WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

Worksheet author(s)

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Clinical question.

In ALS providers undergoing ALS courses (P), does the inclusion of specific leadership/team training (I), as opposed to no such specific training (C), improve outcomes (eg. performance during cardiac arrests) (O)?

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention/therapy
State if this is a proposed new topic or revision of existing worksheet: Revision

Conflict of interest specific to this question

Edelson: Research funding/support: NIH, AHA, Philips healthcare; Speaking honoraria/consulting: Philips Healthcare; Triage Wireless
Davies: RD member of Resuscitation Council (UK) ALS and BLS /AED subcommittees. RD employed by Resuscitation Council to manage electronic ALS learning programme / study

Search strategy (including electronic databases searched).

Edelson/Yuen search parameters:
Medline and Cochrane via OvidSP: 442 hits (408 on Medline and 34 on Cochrane) on 1/28/2010
"(Advanced Cardiac Life Support[keyword] OR Advanced Life Support[keyword] OR resuscitation[MeSH/keyword]) AND (leadership[keyword] OR team[keyword]) AND (education[MeSH] OR educat*[keyword] OR training[keyword] OR simulat*[keyword])."
Medline and Embase via Embase: 421 hits on 1/29/2010
"('advanced cardiac life support' OR 'advanced life support' OR 'resuscitation'/exp) AND ('leadership' OR 'team') AND ('training' OR simulat* OR educat*)."
AHA EndNote Master library. Forward search using Web of Science. Review of references from articles.

Robin Davies search parameters:
PubMed searched for: Mesh Terms Advanced Cardiac Life Support AND Leadership AND Education 6 Hits.
Emergencies AND Crew Resource Management 5 hits.
EMBASE and CINHAL via 'National library for Health' searched for:
Advanced Cardiac Life support AND (Leadership OR Education OR Training) 9 Hits.
Crew Resource Management AND Emergencies 2 Hits
Cochrane searched for:
Advanced Cardiac Life Support" OR Cardiopulmonary Resuscitation AND "Leadership" AND "Education" 22 Hits
Crew Resource management AND emergencies 0 Hits
ERIC searched for:
Cardiopulmonary Resuscitation AND Leadership 3 Hits (all non medical papers)
Crew Resource Management AND Emergencies 0 Hits
Review of reference from articles 6 Hits

- State inclusion and exclusion criteria

The following studies were excluded: non-peer reviewed articles, and studies that did not directly answer the question.
Studies of both simulation training and patient resuscitation were included.

- Number of articles/sources meeting criteria for further review: 567 articles were identified by initial searching, of which 66 met criteria for further review. Upon careful review articles that did not specifically address leadership or team parameters were excluded, leaving two LOE1, two LOE2, and seven LOE 5 articles.

Summary of evidence

Evidence Supporting Clinical Question

Good					*Hunziker, 2009 E1, E3*
Fair	*Thomas, 2007 E2* *Cooper, 2001 E1*				Edelson, 2008 B, E3 Cooper, 1999 E3 *Makinen, 2007 E1* *Marsch, 2004 B* Morey 2002 E1, E2, E4
Poor		*Gilfoyle, 2007 E2* *Devita, 2005 B, E3*			Hayes 2007
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E1 = Leadership demonstration
E2 = Teamwork demonstration
E3 = Resuscitation performance
E4 = Error reduction
Italics = Mannequin studies

Evidence Neutral to Clinical question

Good					
Fair					Edelson, 2008 C
Poor					
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
Italics = Animal studies

Evidence Opposing Clinical Question

Good					
Fair					
Poor					
	1	**2**	**3**	**4**	**5**
Level of evidence					

A = Return of spontaneous circulation
B = Survival of event
C = Survival to hospital discharge
D = Intact neurological survival
E = Other endpoint
Italics = Animal studies

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

Evidence from four studies of advanced life support in simulated IHCA [two LOE1 (Thomas, 2007, 409; Cooper, 2001, 33), and two LOE2 (Gilfoyle, 2007, 276; Devita, 2005, 326)], with support from seven studies of actual and simulated IHCA (Hunziker, 2009, 3; Edelson, 2008, 1063; Cooper, 1999, 27; Makinen, 2007, 264; Marsch, 2004, 51; Morey 2002, 1553; Hayes 2007,1668) demonstrate that adding specific team and/or leadership training to advanced life support courses may improve resuscitation performance. The optimal format for these educational components remains to be determined.

