SIMULATION

12 studies: 8 randomised and 4 observational
4 neonatal, 2 paediatric, 6 adult
5 medical students, 3 nursing students, 3 hospital residents, 2 hospital doctors and nurses
1 OOHCA, 1 IHCA
3 systematic reviews (neonatal 4 studies, paediatric 8 studies, all ages 182 studies)
Mixed results

Positive effect	**No effect**
Patient outcomes • Mundrell et al. 2013 - systematic review (n=182 studies) of the effect of technology enhanced simulation training (vs no intervention): ↑ skills (process, product, time skills)	Patient outcomes •
Knowledge • Biese et al. 2009 – screen-based simulation-training: ↑ knowledge • Cortegiani et al. 2015 - high fidelity simulation (vs frontal lessons): ↑ ALS knowledge • Lee et al. 2012 – simulation training (vs 'current curriculum'): ↑ knowledge • Mundrell et al. 2013 - systematic review (n=182 studies) of the effect of technology enhanced simulation training (vs no intervention): ↑ knowledge • O'Leary et al. 2012 - e-learning resuscitation programme: ↑ knowledge	Knowledge • Nimbalkar et al. 2015 – high fidelity simulation (vs low fidelity simulation) • Roha et al. 2016 - integrated simulation-based resuscitation skills training combined with clinical practicum (vs no simulation training)
Skills • Bender et al. 2014 - booster simulation: ↑ procedural skills @ 15 months • Mills et al. 2013 – systematic review (n=8 studies) of effect of simulation training on procedural and resuscitation training : mixed results • Mundrell et al. 2013 - systematic review (n=182 studies) of the effect of technology enhanced simulation training (vs no intervention): ↑ skills (process, product, time skills) • Mundrell et al. 2013 - systematic review (n=182 studies) of the effect of technology enhanced simulation training (vs non-simulation intervention): ↑ skills (process skills)	Skills • Biese et al. 2009 – screen-based simulation-training: procedural skills • Curran et al. 2015 – high fidelity simulation (vs low fidelity simulation) • Mills et al. 2013 – systematic review (n=8 studies) of effect of simulation training on procedural and resuscitation training : mixed results • Roha et al. 2016 - integrated simulation-based resuscitation skills training combined with clinical practicum (vs no simulation training)

SIMULATION

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Bender, J., K. Kennally, R. Shields and F. Overly (**2014**). "**Does simulation booster impact retention of resuscitation procedural skills and teamwork?**" Journal of Perinatology **34**(9): 664-668. OBJECTIVE: The Neonatal Resuscitation Program (NRP) has transitioned to a simulation-based format. We hypothesized that immersive simulation differentially impacts similar trainee populations' resuscitation knowledge, procedural skill and teamwork behavior. STUDY DESIGN: Residents from NICU and non-NICU programs were Randomised to either control or a booster simulation 7 to 10 months after NRP. Procedural skill and teamwork behavior instruments were validated. Individual resident's resuscitation performance was assessed at 15 to 18 months. Three reviewers rated videos. RESULT: Fifty residents were assessed. Inter-rater reliability was good for procedural skills (0.78) and team behavior (0.74) instruments. The intervention group demonstrated better procedural skills (71.6 versus 64.4) and teamwork behaviors (18.8 versus 16.2). The NICU program demonstrated better teamwork behaviors (18.6 versus 15.5) compared with non-NICU program. CONCLUSION: A simulation-enhanced booster session 9 months after NRP differentiates procedural skill and teamwork behavior at 15 months. Deliberate practice with simulation enhances teamwork behaviors additively with residents' clinical resuscitation exposure.	• Randomised • Neonatal • Manikin • Hospital residents	• Booster simulation versus • Control simulation	• resuscitation knowledge • procedural skill • teamwork behavior	+ve A simulation-enhanced booster session 9 months after training enhances teamwork behavior at 15 months

