting in their current leadership assignments with concepts discussed during a session; one participant used one of the cases to heighten the leadership awareness of some of his own subordinates. Reported personal bonds of participants with the CEO.	0	8
Babitch, 2006 [77]	Single US residency program (paediatrics)	NR	Residents (Paediatrics PGY1-3).	9 months	Nine sessions	Lectures	A core curriculum focusing on physician compensation, medical economics, healthcare system, leadership and communication, career/CVs, contracts, health law, and customer service	1. Satisfaction scores "between 3 and 4" on a four-point scale. 2b. Improvement in tested comprehension of the subject matter of each lecture, with an average increase of 20% to 40% between tests (5-point scale)	n/a	8
Gulati K, 2019 [78]	Indian health care organisation	96	Clinicians and hospital administrators from public and private sector organisations	3 days	3 day leadership residential programme as part of a 6 day residential programme	Didactic lectures, small group workshops, focus group discussions, case-based discussions and experience sharing.	Leadership styles, leadership competencies, team building, strategic management, procurement, operational excellence, legal and ethical issues, budgeting, financial management, conflict management, quality and patient safety, hospital accreditation, communication, human resource development, health-care technology, contract management, hospital projects and supply chain management.	2b. Statistically significant increase in all 30 items related to knowledge and skills	n/a	8
Stoller, 2004 [79]	Single US residency program (internal medicine)	32	Residents (PGY-1)	1 day	One day retreat	Group simulation exercise, group discussion	Team skills, group dynamics, leadership	1. All attendees rated the retreat as valuable. 2a. Based on significant changes in residents' responses on the postretreat questionnaire attendees believed that the retreat enhanced their abilities to be better physicians, resident supervisors, and leaders. (all p<0.001) postretreat responses (table 3) indicated significant increases in agreement that good leaders challenge the process, make decisions based on shared vision, allow others to act, recognize individual contributions, and serve as good role models.	n/a	8
Edmonstone, 2009 [80]	Multiple UK strategic health authorities	200 (approx.)	Senior medical leaders in primary and secondary care and public health	12 months	Two 3-day residential modules at the beginning and end of the programme. Three interim event days.	Personal development plan, coaching, mentoring	Leadership for partnership Personal development – through the creation of a personal development plan, provision of coaching, mentoring, etc. Working in networks Lateral thinking/scenario planning Leading change	1. Participants dissatisfied with the programmes, partly due to high expectations not being met. Falloff in attendance 2a growing sense of identity as clinical leaders. Increased confidence. 2b. Greater appreciation of others' roles and perspectives 3a. Tools and skills applied in practice, increase in personal networking. 3b. Projects completed as part of the programmes.	5	7.5
Stergiopolous, 2009 [81]	Single Canadian residency program	52	Residents (PGY2=24, PGY4=28)	4 half days	Workshops (four half-days)	Interactive teaching as much as possible. Didactic teaching and small groups or other interactive techniques (buzz groups, brain- storming, think-pair-share discussions, a debate, and clinical case studies)	Teamwork, conflict resolution, quality improvement, program planning and evaluation, leadership and change management, mental health reform, organizational structures, and self and career development	1. Attendance averaged 54% overall. Workshops rated average of 4.2/5. Participants appreciated the reflective and interactive components of the workshops and valued the hands-on exercises and the use of case studies and "real life" examples. They suggested that more time be dedicated to quality improvement and medical error and opportunities to take part in administrative committees and quality improvement projects at their hospital sites. Focus requested on current efforts rather than historical overviews. 2b. Objectives related to skills and knowledge rated as met (~4/5 on Likert scale)	2	7.5
Berkenbosch, 2014 [82]	Single Dutch university medical centre	14	Residents (O&G, orthopaedics, paediatrics, internal medicine)	8 hours	2 x 4 hour sessions 3 weeks apart with homework between	Didactic teaching/lectures student presentations simulation	Knowledge of the healthcare system time management	1. Rated 7.66/10, "it fills a gap in our current postgraduate medical training" 2a. Increased interest in leadership development 2b. No significant changes (underpowered)	1	7.5
Block, 2007 [83]	11 residency	146	Residents (134	2 days	2 day programme	Experiential small-	Leadership competencies, self-awareness,	1. High satisfaction scores of 6.2 on a scale of 1 to 7 (sd0.6)	0	7.5