Cooper (Cooper, 2001, 33) conducted a randomized, controlled trial of leadership training as a component of a standard ALS course. 68 rescuers of varying experience and background enrolled in an ALS course were randomized to receive an additional 75 minute "leadership module" or a question session as a part of their ALS course. The intervention involved a didactic, focusing on team structure, and was followed by three video recordings of hospital resuscitation attempts demonstrating good, average and poor leadership skills. Observational assessment of leadership skills using a modified version of the Leadership Behaviour Description Questionnaire (LBDQ) was accomplished by instructors blinded to the randomization. The intervention group improved by 4.53 points out of a total of 40 possible points from their baseline test (compared to an improvement of 2.23 for the control ($p=0.01$, 1-sided U-test)). Significantly greater improvements from baseline were noted in 9 out of the 10 assessment areas (see below).

Individual item analysis of LBDQ ratings
Item 1: 'The leader let the team know what was expected of them (through direction and command)' (Exp=Mean 0.56 vs.Cont=Mean 0.21)
Item 2: 'The leader demonstrated the use of uniform guidelines' (Exp=Mean 0.56 vs Cont=Mean 0.12)
Item 3: 'The leader displayed a positive attitude throughout the scenario' (Exp=Mean 0.44 vs Cont=Mean 0.26)
Item 4: 'The leader decided what should be done' (Exp=Mean 0.32 vs. Cont=Mean 0.38) *insignificant
Item 5: 'The leader decided how things should be done' (Exp=Mean 0.38 vs. Cont=Mean 0.02)
Item 6: 'The leader allocated tasks to specific individuals' (Exp=Mean 0.44 vs. Cont=Mean 0.18)
Item 7: 'The leader made sure that his part in the team was understood by the team members' (Exp=Mean 0.53 vs Cont=Mean 0.41)
Item 8: 'The team leader planned the work to be done' (Exp=Mean 0.32 vs. Cont=Mean 0.12)
Item 9: 'The team leader maintained definite standards of performance' (Exp=Mean 0.41 vs. Cont=Mean 0.18)
Item 10: 'The team leader remained 'hands off' throughout the scenario (except for tasks which could not be delegated)' (Exp=Mean 0.56 vs. Cont=Mean 0.29)

Limitations: There was no measurement of resuscitation performance just demonstration of leadership skills. Reviewers did not cross-over so there could have been bias in determination of the LBDQ between the two groups. Additionally, this course was called a leadership module but clearly incorporated team training.

Thomas et al. (Thomas, 2007, 409) conducted a randomized controlled trial of team training as a component of a neonatal resuscitation program. 40 of 51 interns of varying backgrounds participated in the study. Both groups received similar neonatal resuscitation training, but the intervention group had additional teambuilding training in the format of a 2½ hour session and more teamwork and human error instruction from instructors throughout training. Teams of two or three performed resuscitation on a low-fidelity simulator and were video recorded, the videos of which were randomly divided among two trained, blinded observers. Teamwork behaviors of each team were recorded as rates (number of behaviors per minute). The intervention group exhibited more frequent information sharing, inquiry and assertion than the interns of the control group. Limitations: The study did not measure resuscitation performance but only display of teamwork behaviors. Furthermore, reviewers did not cross-over, and hence there may be potential bias in determining what constituted a teamwork behavior.

Gilfoyle et al. (Gilfoyle, 2007, 276) designed an education workshop of leadership skills and team functioning during resuscitation based on a needs assessment of 15 pediatric residents. The residents then participated in the workshop followed by two simulated resuscitation scenarios. Team performance was evaluated by a checklist. Residents were evaluated again six months later. In addition, a control group, which consisted of residents who did not participate in any of the workshops, was also evaluated at the six month mark. Residents who participated in the workshops scored higher compared to controls ($p<0.05$), but there was no significant difference between performance of residents who repeated the simulation six months later. Retrospective survey, using a 5-point Likert scale revealed self-reported learning. Limitations: There were no concurrent controls at the initial interventional period, and there were no comparisons to resident performance prior to any workshop. The control group used consisted of residents who did not participate in the first workshop, resulting in potential confounders that were not adjusted for.