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Biese, K. J., D. Moro-Sutherland, R. D. Furberg, B. Downing, L. Glickman, A. Murphy, C. L. Jackson, G. Snyder and C. Hobgood (**2009**). "**Using screen-based simulation to improve performance during pediatric resuscitation**." Academic Emergency Medicine **16 Suppl 2**: S71-75. OBJECTIVES: To assess the ability of a screen-based simulation-training program to improve emergency medicine and pediatric resident performance in critical pediatric resuscitation knowledge, confidence, and skills. METHODS: A pre-post, interventional design was used. Three measures of performance were created and assessed before and after intervention: a written pre-course knowledge examination, a self-efficacy confidence score, and a skills-based high-fidelity simulation code scenario. For the high-fidelity skills assessment, independent physician raters recorded and reviewed subject performance. The intervention consisted of eight screen-based pediatric resuscitation scenarios that subjects had 4 weeks to complete. Upon completion of the scenarios, all three measures were repeated. For the confidence assessment, summary pre- and post-test summary confidence scores were compared using a t-test, and for the skills assessment, pre-scores were compared with post-test measures for each individual using McNemar's chi-square test for paired samples. RESULTS: Twenty-six of 35 (71.3%) enrolled subjects completed the institutional review board-approved study. Increases were observed in written test scores, confidence, and some critical interventions in high-fidelity simulation. The mean improvement in cumulative confidence scores for all residents was 10.1 (SD +/-4.9; range 0-19; $p < 0.001$), with no resident feeling less confident after the intervention. Although overall performance in simulated codes did not change significantly, with average scores of 6.65 (+/-1.76) to 7.04 (+/-1.37) out of 9 possible points ($p = 0.58$), improvement was seen in the administering of appropriate amounts of IV fluids (59-89%, $p = 0.03$). CONCLUSIONS: In this study, improvements in resident knowledge, confidence, and performance of certain skills in simulated pediatric cardiac arrest scenarios suggest that screen-based simulations may be an effective way to enhance resuscitation skills of pediatric providers. These results should be confirmed using a Randomised design with an appropriate control group. 	• Observational pre-post • Paediatric • Manikin • Paediatric residents	• Screen-based simulation-training program	• knowledge • confidence • skills performance	Mixed No change • skills performance + • ↑ knowledge • ↑ confidence scores

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Cortegiani, A., V. Russotto, F. Montalto, P. Iozzo, C. Palmeri, S. M. Raineri and A. Giarratano (**2015**). "**Effect of High-Fidelity Simulation on Medical Students' Knowledge about Advanced Life Support: A Randomised Study**." PLoS ONE [Electronic Resource] **10**(5): e0125685. High-fidelity simulation (HFS) is a learning method which has proven effective in medical education for technical and non-technical skills. However, its effectiveness for knowledge acquisition is less validated. We performed a Randomised study with the primary aim of investigating whether HFS, in association with frontal lessons, would improve knowledge about advanced life support (ALS), in comparison to frontal lessons only among medical students. The secondary aims were to evaluate the effect of HFS on knowledge acquisition of different sections of ALS and personal knowledge perception. Participants answered a pre-test questionnaire consisting of a subjective (evaluating personal perception of knowledge) and an objective section (measuring level of knowledge) containing 100 questions about algorithms, technical skills, team working/early warning scores/communication strategies according to ALS guidelines. All students participated in 3 frontal lessons before being Randomised in group S, undergoing a HFS session, and group C, receiving no further interventions. After 10 days from the end of each intervention, both groups answered a questionnaire (post-test) with the same subjective section but a different objective one. The overall number of correct answers of the post-test was significantly higher in group S (mean 74.1, SD 11.2) than in group C (mean 65.5, SD 14.3), p = 0.0017, 95% C.I. 3.34 - 13.9. A significantly higher number of correct answers was reported in group S than in group C for questions investigating knowledge of algorithms (p = 0.0001; 95% C.I 2.22-5.99) and team working/early warning scores/communication strategies (p = 0.0060; 95% C.I 1.13-6.53). Students in group S showed a significantly higher score in the post-test subjective section (p = 0.0074). A lower proportion of students in group S confirmed their perception of knowledge compared to group C (p = 0.0079). HFS showed a beneficial effect on knowledge of ALS among medical students, especially for notions of algorithms and team working/early warning scores/communication.	• Randomised study • Adult • Manikin • Medical students	• High-fidelity simulation	• knowledge	+ HFS ↑ ALS knowledge, especially for algorithms & team working/early warning scores/communication.