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
	programs in Australia		registrars and 12 resident medical officers)			group work, individual exercises, self-analysis questionnaires, videos, simulations, didactic content	communication and learning styles, conflict resolution, serving as teacher, time management, delegation, leadership styles, managing stress, safety and quality, team building, feedback and action planning	2a. Reported desire to explore leadership and management in greater depth. Increased awareness that the transition to being registrar was more multifaceted than it may seem.		
Donaghy, 2018 [84]	Single UK hospital trust	NR (>140)	Specialty trainees ST4-ST8	10 months	14 sessions 90-120 minutes	Large group lectures discussion and reflection action learning (qi or patient safety) trainee presentations at workshops	Medical leadership project management patient safety and QI methodology trust overview and patient client experience high performing teams human factors interview preparation clinical networks commissioning	1. 100% of respondents would recommend step to a friend 2a. Improved confidence, intention to apply 2b. Improved understanding in a range of domains 3b. Completion of some qi projects	n/a	7.5
Frugé, 2010 [85]	Single US hospital department	39	Residents (Paediatric Oncology)	NR	Twice-monthly seminar series	Guided reflection on challenging leadership experiences	Leadership reasoning	1. 75% of fellows continue to participate in later years despite no longer being mandatory. 2a. Significant increase in confidence in all items on the bespoke questionnaire. Examples include working effectively as a team, effective communication, self-awareness.	n/a	7.5
Hunt, 2017 [86]	Single US training camp	30	Residents (Interns at the start of PGY1 surgery)	NR	Surgical pgy1 boot camp	Didactic material, narrated lectures, procedural videos, course manuals. Personality assessment. Non-leadership specific simulation	Unclear	1. Participants agreed that the information was relevant to their future careers 2a. No significant increase in self-awareness (only 55% agree or strongly agree that understanding of own behaviours and motivators improved immediately post, only 40% agree or strongly agree at 3 months)	n/a	7.5
Murdock, 2011 [87]	Programme across 3 US states	>100 (not specified - 'five cohorts of 20 or more')	Community practice physicians (five cohorts)	20-weeks	Weekly three-hour evening sessions	Weekly three-hour evening sessions	The business of medicine, quality improvement, transformational leadership	2b. Increase in self-assessed competency in all the 26 categories in each of the program's five cohorts (significance not reported); 3a. Commentaries and assessments revealed an increasing level of empowerment in their leadership roles and increased desire for selection to leadership roles.	n/a	7.5
Thakur, 2018 [88]	Single UK hospital trust	23	Residents (PGY4-5 Psychiatry residents)	1 year	Six full day workshops; mentoring programme	Case studies, role-play, exercises, reading, mentoring	Medical leadership competency framework (demonstrating personal qualities, working with others, managing services, improving services, setting direction)	1. All workshops rated between 3-4/4 2a. Participants felt the programme helped them in achieving leadership competencies. 2b. Residents described how the conceptual issues learned in the workshops were reinforced with leadership champions and then applied to their projects 3b. Participants completed and presented projects at local medical education day.	5	7
Patterson, 2013 [89]	Single UK GP deanery (South Yorkshire Region)	8	Residents (GP trainees, PGY3)	8 months	Facilitated leadership projects	Project work, personal reflections, facilitated monthly discussions	Leadership, change management, and teamwork skills	1. Participants reported having enjoyed the programme 2a. Participants reported being inspired, feeling more mature as doctors. 2b. Increased self-awareness. In many domains there was a negative shift in self-assessment by the end of the programme - thought to be "re-calibration of confidence", supported by focus groups. Focus groups also reported learning around the difficulty of change management. 4: one participant was noted to have achieved change implementation through their project (not otherwise specified)	4	7
Maza, 2016 [90]	Single Israeli health provider	256	Physician-managers	8 weeks	5 full days over 2 weeks with one overnight, followup meetings at 3 and 6 weeks	Theoretical knowledge, experiential learning, practical tools, deep personal exercises and simulations. Individual, dyadic, and group learning	Models of self-awareness, outcome thinking, determining a personal and organizational vision, and creating a personal approach to	1. Mean rating of 5.7/6 (post) and 5.4/6 (retrospective) 2a. Respondents reported increased self-awareness, which was sustained at 6 months. (>5/6) 2b. Respondents reported increased personal leadership ability, sustained at 6 months. (5.2/6 then 4.9/6) 3a. Respondents reported increased proactivity in management.	3	7
Steinert, 2003 [91]	Single Canadian department	16	Faculty (family medicine)	2 days	Two-day workshop	Interactive modules and exercises	Time management, goals and priorities, leadership styles and skills, and conducting effective meetings	1. All participants rated workshop as "very useful". 2a. Several the participants reported that they would change their behaviour after the workshop, regarding time management, goals and meetings. 3a. Most respondents had successfully attempted determining short-term goals; handling paper more effectively; determining their 'prime time'; protecting time for specific tasks; and setting meeting agendas. They were less successful at: delegating; saying 'no'; adopting different leadership styles; and evaluating meetings.	3	7
Satiani, 2014 [92]	Single US hospital department	24	Surgeons who wish to assume administrative or leadership roles	18 months	4hr seminar once a month	Seminars, project work (teams)	Leadership competency, strategic planning and vision, financial management, business planning, communication skills, change management, quality of care and patient satisfaction, teambuilding, negotiation and problem-solving, stress/burnout and lifestyles issues, human resources and talent management, diversity for healthcare leaders, healthcare law, medical ethics	1. 100% of respondents would recommend the programme to peers 2a. Respondents reported increased confidence in leadership roles 2b. Respondents reported increased leadership skills, knowledge and self- awareness. 3a. Respondents reported using skills from the programme in their practice, and having made networks they otherwise would not have made.	2	7
Lee, 2004 [93]	Single US residency programme (paediatrics, Hawaii)	10	Residents (PYG2)	3hrs	3-hour interactive workshop during resident retreat	Case scenarios, problem solving, role playing, interactive discussions and self-reflection	Managing teams, leading residents, and working with different personalities.	1.written comments from workshop evaluation forms were "overwhelmingly positive". 2a. Resident confidence increased significantly for managing teams ($p< 0.015$), leading junior residents ($p< 0.005$) and leading group discussions ($p< 0.017$). 2b. Self-assessment of leadership skills also increased significantly ($p< 0.043$)	0	7
Steiner, 2004 [94]	Single US department of psychiatry	13	Residents and post-doctoral fellows	5 months	8 x 1.5h seminars	Seminars with guest speakers and case discussions	Exploration of leadership roles in research, clinical practice, teaching, and administration; organizational dynamics and gender; negotiation skills and conflict resolution strategies; role of consultation, seminars, peer support, and mentoring by both men and women in the development of leadership skills; "keeping the balance: work, relationships, and personal health."	1. Participants believed the course should be offered again and had a positive effect on their professional lives. 3a. One participant said it encouraged her to seek out mentors	0	7
Awad, 2004 [95]	Single US residency program (surgery)	NR	Residents (Surgical)	6 months	Nr	Not specified	A "focused program" to train residents to have the capacity/ability to create and manage powerful	2b. Statistically significant increase in score on a 34-item internal strength scorecard: alignment +13%, communication +12%, and integrity +12%.	n/a	7

