Chapter 7

EIT; Education, Implementation, and Teams

■EIT Task Force Chairmen

Taku Iwami, Tomoo Kanna

■EIT Task Force Members

Kazutoshi Ikeshita, Tomoyuki Endo, Keiichi Kato, Masanao Kobayashi, Hideharu Tanaka, Hiroyuki Nakao, Chika Nishiyama, Takahiro Matsumoto, Takashi Moriya, Akihiro Yamaoka, Yoshihiro Yamahata

■Editorial Board

Kunio Ohta, Tetsuya Sakamoto, Naoki Shimizu, Hiroshi Nonogi, Tetsuo Hatanaka

■Co-Chairmen

Kazuo Okada, Seishiro Marukawa

■1 INTRODUCTION

Application of resuscitation science to improve patient care and outcomes requires effective strategies for education and implementation. Systematic reviews suggest there are significant opportunities to improve education, enhance individual and team performance, and avoid delays in implementation of guidelines into practice. It is within this context that the ILCOR Education, Implementation, and Teams (EIT) Task Force was established and addressed thirty-two worksheet topics. Reviewers selected topics from the 2005 Consensus on Science and Treatment Recommendations (CoSTR) Statement and new topics identified by an expert group.

One challenge for the EIT Task Force was extrapolating outcomes from simulation studies to actual patient outcomes. During the evidence evaluation, if the PICO (**P**opulation, **I**ntervention, **C**omparator, **O**utcome) question outcomes were limited to training outcomes such as improved performance on a manikin or simulator, studies were classified to a level of evidence (LOE) according to study design (eg, a randomized controlled trial on a manikin would be LOE 1). Manikin or simulator studies were assigned to a LOE 5 irrespective of the study design if the PICO question also included patient outcomes.

The following is a summary of key 2010 recommendations or changes related to EIT:

- Efforts to implement new resuscitation guidelines are likely to be more successful if a carefully planned, multifaceted implementation strategy is used. Education, while essential, is *only one* element of a comprehensive implementation strategy.
- All courses should be evaluated to ensure that they reliably achieve the program objectives. Training should aim to ensure that learners acquire and retain the skills and knowledge that will enable them to act correctly in actual cardiac arrests.
- Basic and advanced life support knowledge and skills can deteriorate in as little as three to six months. Frequent assessments and, when needed, refresher training is recommended to maintain knowledge and skills.
- Short video/computer self-instruction courses, with minimal or no instructor coaching, combined with hands-on practice can be considered as an effective alternative to instructor-led basic life support (cardiopulmonary resuscitation [CPR] and automated external defibrillator [AED]) courses.
- Laypeople and healthcare providers (HCPs) should be trained to start CPR with chest compressions for adult victims of cardiac arrest. If they are trained to do so, they should perform ventilations. Performing chest compressions alone is reasonable for trained individuals if they are incapable of delivering airway and breathing maneuvers to cardiac arrest victims.
- In order to increase bystander CPR, chest compression-only CPR training might be effective when it is difficult to attend conventional CPR training courses for lay people because of age or limited time.
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- AED use should not be restricted to trained personnel. Allowing use of AEDs by individuals without prior formal training can be beneficial and may be life saving. Since even brief training improves performance, (eg, speed of use, correct pad placement) it is recommended that training in the use of AEDs be provided.
- CPR prompt or feedback devices improve CPR skill acquisition and retention and may be considered during CPR training for laypeople and healthcare professionals. These

devices may be considered for clinical use as part of an overall strategy to improve the quality of CPR.