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Curran, V., L. Fleet, S. White, C. Bessell, A. Deshpandey, A. Drover, M. Hayward and J. Valcour (**2015**). "**A Randomised controlled study of manikin simulator fidelity on neonatal resuscitation program learning outcomes**." Advances in Health Sciences Education **20**(1): 205-218. The neonatal resuscitation program (NRP) has been developed to educate physicians and other health care providers about newborn resuscitation and has been shown to improve neonatal resuscitation skills. Simulation-based training is recommended as an effective modality for instructing neonatal resuscitation and both low and high-fidelity manikin simulators are used. There is limited research that has compared the effect of low and high-fidelity manikin simulators for NRP learning outcomes, and more specifically on teamwork performance and confidence. The purpose of this study was to examine the effect of using low versus high-fidelity manikin simulators in NRP instruction. A Randomised posttest-only control group study design was conducted. Third year undergraduate medical students participated in NRP instruction and were assigned to an experimental group (high-fidelity manikin simulator) or control group (low-fidelity manikin simulator). Integrated skills station (megacode) performance, participant satisfaction, confidence and teamwork behaviour scores were compared between the study groups. Participants in the high-fidelity manikin simulator instructional group reported significantly higher total scores in overall satisfaction ($p = 0.001$) and confidence ($p = 0.001$). There were no significant differences in teamwork behaviour scores, as observed by two independent raters, nor differences on mandatory integrated skills station performance items at the $p < 0.05$ level. Medical students' reported greater satisfaction and confidence with high-fidelity manikin simulators, but did not demonstrate overall significantly improved teamwork or integrated skills station performance. Low and high-fidelity manikin simulators facilitate similar levels of objectively measured NRP outcomes for integrated skills station and teamwork performance.	• Randomised posttest-only control group • Neonatal • Manikin • Medical students	• high-fidelity manikin simulators versus • low fidelity manikin simulators	• skills performance • participant satisfaction • confidence • teamwork behaviour scores	**Mixed** + • satisfaction • confidence scores No difference • teamwork • skills performance
Halamek, L. P. (**2008**). "**The simulated delivery-room environment as the future modality for acquiring and maintaining skills in fetal and neonatal resuscitation**." Seminars In Fetal & Neonatal Medicine **13**(6): 448-453. The science underlying neonatal resuscitation is growing exponentially in quantity and quality. So, too, is the knowledge of effective methodologies that facilitate acquisition and maintenance of the cognitive, technical, and behavioral skills necessary to for successful resuscitation of the newborn. One of these methodologies, simulation-based training, offers many advantages over more traditional methodologies: By providing key visual, auditory, and tactile cues it creates a high level of physical, biological, and psychological fidelity to the real environment and thus is able to elicit realistic responses from trainees. Training scenarios coupled with debriefings (where discussion of what went well and what could be improved upon occur in a nonjudgmental fashion) provide rich learning experiences that rival or exceed those in the real clinical environment. Simulation-based training will likely become the standard for not only routine training but also high-stakes assessment such as licensure and board certification. [References: 20]	Discussion paper = EXCLUDED	•	•	•

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Hansel, M., A. M. Winkelmann, F. Hardt, W. Gijselaers, W. Hacker, M. Stiehl, T. Koch and M. P. Muller (**2012**). "**Impact of simulator training and crew resource management training on final-year medical students' performance in sepsis resuscitation: a Randomised trial**." Minerva Anestesiologica **78**(8): 901-909. BACKGROUND: We developed a 1.5 days crew resource management (CRM) course on situation awareness (SA) to improve the participants' ability to recognise critical situations in crisis scenarios. Objective of the study was to evaluate the influence of the CRM course on SA and medical performance in crisis scenarios and to compare the results with the effects of a purely clinical simulator training. METHODS: Sixty-one final-year medical students, Randomised into three groups, took part in a pre-intervention test scenario of septic shock in a patient simulator setting. Medical performance and SA were assessed using a checklist and the Situation Awareness Global Assessment Tool (SAGAT), respectively. All students received a lecture about the sepsis guidelines. The simulator (SIM) group took part in a 1.5-day simulator training on sepsis resuscitation. The CRM group took part in a course on situation awareness. The control group (CG) did not obtain any training. All students accomplished a post-intervention test scenario comparable to the pre-intervention scenario. RESULTS: The SAGAT score rose from 10.6+/-2.3 to 11.9+/-1.7 (preintervention vs. postintervention test, P=0.04) in the SIM group, whereas no significant changes could be shown in the CRM group and the control group, respectively. The clinical performance scores in the post-intervention test did not differ from those in the preintervention test. CONCLUSION: Neither the 1.5 days simulator training nor the 1.5 days CRM course did influence the clinical performance scores. SAGAT scores were higher after the simulator training, but not after the CRM training.	• Randomised • Adult sepsis resuscitation • Manikin • Medical students	• CRM course on situation awareness	• Medical performance and SA were assess • Situational Awareness (SAGAT scores)	**Mixed** No difference • neither simulator training nor CRM course influenced clinical performance scores +ve • SAGAT scores were higher after the simulator training, but not after the CRM training.