The DeVita group (DeVita, 2005, 326) developed a 3-hour simulation course for training their Medical Emergency Team, which involved three simulated scenarios with facilitator moderated debriefing after each scenario. The study involved 10 courses with a total of 138 individuals (including respiratory therapists, nurses, and physicians) rotating through 30 resuscitations in teams of eight people, each with a specific role. Overall simulator survival (which was predefined based on ALS algorithms) improved from 0% to 90% between the baseline and third resuscitation (Cochran's $Q=12.6$, $p=0.002$). The mean task completion rate improved overall from 31% to 89% (Kendall's $W=0.91$, $p<0.001$). Limitations: Since there was no separate control group and the subjects served as

their own controls, there is no way to account for experience in the simulator as the etiology of the improvement as opposed to the training intervention.

The remaining supportive studies are LOE 5 as they do not directly answer the proposed question:

Hunziker (Hunziker, 2009) examined the performance of 50 general practitioners and 50 hospital physicians randomised in a simulated cardiac arrest. Physicians were randomised to either preformed or ad hoc teams of 3. The preformed teams demonstrated greater "hands on" times (124+/- 34 vs 93+/- 37 seconds; P<0.0001) in the first 3 minutes of the arrest, earlier first defibrillation (67+/- 42 vs 107+/- 46 seconds; P<0.0001) and made more leadership statements (21+/- 6 vs 15+/- 5; P<0.0001). The study design did not test leadership /teamwork training as an intervention, specifically, and instead looked at the effect of teambuilding early on during an event. Nevertheless it is perhaps supportive for the notion of knowing the other members of the team and arriving together.

Edelson et al (Edelson, 2008, 1063) investigated the use of formal debriefing using transcripts of electronic data and compared performance at cardiac arrest with a historical control. Standards of cardiac arrest techniques (quality of compressions, hands off time, pre-shock pauses and ventilation rates) improved in the experimental group. 70% of this group also believed that their team leadership skills had improved. Outcomes for the patients treated by the experimental group were improved (ROSC 59.4% vs 44.6% P=0.03) and in this respect the paper is supportive. When examining a different endpoint there was no change in survival to discharge (7.4% vs 8.9% P=0.69) and as such the paper is neutral. The study did not isolate the effect of leadership/team training but there were components of both in the the debriefing intervention studied.

Makinen et al ((Makinen, 2007, 264) compared the performance of nurses across two hospitals in a simulated cardiac arrest scenario where the skills of BLS and automatic external defibrillation were assessed. In addition participants were evaluated in "non technical skills" described as task management and team working. The nurses from one hospital had leadership skills included in their training whilst the nurses in the control group did not. Nurses from the hospital where team leadership was included in training had a higher mean OSCE score in the technical skills section than that of the compared group (35.1, range 12 -24 vs 26.2, range 7-37), performed successful defibrillation more frequently (100% vs 49% P<0.05) and demonstrated a higher non technical skills score (2.8 vs 1.9 P<0.01). Because the setting was BLS/AED training and not ALS training, it did not directly answer the question but was supportive. It was limited in that the entire study group had been trained in BLS/AED against 75% of the control group and the two groups were likely different at baseline because they came from two different hospitals.

Morey et al (Morey, 2002, 1553) evaluated the effectiveness of training in team work behaviours on performance of emergency department staff in the clinical environment. Emergency Departments (ED) self selected participation in either the study group(n=6) or control group(n=3). Three outcomes were measured; clinical performance, team performance and opinions and attitudes. Study groups were subject to training in an "Emergency Team Coordination Course" and both control and study groups were evaluated against the three measures before and after the intervention. The study group demonstrated a significant improvement in Team Behaviours (30.4, std 14.3 vs 57.0, std 10.7). Observed errors in clinical performance fell in the study group (30.9%, std 22.5 vs 4.4%,std 4.9). No other statistically significant effects were observed in either the study group or the control group. Because the setting was not \als courses and \als providers specifically, but rather ED departments and overall emergency care, the study was included as LOE5. In addition it was not blinded and the ED's self selected into study or control groups, potentially introducing bias.