- It is reasonable to wear personal protective equipment (PPE) (eg, gloves) when performing CPR. CPR should not be delayed or withheld if PPE is not available unless there is a clear risk to the rescuer.
- Manual chest compressions should not continue during the delivery of a shock because safety has not been established.
- Several important knowledge gaps were identified during the evidence review process:

    - The optimal duration and type of initial training to acquire resuscitation knowledge and skills.
    - The optimal frequency and type of refresher training required to maintain resuscitation knowledge and skills.
    - The optimal use of assessment as a tool to promote the learning of resuscitation knowledge and skills.
    - The impact of experience in actual resuscitation attempts on skill decay and the need for refresher training.
    - The impact of specific training interventions on patient outcomes.
    - A standardized nomenclature and definitions for different types of simulation training and terms such as “high fidelity simulation,” “feedback,” “briefing” and “debriefing”.
    - The most effective and efficient methods of disseminating information about new resuscitation interventions or guidelines to reduce time to implementation.
    - For cardiac resuscitation centers, the optimal emergency medical system (EMS) characteristics, safe patient transport interval, optimal mode of transport, and role of secondary transport.

The EIT Task Force organized its work into five major sections:

- Education - including who should be trained and how to prepare for training, the use of specific instructional strategies and techniques, retraining intervals, retention of knowledge and skills, and assessment methods
- Risks and Effects on the Rescuer of CPR Training and Actual CPR Performance
- Rescuer Willingness to Respond

- Implementation and Teams - including a framework for implementation efforts as well as individual and team factors associated with success
- Ethics and Outcomes

■2 EDUCATION

Effective and efficient resuscitation education is one of the essential elements in the translation of guidelines into clinical practice. Educational interventions need to be population specific (eg, lay rescuers, HCPs) and evaluated to ensure that they achieve the desired educational outcomes – not just at the end of the course but also during actual resuscitation events. Retention of knowledge and skills should be confirmed through assessment and not assumed to persist for pre-established time intervals (eg, two years).

1. Populations

Who should be trained and how should they prepare for training?

1) Focused Training

In lay providers requiring basic life support training, does focusing training on high risk populations compared with no such targeting increase outcomes (eg, bystander CPR, survival)? In three studies (LOE 1[Dracup, 1994, 116] and LOE 2[Kliegel, 2000, 147] [Cheng, 1997, 273]), people reported that they would be more willing to perform bystander CPR on family members than on non-relatives. One LOE 2[Swor, 2006, 596] study of people who called 911 found that unless family members had received CPR training, they were less likely to perform CPR than unrelated bystanders. Computer modelling (LOE 5[Swor, 2005, 7]) suggested that very large numbers of older adults would need to be trained to achieve a sufficient increase in private residence bystander CPR rates to improve survival. Twelve studies (LOE 1[Dracup, 1994, 116] [Dracup, 1986, 1757] [Dracup, 2000, 3289] [Ingram, 2006, 89] [Moser, 1999, 326] [Moser, 2000, 270], LOE 2[Kliegel, 2000, 147], [Sigsbee, 1990, 662], LOE 4[McDaniel, 1988, 2029][Messmer, 1993, 217], LOE 5[Groeneveld, 2005, 58] [Swor, 2004, 420]) reported that training of patients and family members in CPR provides psychological benefit. Two LOE 1[Dracup, 1986, 1757] [Dracup, 1997, 1434] studies reported negative psychological effects on patients can be avoided by providing social support.

There is insufficient evidence to support or refute the use of training interventions that focus on high-risk populations. Training with social support reduces family member and patient anxiety, improves emotional adjustment and increases feelings of empowerment(Class IIa).

2. Methods to improve educational effects

There are several approaches to increasing the effectiveness of CPR education. Training in AED use is described in the section on "Training how to use an AED".