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Lee, M. O., L. L. Brown, J. Bender, J. T. Machan and F. L. Overly (**2012**). "**A medical simulation-based educational intervention for emergency medicine residents in neonatal resuscitation**." Academic Emergency Medicine **19**(5): 577-585. OBJECTIVES: The objective was to determine if a medical simulation-based neonatal resuscitation educational intervention is a more effective teaching method than the current emergency medicine (EM) curriculum at one 4-year EM residency program. METHODS: A prospective, Randomised study of second-, third-, and fourth-year EM residents was performed. Of 36 potential subjects, 27 residents were enrolled. Each resident was assessed at baseline and after the intervention using 1) a questionnaire to evaluate confidence in leading adult, pediatric, and neonatal resuscitation and prior neonatal resuscitation experience and 2) a neonatal resuscitation simulation scenario in which each participant was the code leader to evaluate knowledge and skills. Assessments were digitally recorded and reviewed independently by two Neonatal Resuscitation Program (NRP) instructors using a validated neonatal resuscitation scoring tool. Controls (15 participants) received the current EM curriculum. The intervention group (12 participants) experienced an educational session, which incorporated didactics, skills station, and medical simulation about neonatal resuscitation. Outcomes measured included changes in overall neonatal resuscitation score, number of critical actions, time to initial steps of neonatal resuscitation, and changes in confidence level leading neonatal resuscitation. RESULTS: Baseline neonatal resuscitation scores were similar for the control and intervention groups. At the final assessment, the intervention group's neonatal resuscitation score improved ($p = 0.016$) and the control group's score did not. The intervention group performed 2.31 more critical actions overall and the time to achieve warming ($p = 0.0002$), drying ($p < 0.0001$), tactile stimulation ($p = 0.002$), and placing a hat on the patient ($p < 0.0001$) were also improved compared to controls. At the baseline assessment, 80% of the control group and 75% of the intervention group reported being "not at all confident" in leading neonatal resuscitation. At the final assessment, the proportion of residents who were "not at all confident" leading neonatal resuscitation decreased to 35% in the intervention group compared to 67% of the control group. The majority of the intervention group (65%) reported an increased level of confidence in leading neonatal resuscitation. CONCLUSIONS: Medical simulation can be an effective tool to assess the knowledge and skills of EM residents in neonatal resuscitation. Our simulation-based educational intervention significantly improved EM residents' knowledge and performance of the critical initial steps in neonatal resuscitation. A medical simulation-based educational intervention may be used to improve EM residents' knowledge and performance with neonatal resuscitation. 	• prospective, Randomised • Neonatal • Manikin • Emergency medicine residents	• medical simulation-based neonatal resuscitation	• Confidence • Knowledge • Skills • Overall neonatal resuscitation score • Number of critical actions • Time to initial steps of neonatal resuscitation	+ve • ↑ knowledge • ↑ confidence • ↑ performance of the critical initial steps in neonatal resuscitation

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Lin, Y. and A. Cheng (**2015**). "**The role of simulation in teaching pediatric resuscitation: current perspectives**." Advances in Medical Education & Practice **6**: 239-248. The use of simulation for teaching the knowledge, skills, and behaviors necessary for effective pediatric resuscitation has seen widespread growth and adoption across pediatric institutions. In this paper, we describe the application of simulation in pediatric resuscitation training and review the evidence for the use of simulation in neonatal resuscitation, pediatric advanced life support, procedural skills training, and crisis resource management training. We also highlight studies supporting several key instructional design elements that enhance learning, including the use of high-fidelity simulation, distributed practice, deliberate practice, feedback, and debriefing. Simulation-based training is an effective modality for teaching pediatric resuscitation concepts. Current literature has revealed some research gaps in simulation-based education, which could indicate the direction for the future of pediatric resuscitation research.	Discussion paper = EXCLUDED	•	•	•
Luctkar-Flude, M., C. Baker, C. Pulling, R. McGraw, D. Dagnone, J. Medves and C. Turner-Kelly (**2010**). "**Evaluating an undergraduate interprofessional simulation-based educational module: communication, teamwork, and confidence performing cardiac resuscitation skills**." Advances in Medical Education & Practice **1**: 59-66. PURPOSE: Interprofessional (IP) collaboration during cardiac resuscitation is essential and contributes to patient wellbeing. The purpose of this study is to evaluate an innovative simulation-based IP educational module for undergraduate nursing and medical students on cardiac resuscitation skills. METHODS: Nursing and medical trainees participated in a new cardiac resuscitation curriculum involving a 2-hour IP foundational cardiac resuscitation skills lab, followed by three 2-hour IP simulation sessions. Control group participants attended the existing two 2-hour IP simulation sessions. Study respondents (N = 71) completed a survey regarding their confidence performing cardiac resuscitation skills and their perceptions of IP collaboration. RESULTS: Despite a consistent positive trend, only one out of 17 quantitative survey items were significantly improved for learners in the new curriculum. They were more likely to report feeling confident managing the airway during cardiac resuscitation (P = 0.001). Overall, quantitative results suggest that senior nursing and medical students were comfortable with IP communication and teamwork and confident with cardiac resuscitation skills. There were no significant differences between nursing students' and medical students' results. Through qualitative feedback, participants reported feeling comfortable learning with students from other professions and found value in the IP simulation sessions. CONCLUSION: Results from this study will inform ongoing restructuring of the IP cardiac resuscitation skills simulation module as defined by the action research process. Specific improvements that are suggested by these findings include strengthening the team leader component of the resuscitation skills lab and identifying learners who may benefit from additional practice in the role of team leader and with other skills where they lack confidence.	• Observational study with control group - ? randomisation • Adult • Manikin • Nursing and medical students	• simulation-based IP educational module	• Confidence • Perceptions of IP collaboration	No difference • Confidence (except for airway Mx)

