

Data tables

Table 1. Characteristics of included studies

	Article Type	Methods	Participants	Interventions	Comparisons	Outcomes	Course
Instructor qualification/training							
Einspruch EL 2011 E4	Article	RCT	Instructor candidates (N=24)	Internet-based AHA Core Instructor Course (CIC) (n=11)	Traditional classroom-based AHA CIC (n=13)	Primary outcome: candidates' scores on their pretest and posttest ratings(given by expert rater and study coordinator). No difference in pretest and posttest scores/ratings. Candidates in the Online group had significantly higher adjusted posttest scores (p=0.035).	BLS
Feltes M 2019 202	Article	Non-RCT	Faculty and chief residents in anesthesiology, pediatrics, and emergency medicine	First PALS course(Group1): PALS with train-the-trainer programs, included 4 interactive presentations on learner-focused teaching methods (n=9). Second PALS course(Group2): 28 additional residents trained by the newly trained "trainers."	Compare pass rate, test score and questionnaire response among two groups.	The pass rate (>80% on the posttest) was 67% for group 1 and 79% for group 2. Both groups showed improvement in their comfort level in caring for sick children after the PALS course. Both groups showed improvement in their comfort level in caring for sick children after the PALS course.	PALS
Rajapakse BN 2013 e79491	Article	Non-RCT	Non-specialist doctors from selected rural hospital in Sri Lanka	First phase: 2-day instructor course with train-the-trainer model(include knowledge of the resuscitation syllabus and instructor workshop) (n=8) Second phase: sending the "trained trainers" to deliver 8 resuscitation training workshops(BLS/ALS), including 57 participants.	N/A	Primary outcome: assess resuscitation knowledge and skill endpoints(pre-test/post-test/6-week/12-week) among the peripheral hospital doctors taught by the 'trained trainers'.(Knowledge assessment: MCQ test. Skills assessment: performance in a cardiac arrest scenario.) Mean MCQ scores significantly improved over time (p<0.001), and a significant improvement was noted in specific resuscitation skills.	ALS
Ismail A 2019 604	Article	Non-RCT	Medical students from Al Azhar University-Gaza(N=117)	BLS and CPR instructor course(12 hr practical BLS and CPR skills+4 hr communication and didactical skills) (material based on the ERC 2015 guidelines)	N/A	95 medical students completed the online questionnaire. Students reported to be motivated to participated the course for building the capacity of the community (n = 29), contributing to better coping with the tense situation the recurrent incursions (n = 22). Nearly two-thirds (n=61, 64.2%) described a sense of belonging and duty to the community as their most important inspiration. 58 training sessions with 1,312 lay participants were completed after the 58 training sessions with 1,312	BLS

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Benthem Y 2012 e103	Conference Abstract	Non-RCT	Senior student attending DRC train-the-trainer course(n=10)	2-days train the trainer course for BLS(in-service training + train the trainer) held by Dutch Resuscitation Council (DRC)	student control instructors (in-service training only)(n=14)	lay participants were completed (so far). 350 students were randomized to receive training from either a control instructor (n = 202) or DRC-instructor (n = 148). 1. DRC-instructors scored significantly higher on the practical training of BLS (p = 0.008). 2. Control instructors performed significantly better on parts of the theoretical BLS training (p = 0.001). 3. The type of instructor had no effect on the result of the final exam of the first year students (p = 0.949).	BLS
Pollock L 2011 A75	Conference Abstract	Non-RCT	Senior healthcare workers from 25 hospitals in 18 Malawian healthcare districts(N=79)	4-day train the trainer course including local Emergency Triage Assessment and Treatment (ETAT) implementation planning workshop	N/A	Pre and postcourse knowledge tests (n=79) showed improvement in both individual and overall scores (overall mean score pre: 10.27 post: 12.48 p= < 0.001). 11 hospitals had obtained funding for participants to train colleagues: a further 272 healthcare workers had been trained in triage skills.	Pediatric resuscitation (WHO ETAT)
López-Herce J 2021 71	Article	Non-RCT	Participants from different professional groups in 24 pediatric and neonatal CPR instructor courses held over 21 years (1999 to 2019). (N=516)	Pediatric and neonatal CPR instructor courses (26–28 h distributed over 3–4 days; 2 phases: an initial preparation phase and a phase involving face-to-face sessions)	N/A	Theoretical evaluation by multiple-choice questions (score 1-10); practical evaluation score ranging from 1 to 5. (Criteria for passing: theory > 6.5 and practice > 3.5). 554 passed theory and practice tests (98.9 %). Mean (SD) score in theory tests was 9.2 (0.8) out of 10. The mean score obtained in all practice tests was > 3.5 out of 5.	PBLS
Wada M 2015 629	Article	Non-RCT	Participants in instructor course of neonatal cardiopulmonary resuscitation included lectures and instruction practice.(N=232)	New instructor course included lectures, instruction practice and resuscitation scenarios developed by the participants (n=143)	Conventional instructor training course with practicing using the text in advance (n=89)	Participants in new course have more confidence to teach neonatal CPR (>90% vs 50~60%, p<0.001), could instruct on resuscitation procedures and practice (63.6% vs 38.2%, P<0.001). Significantly more participants in new course work as instructors 6 months after certification(60% vs 34%, P<0.001).	NRP
Kim EJ 2019 198	Article	Descriptive survey study	Sampling of Korean BLS instructors.(N=213)	Web-based questionnaire survey with a 29 item Competence Importance–Performance scale	N/A	Factor analysis identified several important factors for the competence of instructors: assessment, professional foundations, planning and preparation, educational method and strategies and evaluation. The importance and performance analysis matrix showed that training priorities for novice instructors were communication with learners and instructors, learner motivation, educational design, and qualifications of instructors, whereas checking equipment status and educational environment had	BLS