Coopers' observational study (Cooper, 1999 27) of actual resuscitations showed a correlation between leadership skill demonstration and resuscitation performance. Twenty resuscitation attempts were video-recorded and were reviewed by the researcher. Measurements were then made using the recording and notes. Leaders who participated less in the actual resuscitation process, such as compressions, intravenous access, or defibrillation, built a more structured team (p=0.005) and the team performed resuscitation tasks more effectively (p=0.099). Furthermore, team dynamics (p<0.001) and task performance (p=0.013) were correlated with higher Leadership Behaviour Description Questionnaire score. Although there was no intervention specifically tested, the study demonstrated the potential benefits of teaching leadership or teamwork on improving resuscitation outcomes.

March et al (Marsch, 2004, 51) conducted an observational study of a simulated cardiac arrest scenario involving 16 cardiac arrest teams and found that leadership behaviour (4/6 vs 1/10; p=0.035) and explicit task direction (6/6 vs 4/10; p= 0.033) was significantly linked to 'successful' management of cardiac arrest (successful being defined by a number of timely clinical actions (time to first shock, time to commence CPR and length of interruption to CPR)). Absence of these behaviours was associated with poor team performance. All teams had sufficient theoretical knowledge to treat the cardiac arrest. The study did not test an intervention.

Hayes et al (Hayes, 2007 1668) surveyed 654 internal medicine residents to ascertain their perceptions of the value of ACLS training in preparing them to become team leaders. 289 responded with 49.3% reporting that they felt inadequately trained to lead a cardiac arrest team and 50.9% felt that the ACLS course did not provide the necessary training for team leadership. A similar

number reported worried that they made errors in the management of cardiac arrest (55.3%). This case series was included as LOE5 because it suggests the absence of specific leadership training in ACLS courses.

There is limited data to support adding leadership and/or team training to ALS courses. The critical studies demonstrate that specific team leadership training can improve team leadership performance and the delivery fo resuscitation tasks in a simulated setting. It is not known whether such training impacts on behavior in the clinical environment or if this in turn impacts on patient outcome. However, there is no opposing evidence, the intervention is low risk and, based on the above data, may be beneficial for improving performance. Therefore it is reasonable to advocate incorporating these topics in courses. Future work will need to be done to determine the best way to accomplish this training and whether it indeed improves performance and outcomes.

Acknowledgements:
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Citation List

Cooper S. Developing leaders for advanced life support: evaluation of a training programme. Resuscitation, 2001; 49(1): 33-38.

Level 1 (randomized control trial),good (potential bias of evaluators), supportive
68 rescuers of varying experience and background enrolled in an ALS course were randomized to receive a 75 leadership training course (with video examples)as part of the ALS course or the standard course with a question session instead. Observational assessment of leadership skills using a modified version of the Leadership Behaviour Description Questionnaire was accomplished by instructors blinded to the randomization. The intervention group improved by 4.53 points out of a total of 40 possible points from their baseline test (compared to an improvement of 2.23 for the control (p=0.01, 1-sided U-test)). Significantly greater improvements from baseline were noted in 9 out of the 10 assessment areas. There was no measurement of resuscitation performance just demonstration of leadership skills.

Study was included as fair because there were no cross-over of evaluators, which could result in bias of the results.

Cooper, S. and A. Wakelam (1999). "Leadership of resuscitation teams: "Lighthouse Leadership'." Resuscitation 42(1): 27-45.

Level 5 (does not directly address question), poor (observational study), supportive
An observational study of actual resuscitations that showed a correlation between leadership skill demonstration and resuscitation performance. Twenty resuscitation attempts were video-recorded and were reviewed by the researcher. Measurements were then made using the recording and notes. Leaders who participated less in the actual resuscitation process, such as compressions, intravenous access, or defibrillation, built a more structured team (p=0.005) and the team performed resuscitation tasks more effectively (p=0.099). Furthermore, team dynamics (p<0.001) and task performance (p=0.013) was correlated to the degree of which the leader built a structured team, which was defined using an adapted Leadership Behaviour Description Questionnaire.