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
							teams through alignment, communication, and integrity			
Bayard, 2003 [96]	Single US residency program (family medicine)	NR	Residents (Family Medicine PGY2-3).	2 years	Nine half day sessions (first year), monthly one-hour sessions (second year)	Interactive-lectures and group assignments	A practice management curriculum: Determining/ balancing personal and professional goals, practice opportunities, facilities, organization, operation and management. Staff policies, legal issues, marketing, resources and hospital issues	1. Reported that the course was beneficial, a positive experience. 2a. Reported increased interest (and knowledge) in practice management 2b. Self-reported knowledge/comp fit with each of 13 practice management topics increased by roughly 2 points (five point Likert scale)	n/a	7
Hanna, 2012 [97]	Single Canadian hospital	43	Residents (PGY3-6 Surgery)	1 day	One-day conference	Interactive lectures and case-based discussions; role-play, scenario simulation, small-group problem-solving sessions, and live feedback sessions.	Giving feedback and delegating duties, building teamwork, managing time, making rounds, coping with stress, effective learning while on duty, teaching at bedside and in the OR, and managing conflicts. Negotiating employment, managing personal finances, hedging malpractice risk, and managing a private practice	1. 79% felt that management was well-addressed or very well-addressed cf. 5% before the course 2a. Statistically significant improvement on perceived preparedness for all 4 managerial duties (negotiating employment, managing personal finances, hedging malpractice risk, managing a private practice) 2b. Participants reported improved skills in giving feedback, delegating duties, coping with stress, effective learning, and effective teaching. These were not significant with Bonferroni correction applied.	n/a	7
Patel, 2019 [98]	Single US hospital residency	17	Residents (PGY1-2)	2 years	Quarterly mentoring meetings for 2 years as part of a healthcare leadership programme	Mentoring	Leadership NOS	1. Participants rated their likelihood of recommending the programme at 7.8/10 (10 being extremely likely); 2a. Confidence seemed to increase (limited data reported) 2b. Gained confidence in time management, negotiation and leadership skills	n/a	7
Stefan, 2011 [99]	Single US hospital	24	Residents (Senior)	4 weeks	Weekly 1hr simulation sessions	Lecture, briefing, simulations, reflections	Advanced cardiovascular life support leadership, equipment management, and cardiac rhythm recognition and management.	1. "more than half of the participants considered the program to be beneficial"; 2a. Overall self-confidence score improved from 2.8 to 3.9	n/a	7
Gagliano, 2010 [100]	Single US hospital	90	Physicians with leadership responsibilities	2 years	Monthly sessions of 2–4 hours	Lectures and case-based discussion	Organizational leadership, financial management, management strategy, applied skills and tools	1. Participants reported high satisfaction with the course, and most would recommend to colleagues. 2a. Participants reported feeling more interested in and prepared for leadership responsibilities. 3a. 79% of participants reported having changed their approaches to projects or problems as a result of the course.	2	6.5
Gurrera, 2014 [101]	Single US hospital	8	Residents	5 months	1hr per week sessions for 5 months; team project	Didactic teaching, team projects	(1) overview of course; explanation of business plan project and expectations; resident interest survey; (2) organization and leadership models; (3) strategic planning; (4) the learning organization; (5) leadership/organizational ethics; (6) risk management; (7) marketing—part 1; (8) marketing—part 2; (9) decision-making; (10) lean management—part 1; (11) lean management—part 2; (12) QA processes and measures; (13) business plan workshop; (14) healthcare delivery systems; (15) microeconomics/ accounting; (16) medical errors/safety—part 1; (17) medical errors/ safety—part 2; (18) presentation of business plans.	1. Participants enjoyed the course and found it interesting 2b. Self-reported new knowledge. Self-reported reassessment of own personal skills 3a. Self-reported improved interpersonal skills and decision making	0	6.5
Bhatia, 2015 [102]	Single US institution	20	Residents (Internal medicine, surgery, emergency, >PGY2)	1 week	1 week programme	Case-based learning interactive talks small-group sessions simulation	Team dynamics leading change business of medicine communication skills	1. All topics rated >8/10	n/a	6.5
Hadley, 2015 [103]	Single UK deanery	NR (549 forms analysed)	Residents (FY2 doctors)	Single brief intervention	Leadership assessment and feedback	Evaluation and feedback	Leadership (personal qualities) Effective services (managing services), acting in a team (working with others), direction setting enabling improvement (improving services, reflection)	2b. 60% of participants felt that their leadership skills had improved as a result of the feedback received	n/a	6.5
Kasuya, 2001 [104]	Single US residency program (internal medicine)	NR	Residents (PGY1).	1 day	Six-hour retreat	Lectures and small- group tasks and discussions, scenarios and role play	Setting personal vision, leadership vs. management, building a team, practical negotiation skills, providing effective feedback, and problem-solving as a team leader	2a. Increased confidence in their abilities to lead a ward team (p = .0002) and fulfil their responsibilities as upper- level residents (p = .0002) and felt better prepared to deal with the challenges of being upper-level residents (mean = 3.65, SD .61). The participants also believed that they would use what they learned at this retreat as upper-level residents (mean = 3.88, SD .33). 2b. Reported having identified qualities they aspired to as upper-level residents (p = .0014). They also reported that as a result of the retreat they better appreciated their roles as team leader and manager (mean =3.76, SD .44)	n/a	6.5
Ninan, 2018 [105]	Single US Residency programme	NR	Residents (Anaesthesia)	1 year	Monthly 1hr didactic sessions	Didactic teaching, assignment	Personal branding, curriculum vitae, marketing, networking, evaluating and evaluating different types of medical practice, medical staff structure, governance, healthcare reform, future trends in medicine	Not possible to reliably infer due to poor quality reporting. 1. Junior residents expressed frustration that the program was taking them away from their clinical studies. Senior residents did not express this. 2a. Possible increase in knowledge across course objectives (no statistical analysis) 3a. Reported increase in quality improvement project involvement, scholarly production and networking behaviours, though the methods for this were not reported	n/a	6.5
Schwartz, 2014 [106]	International (US and Canada) Psychiatry leadership conference	541	Residents (all US and Canadian residency programmes)	3 days	3-day immersion course	Large and small group sessions, group tasks, peer and teacher feedback	Psychological challenges in leadership situations, personal conflicts, self-reflection and self-awareness, group process, conflict resolution, navigation of challenging leadership roles	1. Respondents found the feedback they had received to have been helpful (89%) 2a. Respondents reported improved understanding of group process and self-awareness 2b. Respondents reported improved leadership confidence and willingness to use conflict resolution skills and increased interest in pursuing leadership roles.	n/a	6.5
Ennis-Cole, 2018 [107]	Single US hospital	10	Physicians NOS	6 months	2hrs once a fortnight	Multi-source feedback,	Communication, development and learning,	1. The attendance rate was 86% and the graduation rate was 96%.	3	6

Source (First Author, Year)	Setting	Learner Number	Learner Type	Intervention Length	Intervention Description	Teaching Methods	Educational Content	Main findings by Kirkpatrick level	JBI Score	MERSQI Score
					for 6 months (24hrs total)	"insights" self-assessment and professional debrief, mentoring, classroom session, book club, reading, journaling, self-coaching, executive coaching edit: instructor led classes, assigned readings, self-directed learning via a binder resource guide, case studies and online experiences	management and planning, relationship and team building, innovation and change, and patient centricity.	2b. Participants reported increased team-building skills 3a. Participants reported daily implementation of skills learned		
Steinhardt, 2015 [108]	Single US hospital	NR	Residents (GPGY4 Obstetrics and Gynaecology)	2.5 hours	2.5 hour workshop delivered by midwives	Roleplay, reflection, discussion, games	Principles of leadership, innovation, creative problem solving, and communication techniques	1. "nearly 100% numerical rating of 5" 2b. Participants reported improved insight into self and team 3a. Participants reported increased ability to be confident and vulnerable as a leader	3	6
Torbeck, 2018 [109]	Single US academic department	Unclear	Academic Faculty (New faculty up to senior leadership/chairs)	3 to 12 months	Four related programs for respectively new faculty, junior faculty, junior leadership, senior leadership.	Action learning, small group discussions, case scenarios, assignments, reflection exercises, multisource feedback, executive coaching (depending on which tier of the programme)	Leadership, communication, strategic planning, negotiation and conflict management, marketing, change, creating vision, managing difficult people, emotional intelligence, finances	1. Only 20% of faculty attended basic programme. Overall reaction post-session was positive to extremely positive. 3a. Participants noted in assignments that they had applied learning from the programme into their day to day work. 3b. Multiple participants interviewed for a leadership position.	2	6
Vimr, 2013 [110]	Single Canadian hospital	29	Physician leaders.	8 months	Five 1.5 day meetings over 8 months	Multi-source feedback, self-reflection, readings, action learning projects, coaching	Alignment of competencies, a systems and collaborative approach, affective learning strategies	1. "average rating for all components was 4.64 on a 6.0-point Likert scale". Components were not specified, nor the anchors of the Likert scale 2a. Comments cited increased awareness and understanding of leadership principles. 2b. Increased understanding of different leadership roles, accountabilities, and approaches. 3b. Some of the individuals from the first cohort continued to work with their coach after the program was over.	2	6
Bircher, 2013 [111]	Single UK deanery (extension of GP training)	NR	Residents (GP trainees)	2 years	Unspecified number of programme days	Didactic teaching, online learning environment, supervision, project work as individuals	The content was guided by the medical leadership competency framework, which includes domains of (1) delivering the service, (2) demonstrating personal qualities, (3) working with others, (4) managing services, (5) improving services, (6) setting direction	2a. Increased confidence in having difficult conversations 3a. Participants reported improved time management and application of skills learnt	0	6
Kochar, 2003 [112]	Single US academic medical centre	30	Faculty members	5 months	72hours - Nine-day course in three-day segments over five months	Sessions, lectures	Managing people, health care finance and accounting, leadership, marketing, health care informatics and information technology, health care quality, health care economics, time management	1. Overall course rated 4.6 out of 5 3b. Examples of cross-departmental collaboration have been seen.	0	6
Biese, 2011 [113]	Single US hospital department	NR	Residents (Senior Residents, Emergency Medicine)	1 year	Programme restructure to allocate leadership roles	Residents are allocated a leadership role in their final year of residency	Roles in: Administrative Chief, Resident Education, Resident Research, Journal Club, Medical Student Education, Ultrasonography Education, Resident Reading, Simulation, Information Technology	1. 100% of chiefs felt that the new system allowed the residency to meet more of its goals. All participants said they would recommend their position to other residents 2a. 100% felt their experience encouraged them to seek future leadership roles 3a. 100% felt their experience contributed to them deciding to enter academics.	n/a	6
Cherry, 2010 [114]	Single US university	141	Junior faculty	9 months	Two hours per week	Didactic classroom discussions, expert panel presentations, interactive case-based learning, group exercises, skill enhancement workshops, individual project with supervision	Setting goals, mentoring, negotiation and conflict resolution, performance review and compensation, presentation skills, facilitation, teaching, feedback, communication	1. Participants reported high satisfaction with the programs and with their mentor pairings 2b. Participants reported enhanced skills related to initiating and negotiating a new mentoring relationship 3b. "the project…often results in one or more scholarly products for the individual"	n/a	6
Johnson, 2014 [115]	Single US hospital department	Unclear (16 responses to survey)	Residents (Senior medical residents)	1/2 day	3hr seminar focussed on emotional intelligence	Readings, formalized presentation, analysis of videos, role-play	Emotional intelligence	1. Seminar was felt by participants to have provided relevant content	n/a	6
O'Donnell, 2011 [116]	Single US hospital (residency programs)	NR	Residents (PGY1). Numbers not specified	4 weeks	Compulsory first year resident rotation in case management with 2hrs/week for 4 weeks	Lectures, discussions, case presentations	Overview of case management, advocacy, communication, and resource management	1. Evaluation broadly positive (>90% agreement with 6 statements); 2b. They acknowledge the case managers for their expertise, better understand utilization management, compliance, and coordination of care as a team and how this knowledge has also assisted them in their understanding of the continuum of care and regulations.	n/a	5.5
Ringdahl, 2014 [117]	Single US residency programme	36	Residents (Family medicine, PGY1-3)	NR	Unclear	Networking, mentoring, role play, simulations, discussions	Awareness of leadership opportunities, understanding organizational dynamics, conflict resolution, negotiation skills, mentoring, and personal wellness.	1. Feedback from participants has been uniformly positive	n/a	5

