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

Worksheet author(s)

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Clinical question.

EIT-018B - "In ALS providers undergoing ALS courses (P), does the inclusion of specific pre-course preparation (eg. e-learning and pre-testing) (I), as opposed to no such preparation (C), improve outcomes (eg. same skill assessment, but with less face to face (instructor) hands on training) (O)?"

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

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?

Consultant to Laerdal Medical in the area of medical simulation

Search strategy (including electronic databases searched).

Rodgers Search Strategy
Utilizing a university library master search engine, the following databases were searched:

Academic Search Premiere
CINAHL
ERIC
Health Source: Nursing/Academic Edition
JSTOR Arts and Science Collection
MEDLINE (CSA)
MEDLINE (EBSCO)
ProQuest Nursing and Allied Health Source
PsycARTICLES
PsycINFO
PubMed Central
Science Reference Center
SpringerLink Contemporary
Wiley InterScience

An independent search of Google Scholar was also performed

PubMed was also searched through the EndNote reference management software.

AHA Master Library was searched with EndNote reference management software.

All searches were “any field” searches unless otherwise noted.

Pretest AND Effect – 60 (Combined database search)
Pretest AND Effect – 143 (Google Scholar)
Pretest AND Sensitization – 124(Combined database search)
Pretest AND Predict – 119 (Combined database search)
Advanced Life Support AND Prepare – 33 (PubMed)
Advanced Life Support AND Pretest – 24 (PubMed)
Advanced Life Support AND Predict – 136 (PubMed)
Prepare AND Education (MeSH Major Topic) – 2103 (PubMed)
Precourse AND Education (MeSH Major Topic) – 69 (PubMed)
Pretest AND Education (MeSH Major Topic) – 1298 (PubMed)
Advanced Life Support AND Education (MeSH Major Topic) – 453 (PubMed)
ACLS and Education (MeSH Major Topic) – 110 (PubMed)

Education (Keyword) and Advanced – 126 (AHA Master Library)

Lockey Search Strategy

- "ALS course" OR "ACLS course" OR "ATLS course" OR "PLS course" OR "ILS course" OR "APLS course" OR "life support course": textword in title or abstract – 235 articles found on PubMed/Embase, 780 articles found on SCOPUS
- "Advanced Cardiac Life Support" as MESH term – 373 articles found
- Review of references from articles
- EMBASE "cited by" search strategy for two key papers from original search

Databases: PubMed, Embase, Cochrane, Endnote, Google Scholar, SCOPUS

Initial Search: September 2008

Subsequent Search: December 2009 – no further relevant studies identified

• State inclusion and exclusion criteria

Inclusion criteria were ranked in seven hierarchical levels and included (in order, highest rank to lowest):

1. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes and impacting on instructor/student face-to-face time
2. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes with no report on impact on instructor/student face-to-face time
3. Studies reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities

If studies related specifically to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) were absent or inadequate in number, key articles from the following two inclusion criteria would be included:

4. Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
5. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)

If studies related specifically to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) or extrapolated studies from the broader medical literature were absent or inadequate in number, key articles from the following two inclusion criteria would be included:

6. Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
7. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)

Excluded studies related to BLC or CPR courses.

• Number of articles/sources meeting criteria for further review:

A total of 37 were included for further review. The number of articles corresponding to the inclusion criteria is listed below.

Inclusion Criteria	Number of articles
E1. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes and impacting on instructor/student face-to-face time	1
E2. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes with no report on impact on instructor/student face-to-face time	3
E3. Studies reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities	4
E4. Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)	7
E5. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time	17
E6. Studies in the broader education literature on the impact of precourse activities that could be extrapolated to	5, Numerous findings on initial

Advanced Life Support courses (ACLS, PALS, or ERC equivalent)	return, selected key studies that included comprehensive reviews and metanalysis
E7. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time	0, Adequate findings in the medical literature