Although there was no intervention specifically tested, the study demonstrated the potential benefits of teaching leadership or teamwork on improving resuscitation outcomes.

Devita MA, Schaefer J, et al. Improving medical emergency team (MET) performance using a novel curriculum and a computerized human patient simulator. Quality Safety Health Care, 2005; 14(5): 326-331

Level 4 (uncontrolled), fair (many potential confounders), supportive
Study of a simulation course focusing on teamwork through the use of debriefing showing improvement in resuscitation task performance and simulated survival in the same group from baseline at the beginning of the course. Practice is not accounted for since there is no control and serves as a significant confounder. Hence, the study was included as fair.

Edelson, D. P., B. Litzinger, et al. Improving in-hospital cardiac arrest process and outcomes with performance debriefing. Arch Intern Med, 2008; 168(10): 1063-9.

Level 5 (not directly related to question), fair (historical control), supportive
Historical control study on the effects of resuscitation-performance debriefing on CPR performance, initial return of spontaneous circulation, and survival to discharge. Compared to the historical control, the interventional group improved CPR quality (deeper and faster compressions, slower ventilations and smaller no flow fraction), had shorter pre- and post-shock pause, and had a higher percentage of appropriate shocks. Achievement of ROSC was higher in the interventional group but survival to discharge had no significant change. Although intervention did not specifically teach leadership or teamwork, they would be incorporated in the debriefing sessions. Limitations: Improvements in CPR quality due to secular trend cannot be controlled, and it was a single institution study. Therefore the study was included as a level 5.

Hunziker S, Tschan F, et al. Hands-on time during cardiopulmonary resuscitation is affected by the process of teambuilding: a prospective randomized simulator-based trial. BMC Emergency Medicine, 2009; 9(3).

Level 5 (not directly related to question), good (prospective randomized study), supportive
100 teams of three physicians were randomized to two different versions of a simulated witnessed cardiac arrest – the arrest either occurred in the presence of one physician while the remaining two physicians were summoned for help or it occurred in the presence of all three physicians ("preformed" team). Hands-on time during the first 3 minutes of arrest and time to first defibrillation were recorded. Observational assessment of leadership statements using a modified

version of the Leadership Behaviour Description Questionnaire was accomplished by two independent observers. The intervention group (preformed team) had longer hands-on time during the first 3 minutes, shorter time to first defibrillation, and made more leadership statements. Limitations: The study design did not test leadership/teamwork training as an intervention, specifically, and instead looked at the effect of teambuilding early on during an event. Nevertheless it is perhaps supportive for the notion of knowing the other members of the team and arriving together.

Gilfoyle, E., R. Gottesman, et al. Development of a leadership skills workshop in paediatric advanced resuscitation. Medical Teacher, 2007; 29(9): e276-83.

Level 2 (concurrent control), poor (potential bias of evaluators), supportive
15 paediatric residents at Montreal Children's Hospital, McGill University Health Centre, participated in a workshop followed by two simulated resuscitation scenarios. Team performance was evaluated by a checklist. Residents were evaluated again six months later. In addition, a control group, which consisted of residents who did not participate in any of the workshops, was also evaluated at the six month mark. Residents who participated in the workshops scored higher compared to control on completing tasks during resuscitation. Retrospective survey, using a 5-point Likert scale, revealed self-reported learning.

Hayes, C. W., A. Rhee, et al. Residents feel unprepared and unsupervised as leaders of cardiac arrest teams in teaching hospitals: A survey of internal medicine residents. Critical Care Medicine, 2007; 35(7): 1668-1672.

LOE5, poor, supportive. The study did not test an intervention and therefore did not directly address the question. The study was a postal survey of internal medicine residents attending Canadian English-speaking medical schools regarding their perception of training adequacy as cardiac arrest team leaders. No performance of resuscitation, teamwork behavior or leadership demonstration was recorded but it did demonstrate an absence of leadership training in ACLS courses.