Supplementary Table 1: Summary of included studies. NR= Not Reported; NOS=Not Otherwise Specified; n/a=not applicable. MERSQI=Medical Education Research Study Quality Instrument; JBI=Joanna Briggs Institute Critical Appraisal Checklist for Qualitative Research.

References:

1 Boyle DK, Kochinda C. Enhancing Collaborative Communication of Nurse and Physician Leadership in Two Intensive Care Units. *J Nurs Adm* 2004;34:60–70. doi:10.1097/00005110-200402000-00003

2 Parsons JR, Crichlow A, Ponnuru S, *et al.* Filling the Gap: Simulation-based Crisis Resource Management Training for Emergency Medicine Residents. *West J Emerg Med* 2018;19:205–10. doi:https://dx.doi.org/10.5811/westjem.2017.10.35284

3 Cooper S. Developing leaders for advanced life support: evaluation of a training programme. *Resuscitation* 2001;49:33–8. doi:10.1016/S0300-9572(00)00345-2

4 Malling B, Mortensen L, Bonderup T, *et al.* Combining a leadership course and multi-source feedback has no effect on leadership skills of leaders in postgraduate medical education. An intervention study with a control group. *BMC Med Educ* 2009;9:72. doi:10.1186/1472-6920-9-72

5 von Vultée PJ, Arnetz B. The impact of management programs on physicians' work environment and health: A prospective, controlled study comparing different interventions. *J Health Organ Manag* 2004;18:25–37. doi:10.1108/14777260410532047

6 Fassiotto M, Maldonado Y, Hopkins J. A long-term follow-up of a physician leadership program. *J Health Organ Manag* 2018;32:56–68. doi:10.1108/JHOM-08-2017-0208

7 Levine SA, Chao SH, Brett B, *et al.* Chief resident immersion training in the care of older adults: An innovative interspecialty education and leadership intervention. *J Am Geriatr Soc* 2008;56:1140–5. doi:10.1111/j.1532-5415.2008.01710.x

8 Hopkins J, Fassiotto M, Ku MC, *et al.* Designing a physician leadership development program based on effective models of physician education. *Health Care Manage Rev* 2018;43:293–302. doi:10.1097/HMR.0000000000000146

9 Dannels SA, Yamagata H, McDade SA, *et al.* Evaluating a leadership program: A comparative, longitudinal study to assess the impact of the Executive Leadership in Academic Medicine (ELAM) program for women. *Acad Med* 2008;83:488–95. doi:10.1097/ACM.0b013e31816be551

10 Orme D, Campbell C. How leadership training saves money 'service line leadership' at Nottingham University Hospitals. *BMJ Lead* 2019;3:29–36. doi:10.1136/leader-2018-000132

11 Cole DC, Giordano CR, Vasilopoulos T, *et al.* Resident Physicians Improve Nontechnical Skills When on Operating Room Management and Leadership Rotation. *Anesth Analg* 2017;124:300–7. doi:10.1213/ANE.0000000000001687

12 Haftel HM, Swan R, Anderson MS, *et al.* Fostering the Career Development of Future Educational Leaders: The Success of the Association of Pediatric Program Directors Leadership in Educational Academic Development Program. *J Pediatr* 2018;194:5-6.e1. doi:10.1016/j.jpeds.2017.11.066

13 Ten Have ECM, Nap RE, Tulleken JE. Quality improvement of interdisciplinary rounds by leadership training based on essential quality indicators of the Interdisciplinary Rounds Assessment Scale. *Intensive Care Med* 2013;39:1800–7. doi:10.1007/s00134-013-3002-0

14 Gilfoyle E, Gottesman R, Razack S. Development of a leadership skills workshop in paediatric advanced resuscitation. *Med Teach* 2007;29:e276–83. doi:10.1080/01421590701663287