Summary of evidence

Evidence Supporting Clinical Question

Good	Schwid (1999) 821 E2	Gerard (2006) 649 E3			Christenson (1998) 702 E3 Hudson (2004) 887 E4 Kim (2002) 395 E4 Leong (2003) 295 E4H Buzzell (2002) 21E5 Engum (2003) 67 E5 Fordis (2005) 1043 E5 Goldrick (1990) 20 E5 Harrington (2002) 39 E5 Jeffries (2001) 323 E5 Jeffries (2003) 70 E5 O'Leary (2005) 1848 E5 Rosser (2000) 320 E5 Hartley (1976) 239 E6 Hoogstraten (1979) 25 E6 Hoogstraten (1980) 39 E6 Wilson (1982) 249 E6
Fair				Polgase (1989) 997 E3	Jang (2005) 35 E4 Clark (2000) 109 E5 Flynn (1996) 19 E5 Miller (1985) 173 E5 Schlomer (1997) 249 E5 Ryan (2007) e251 E5 Wiecha (2006) 647 E5
Poor				Darr (2000) 116 E1 Eliot (1996) 7 E2 Patterson (1989) 244 E2 Xie (1999) 117 E3	Denton (2004) 329 E4 Woodworth (2005) 77 E4 Kinney (1997) 57 E5
	1	**2**	**3**	**4**	**5**
Level of evidence					

E1. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes and impacting on instructor/student face-to-face time
E2. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes with no report on impact on instructor/student face-to-face time
E3. Studies reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities
E4. Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
E5. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
E6. Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
E7. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time

Evidence Neutral to Clinical question

Good					Welch (1970) 605 E6
Fair					
Poor					Rizzolo (2002) 351 E4
	1	**2**	**3**	**4**	**5**
Level of evidence					

E1. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes and impacting on instructor/student face-to-face time
E2. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes with no report on impact on instructor/student face-to-face time
E3. Studies reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities
E4. Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
E5. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
E6. Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
E7. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time

Evidence Opposing Clinical Question

Good					
Fair					Maki (2000) 230 E5
Poor					
	1	**2**	**3**	**4**	**5**
Level of evidence					

E1. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes and impacting on instructor/student face-to-face time
E2. Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes with no report on impact on instructor/student face-to-face time
E3. Studies reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities
E4. Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
E5. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
E6. Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
E7. Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time

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

Lockey Review Comments

Two papers were reviewed.

Gerard, 2006[2]
This paper was the most pertinent one to the PICO question. It compared the cognitive and psychomotor performances of candidates attending a 'Traditional PALS Course' (3 day PALS plus Trauma course) with those undergoing an e-learning (Web-PALS) equivalent followed by a 1 day skills/testing course. There was no randomisation, convenience samples were used. All candidates entered were accounted for at the end and there was no crossover between the groups. The study was powered for a 2.5% difference in marks with 40 candidates in each arm (80% power with 0.05 significance level).

Moderators and candidates were not blinded but assessors were. The psychomotor tests (identical for both groups) were all videotaped and independently assessed by assessors blinded to which arm of the study they were from. The groups were similar in demographics. The only difference between the groups, other than the e-learning component, was that the trad-PALS group also had teaching on trauma.

Results:
MCQ: all passed on 1st attempt with 1.7% difference between groups (Trad>Web), conf 0.1-3.2
Psychomotor: Difference between groups 2% (Web>Trad), conf -2 to 6

Limits:
- Not randomised, ?selection bias
- Trad-PALS received trauma training as well ?reinforced some teaching points

Bottom Line: The PICO question relates specifically to ALS, not PALS, but the principles surrounding both courses are the same. Whilst not a randomised study, it does suggest that the cognitive and psychomotor outcomes are similar with an e-learning component and reduced face-to-face teaching.

Christenson, 1998[1]
This paper looked at a multimedia version (MM) of an ACLS course when compared with a standard (ST) ACLS course. As with the Gerard paper, the outcomes measured were cognitive and psychomotor (MCQ and mock arrest). An "educationally important difference" was stated as being 10%, although there are no power calculations to support this. There was no randomisation, convenience samples were used. Some of the candidates were analysed in groups that they were not originally assigned to – it is unclear how many.

All assessments were videotaped and assessed by blinded assessors as well as on-site unblended assessors. It is difficult to assess whether the two groups were similar, other than the fact that they were all medical students in the final 4 months of their training. The two groups were treated equally.

Results:
MCQ: No difference between the two groups – 89.3%+/-4.9% MM vs 89.3%+/-4.8% ST
On-site psychomotor assessment: No difference – 14.1+/-2.5 MM vs 14.1+/-2.0 ST
Blinded psychomotor evaluation: Difference p=0.024 – 13.1+/-2.9 MM vs 14.4+/-2.9, however it is noted that the difference is only 1.3 marks out of 20 which is less than the required 10% for an "educationally important difference".