						the highest training priority for experienced instructors.	
Assessment tools							
Al-Rasheed RS 2013 242	Article	RCT	Recruited BLS CPR-I/Cs(instructor/coordinator) (N=30)	Phase 1: All participants performed compression 2-minute simulation, then reviewed 6 videos of simulated CPR performances. Phase 2: Repeat the protocol, participants in the experimental group were provided with real-time compression feedback.	Phase 1. Determine the chest compression quality and the accuracy of CPR-I/C chest compression assessment Phase 2. Determine CPR quality and assessment skills through cardiac arrest simulations with objective in-scenario performance feedback	For CPR quality: All CPR-I/C subjects compressed suboptimally at baseline. Real-time manikin feedback improved the proportion of subjects with more than 77% correct compressions to 0.53 (P < 0.01). For chest compression assessment: Video review data revealed persistently low CPR-I/C assessment accuracy. Correlation between subjects' correctness of compressions and their assessment accuracy remained poor regardless of interventions.	BLS
Yamahata Y 2014 S49	Conference Abstract	Non-RCT	Experienced instructors(n=14) and fresh instructors(n=10)	Evaluate the accuracy of chest compressions, and the self-learning ability with recorded chest compression by motion capture camera.	compare assessment of chest compression quality among novice/experienced instructors and motion camera	1. Score between experienced instructors and the device is similar (2.67 of 4–2.58 of 4). 2. Fresh instructors tend to give higher score than the device (2.57 of 4–2.26 of 4), and sometimes give certification to inappropriate performances. 3. Ability of fresh instructors after self-training is improved, but cannot catch up to experienced instructors.	Not mentioned(BLS/CPR)
Nallamilli S 2012 e40	Conference Abstract	Non-RCT	Accredited instructors were asked to deliver BLS training using Skillmeter manikins	Accredited instructors were asked to deliver BLS training using Skillmeter manikins	N/A	97% of BLS instructors within our course regarded the program to be useful, with the majority stating that Skillmeter –based training was better delivered by themselves, rather than course directors (59% vs 38%).	BLS
Teaching skills enhancement							
Baldwin LJL 2015 199	Article	Randomised crossover study	ERC BLS instructors (N=58)	Teach BLS using either the learning conversation structured methods or sandwich feedback technique	cross over study, compare with alternative method	1. Scores(VAS) assigned to use of the learning conversation structured methods by instructors were significantly more favourable than for the sandwich technique across most domains relating to instructor perception of the feedback technique, and all skills-based domains. 2. No difference was seen in either assessment pass	BLS