15 LoPresti L, Ginn P, Treat R. Using a simulated practice to improve practice management learning. 2009.

16 Wurster AB, Pearson K, Sonnad SS, *et al.* The Patient Safety Leadership Academy at the University of Pennsylvania: The First Cohort's learning experience. *Qual Manag Health Care* 2007;16:166–73. doi:10.1097/01.QMH.0000267454.63123.e7
17 Pradarelli JC, Jaffe GA, Lemak CH, *et al.* A leadership development program for surgeons: First-year participant evaluation. *Surgery* 2016;160:255–63. doi:https://dx.doi.org/10.1016/j.surg.2016.03.011
18 Throgmorton C, Mitchell T, Morley T, *et al.* Evaluating a physician leadership development program - a mixed methods approach. *J Health Organ Manag* 2016;30:390–407. doi:https://dx.doi.org/10.1108/JHOM-11-2014-0187
19 Bergman D, Fransson-Sellgren S, Wahlstrom R, *et al.* Healthcare leadership: Impact of short-term intensive and long-term less intensive training programmes. *Leadersh Heal Serv* 2009;22:161–75. doi:10.1108/17511870910953805
20 Monkhouse A, Sadler L, Boyd A, *et al.* The Improving Global Health fellowship: A qualitative analysis of innovative leadership development for NHS healthcare professionals. *Global Health* 2018;14:69. doi:10.1186/s12992-018-0384-3
21 Tsoh JY, Kuo AK, Barr JW, *et al.* Developing faculty leadership from 'within': a 12-year reflection from an internal faculty leadership development program of an academic health sciences center. *Med Educ Online* 2019;24:1567239. doi:10.1080/10872981.2019.1567239
22 Bearman M, O'Brien R, Anthony A, *et al.* Learning surgical communication, leadership and teamwork through simulation. *J Surg Educ* 2012;69:201–7. doi:10.1016/j.jsurg.2011.07.014
23 Carney PA, Eiff MP, Green LA, *et al.* Transforming Primary Care Residency Training: A Collaborative Faculty Development Initiative among Family Medicine, Internal Medicine, and Pediatric Residencies. *Acad Med* 2015;90:1054–60. doi:10.1097/ACM.0000000000000701
24 Cooper JB, Singer SJ, Hayes J, *et al.* Design and evaluation of simulation scenarios for a program introducing patient safety, teamwork, safety leadership, and simulation to healthcare leaders and managers. *Simul Healthc* 2011;6:231–8. doi:10.1097/SIH.0b013e31821da9ec
25 Agius SJ, Brockbank A, Baron R, *et al.* The impact of an integrated medical leadership programme. *J Heal Organ Manag* 2015;29:39–54. doi:10.1108/JHOM-09-2013-0188
26 Mckimm J, Hickford D, Lees P, *et al.* Evaluating the impact of a national clinical leadership fellow scheme. *BMJ Lead* 2019;3:37–42. doi:10.1136/leader-2019-000135
27 Cohen D, Vlaev I, McMahon L, *et al.* The Crucible simulation: Behavioral simulation improves clinical leadership skills and understanding of complex health policy change. *Health Care Manage Rev* 2017;44:246–55. doi:10.1097/HMR.0000000000000162
28 Ruston A, Tavabie A. Fostering clinical engagement and medical leadership and aligning cultural values: An evaluation of a general practice specialty trainee integrated training placement in a primary care trust. *Qual Prim Care* 2010;18:263–8.
29 Hackworth J, Steel S, Cooksey E, *et al.* Faculty Members' Self-Awareness, Leadership Confidence, and Leadership Skills Improve after an Evidence-Based Leadership Training Program. J. Pediatr. 2018;199:4-6.e2. doi:10.1016/j.jpeds.2018.05.007
30 Al-Mutawa N, Elmahdi H, Joyce P. The implementation of a practice management programme for family medicine residents in Qatar. *Educ Prim Care* 2016;27:380–5. doi:10.1080/14739879.2016.1219620
31 Fernandez CSP, Noble CC, Jensen ET, *et al.* Improving Leadership Skills in Physicians: A 6-Month Retrospective Study. *J Leadersh Stud* 2016;9:6–19. doi:10.1002/jls.21420

32 Chang A, Lundebjerg NE, Abrams J, *et al.* Leadership, Inside and Out: The Tideswell-AGS-ADGAP Emerging Leaders in Aging Program. *J Am Geriatr Soc* 2019;67:437–42. doi:10.1111/jgs.15702

33 Day CS, Tabrizi S, Kramer J, *et al.* Effectiveness of the AAOS leadership fellows program for orthopaedic surgeons. *J Bone Jt Surg - Ser A* 2010;92:2700–8. doi:10.2106/JBJS.J.00272

34 Korschun HW, Redding D, Teal GL, *et al.* Realizing the vision of leadership development in an academic health center: The Woodruff Leadership Academy. *Acad Med* 2007;82:264–71. doi:10.1097/ACM.0b013e31803078b5

35 McDade SA, Richman RC, Jackson GB, *et al.* Effects of Participation in the Executive Leadership in Academic Medicine (ELAM) Program on Women Faculty's Perceived Leadership Capabilities. *Acad Med* 2004;79:302–9. doi:10.1097/00001888-200404000-00005

36 Edmonstone J. The development of strategic clinical leaders in the National Health Service in Scotland. *Leadersh Heal Serv* 2011;24:337–53. doi:10.1108/17511871111172376

37 MacPhail A, Young C, Ibrahim JE. Workplace-based clinical leadership training increases willingness to lead: Appraisal using multisource feedback of a clinical leadership program in regional Victoria, Australia. *Leadersh Heal Serv* 2015;28:100–18. doi:10.1108/LHS-01-2014-0002

38 Cerrone SA, Adelman P, Akbar S, *et al.* Using objective structured teaching encounters (OSTEs) to prepare chief residents to be emotionally intelligent leaders. *Med Educ Online* 2017;22:1320186. doi:10.1080/10872981.2017.1320186

39 Patel N, Brennan PJ, Metlay J, *et al.* Building the pipeline: The creation of a residency training pathway for future physician leaders in health care quality. *Acad Med* 2015;90:185–90. doi:10.1097/ACM.0000000000000546

40 Nakanjako D, Namagala E, Semeere A, *et al.* Global health leadership training in resource-limited settings: A collaborative approach by academic institutions and local health care programs in Uganda. *Hum Resour Health* 2015;13:87. doi:10.1186/s12960-015-0087-2

41 Kuo AK, Thyne SM, Chen HC, *et al.* An innovative residency program designed to develop leaders to improve the health of children. *Acad Med* 2010;85:653. doi:10.1097/ACM.0b013e3181eb60f6

42 Brandon CJ, Mullan PB. Teaching Medical Management and Operations Engineering for Systems-Based Practice to Radiology Residents. *Acad Radiol* 2013;20:345–50. doi:10.1016/j.acra.2012.09.025

43 Green PL, Plsek PE. Coaching and leadership for the diffusion of innovation in health care: A different type of multi-organization improvement collaborative. *Jt Comm J Qual Improv* 2002;28:55–71. doi:10.1016/S1070-3241(02)28006-2

44 Hemmer PR, Karon BS, Hernandez JS, *et al.* Leadership and management training for residents and fellows: A curriculum for future medical directors. *Arch Pathol Lab Med* 2007;131:610–4. doi:10.1043/1543-2165(2007)131[610:LAMTFR]2.0.CO;2

45 McCurdy FA, Beck G, Maroon A, *et al.* The administrative colloquium: Developing management and leadership skills for faculty. *Ambul Pediatr* 2004;4:124–8. doi:10.1367/1539-4409(2004)004<0124:TACDMA>2.0.CO;2

46 Hadley L, Marshall P, Black D. Pairing trainee managers and doctors: an initiative to facilitate joint working for better patient care. *Br J Hosp Med (Lond)* 2014;75:103–5.