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Mills, D. M., D. C. Williams and J. V. Dobson (**2013**). "**Simulation training as a mechanism for procedural and resuscitation education for pediatric residents: a systematic review**." Hospital Pediatrics **3**(2): 167-176. BACKGROUND: Pediatric residents often finish their training lacking sufficient procedural proficiency and resuscitation experience in the care of critically ill children. Simulation is gaining favor in pediatric residency programs as a modality for procedural and resuscitation education. We reviewed the literature assessing simulation and its role in pediatric resident training. METHODS: We conducted a Medline and PubMed search of simulation training in pediatric resident education from January 2007 to July 2012. RESULTS: Eight studies were included and divided into simulated procedural assessments and simulated resuscitation scenario assessments. The studies varied widely in their approach and analysis, and they yielded mixed results. CONCLUSIONS: Although some studies show the merits of simulation in the procedural and resuscitation training of pediatric residents, more research is needed to assess the effectiveness of simulation as an educational tool. Goals of future simulation research should include creation of validated assessment tools and applying skills learned to patient care outcomes.	• Systematic review = 8 studies • Paediatric • Paediatric residents	• Simulation training	• procedural and resuscitation training	• **Mixed**

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Mundell, W. C., C. C. Kennedy, J. H. Szostek and D. A. Cook (**2013**). "**Simulation technology for resuscitation training: a systematic review and meta-analysis**." Resuscitation **84**(9): 1174-1183. OBJECTIVES: To summarize current available data on simulation-based training in resuscitation for health care professionals. DATA SOURCES: MEDLINE, EMBASE, CINAHL, PsycINFO, ERIC, Web of Science, Scopus and reference lists of published reviews. STUDY SELECTION: Published studies of any language or date that enrolled health professions' learners to investigate the use of technology-enhanced simulation to teach resuscitation in comparison with no intervention or alternative training. DATA EXTRACTION: Data were abstracted in duplicate. We identified themes examining different approaches to curriculum design. We pooled results using random effects meta-analysis. DATA SYNTHESIS: 182 studies were identified involving 16,636 participants. Overall, simulation-based training of resuscitation skills, in comparison to no intervention, appears effective regardless of assessed outcome, level of learner, study design, or specific task trained. In comparison to no intervention, simulation training improved outcomes of knowledge (Hedges' g) 1.05 (95% confidence interval, 0.81-1.29), process skill 1.13 (0.99-1.27), product skill 1.92 (1.26-2.60), time skill 1.77 (1.13-2.42) and patient outcomes 0.26 (0.047-0.48). In comparison with non-simulation intervention, learner satisfaction 0.79 (0.27-1.31) and process skill 0.35 (0.12-0.59) outcomes favored simulation. Studies investigating how to optimize simulation training found higher process skill outcomes in courses employing "booster" practice 0.13 (0.03-0.22), team/group dynamics 0.51 (0.06-0.97), distraction 1.76 (1.02-2.50) and integrated feedback 0.49 (0.17-0.80) compared to courses without these features. Most analyses reflected high between-study inconsistency (I(2) values >50%). CONCLUSIONS: Simulation-based training for resuscitation is highly effective. Design features of "booster" practice, team/group dynamics, distraction and integrated feedback improve effectiveness. 	• Systematic review 182 studies • Health care professionals	• Technology-enhanced simulation	• resuscitation training	+ve - vs no intervention • knowledge 1.05 (95% CI, 0.81-1.29), • process skill 1.13 (0.99-1.27) • product skill 1.92 (1.26-2.60) • time skill 1.77 (1.13-2.42) • patient outcomes 0.26 (0.047-0.48). +ve - vs non-simulation intervention • learner satisfaction 0.79 (0.27-1.31) • process skill 0.35 (0.12-0.59)