1) New teaching method for BLS

Twelve studies (LOE 1[Lynch, 2005, 31] [Todd, 1998, 364] [Einspruch, 2007, 476] [Todd, 1999, 730] [Reder, 2006, 443] [Roppolo, 2007, 276] and LOE 2 or 3[Batcheller, 2000, 101] [Braslow, 1997, 207] [Isbye, 2006, 435] [Moule, 2008, 427] [Liberman, 2000, 249] [Jones, 2007, 350]) demonstrated that basic life support skills can be acquired and retained at least as well and, in some cases, better using video-based self- instruction compared with traditional instructor-led courses. Video-based self-instruction lasted from eight to thirty-four minutes, whereas instructor-led courses were usually four to six hours in duration. One LOE 1[Brannon, 2009, 133] study demonstrated that prior viewing of a video on infant CPR before an instructor-led course improved skill acquisition.
One Japanese RCT study (J-LOE [Nishiyama, 2009, 1164]) suggested that effective chest compressions skill can be mastered through a 60-minute compression-only CPR course with pre-video learning.
When compared with traditional instructor-led CPR courses, various self-instructional and shortened programs have been demonstrated to be efficient (from the perspective of time) and effective (from the perspective of skill acquisition) in teaching CPR skills to various populations.
Short video/computer self-instruction with minimal or no instructor coaching) that includes synchronous hands-on practice in basic life support can be considered as an effective alternative to instructor-led courses(Class IIb).

2) Precourse Preparation for ALS
For advanced life support providers undergoing advanced life support courses, does the inclusion of specific pre-course preparation (eg, e-learning and pre-testing) as opposed to no

such preparation, improve outcomes (eg, same skill assessment, but with less face-to-face (instructor) hands on training)?
Eight studies (LOE 1[Schwid, 1999, 821], LOE 4[Polglase, 1989, 997], LOE 5[Clark, 2000, 109][Hudson, 2004, 887][Jang, 2005, 35][Kim, 2002, 395][Leong, 2003, 295][Rosser, 2000, 320]) reported that a diverse range of pre-course preparatory actions (eg, computer-assisted learning, pretests, video based learning, textbook reading) improved learner outcomes in advanced life support courses. One large LOE 1[Perkins, 2010, 877]) randomized controlled study[26] of use of a commercially available e-learning simulation program prior to attending an advanced life support course compared with standard preparation with a course manual did not improve either cognitive or psychomotor skills performance during cardiac arrest simulation testing.
Eighteen studies (LOE 2[Gerard, 2006, 649], LOE 4[Polglase, 1989, 997][Xie, 1999, 117], LOE 5[Clark, 2000, 109] [Rosser, 2000, 320] [Buzzell, 2002, 21] [Christenson, 1998, 702] [Engum, 2003, 67] [Flynn, 1996, 19] [Fordis, 2005, 1043] [Goldrick, 1990, 20] [Harrington, 2002, 39] [Jeffries, 2001, 323] [Jeffries, 2003, 70] [Miller, 1985, 173] [O'Leary, 2005, 1848] [Ryan, 2007, e251] [Schlomer, 1997, 249]) showed that alternative course delivery formats such as electronically delivered (CD or internet-based) courses produced as good or better learner outcomes compared with traditional courses, and also reduced instructor to learner face-to-face time.

Pre-course preparation including, but not limited to, use of computer-assisted learning tutorials, written self-instruction materials, video based learning, textbook reading, and pretests are recommended as part of advanced life support courses. Any method of pre-course preparation that is aimed at improving knowledge and skills or reducing instructor to learner face-to-face time should be formally assessed to ensure equivalent or improved learning outcomes compared with standard instructor-led courses.
Pre-course preparation including pretests and self learning using computer software, videos and traditional materials, are recommended as part of the ALS courses (Class Ⅰ).

Instructional Methods

There are multiple methods to deliver course content. This section examines specific instructional methods and strategies that may have an impact on course outcomes.
Alternative Instructor Methods

For lay and HCPs, does the use of specific instructional methods (video/computer self-instruction), when compared with traditional instructor-led courses improve skill acquisition and retention?

3) Advanced Life Support Leadership/Team Training

For advanced life support providers undergoing advanced life support courses, does the inclusion of specific leadership/team training, as opposed to no such specific training, improve outcomes (eg, performance during cardiac arrests)?