Limits:
- Not randomised
- Novice learners only
- Psychomotor marking system not validated

Bottom Line: This paper looks at a multimedia variant of ACLS, but this still involves face-to-face tuition. The e-learning component does not reduce the amount of face-to-face time and technically is not pre-course learning. As such it does not exactly fit the criteria of the PICO question, but it is the only study addressing e-learning versus traditional learning for the ALS/ACLS course. It concludes that there is no real difference between the two modalities.

Rodgers Review Comments

The literature did not reveal many findings that directly related to all aspects of the question "In ALS providers undergoing ALS courses (P), does the inclusion of specific pre-course preparation (eg. e-learning and pre-testing) (I), as opposed to no such preparation (C), improve outcomes (eg. same skill assessment, but with less face to face (instructor) hands on training) (O)?" Only one study was found that met this question's requirements. This study supported the question. Darr [Darr (2000) 142] (LOE 4) provided a descriptive case study of an alternative ACLS course format that included multiple preparatory options including attending optional lectures, viewing lectures on video tape, using an interactive computer-assisted instruction program, viewing a series of ACLS core case videos, and participating in teaching labs. This study was small (n=17) and did not evaluate learning outcomes; therefore it was classified as "poor" in its ability to address the question. The primary intent of the study was to evaluate learner attitudes on this flexible format as an optimal learning format. Most comments and survey responses reported learners favored this course format. Instructor to student face-to-face time was dramatically decreased and costs for this course format were 42% lower than the traditional ACLS course.

Several studies addressed individual components of the question – either addressing the impact of preparatory activities on ACLS outcomes or alternate course formats that reduced instructor to student face-to-face time during the course. Three studies (One LOE 1 [Schwid (1999) 821] and two LOE 4 with poor quality [Eliot (1996) 7, Patterson (1989) 244] addressed course preparatory activities. All supported the question. Noteworthy among these was Schwid [Schwid (1999) 821] who conducted a randomized control study evaluating a computerized screen-based simulator to textbook review. Expert scored videotape review of learner performance indicated significantly higher scores for the computerized simulation group over the textbook prepared course.

Four studies (One LOE 2 [Gerard (2006) 649] and two LOE 4 [Polglase (1989) 997, Xie (1999) 117] and one LOE5 [Christenson (1998) 702,]) examined alternate course delivery methods from the traditional ALS course format. All four studies supported the question. Noteworthy among these were Christenson [Christenson (1998) 702] and Gerard [Gerard (2006) 649], both of whom utilized a computer-based alternative to the traditional course. Their findings indicated computer-based learning produced comparable learner outcomes with traditional course format. In both instances, instructor to student face-to-face time was greatly reduced.

When examining the broader medical literature, six studies were identified that supported the portion of the question that addressed preparatory strategies (LOE 5 [Denton (2004) 329, Hudson (2004) 887, Jang (2005) 35, Kim (2002) 395, Leong (2003) 295, Woodworth (2005) 77]) while one was identified that was neutral (LOE 5 [Rizzolo (2002) 352]). Three studies ([Hudson (2004) 887, Jang (2005) 35, Leong (2003) 295]) demonstrated that computer-assisted learning was a viable means for course preparation and learners performed as well or better than other learners using other methods of preparation. However, Kim [Kim (2002) 395] found that traditional textbook preparation was more effective than computer assisted learning in preparing for a program based on ACLS-like material. Importantly, Kim stated that textbook studying may be more effective for courses of short duration. Denton [Denton (2004) 329] and Woodworth [Woodworth (2005) 77] examined pretests as a means of improving learner outcome. Denton cited the use of a pretest as a means of identifying learners at risk of poor performance. Woodworth cited pretests as a means of attention-getting prior to presentation of course content. Rizzolo [Rizzolo (2002) 352] compared learners' usage patterns of Internet-based preparatory material against learner outcomes. Interestingly, he found 10 learners who used the resource the most, scored below the mean.

Many studies have been published in the broader medical literature on alternative course delivery methods when compared to more traditional (usually lecture) course formats. Sixteen LOE 5 [Buzzell (2002) 21, Clark (2000) 109, Engum (2003) 67, Flynn (1996) 19, Fordis (2005) 1043, Goldrick (1990) 20, Harrington (2002) 39, Jeffries (2001) 323, Jeffries (2003) 70, Kinney (1997) 57, Miller (1985) 173, O'Leary (2005) 1848, Rosser (2000) 320, Ryan (2007) e251, Schlomer (1997) 249, Welch (1970) 605] studies supported the question that alternative course delivery methods could reduce instructor to student face-to-face time without decreasing learner outcomes, and at times improving learner outcomes compared to traditional courses. One LOE 5 study [Maki (2000) 230] showed a traditionally delivered course format was better than a computer-based alternative delivery method, thus opposing the question.