Makinen, M., S. Aune, et al. Assessment of CPR-D skills of nurses in Goteborg, Sweden and Espoo, Finland: teaching leadership makes a difference. Resuscitation, 2007; 72(2): 264-9.

LOE5, fair, supportive
Nurses from two institutions participated in cardiac arrest simulations, and performance was evaluated by the same investigator using a skills check-list. Nurses at both hospitals were trained the same way except for the defining and teaching of leadership in one of them. Nurses at the hospital with leadership training performed better in several measurements – activating the alarm ($p<0.001$), activating the automatic external defibrillator without delay ($p<0.01$), setting the lower defibrillation electrode correctly ($p<0.001$), and using the correct resuscitation technique ($p<0.05$). Although there are no statistically significant differences in cardiac arrest cases between the two institutions, the nurses may have different experiences beyond training, presenting confounding factors. Limitations: There was no specific intervention and there was no way to control for confounders, such as experience and education. The characteristics of participating nurses at the two sites were different, with potential bias supporting the hypothesis. Furthermore, an investigator scored the simulated resuscitations, resulting in bias potential. Nevertheless, the study was included as LOE5 because it demonstrated that defining and teaching leadership may correlate with improved resuscitation performance.

Marsch, S. C. U. Muller, C. et al. Human factors affect the quality of cardiopulmonary resuscitation in simulated cardiac arrests. Resuscitation, 2004; 60(1): 51-56.

Level 5 (not directly on point), poor (concurrent control but did not test an intervention), supportive
This videotaped mannequin study of VF arrests tested 16 teams of 3 rescuers each and showed a correlation between demonstration of leadership skills and teamwork with simulated ROSC. It did not test an intervention.

The study showed an correlation between demonstration of leadership skills and teamwork with simulated ROSC, and hence was included as an LOE5 study.

Morey, J. C., R. Simon, et al. (2002). "Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project." Health Serv Res 37(6): 1553-81.

LOE5, fair, supportive. Morey et al (Morey, 2002, 1553) evaluated the effectiveness of training in team work behaviours on performance of emergency department staff in the clinical environment. Emergency Departments (ED) self selected participation in either the study group(n=6) or control group(n=3). Three outcomes were measured; clinical performance,

team performance and opinions and attitudes. Study groups were subject to training in an "Emergency Team Coordination Course" and both control and study groups were evaluated against the three measures before and after the intervention. The study group demonstrated a significant improvement in Team Behaviours (30.4, std 14.3 vs 57.0, std 10.7). Observed errors in clinical performance fell in the study group (30.9%, std 22.5 vs 4.4%,std 4.9). No other statistically significant effects were observed in either the study group or the control group. Because the setting was not \als courses and \als providers specifically, but rather ED departments and overall emergency care, the study was included as LOE5. In addition it was not blinded and the ED's self selected into study or control groups, potentially introducing bias.

Thomas, E. J., B. Taggart, et al. Teaching teamwork during the Neonatal Resuscitation Program: A randomized trial. Journal of Perinatology, 2007; 27(7): 409-414.

Level 1 (randomized control trial), fair (potential reviewer bias), supportive
40 of 51 interns from pediatrics, combined pediatrics and internal medicine, family medicine, and obstetrics and gynecology participated in the study. The intervention group and the control group had similar demographic distributions. Both groups received similar neonatal resuscitation training, but the intervention group had additional teambuilding training in the format of a 2½ hour session and more teamwork and human error instruction from instructors. Teams of two or three performed resuscitation on a low-fidelity simulator and were video recorded, which were randomly divided among two trained, blinded observers. Teamwork behaviors of each team were recorded as rates (number of behaviors per minute). The intervention group exhibited greater teamwork behaviors than the control group. The study was included as fair due to lack of reviewer cross-over, which may result in evaluator bias of what constitutes a teamwork behavior.

Insufficent data for inclusion

Ali, J., P. Danne, et al. Assessment of the trauma evaluation and management (TEAM) module in Australia. Injury, 2004; 35(8): 753-8.

Intervention did not specifically teach leadership or teamwork.