Four studies (LOE 1[Thomas, 2007, 409] [Cooper, 2001, 33]、LOE 2[Gilfoyle, 2007, e276] [DeVita, 2005, 326]) of advanced life support in simulated in-hospital cardiac arrest and seven LOE 5[Cooper, 1999, 27] [Edelson, 2008, 1063] [Hayes, 2007, 1668] [Hunziker, 2009, 3] [Makinen, 2007, 264] [Marsch, 2004, 51] [Morey, 2002, 1553] studies of actual and simulated arrests demonstrated improved resuscitation team performance when specific team and/or leadership training was added to advanced life support courses. Specific teamwork training, including leadership skills, should be included in advanced life support courses(Class I).

4) Teaching Chest Compressions to Achieve Recoil

In order to maximize the effect of chest compressions, it is important to achieve full chest recoil (complete release) after each chest compression while performing deep and fast chest compressions.

In patients receiving chest compressions is there a method to teach chest compressions compared with current teaching to achieve full chest recoil (complete release) after each chest compression?

One LOE 5 clinical case series [Aufderheide, 2005, 353] documented a 46% incidence of incomplete chest recoil by professional rescuers using the 2005 recommended CPR technique. One LOE 4 study [Niles, 2009, 553] electronically recorded chest recoil during in-hospital pediatric cardiac arrests, and found that leaning on the chest (>2.5 kg; an adult feedback threshold) occurred in 50% of chest compression/decompressions using the recommended hand position and that incomplete recoil was reduced with real-time automated feedback. Another LOE 4 in-hospital pediatric study[Sutton, 2009, 494] demonstrated a 23.4% incidence of incomplete recoil. One LOE 5 study has shown that without specific training in complete chest recoil technique, 22% of trained rescuers leaned on the chest when performing CPR. Two LOE 5 studies [Aufderheide, 2005, 353]

[Aufderheide, 2006, 341] demonstrated incomplete chest recoil is significantly reduced with three techniques (ie, ‘two-finger fulcrum’, ‘five-finger fulcrum’ and ‘hands-off’) of lifting the heel of the hand slightly, but completely off the chest during CPR in a manikin model. However, duty cycle（percent of time in compression during each cycle） and compression depth were reduced when professional and lay rescuers applied these techniques.
There is insufficient evidence to recommend teaching a specific technique to optimize complete chest recoil during actual CPR. CPR instructors should recognize the difficulty of teaching adequate depth and rates of chest compressions and the full release of pressure (Class Ⅱa).

5) Use of CPR Prompt/Feedback Devices
Real-time CPR prompting and feedback devices have been developed recently.
For lay rescuers and HCPs performing CPR, does the use of CPR prompt/feedback devices when compared to no device improve CPR skill acquisition, retention, and actual performance?
Most devices considered in this review combine prompting (signal to perform an action eg, metronome for compression rate) with feedback (ie, after event information based on effect of an action, such as visual display of compression depth). The effects have been considered together in this question and devices are referred to as prompt/feedback devices.
Seven LOE 5 manikin studies[Beckers, 2007, 100] [Isbye, 2008, 73] [Monsieurs, 2005, 45] [Spooner, 2007, 417] [Sutton, 2007, 161] [Wik, 2002, 273] [Wik, 2001, 167] demonstrated that CPR prompt/feedback devices either in addition to or in place of instructor-led training improved basic CPR skill acquisition (tested without use of the device). Another LOE 5 manikin study [Isbye, 2008, 73] showed that automated feedback might be less effective than instructor feedback for more complex skills (eg, bag-mask ventilation).
Two LOE 5 manikin studies [Beckers, 2007, 100] [Spooner, 2007, 417] showed improved skill retention when a CPR prompt/feedback
device was used during initial training. A further LOE 5 manikin study [Wik, 2002, 273] showed that unsupervised refresher training with a CPR prompt/feedback device compared to no refresher training also improved skill retention. The LOE 5 follow-up arm of the manikin study of bag-mask ventilation/CPR [Isbye, 2008, 73]continued to show poorer ventilation skills in the voice activated manikin feedback arm compared to the instructor arm.