47 Revere L, Robinson A, Schroth L, *et al.* Preparing academic medical department physicians to successfully lead. *Leadersh Heal Serv* 2015;28:317–31. doi:10.1108/LHS-03-2014-0023

48 Osborn LM, DeWitt T. The HRSA-APA Faculty Development Scholars Program: Executive Leadership Track. *Ambul Pediatr* 2004;4:98–102. doi:10.1367/1539-4409(2004)004<0098:THFDSP>2.0.CO;2

49 Wichman CL, Netzel PJ, Menaker R. Preparing psychiatric residents for the 'real world': A practice management curriculum. *Acad Psychiatry* 2009;33:131–4. doi:10.1176/appi.ap.33.2.131

50 Monaghan H, Swenson C, Kerins J, *et al.* Bridging the gap: using 'Paired Learning' to improve clinician/management understanding. *BMJ Lead* 2018;2:80–2. doi:10.1136/leader-2017-000064

51 Voogt JJ, van Rensen ELJ, van der Schaaf MF, *et al.* Building bridges: engaging medical residents in quality improvement and medical leadership. *Int J Qual Heal care J Int Soc Qual Heal Care* 2016;28:665–74. doi:https://dx.doi.org/10.1093/intqhc/mzw091

52 Heitkamp DE, Kerridge WD, Ballenger ZE, *et al.* A Leadership Development Program for Radiology Residents. *J Am Coll Radiol* 2017;14:1468–70. doi:10.1016/j.jacr.2017.05.005

53 Pearson A, Ryan C, MacVicar R. Preliminary programme evaluation of the Scottish Clinical Leadership Fellowship. *BMJ Lead* 2018;2:40–2. doi:10.1136/leader-2017-000038

54 Crites GE, Schuster RJ. A preliminary report of an educational intervention in practice management. *BMC Med Educ* 2004;4:15. doi:10.1186/1472-6920-4-15

55 Dickey C, Dismukes R, Topor D. Creating opportunities for organizational leadership (cool): Creating a culture and curriculum that fosters psychiatric leadership development and quality improvement. *Acad Psychiatry* 2014;38:383–7. doi:10.1007/s40596-014-0082-2

56 Foster T, Regan-Smith M, Murray C, *et al.* Residency education, preventive medicine, and population health care improvement: The Dartmouth-Hitchcock leadership preventive medicine approach. Acad. Med. 2008;83:390–8. doi:10.1097/ACM.0b013e3181667da9

57 Freeman AM, Nelson R, Sinha SS. The Essential Role of Leadership Development. J. Am. Coll. Cardiol. 2018;72:2272–5. doi:10.1016/j.jacc.2018.09.029

58 Saravo B, Netzel J, Kiesewetter J. The need for strong clinical leaders - Transformational and transactional leadership as a framework for resident leadership training. *PLoS One* 2017;12:e0183019. doi:https://dx.doi.org/10.1371/journal.pone.0183019

59 Schulz K, Puscas L, Tucci D. Surgical Training and Education in Promoting Professionalism: a comparative assessment of virtue-based leadership development in otolaryngology-head. *Med Educ …* 2013;18:22440. doi:https://dx.doi.org/10.3402/meo.v18i0.22440

60 Stoller JK, Berkowitz E, Bailin PL. Physician management and leadership education at the cleveland clinic foundation: Program impact and experience over 14 years. *J Med Pract Manag* 2007;22:237–42.

61 Wulfert C-H, Hoitz J, Senger U. Initial Results of the Master's Degree Programme in 'Leadership in Medicine' - Impact on hospital-based follow-on training of doctors. *GMS J Med Educ* 2017;34:Doc52. doi:https://dx.doi.org/10.3205/zma001129

62 Blumenthal DM, Bernard K, Fraser TN, *et al.* Implementing a pilot leadership course for internal medicine residents: Design considerations, participant impressions, and lessons learned. *BMC Med Educ* 2014;14:257. doi:10.1186/s12909-014-0257-2

63 Sanfey H, Harris I, Pollart S, *et al.* Evaluation of the University of Virginia Leadership in Academic Medicine Program. *Teach Learn Med* 2011;23:347–58. doi:10.1080/10401334.2011.611773

64 Edler A, Adamshick M, Fanning R, *et al.* Leadership lessons from military education for postgraduate medical curricular improvement.

Clin Teach 2010;7:26–31. doi:10.1111/j.1743-498X.2009.00336.x

65 Richman RC, Morahan PS, Cohen DW, *et al.* Advancing women and closing the leadership gap: The executive leadership in academic medicine (ELAM) program experience. *J Women's Heal Gender-Based Med* 2001;10:271–7. doi:10.1089/152460901300140022

66 Farver CF, Smalling S, Stoller JK, *et al.* Developing leadership competencies among medical trainees: Five-year experience at the Cleveland Clinic with a chief residents' training course. *Australas Psychiatry* 2016;24:499–505. doi:10.1177/1039856216632396

67 Gregg SC, Heffernan DS, Connolly MD, *et al.* Teaching leadership in trauma resuscitation: Immediate feedback from a real-time, competency-based evaluation tool shows long-term improvement in resident performance. *J Trauma Acute Care Surg* 2016;81:729–34. doi:https://dx.doi.org/10.1097/TA.0000000000001186

68 Hill DAMD, Jimenez J-C, Cohn SM, *et al.* How To Be a Leader: A Course for Residents. *Cureus* 2018;10:e3067. doi:https://dx.doi.org/10.7759/cureus.3067

69 Pugno PA, Dornfest FD, Kahn NB, *et al.* The National Institute for Program Director Development: a school for program directors. *J Am Board Fam Pract* 2002;15:209–13.

70 Denney M, Johnstone A. Can general practice trainees engage with leadership activities during their GP training placements? - An evaluation of an intervention in South East Scotland. *Educ Prim Care* 2019;30:102–9. doi:10.1080/14739879.2019.1566782

71 McAlearney AS, Fisher D, Heiser K, *et al.* Developing effective physician leaders: changing cultures and transforming organizations. *Hosp Top* 2005;83:11–8.

72 Shah P, Cross V, Sii F. Sailing a safe ship: Improving patient safety by enhancing the leadership skills of new consultant specialist surgeons. *J Contin Educ Health Prof* 2013;33:190–200. doi:10.1002/chp.21184

73 Clapp JT, Gordon EKBB, Baranov DY, *et al.* Encouraging Reflexivity in a Residency Leadership Development Program: Expanding Outside the Competency Approach. *Acad Med* 2018;93:210–3. doi:10.1097/ACM.0000000000001915

74 Pettit JE, Dahdaleh NS, Albert GW, *et al.* Neurosurgery resident leadership development: An innovative approach. *Neurosurgery* 2011;68:546–50. doi:10.1227/NEU.0b013e318201c2ac

75 Laura Donnelly. Jeremy Hunt: Doctors and nurses should be put in charge of hospitals. Telegraph. 2016.

76 Gruver W, Spahr RC. Imparting Wisdom to Evolving Leaders. *Physician Exec* 2006;32:24–9.

77 Babitch LA. Teaching practice management skills to pediatric residents. *Clin Pediatr (Phila)* 2006;45:846–9. doi:10.1177/0009922806294216

78 Gulati K, Singh AR, Kumar S, *et al.* Impact of a leadership development programme for physicians in India. doi:10.1108/LHS-05-2019-0027

79 Stoller JK, Rose M, Lee R, *et al.* Teambuilding and leadership training in an internal medicine residency training program: Experience with a one-day retreat. *J Gen Intern Med* 2004;19:692–7. doi:10.1111/j.1525-1497.2004.30247.x

80 Edmonstone J. Evaluating clinical leadership: A case study. *Leadersh Heal Serv* 2009;22:210–24. doi:10.1108/17511870910978132

81 Stergiopoulos V, Maggi J, Sockalingam S. Teaching the physician-manager role to psychiatric residents: development and implementation of a pilot curriculum. *Acad Psychiatry* 2009;33:125–30. doi:10.1176/appi.ap.33.2.125

82 Berkenbosch L, Muijtjens AMM, Zimmermann LJI, *et al.* A pilot study of a practice management training module for medical residents. *BMC Med Educ* 2014;14:107. doi:https://dx.doi.org/10.1186/1472-6920-14-107

83 Block AA, Singh J, Kanaris AM, *et al.* Equipping our front-line managers: a national program for the Professional Development of Registrars. *Med J Aust* 2007;186. doi:10.5694/j.1326-5377.2007.tb00961.x

84 Donaghy G, McKeever K, Flanagan C, *et al.* Helping doctors in training to STEP-UP: A leadership and quality improvement programme in the belfast health and social care trust. *Ulster Med J* 2018;87:112–6.