Bergman, S., D. Deckelbaum, et al. Assessing the impact of the trauma team training program in Tanzania. Journal of Trauma-Injury Infection & Critical Care, 2008; 65(4): 879-83.

Intervention did not specifically teach leadership or teamwork.

Cherry, R. A. and J. Ali. Current concepts in simulation-based trauma education. Journal of Trauma-Injury Infection & Critical Care, 2008; 65(5): 1186-93.

Review of simulation-based trauma education, which does not address question.

Camp BN, Parish DC, Andrews RH: Effect of Advanced Cardiac Life Support training on resuscitation efforts and survival in a rural hospital. Annals Emergency Medicine, 1997; 29: 529-533.

Cole, E. and N. Crichton. The culture of a trauma team in relation to human factors. Journal of Clinical Nursing, 2006; 15(10): 1257-66.

No intervention. Observational study. Observed a trauma team in one teaching hospital during calls followed by semi-structured interviews that were analyzed. Findings suggest leadership, role competence, conflict, communication, the environment and the status of the patient all influence the culture of the trauma team, suggesting education should include human factor considerations, such as leadership skills, team management, conflict resolution and communication strategies.

Cooper, S. and J. Cade. Predicting survival, in-hospital cardiac arrests: resuscitation survival variables and training effectiveness. Resuscitation, 1997; 35(1): 17-22.

Did not test an intervention of training. Study did not correlate leadership/teamwork with resuscitation performance.

Curry L, D. Gass. Effects of training in cardiopulmonary resuscitation on competence and patient outcome. Canadian Medical Association Journal. 1987; 137(6): 491-6.

Dane FC, KS Russell-Lindgren, et al. In-hospital resuscitation: association between ACLS training and survival to discharge. Resuscitation, 2000; 47(1): 83-7.

Falcone, R. A., Jr., M. Daugherty, et al. Multidisciplinary pediatric trauma team training using high-fidelity trauma simulation. Journal of Pediatric Surgery, 2008; 43(6): 1065-71.

Intervention did not specifically teach leadership or teamwork, so cannot isolate effects of leadership or teamwork training.

Gilligan, P., C. Bhatarcharjee, et al. To lead or not to lead? Prospective controlled study of emergency nurses' provision of advanced life support team leadership. Emergency Medicine Journal, 2005; 22(9): 628-632.

The study was omitted because there was no intervention tested and it did not address the question. It was an observational study on the knowledge of handling a cardiac arrest situation by ALS-trained nurses, ALS-trained doctors, and doctors who have not been trained in ALS. All participants were observed during a cardiac arrest simulation and performance was scored based on several parameters. ALS trained nurses scored highest among the groups, but there were no statistical differences among the groups. However, it did not measure teamwork behavior or leadership skill demonstration. Hence it was excluded.

Gwinnutt, C. L. Columb, M. Harris, R. Outcome after cardiac arrest in adults in UK hospitals: effect of the 1997 guidelines. Resuscitation, 2000; 47(2): 125-135.

Intervention did not teach teamwork or leadership.

Hoyer, C. B., E. F. Christensen, et al. Junior physician skill and behaviour in resuscitation: a simulation study. Resuscitation, 2009; 80(2): 244-8.

The observational study of physicians in Denmark was excluded since it did not test an intervention. Although the authors concluded that variations in time to initiation of treatments suggest lack of leadership skills, which implies the need to include leadership/teambuilding training in physician education, no performance of resuscitation, teamwork, or leadership was measured.

Kaye, W. Mancini, M. E. Use of the Mega Code to evaluate team leader performance during advanced cardiac life support. Critical Care Medicine, 1986; 14(2): 99-104.

The observational study of ACLS-trained medical residents and critical care nurses was omitted because it did not test an intervention of teaching teamwork or leadership. Furthermore, leadership skills and team behavior was not measured. Although the authors concluded that the AHA ACLS curriculum should include lectures on teamwork and leadership, the effect of such was not studied.

Lowenstein SR, EM, Sabyan, et al. Benefits of training physicians in advanced cardiac life support. Chest, 1986; 89(4): 512-6.

Did not address teamwork/leadership as part of ALS training.