Evidence from 14 manikin studies (LOE 5[Beckers, 2007, 100] [Monsieurs, 2005, 45] [Wik, 2002, 273] [Wik, 2001, 167] [Boyle, 2002, 63] [Dine, 2008, 2817] [Elding, 1998, 169] [Handley, 2003, 57] [Noordergraaf, 2006, 241] [Perkins, 2005, 103] [Thomas, 1995, 155] [Williamson, 2005, 140] [Kern, 2010, 206] [Peberdy, 2009, 1169]) consistently demonstrated that CPR prompt/feedback devices used during CPR improved the quality of CPR performance on manikins. Three additional manikin studies (LOE 5[Jantti, 2009, 453] [Oh, 2008, 273] [Rawlins, 2009, b4707]) examined the utility of video/animations on mobile phone devices: two studies showed improved checklist scores and quality of CPR[Choa, 2008, 87] [Ertl, 2007, 286] and faster initiation of CPR[Choa, 2008, 87] while the third study showed that participants using multi-media phone CPR instruction took longer to complete tasks than dispatcher-assisted CPR[Zanner, 2007, 487]. Two manikin studies (LOE 5[Bolle, 2009, 116] [Yang, 2009, 490]) that used two-way video communication to enable the dispatcher to review and comment on CPR in real time produced equivocal findings.
There are no studies demonstrating improved patient outcomes with CPR prompt/feedback devices. One study each in children (LOE2 [Berg, 1994, 35]) and adults (LOE 2[Kern, 1992, 145]) showed that metronomes improved chest compression rate and increased end-tidal carbon dioxide. Five studies evaluating the introduction of CPR prompt/feedback devices in clinical practice (pre/post comparisons) found improved CPR performance (LOE 3 [Niles, 2009, 553] [Abella, 2007, 54] [Chiang, 2005, 297] [Fletcher, 2008, 127] [Kramer-Johansen, 2006, 283]).
There may be some limitations to the use of CPR prompt/feedback devices. Two LOE 5 manikin studies [Nishisaki, 2009, 540] [Perkins, 2009, 79]report that chest compression devices may overestimate compression depth if CPR is being performed on a compressible surface such as a mattress on a bed. One LOE 5 study[Perkins, 2005, 103] reported harm to a single participant when a hand got stuck in moving parts of the CPR feedback device. A further LOE 5 manikin study[van Berkom, 2008, 66] demonstrated that additional mechanical work is required from the CPR provider to compress the spring in one of the pressure sensing feedback devices. One case report (LOE 5[Cho, 2009, 600]) documented soft tissue injury to a patient’s chest when an accelerometer device was used for prolonged CPR.
CPR prompt/feedback devices may be considered during CPR training for laypeople and HCPs（ClassⅡb）.
CPR prompt /feedback devices may be considered for clinical use as part of an overall strategy to improve the quality of CPR（ClassⅡb）. Instructors and rescuers should be made

aware that a compressible support surface (eg, mattress) may cause a feedback device to overestimate depth of compression （Class I ）.

6）Training Interventions of ALS/PALS

For adult and pediatric advanced life support (PALS) providers, are there any specific training interventions (eg, duration of session, interactive computer programs, e-learning, video self- instruction) compared with traditional lecture/practice sessions that increase outcomes (eg, skill acquisition and retention)?

There is limited evidence about interventions that enhance learning and retention from advanced life support courses. One LOE 3 study [Perkins, 2008, 69] suggested that the 2005 Guidelines have helped improve "no-flow" fraction (ie, percent of total resuscitation time that compressions are not performed) but not other elements of quality of CPR performance. One LOE 1 study [Jensen, 2009, 238] demonstrated that clinical training prior to an advanced life support (ALS) course might improve long-term retention of ALS knowledge and skills. One LOE 5 advanced trauma life support study [Ali, 2002, 142] suggested that post-course experience might play a role in knowledge and skills retention. In one LOE 3 study [Farah, 2007, 332]）, unscheduled mock-codes improved mock-code performance in hospital personnel. One LOE 2 study [Miotto, 2008, 244] found no difference in knowledge retention when live actors were used in ALS course training compared to manikins.

