Supplemental material

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BMJ Leader

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. Mandatory assignments.	Residential modules and followup day	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

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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	Return On Investment of 364%. Quality improvements were observed. 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

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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	3b. 9.6% of graduates reported a new leadership position; 12.4% of female graduates, 33.3% of underrepresented minority graduates. 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 residences (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

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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

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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
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.	4b. Across a 2-year follow-up period 8/30 (27%) obtained a peer-reviewed grant 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 Communication	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

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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

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	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

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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.

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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

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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

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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

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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

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BMJ Leader

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.

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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		Contract
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		

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