Of these studies, 13 compared electronically delivered (CD or internet-based) course formats against traditional lecture course formats [Buzzell (2002) 21, Clark (2000) 109, Engum (2003) 67, Fordis (2005) 1043, Harrington (2002) 39, Jeffries (2001) 323, Jeffries (2003) 70, Kinney (1997) 57, Maki (2000) 230, Miller (1985) 173, Rosser (2000) 320, Ryan (2007) e251, Wiecha (2006) 647]. All supported the use of an electronically delivered course over the traditional format. Three studies [Flynn (1996) 19, Goldrick (1990) 20, Schlomer (1997) 249] compared the use of written self-instructional packets or linear video and found these methods produced equal or better results than traditional lecture. However, it should be noted the topic selections for these studies was fairly narrow when compared to Emergency Cardiovascular Care. One study [O'Leary (2005) 1848] used a gaming format compared to traditional lecture and found learner outcomes equivalent with lecture format.

As there were an adequate number of publications in the medical literature regarding alternative course delivery formats, a search of the broader education literature was suspended. The education literature was searched for studies on the use of preparatory strategies as only 11 publications were found in the medical literature on this component of the question. In the broader education literature, there were numerous returns on the search. These results were pared down to five key articles [Hartley (1976) 239, Hoogstraten (1979) 25, Hoogstraten

(1980) 39, Welch (1970) 605, Wilson (1982) 249 that included metanalysis and in depth review. It should be noted that much of this literature dates to the 1960s and 1970s and there has been very little substantial publication in this area in the past two decades.

Of note in this group is Hartley Hartley (1976) 239. He examined the use of four preparatory strategies – pretest, behavioral objectives, overviews, and advance organizers. His conclusions stated that each strategy could positively impact on learner outcomes; however, there were limitations to their effectiveness based on the length and complexity of the instructional program and on the learners' level of sophistication.

Specific findings by Hartley included:
Pretests –
- Use as a measure to define what student already knows so instructional time is not wasted in teaching previously acquired knowledge.
- Provides a sensitizing effect in preparing the learner what to watch for in the course. Alternatively, there may be a detrimental effect in the pretest in that material presented n the course but not referenced on the pretest may be discounted by the learner as unimportant.
- Produce a generally positive effect on learner outcomes.

Behavioral Objectives –
- Generate expectations on the part of the learner against which the learner can benchmark themselves as progress is made.
- Allows learners to study more effectively and not waste time on irrelevant information. Conversely, course information not included in the objectives may be ignored by the learner, even when that information may be considered important by the instructor.
- There was very little difference between general learning objectives (Tyler style) and specific learning objectives (Mager style) on learner outcomes.
- Training learners in the use of learning objectives does not impact learner outcomes. However, training instructors in the use of learning objectives does impact learner outcomes.
- Produce a generally positive effect on learner outcomes.

Overviews –
- Allow emphasis of key material in a condensed format
- Overviews need not be all at once; for processes that require steps, overviews prior to each step may be more effective.
- Overviews work better with facts as opposed to principles.
- Overviews include textual layout of course content in call-out boxes and highlighted headings, making typography layout of textual materials a contributor to learner outcomes.
- Produce a generally positive effect on learner outcomes.

Advance Organizers –
- Provide a conceptual framework that learners use to clarify upcoming tasks.
- Process-oriented rather than content-oriented (as with pretest, objectives, and overviews), supplying a broad framework.
- Often deployed as visual frameworks
- Helps learner fit new information into an existing cognitive structure.
- Majority of studies have shown positive impact on learning and retention.
- Are best used with above average learners

Hoogstraten Hoogstraten (1979) 25, Hoogstraten (1980) 39 demonstrated another effect of pretests. These studies showed pretest wording could have an impact on the learners' affect towards course material.

Welch Welch (1970) 605 and Wilson Wilson (1982) 249 both conducted extensive literature reviews on pretest effect and concluded that, while often weak, generally the inclusion of a pretest in experimental designs increases posttests scores.