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Nimbalkar, A., D. Patel, A. Kungwani, A. Phatak, R. Vasa and S. Nimbalkar (**2015**). "**Randomised control trial of high fidelity vs low fidelity simulation for training undergraduate students in neonatal resuscitation**." BMC Research Notes **8**: 636. BACKGROUND: Knowledge acquisition and skill maintenance are important in learning neonatal resuscitation. Traditionally this is taught by using low fidelity mannequins. Technological advancement enabled a move towards high fidelity mannequins. In a low resources setting, it is incumbent to ensure reasonable cost benefit ratio before investing in technology. METHODS: A Randomised control trial was conducted in 101 undergraduate students who were assigned to conventional Resusci() Baby Basic or SimNewB group over a period of 3 days. The lectures were the same for both groups but the hands on training was on different mannequins. There were five experienced and accredited teachers who were standardized for training the students. Both the groups received a written test and a Megacode before and after the training, and 3 months later a post-test. RESULTS: The baseline written exam score (p = 0.07), Megacode assessment score (p = 0.19) and sex distribution (p = 0.17) were similar in both groups. Both groups showed significant improvement in the written exam score as well as in the Megacode assessment score at post-test and 3 months (retention) period. However there was no significant difference in the "improvement" between both the groups with respect to written exam (p = 0.38) or Megacode assessment (p = 0.92). Further the post-test and 3 month scores were comparable for the skills as well as content components suggesting that the skills were retained in 3 months with an opportunity of self learning them. CONCLUSIONS: Due diligence is a caveat before contemplating the acquisition of high fidelity mannequins by educational centers for neonatal resuscitation.	• Randomised control trial • Neonatal • Manikin • Undergraduate students	• High fidelity simulation versus • Low fidelity simulation	• Knowledge	No difference • No difference in knowledge

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
O'Leary, F. M. (**2012**). "**Paediatric resuscitation training: is e-learning the answer? A before and after pilot study**." Journal of Paediatrics & Child Health **48**(6): 529-533. AIM: To determine whether an e-learning resuscitation programme was able to improve the knowledge and competence of doctors and nurses in providing cardiopulmonary resuscitation to children in a simulated cardiac arrest. METHOD: A prospective before and after pilot study comprising of a simulated paediatric resuscitation before and after participants undertook an e-learning programme. Participants were emergency department doctors and new graduate nurses from The Children's Hospital at Westmead, Australia. Primary outcome measures were the ability to perform successful basic life support (BLS) and advanced life support (ALS) according to published guidelines. Secondary outcome measures were the individual steps in performing the overall resuscitation and subjective feedback from participants. RESULTS: Fifty-six clinicians were enrolled in the study (29 doctors and 27 nurses). Thirty-seven were re-tested (25 doctors and 12 nurses). The mean time between tests was 49 days (17 standard deviation). The e-learning module led to an improvement in participants' ability to perform BLS by 51% (P < 0.001) and ALS by 57% (P= 0.001) overall resulting in an overall competence of 89% (BLS) and 65% (ALS). There were also significant improvements in time to rhythm recognition (P= 0.006), time to first defibrillation (P= 0.009) and participants' self-reported knowledge and confidence in BLS and ALS (P < 0.001). CONCLUSIONS: E-learning does improve both the knowledge and competence of doctors and nurses in providing cardiopulmonary resuscitation to children in the simulation environment. Copyright © 2011 The Author. Journal of Paediatrics and Child Health © 2011 Paediatrics and Child Health Division (Royal Australasian College of Physicians).	• prospective before and after study • paediatrics • manikin • ED doctors and graduate nurses	• e-learning resuscitation programme	• BLS guideline compliance • ALS guideline compliance • Self reported knowledge • Self reported confidence	+ve • ↑ BLS performance • ↑ALS performance • ↑ knowledge • ↑ confidence