Makker R, Gray-Siracusa K, M, Evers, et al. Evaluation of advanced cardiac life support in a community teaching hospital by use of actual cardiac arrests. Heart Lung, 1995; 24(2): 116-20.

Did not test an intervention and did not look at correlation of leadership or teamwork on resuscitation performance.

Mancini, M. E. Kaye, W. A Comparison of the Results of Mega Code Testing with Advanced Cardiac Life-Support (ACLS) Performance during Actual Resuscitations - a Pilot-Study. Critical Care Medicine, 1987; 15(4): 368-368.

Mann, C. J. Heyworth, J. Comparison of cardiopulmonary resuscitation techniques using video camera recordings. Journal of Accident & Emergency Medicine, 1996; 13(3): 198-199.

Did not test an intervention and did not look at correlation of leadership or teamwork on resuscitation performance.

Manser, T. Teamwork and patient safety in dynamic domains of healthcare: A review of the literature. Acta Anaesthesiologica Scandinavica, 2009; 53(2): 143-151.

Literature review with little relevancy to the question.

Mikrogianakis, A., M. H. Osmond, et al. Evaluation of a multidisciplinary pediatric mock trauma code educational initiative: a pilot study. Journal of Trauma-Injury Infection & Critical Care, 2008; 64(3): 761-7.

Intervention did not specifically teach leadership or teamwork.

Moretti MA, LA Cesar, et al. Advanced cardiac life support training improves long-term survival from in-hospital cardiac arrest. Resuscitation, 2007; 72(3): 458-65.

Did not test an intervention and did not look at correlation of leadership or teamwork on resuscitation performance.

Nadel, F. M. Lavelle, J. M. et al. Teaching resuscitation to pediatric residents: the effects of an intervention. Archives of Pediatrics & Adolescent Medicine, 2000; 154(10): 1049-54.

Intervention did not teach teamwork or leadership.

Pittman, J., B. Turner, et al. Communication between members of the cardiac arrestteam- A postal survey. Resuscitation, 2001; 49(2): 175-177.

The study was excluded because there was no intervention tested and no observation of teamwork or leadership during resuscitation. In the observational study, a postal survey was sent out to Resuscitation Training Officers in 237 hospitals across the United Kingdom. The study concluded that communication before and after cardiac arrests was poor.

Pottle, A. Brant, S. Does resuscitation training affect outcome from cardiac arrest? Accid Emerg Nurs, 2000; 8(1): 46-51.

Did not test an intervention and did not look at correlation of leadership or teamwork on resuscitation performance.

Sanders, A. B. Berg, R. A. et al. The efficacy of an ACLS training program for resuscitation from cardiac arrest in a rural community. Annals of Emergency Medicine, 1994; 23(1): 56-9.

Intervention did not teach teamwork or leadership.

Sandroni, C., P. Fenici, et al. Haemodynamic effects of mental stress during cardiac arrest simulation testing on advanced life support courses. Resuscitation, 2005; 66(1): 39-44.

No intervention. Observational study on haemodynamic response to mental stress as a team leader in simulated advanced life support scenarios, which was found to be mainly dependent on age and BMI rather than knowledge and skills.

Schenarts, P. J. Incorporating leadership training, a horizontal approach to resuscitation and performance feedback, into advanced life support. Critical Care Medicine, 2007; 35(7): 1781-2.

Comment on Hayes CW, Rhee A et al, Crit Care Med 2007; 35(7): 1668-1672. No intervention.

Settgast, A. Nguyen, J. T. et al. An innovative approach to teaching resuscitation skills. Medical Teacher, 2006; 28(3): e90-3.

Intervention did not teach teamwork or leadership.

Van Schaik, S. M., I. Von Kohorn, et al. Pediatric resident confidence in resuscitation skills relates to mock code experience. Clinical Pediatrics, 2008; 47(8): 777-783.

No intervention. Pediatric residents at single institution were surveyed.

Wayne, DB, A. Didwania, et al. Simulation-based education improves quality of care during cardiac arrest team responses at an academic teaching hospital: a case-control study. Chest, 2008; 133(1): 56-61.

Intervention did not teach teamwork or leadership.