85 Frugé E, Mahoney DH, Poplack DG, *et al.* Leadership: 'They never taught me this in medical school'. J. Pediatr. Hematol. Oncol. 2010;32:304–8. doi:10.1097/MPH.0b013e3181cf4594

86 Hunt MA, Heilman CB, Shutran M, *et al.* Commentary: An introduction to leadership self-assessment at the society of neurological surgeons post-graduate year 1 boot camp: Observations and commentary. United States: 2017. doi:10.1093/neuros/nyw093

87 Murdock J, Brammer C. A successful model of leadership development for community practice physicians. *Physician Exec* 2011;37:52-54,56.

88 Thakur A, O'Leary B, Cowie W, *et al.* The Development and Validation of a Workplace-Based Leadership Program for Senior Residents in Psychiatry. *Acad Psychiatry* 2018;43:123–7. doi:https://dx.doi.org/10.1007/s40596-018-0982-7

89 Patterson D, Godden A, Rughani A, *et al.* A leadership programme in GP training: an action learning approach. *Educ Prim Care* 2013;24:65–8. doi:10.1080/14739879.2013.11493457

90 Maza Y, Shechter E, Pur Eizenberg N, *et al.* Physician empowerment programme; a unique workshop for physician-managers of community clinics. *BMC Med Educ* 2016;16:269. doi:10.1186/s12909-016-0786-y

91 Steinert Y, Nasmith L, Daigle N. Executive skills for medical faculty: A workshop description and evaluation. *Med Teach* 2003;25:666–8. doi:10.1080/0142159032000150485

92 Satiani B, Sena J, Ruberg R, *et al.* Talent management and physician leadership training is essential for preparing tomorrow's physician leaders. *J Vasc Surg* 2014;59:542–6. doi:10.1016/j.jvs.2013.10.074

93 Lee MT, Tse AM, Naguwa GS. Building leadership skills in paediatric residents. *Med Educ* 2004;38:559–60. doi:10.1111/j.1365-2929.2004.01867.x

94 Steiner JL, Mazure C, Siggins LD, *et al.* Teaching psychiatric residents about women and leadership. 2004. doi:10.1176/appi.ap.28.3.243

95 Awad SS, Hayley B, Fagan SP, *et al.* The impact of a novel resident leadership training curriculum. *Am J Surg* 2004;188:481–4. doi:10.1016/j.amjsurg.2004.07.024

96 Bayard M, Peeples CR, Holt J, *et al.* An interactive approach to teaching practice management to family practice residents. *Fam Med* 2003;35:622–4.

97 Hanna WC, Mulder DS, Fried GM, *et al.* Training future surgeons for management roles: The resident-surgeon-manager conference. In: *Archives of Surgery*. 2012. 940–4. doi:10.1001/archsurg.2012.992

98 Patel N, Vemuri D, Frasso R, *et al.* Perceptions of Health Care Executives on Leadership Development Skills for Residents After Participating in a Longitudinal Mentorship Program. *Am J Med Qual* 2019;34:80–6. doi:10.1177/1062860618786798

99 Stefan MS, Belforti RK, Langlois G, *et al.* A Simulation-Based Program to Train Medical Residents to Lead and Perform Advanced Cardiovascular Life Support. *Hosp Pract* 2011;39:63–9. doi:10.3810/hp.2011.10.923

100 Gagliano NJ, Ferris T, Colton D, *et al.* A physician leadership development program at an academic medical center. *Qual Manag Health Care* 2010;19:231–8. doi:10.1097/QMH.0b013e3181eb13ab

101 Gurrera RJ, Dismukes R, Edwards M, *et al.* Preparing residents in training to become health-care leaders: A pilot project. *Acad Psychiatry* 2014;38:701–5. doi:10.1007/s40596-014-0162-3

102 Bhatia K, Morris CA, Wright SC, *et al.* Leadership Training for Residents: a Novel Approach. *Physician Leadersh J* 2015;2:76–80.

103 Hadley L, Black D, Welch J, *et al.* Encouraging formative assessments of leadership for foundation doctors. *Clin Teach* 2015;12:231–5. doi:https://dx.doi.org/10.1111/tct.12289

104 Kasuya R, Nip I, Anderson MB. A retreat on leadership skills for residents. *Acad Med* 2001;76:554. doi:10.1097/00001888-200105000-00099

105 Ninan D, Patel D. Career and Leadership Education in Anesthesia Residency Training. *Cureus* 2018;10:e2546. doi:https://dx.doi.org/10.7759/cureus.2546

106 Schwartz BJ, Blackmore MA, Weiss A. The Tarrytown Chief Residents Leadership Conference: A Long-Term Follow-up. *Acad Psychiatry* 2014;38:15–8. doi:10.1007/s40596-013-0016-4

107 Ennis-Cole DL, Cullum PM, Iwundu C. Physicians as Operational Leaders: Cost, Curriculum, Technology, and Organizational Challenges. *TechTrends* 2018;62:239–49. doi:10.1007/s11528-018-0273-x

108 Steinhardt L. Workshop for New Leaders: Innovative Midwifery Teaching for Obstetrics and Gynecology Residents. *J Midwifery Women's Heal* 2015;60:313–7. doi:10.1111/jmwh.12292

109 Torbeck L, Rozycki G, Dunnington G. Leaders Growing Leaders: Designing a Tier-Based Leadership Program for Surgeons. *J Surg Educ* Published Online First: 2018. doi:https://dx.doi.org/10.1016/j.jsurg.2017.12.009

110 Vimr M, Dickens P. Building Physician Capacity for Transformational Leadership—Revisited. *Healthc Manag Forum* 2013;26:16–9. doi:https://doi.org/10.1016/j.hcmf.2013.01.003

111 Bircher J. Extending GP training and the development of leadership skills: The experience of the North Western Deanery pilot. *Educ Prim Care* 2013;24:57–60. doi:10.1080/14739879.2013.11493457

112 Kochar MS, Robertson RG, Mone MA. A faculty leadership development program at the Medical College of Wisconsin. Wis. Med. J. 2003;102:24–8.

113 Biese K, Leacock BW, Osmond CR, *et al.* Engaging Senior Residents as Leaders: A Novel Structure for Multiple Chief Roles. *J Grad Med Educ* 2011;3:236–8. doi:10.4300/jgme-d-10-00045.1

114 Cherry RA, Davis DC, Thorndyke L. Transforming culture through physician leadership development. *Physician Exec* 2010;36:38–44.