Based on this review, the following conclusions can be made:

- Several forms of precourse preparation have the potential to positively impact learner outcomes in advanced level Emergency Cardiovascular Care courses, including electronically available materials (CD or Internet-based) and written materials (self-instructional materials).

- Alternative course delivery formats – most notably electronic course formats such as CD or Internet-based – are viable alternatives to traditional course formats that are more lecture based and may reduce instructor to student face-to-face time. However, it should be noted there are no studies available comparing the current versions of ACLS and PALS (post 2006 course release) with alternative delivery methods. The current versions of the course do not depend heavily on lecture presentation of course content, but are presented in a case-based format.

- Pretests in advanced Emergency Cardiovascular Care courses should provide a positive contribution to learner outcomes as a means of attention getting, identification of at-risk learners, self-evaluation of current knowledge deficits, and as an organizer for learners in identifying key material during the course. Additionally, care must be taken on pretest design to ensure that the pretest accurately reflects key course content as material not addressed in the pretest may be deemed unimportant by the learner. Pretest design may also impact learner affect and care must be taken in question design to state questions in a positive manner.

- Other preparatory strategies including the appropriate use of behavioral objectives, overviews, and graphic advance organizers have potential to impact learner outcomes, but more study is needed to evaluate their role in advanced Emergency Cardiovascular care programs.

Acknowledgements:
None

Citation List

Buzzell (2002) 21	Buzzell, P. R., V. M. Chamberlain, et al. (2002). "The effectiveness of web-based, multimedia tutorials for teaching methods of human body composition analysis." Adv Physiol Educ **26**(1-4): 21-9. LOE 5 (Extrapolated to ECC programs), Good, Supports End Point: E5 - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
Christenson (1998) 702	Christenson, J., K. Parrish, et al. (1998). "A comparison of multimedia and standard advanced cardiac life support learning." Acad Emerg Med **5**(7): 702-8. LOE 5, Good, Supports End Point: E3 - Study reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities
Clark (2000) 109	Clark, L. J., J. Watson, et al. (2000). "CPR '98: a practical multimedia computer-based guide to cardiopulmonary resuscitation for medical students." Resuscitation **44**(2): 109-117. LOE 5 (Extrapolated to ECC programs), Fair, Supports End Point: E5 - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
Darr (2000) 116	Darr, L. R. (2000). "Advanced cardiac life support education: a self-directed, scenario-based approach." J Contin Educ Nurs **31**(3): 116-20; quiz 142-3. LOE 4, Poor (small sample size, evaluated student attitudes instead of learning outcomes) Good, Supports End Point: A - Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes and impacting on instructor/student face-to-face time
Denton (2004) 329	Denton, G. D., S. J. Durning, et al. (2004). "Is a faculty developed pretest equivalent to pre-third year GPA or USMLE step 1 as a predictor of third-year internal medicine clerkship outcomes?" Teach Learn Med **16**(4): 329-32.

	LOE 5, Poor, Supports End Point; E4 - Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
Eliot (1996) 7	Eliot, C. R., K. A. Williams, et al. (1996). "An intelligent learning environment for advanced cardiac life support." Proc AMIA Annu Fall Symp: 7-11. LOE 4, Poor (detailed descriptions of data not available, proceedings publication), Supports End Point: B - Studies reporting impact of precourse activities on Advanced Life Support courses (ACLS, PALS, or ERC equivalent) on learner outcomes with no report on impact on instructor/student face-to-face time
Engum (2003) 67	Engum, S. A., P. Jeffries, et al. (2003). "Intravenous catheter training system: computer-based education versus traditional learning methods." Am J Surg **186**(1): 67-74. LOE 5 (Extrapolated to ECC programs), Good, Supports End Point: E5 - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
Flynn (1996) 19	Flynn, E. R., Z. R. Wolf, et al. (1996). "Effect of three teaching methods on a nursing staff's knowledge of medication error risk reduction strategies." J Nurs Staff Dev **12**(1): 19-26. LOE 5 (Extrapolated to ECC programs), Fair, Supports End Point: E5 - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
Fordis (2005) 1043	Fordis, M., J. E. King, et al. (2005). "Comparison of the instructional efficacy of Internet-based CME with live interactive CME workshops: a randomized controlled trial." JAMA **294**(9): 1043-51. LOE 5 (Extrapolated to ECC programs), Good, Supports End Point: E5 - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
Gerard (2006) 649	Gerard, J. M., A. J. Scalzo, et al. (2006). "Evaluation of a novel Web-based pediatric advanced life support course." Arch Pediatr Adolesc Med **160**(6): 649-55. LOE 2, Good, Supports End Point: E3 - Studies reporting impact of alternative course delivery mechanisms in Advanced Life Support courses (ACLS, PALS, or ERC equivalent) that impacted instructor/student face-to-face time but did not reference precourse activities
Goldrick (1990) 20	Goldrick, B., S. Appling-Stevens, et al. (1990). "Infection control programmed instruction: an alternative to classroom instruction in baccalaureate nursing education." J Nurs Educ **29**(1): 20-5. LOE 5 (Extrapolated to ECC programs), Good, Supports End Point: E - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time