						rates (80.9% sandwich technique vs. 77.2% learning conversation structured methods; OR 1.2, 95% CI 0.85–1.84; p = 0.29).	
Cheng A 2013 528	Article	RCT	Novice instructors participates in Examining Pediatric Resuscitation Education Using Simulation and Scripted Debriefing (EXPRESS) network simulation programs from 2008 to 2011(N=90)	For novice instructors to use (1) nonscripted debriefing and low physical-realism simulator(n=23), (2) scripted debriefing and low physical-realism simulator(n=22), (3) nonscripted debriefing and high physical-realism simulator(n=23), (4) scripted debriefing and high physical-realism simulator(n=22).	Compare with the alternative intervention	Students' performance in scripted debriefing showed greater improvement in knowledge (mean MCQ-PPC, 5.3% vs 3.6% ; P=.04) and team leader behavioral performance (median BAT-PPC,16% vs 8% ; P=.03). BAT: Behavioral Assessment Tool (team leader performance); PPC: postintervention vs preintervention comparison	PALS
Herrero P 2010 S106	Conference Abstract	Non-RCT	Instructor candidates in BLS / AED instructor courses and one ALS instructors course.(N=180)	New training tool consisting in a tape recording and a later critical viewing of a lecture	N/A	All candidates (100%) considered interesting to compare the subjective impression with the objectivity viewing, and the opinion was positive on 100% of trainers who used this tool.	BLS/AED, ALS
Additional course for instructors							
Goldman SL 1986 163	Article	RCT	Candidates enrolled from two successive Wisconsin Heart Association ACLS Instructor Courses in 1985.(N=92)	Specific educational program to teach instructors to evaluate team leader performance in cardiac arrest simulations(reviewed commonly observed errors and critical error identification)	No formal educational program	Each group of instructor candidates then reviewed and rated the 3 video taped team leader performances. The experimental group identified more critical errors (p=0.006), more correct grade assignments(p=0.026), and more observed errors (p=0.0001).	ALS
Thorne CJ 2013 526	Short communication	Non-RCT	ERC accredited instructors(N=18)	Additional training through the Assessment Training Programme(ATP)(n=9)	Standard ERC instructor training(n=9) and ERC instructor trainer(n=6)	Seventy-three candidate assessments were undertaken. Instructors (49.3%) had lower raw pass rates than assessors (67.1%) and instructor trainers (64.4%). There was a significant difference in overall decisions between instructors and instructor trainers (p=0.035), and instructors and assessors (p=0.015). Instructors were more prone to incorrectly failing candidates than assessors (sensitivities of 80.5% and 63.8%, p=0.077).	BLS/AED
Thorne CJ 2015 58	Article	Non-RCT	ERC instructor course candidates(n=47)	Instructors undertook Assessment Training Programme(ATP) as additional	Candidates attending an ERC BLS/AED instructor	Primary outcome: Assessment confidence over ten-point Visual Analogue Scales collected by pre- and post-course questionnaires.	BLS/AED

			and qualified ERC BLS/AED instructors(n=20)	training, focuses on decision making in equivocal situations.(n=20)	course.(n=47)	Overall confidence on the ERC BLS/AED instructor and ATP assessors course rose from 5.9 (SD 1.8) to 8.7 (SD 1.4) (P < 0.001) and from 8.2 (SD 1.4) to 9.6 (SD 0.5) (P < 0.001), respectively. Assessors (mean 9.6, SD 0.5) were significantly more confident at assessing than instructors (mean 8.7, SD 0.5) (P < 0.001).	
Amin HJ 2013 251	Article	Descriptive survey study	Experienced NRP instructors or instructor trainers participating neonatal resuscitation workshop (N=17)	Pre-post test questionnaire to determine perceptions over the neonatal resuscitation workshop(lectures; scenario development and enactment; video recording and playback; and debriefing).	N/A	Pre- and post-test comparisons showed significant improvements in participants' perceptions of their ability to: conduct (as an instructor) a simulation (p < .05, η ² .47); participate in a simulation (p < .05, η ² .45); recognize cues (p < .05, η ² .35); and debrief (p < .05, η ² .41).	NRP
Breckwoldt J 2014 6	Article	RCT	Clinical teachers(N=18) from emergency medicine and anaesthesiology in a university teaching hospital	Two-day clinical teacher training, content including 'role of the teacher', 'needs of learners', 'providing feedback', 'structure of session', 'defining learning objectives', 'activating learners', 'teaching of skills', 'teaching with patients'(n=9)	No clinical teacher training	Students's outcome: Students taught by untrained teachers performed better in the SCE domains 'alarm call' (p < 0.01) and 'ventilation' (p = 0.01). No significant difference in chest compression and use of AED. Teachers' outcome: Teaching quality was rated significantly better by students of untrained teachers (p = 0.05).	BLS+EM course

Table 2. Interventions to improve instructional competence

	Intervention	Results
1. Instructor qualification/training		
Internet-based AHA Core Instructor Course (CIC) for BLS (Einspruch EL 2011 E4)	Comparing internet-based AHA CIC (Core Instructor Course) with traditional classroom-based AHA CIC	No difference for instructors in pretest and posttest practical scores between classroom-based and Internet-based CIC. Candidates in the online group had significantly higher adjusted posttest scores.
Train-the-trainer course (Feltus M 2019 202, Rajapakse BN 2013 e79491, Ismail A 2019 604, Benthem Y 2012 e103, Pollock L 2011 A75)	Instructor course with train-the-trainer model, sending the "trained trainers" to deliver further resuscitation training.	Train-the-trainer programs may be effective in improving resuscitation knowledge and skills, and are important for developing local expertise.