115 Johnson JM, Stern TA. Teaching Residents About Emotional Intelligence and Its Impact on Leadership. *Acad Psychiatry* 2014;38:510–3. doi:10.1007/s40596-014-0048-4

116 O'donnell L, Bennett GL. Case management takes lead role in educating medical residents. *Prof Case Manag* 2011;16:253–5.

doi:10.1097/ncm.0b013e31821b0785

117 Ringdahl EN, Tarwater KD, Lindbloom EJ. A Longitudinal Curriculum to Address the Gender Gap in Physician Leadership. *J Grad Med Educ* 2014;6:361–2. doi:10.4300/JGME-D-14-00081.1

MERSQI Component	Classification	All studies (117)	MERSQI>12 (16)	JBI>6 (14)
Study Design	Single Group Cross-Sectional or Post-programme only	54 (46%)	0 (0%)	8 (57%)
	Single Group Pre and Post Programme	54 (46%)	9 (56%)	5 (36%)
	Non-Randomised Two Group	8 (7%)	6 (38%)	0 (0%)
	Randomised Controlled Trial	1 (1%)	1 (6%)	1 (7%)
Institution #	Single	81 (69%)	10 (63%)	9 (64%)
	Double	1 (1%)	1 (6%)	0 (0%)
	Multi	35 (30%)	5 (31%)	5 (36%)
Response Rate	<50% or NR	44 (38%)	3 (19%)	1 (7%)
	50-75%	23 (20%)	3 (19%)	6 (43%)
	>75%	48 (41%)	9 (56%)	7 (50%)
Type of Data	Self-reported	70 (60%)	2 (13%)	9 (64%)
	Observed	47 (40%)	14 (88%)	5 (36%)
Questionnaire Construct Validity (Internal Structure)	Reported	9 (8%)	7 (44%)	2 (14%)
	Not Reported	108 (92%)	9 (56%)	12 (86%)
Questionnaire Content Validity (Content)	Reported	45 (38%)	14 (88%)	5 (36%)
	Not Reported	72 (62%)	2 (13%)	9 (64%)
Relationships to Other Variables	Reported	8 (7%)	5 (31%)	3 (21%)
	Not Reported	108 (92%)	11 (69%)	11 (79%)
Data Analysis Comprehensiveness (Appropriateness)	Comprehensive	23 (20%)	14 (88%)	6 (43%)
	Less Comprehensive	94 (80%)	2 (13%)	8 (57%)
Data Analysis Complexity	Descriptive only	102 (87%)	7 (44%)	11 (79%)
	Beyond Descriptive	15 (13%)	9 (56%)	3 (21%)
Outcomes (Kirkpatrick Level)	Level 1	80 (68%)	8 (50%)	14 (100%)
	Level 2a	70 (60%)	7 (44%)	13 (93%)
	Level 2b	79 (68%)	11 (69%)	11 (79%)
	Level 3a	51 (44%)	7 (44%)	10 (71%)
	Level 3b	54 (46%)	14 (88%)	7 (50%)
	Level 4a	9 (8%)	1 (6%)	2 (14%)
	Level 4b	26 (22%)	7 (44%)	4 (29%)

Supplementary Table 2: Study characteristics organised by MERSQI heading. Brackets in headings refer to original MERQSI items where headings have been adapted for clarity.

JBI Component	Description of component	High-reliability studies (n=14)	Mixed-Methods Studies (n=53)	Qualitative Studies (n=10)
Philosophical Perspective	*Congruity between the stated philosophical perspective and the research methodology*	0 (0%)	0 (0%)	0 (0%)
Objectives	*Congruity between the research methodology and the research question or objectives*	39 (63%)	33 (62%)	6 (60%)
Methods	*Congruity between the research methodology and the methods used to collect data*	38 (61%)	32 (60%)	6 (60%)
Analysis	*Congruity between the research methodology and the representation and analysis of data*	18 (29%)	15 (28%)	3 (30%)
Interpretation	*Congruity between the research methodology and the interpretation of results*	17 (27%)	13 (25%)	4 (40%)
Researcher Location	*Statement locating the researcher culturally or theoretically*	10 (16%)	8 (15%)	2 (20%)
Researcher Influence	*Influence of the researcher on the research addressed*	13 (21%)	12 (23%)	1 (10%)
Participant Representation	*Participants and their voices adequately represented*	21 (34%)	16 (30%)	5 (50%)
Ethics	*Evidence of ethical approval by an appropriate body*	26 (42%)	23 (43%)	3 (30%)
Conclusions Supported	*Conclusions drawn in the research report flow from the analysis or interpretation of the data*	20 (32%)	16 (30%)	4 (40%)

Supplementary Table 3: Proportion of studies which met Joanna Briggs Institute (JBI) Critical Appraisal Items for Qualitative Studies. Descriptions are adapted from the JBI tool. Higher Reliability Studies scored 6 or more on the JBI tool.

# ▲	Searches	Results	Type	Actions	Annotations
1	PHYSICIANS/	87338	Advanced	Display Results | More	
2	PHYSICIAN EXECUTIVES/	4211	Advanced	Display Results | More	
3	CONSULTANTS/	6648	Advanced	Display Results | More	
4	INTERNSHIP/	48084	Advanced	Display Results | More	
5	RESIDENCY/	48084	Advanced	Display Results | More	
6	MEDICAL STAFF/	2559	Advanced	Display Results | More	
7	(physician* or surgeon* or doctor* or intern or interns or residen* or registrar* or consultant* or "house officer*" or "medical staff*").ti.	230256	Advanced	Display Results | More	
8	1 or 2 or 3 or 4 or 5 or 6 or 7	304607	Advanced	Display Results | More	
9	LEADERSHIP/	40117	Advanced	Display Results | More	
10	PRACTICE MANAGEMENT/	1344	Advanced	Display Results | More	
11	"leader*".ti.	21361	Advanced	Display Results | More	
12	(practice and manag*).ti.	9878	Advanced	Display Results | More	
13	9 or 10 or 11 or 12	58933	Advanced	Display Results | More	
14	PROGRAM EVALUATION/	61451	Advanced	Display Results | More	
15	PROGRAM DEVELOPMENT/	28428	Advanced	Display Results | More	
16	CURRICULUM/	73527	Advanced	Display Results | More	
17	EDUCATION,MEDICAL,CONTINUING/	24544	Advanced	Display Results | More	
18	EDUCATION,MEDICAL,GRADUATE/	28493	Advanced	Display Results | More	
19	(teach* or train* or educat* or course* or program* or pathway* or curricul*).ti.	783506	Advanced	Display Results | More	
20	14 or 15 or 16 or 17 or 18 or 19	873227	Advanced	Display Results | More	
21	8 and 13 and 20	1068	Advanced	Display Results | More	
22	limit 21 to yr="2013 -Current"	461	Advanced	Display Results | More	
23	GENERAL PRACTITIONERS/	7485	Advanced	Display Results | More	
24	FAMILY PHYSICIANS/	16222	Advanced	Display Results | More	
25	MEDICAL STAFF,HOSPITAL/	22748	Advanced	Display Results | More	
26	(GP or GPs or "general practitioner*" or "family practitioner*").ti.	22053	Advanced	Display Results | More	
27	23 or 24 or 25 or 26	60255	Advanced	Display Results | More	
28	13 and 20 and 27	161	Advanced	Display Results | More	
29	limit 28 to yr="2013 -Current"	63	Advanced	Display Results | More	
30	29 not 22	40	Advanced	Display Results | More	

Contract

Supplementary Figure 1: Medline (OVID) Search Strategy, January 2020