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Rakshasbhuvankar, A. A. and S. K. Patole (**2014**). "**Benefits of simulation based training for neonatal resuscitation education: a systematic review**." Resuscitation **85**(10): 1320-1323. BACKGROUND: Simulation-based training (SBT) is being more frequently recommended for neonatal resuscitation education (NRE). It is important to assess if SBT improves clinical outcomes as neonatal resuscitation aims to improve survival without long-term neurodevelopmental impairment. We aimed to assess the evidence supporting benefits of SBT in NRE. METHOD: A systematic review was conducted using the Cochrane methodology. PubMed, Embase, PsycInfo and Cochrane databases were searched. Related abstracts were scanned and full texts of the potentially relevant articles were studied. Randomised controlled trials (RCT) and quasi-experimental studies with controls (non-RCT) assessing SBT for NRE were eligible for inclusion in the review. RESULTS: Four small studies [three RCT (n=126) and one non-RCT (n=60)] evaluated SBT for NRE. Participants included medical students (one RCT and one non-RCT), residents (one RCT) and nursing staff (one RCT). Outcomes included performance in a simulation scenario, theoretical knowledge, and confidence in leading a resuscitation scenario. One RCT favoured simulation [improved resuscitation score (p=0.016), 2.31 more number of critical actions (p=0.017) and decreased time to achieve resuscitation steps (p=<0.001)]. The remaining two RCTs and the non-RCT did not find any difference between SBT and alternate methods of instruction. None of the four studies reported clinical outcomes. CONCLUSIONS: Evidence regarding benefits of SBT for NRE is limited. There are no data on clinical outcomes following SBT for NRE. Large RCTs assessing clinically important outcomes are required before SBT can be recommended widely for NRE. 	• Systematic review = 4 studies • Neonatal • Health care professionals	• Simulation-based training	• performance in a simulation scenario • theoretical knowledge • confidence in leading a resuscitation scenario	**Mixed** One RCT = ↑ performance • ↑ resuscitation score • ↑ critical actions • ↓ time to resuscitation steps Two RCTs & non-RCT did • no difference None of the four studies reported clinical outcomes
Roh, Y. S. and S. S. Kim (**2014**). "**The effect of computer-based resuscitation simulation on nursing students' performance, self-efficacy, post-code stress, and satisfaction**." Research & Theory for Nursing Practice **28**(2): 127-139. Computer-based simulation has intuitive appeal to both educators and learners with the flexibility of time, place, immediate feedback, and self-paced and consistent curriculum. The purpose of this study was to assess the effects of computer-based simulation on nursing students' performance, self-efficacy, post-code stress, and satisfaction between computer-based simulation plus instructor-led cardiopulmonary resuscitation training group and instructor-led resuscitation training-only group. This study was a nonequivalent control group posttest-only design. There were 213 second year nursing students randomly assigned to one of two groups: 109 nursing students with computer-based simulation or 104 with control group. Overall nursing students' performance score was higher in the computer-based simulation group than in the control group but reached no statistical significance (t = 1.086, p = .283). There were no significant differences in resuscitation-specific self-efficacy, post-code stress, and satisfaction between the two groups. Computer-based simulation combined with hands-on practice did not affect in nursing students' performance, self-efficacy, post-code stress, and satisfaction in nursing students. Further study must be conducted to inform instructional design and help integrate computer-based simulation and rigorous scoring rubrics.	• nonequivalent control group posttest-only • adults • nursing students	• Computer-based simulation versus • instructor-led CPR training group and instructor-led CPR training-only group	• Performance • self-efficacy • post-code stress • satisfaction	No difference • performance score • self-efficacy • post-code stress • satisfaction

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Roha, Y. S., E. J. Lima and S. B. Issenberg (**2016**). "**Effects of an integrated simulation-based resuscitation skills training with clinical practicum on mastery learning and self-efficacy in nursing students**." Collegian: Journal of the Royal College of Nursing, Australia **23**(1): 53-59. BACKGROUND: This study evaluates the effectiveness of integrated simulation-based resuscitation skills training combined with a clinical practicum by assessing nursing students' knowledge, psychomotor skills, and self-efficacy. METHODS: In a pretest-posttest design, 255 second-year nursing students participated in an emergency nursing clinical course consisting of a two-hour simulation-based resuscitation skills training component along with an 80-hour clinical placement in an emergency department. Knowledge, self-efficacy, and psychomotor skill errors were measured. Analyses of pre- and post-test data were performed on three subgroups: the simulation-only group, the simulation with clinical observation group, and the simulation with clinical performance group. Stu- dents were divided into these groups based on resuscitation experiences during their clinical practicum in the emergency department. RESULTS: Mean scores of knowledge ($z = -13.879$, $p < .001$) and self-efficacy ($z = -10.969$, $p < .001$) significantly improved after the clinical practicum compared to baseline. Knowl- edge ($F = .502$, $p = .606$), psychomotor skill error ($F = 1.587$, $p = .207$), and self-efficacy ($F = .481$, $p = .619$) did not significantly differ among the three subgroups after controlling for two covari- ates (age, Basic Life Support certification) in the analysis of covariance models. CONCLUSION: Integrated simulation-based resuscitation skills training combined with a clinical practicum might be beneficial for enhancing mastery learning and self-efficacy in nursing students through learner engagement and feedback.	• pretest-posttest design • adults • nursing students	• integrated simulation-based resuscitation skills training combined with clinical practicum	• knowledge • self-efficacy • psychomotor skill errors	No difference when controlled for age, BLS certification) • Knowledge • psychomotor skill error • self-efficacy