Harrington (2002) 39	Harrington, S. S. and B. L. Walker (2002). "A comparison of computer-based and instructor-led training for long-term care staff." J Contin Educ Nurs **33**(1): 39-45. LOE 5 (Extrapolated to ECC programs), Good, Supports End Point: E5 - Studies in the broader medical literature on the impact of alternative course delivery mechanisms that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent) by reducing instructor/student face-to-face time
Hartley (1976) 239	Hartley, J. and I. Davies (1976). "Preinstructional strategies: The role of pretests, behavioral objectives, overviews, and advance organizers." Issues in Educational Research **46**(2): 239-265. No Abstract – In depth review article assessing the literature on the impact of pretests, behavioral objectives, overviews, and advance organizers on learning outcomes. Reported the following conclusions: 1. A pretest might best be used in those situations in which students need to be alerted to what it is they do not know. Furthermore, the period of instruction should be relatively short in duration and posses a rather loose structure. Students should probably have a reasonable acquaintance with the topic prior to its formal presentation, and they might typically be of above average in intelligence. If the effectiveness of the instruction is to be assessed, pretest may also be useful (although, of course, one has to be aware of their instructional implications. 2. Behavioral objectives, on the other hand, might best be used in situations in which students should be precisely informed of what it is they are to accomplish. They appear to be most suitable when they are used to preface quite long periods of instruction, which also might typically possess a dominant overall structure. Students should probably be within the middle-ability range, and quite possibly of an independent frame of mind. 3. Overviews might best be reserved for those learning situations in which students need to be prepared for the learning task ahead. The task might typically possess little or no structure, yet students would benefit from being made familiar with the central arguments to be expounded. Overviews might also be best used when factual information is going to be presented to lower-ability students, or when concepts are principles are going to be presented to students of higher ability. 4. Advance organizers would seem to be best reserved for situations requiring some sort of conceptual framework that students can subsequently use to help clarify the task ahead. The subject material should possess a dominant structure that can be readily integrated with the existing knowledge already possessed by the students. Learning tasks should be relatively short in duration. Finally, it is probably best if the students involved – whether adult or children – are of above average ability, maturity, and sophistication. (p. 259-260) LOE 5 (Extrapolated to ECC programs), Good, Supports End Point: E6 - Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
Hoogstraten (1979)	Hoogstraten, J. (1979). "Pretesting as Determinant of Attitude Change in Evaluation Research." Applied Psychological Measurement **3**(1): 25-30. LOE5 (Extrapolated to ECC programs), Good, Supports End Point: E6 - Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
Hoogstraten (1980) 39	Hoogstraten, J. (1980). "The Reactive Effect of Pretesting in Attitude Change Research: General or Specific?" Applied Psychological Measurement **4**(1): 39-42. LOE5 (Extrapolated to ECC programs), Good, Supports End Point: E6 - Studies in the broader education literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)

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Jang (2005) 35	Jang, K. S., S. Y. Hwang, et al. (2005). "Effects of a Web-based teaching method on undergraduate nursing students' learning of electrocardiography." J Nurs Educ **44**(1): 35-9. LOE 5, Fair, Supports End Point; E4 - Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
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Leong (2003) 295	Leong, S. L., C. D. Baldwin, et al. (2003). "Integrating Web-based computer cases into a required clerkship: development and evaluation." Acad Med **78**(3): 295-301. LOE 5, Good, Supports End Point; E4 - Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)

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	orientation? Wake 'em up with a test!" Med Ref Serv Q **24**(1): 77-91. LOE 5, Poor, Supports End Point; E4 - Studies in the broader medical literature on the impact of precourse activities that could be extrapolated to Advanced Life Support courses (ACLS, PALS, or ERC equivalent)
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