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System-wide instructor training program (López-Herce J 2021 71)	Retrospective analysis of 24 PALS instructor courses certificated by Spanish Pediatric and Neonatal Resuscitation Group (SPNRG) held between 1999 and 2019.	Specific pediatric and neonatal CPR instructor course is an adequate method for sustainable training health professionals to teach pediatric resuscitation.
Modified instructor course with lectures, instruction practice and self-developed resuscitation scenarios (Wada M 2015 629)	Comparing new instructor course with conventional instructor training. The new course included lectures and instruction practice, and was characterized by using a scenario they had developed themselves to provide instructions.	Participants are more confident teaching neonatal CPR when participating a new course when compared to the traditional course.
Web-based questionnaire survey for instructors (Kim EJ 2019 198)	Web-based survey with a 29 item Competence Importance Performance scale to identify several important factors for the competence of instructors.	Several important factors for the competence of instructors identified by factor analysis.
2. Assessment tools		
Assessment for chest compression with real-time compression feedback (Al-Rasheed RS 2013 242)	To determine the chest compression quality and the accuracy of CPR-I/C (instructor/coordinator) chest compression assessment, with/without real-time compression feedback.	Real-time compression feedback during simulation improved CPR-I/C's chest compression performance skills, without comparable improvement in chest compression assessment skills in video review.
Assessment for chest compression with self-learning (Yamahata Y 2014 S49)	To determine the ability of instructors to evaluate the accuracy of chest compressions, and the self-learning ability with recorded chest compression by motion capture camera.	Ability of novice instructors to assess chest compressions after self-training is improved, but cannot catch up to experienced instructors.
Deliver BLS training using fully body sensor-equipped manikins (Nallamilli S 2012 e40)	Accredited instructors were asked to deliver BLS training using sensor-equipped manikins.	Instructors feel useful and confident when delivering course and may be beneficial to trainer's perception.
3. Teaching skills enhancement		
Different feedback method (Baldwin LJJ 2015 199)	Compare the sandwich technique and learning conversation structured methods of feedback delivery in BLS training.	Using learning conversation structured methods by instructors were significantly more favorable than using the sandwich technique, and may give instructors more confidence.
Using standardized script by novice instructors to facilitate	To determine whether use of a scripted debriefing by novice instructors and/or simulator physical realism	The use of a standardized script to debrief by novice instructors improves students' acquisition of knowledge and team leader

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team debriefing (Cheng A 2013 528)	affects knowledge and performance in simulated cardiopulmonary arrests.	behavioral performance during subsequent simulated cardiopulmonary arrests.
Tape recording and a later critical viewing of a lecture (Herrero P 2010 S106)	Record the lecture provided by BLS/AED or ALS instructor candidates with a tape, a later video review and oral self-assessment.	Candidates considered interesting and feel positive to compare the subjective impression with the objectivity viewing.
4. Additional course for instructors		
Educational program to teach ACLS instructors to evaluate team leader performance (Goldman SL 1986 163)	Educational program to review commonly observed errors and to identify critical errors in particular.	Trained instructors identified more critical errors, and gave more correct grade assignments.
Assessment Training Program (ATP) (Thorne CJ 2013 526; Thorne CJ 2015 58)	Instructors undertook Assessment Training Programme (ATP) as additional training, focusing on decision making in equivocal situations.	Trained instructors were less prone to incorrectly failing candidates. (Thorne CJ 2013). Instructors with additional training were significantly more confident at assessing. (Thorne CJ 2015).
Neonatal resuscitation workshop (Amin HJ 2013 251)	2-day neonatal resuscitation workshop (content: lectures; scenario development and enactment; video recording and playback; and debriefing) to enhance teaching abilities.	Pre- and post-test comparisons showed significant improvements in participants' perceptions of their teaching ability.
Clinical teacher training course/workshop (enhance teaching skills and methods (Breckwoldt J 2014 6)	2-day BLS and emergency medicine teacher training program (content: 'role of the teacher', 'needs of learners', 'providing feedback', 'structure of session', 'defining learning objectives', 'activating learners', 'teaching of skills', 'teaching with patients'.)	Students taught by untrained teachers performed better in some domains. Teaching quality was rated significantly better by students of untrained teachers.