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Sullivan, N. J., J. Duval-Arnould, M. Twilley, S. P. Smith, D. Aksamit, P. Boone-Guercio, P. R. Jeffries and E. A. Hunt (**2015**). "**Simulation exercise to improve retention of cardiopulmonary resuscitation priorities for in-hospital cardiac arrests: A Randomised controlled trial**." Resuscitation **86**: 6-13. BACKGROUND: Traditional American Heart Association (AHA) cardiopulmonary resuscitation (CPR) curriculum focuses on teams of two performing quality chest compressions with rescuers on their knees but does not include training specific to In-Hospital Cardiac Arrests (IHCA), i.e. patient in hospital bed with large resuscitation teams and sophisticated technology available. DESIGN: A Randomised controlled trial was conducted with the primary goal of evaluating the effectiveness and ideal frequency of in-situ training on time elapsed from call for help to; (1) initiation of chest compressions and (2) successful defibrillation in IHCA. METHODS: Non-intensive care unit nurses were Randomised into four groups: standard AHA training (C) and three groups that participated in 15 min in-situ IHCA training sessions every two (2M), three (3M) or six months (6M). Curriculum included specific choreography for teams to achieve immediate chest compressions, high chest compression fractions and rapid defibrillation while incorporating use of a backboard, stepstool. RESULTS: More frequent training was associated with decreased median (IQR) seconds to: starting compressions: [C: 33(25-40) vs. 6M: 21(15-26) vs. 3M: 14(10-20) vs. 2M: 13(9-20); $p < 0.001$]; and defibrillation: [C: 157(140-254) vs. 6M: 138(107-158) vs. 3M: 115(101-119) vs. 2M: 109(98-129); $p < 0.001$]. A composite outcome of key priorities, compressions within 20s, defibrillation within 180 s and use of a backboard, revealed improvement with more frequent training sessions: [C:5%(1/18) vs. 6M: 23%(4/17) vs. 3M: 56%(9/16) vs. 2M: 73%(11/15); $p < 0.001$]. CONCLUSION: Results revealed short in-situ training sessions conducted every 3 months are effective in improving timely initiation of chest compressions and defibrillation in IHCA. 	• Randomised controlled trial • adult IHCA • non-ICU nurses	15 min in-situ IHCA training sessions • two months • three months • six months versus • standard AHA training	Time from call for help to • initiation of CC • successful defibrillation Composite outcome • CC<20s • defibrillation < 180 s • backboard use	+ve • frequent training ↓ time to CC ($p<0.001$) ** only 1 sec difference between 3M & 2M • ↓ time to defibrillation ($p< 0.001$) ** 6 sec difference between 3M & 2M • ↑ % composite outcome ($p<0.001$)

Study	Study features	Intervention	Outcomes	Major finding
Simulation				
Ten Eyck, R. P., M. Tews, J. M. Ballester and G. C. Hamilton (**2010**). "**Improved fourth-year medical student clinical decision-making performance as a resuscitation team leader after a simulation-based curriculum**." Simulation in Healthcare: The Journal of The Society for Medical Simulation **5**(3): 139-145. OBJECTIVE: To determine the impact of simulation-based instruction on student performance in the role of emergency department resuscitation team leader. METHODS: A Randomised , single-blinded, controlled study using an intention to treat analysis. Eighty-three fourth-year medical students enrolled in an emergency medicine clerkship were randomly allocated to two groups differing only by instructional format. Each student individually completed an initial simulation case, followed by a standardized curriculum of eight cases in either group simulation or case-based group discussion format before a second individual simulation case. A remote coinvestigator measured eight objective performance end points using digital recordings of all individual simulation cases. McNemar chi2, Pearson correlation, repeated measures multivariate analysis of variance, and follow-up analysis of variance were used for statistical evaluation. RESULTS: Sixty-eight students (82%) completed both initial and follow-up individual simulations. Eight students were lost from the simulation group and seven from the discussion group. The mean postintervention case performance was significantly better for the students allocated to simulation instruction compared with the group discussion students for four outcomes including a decrease in mean time to (1) order an intravenous line; (2) initiate cardiac monitoring; (3) order initial laboratory tests; and (4) initiate blood pressure monitoring. Paired comparisons of each student's initial and follow-up simulations demonstrated significant improvement in the same four areas, in mean time to order an abdominal radiograph and in obtaining an allergy history. CONCLUSIONS: A single simulation-based teaching session significantly improved student performance as a team leader. Additional simulation sessions provided further improvement compared with instruction provided in case-based group discussion format.	• Randomised , single-blinded, controlled study • emergency department • medical students	• simulation-based instruction versus • discussion group	Student team leader performance • order IV line • initiate cardiac monitoring • order initial laboratory tests • initiate BP monitoring	+ve • single simulation-based teaching session significantly improved student performance as a team leader across all outcomes studied