There is insufficient evidence to recommend any specific training intervention, compared with traditional lecture/practice sessions, to improve learning, retention, and use of ALS advanced life support skills.

7) Realistic training techniques

For participants undergoing basic or advanced life support courses, does the inclusion of more realistic techniques (eg, high-fidelity manikins, in-situ training), as opposed to standard training (eg, low fidelity, education centre), improve outcomes (eg, skills performance on manikins, skills performance in real arrests, willingness to perform)?

Studies report conflicting data on the effect of increasing realism (eg, use of actual resuscitation settings, high fidelity manikins) on learning, and few data on patient outcomes. Two studies (LOE 1 [Mayo, 2004, 2422], LOE 2 [Wayne, 2008, 56]) supported an improvement in performance of skills in actual arrests, but were underpowered to identify improved survival rates. One small LOE 1 study [Knudson, 2008, 255] showed no overall effect on performance, although the simulation-trained group demonstrated superior teamwork skills. Thirteen studies (LOE 1 [Mayo, 2004, 2422] [Campbell, 2009, 19] [Donoghue, 2009, 139] [Owen, 2006, 204] [Perkins, 2006, 432] [Wayne, 2005, 210], LOE 2[Ali, 1998, 588] [Hunt, 2009, 819] [Rodgers, 2009, 200], LOE 3[Barsuk, 2005, 803] [Kory, 2007, 1927], and LOE 4 [Marshall, 2001, 17] [Wayne, 2006, S9]) reported an improvement in skills assessed using a manikin. Seven LOE 1 studies [Cherry, 2007, 229] [Curran, 2004, 157] [Friedman, 2008, 1663] [Hoadley, 2009, 91] [Iglesias-Vazquez, 2007, 18] [Schwartz, 2007, 130] [Wang, 2008, 1651] reported no effect on skills assessed using a manikin. Eleven LOE 1 studies tested the effect of simulation fidelity on the participant's knowledge using multiple-choice questions. Nine [Miotto, 2008, 244] [Knudson, 2008, 255] [Campbell, 2009, 19] [Owen, 2006, 204] [Cherry, 2007, 229] [Curran, 2004, 157] [Hoadley, 2009, 91] [Iglesias-Vazquez, 2007, 18] [Cavaleiro, 2009, 636] of these studies found no effect. Two [Ali, 2009, 98] [Mueller, 2005, 300] of the eleven studies demonstrated an improvement in participant knowledge with the more realistic techniques.

Two studies (LOE 3 [Barsuk, 2005, 803], LOE 4 [Marshall, 2001, 17]) that focused on resuscitation in trauma reported improved

skills performance (on a manikin) with higher-fidelity simulation. One LOE 1 study [Cherry, 2007, 229] found no difference in skill performance or knowledge in advanced trauma life support with the use of high-fidelity simulation. One LOE 1 study [Ali, 2009, 98] reported a significant increase in knowledge when using manikins or live patient models for trauma teaching compared with no manikins or live models. In this study there was no difference in knowledge acquisition between using manikins or live patient models, although learners preferred using the manikins.

Four studies (LOE 1 [Campbell, 2009, 19] [Cherry, 2007, 229] [Curran, 2004, 157], LOE 2 [Ali, 2009, 98]) reported higher fidelity simulation was associated with improved learner satisfaction rates when compared with a traditional curriculum. One LOE 1 study [Iglesias-Vazquez, 2007, 18] questioned the cost effectiveness of higher fidelity approaches compared with standard manikins.

Three studies (LOE 1 [Mayo, 2004, 2422], LOE 2 [Hunt, 2009, 819], LOE 3 [Kory, 2007, 1927]) reported that requiring learners to perform all of the steps of psychomotor skills in simulation as they would in a real clinical situation could reveal inadequacies in training.

There is insufficient evidence to support or refute the use of more realistic techniques (eg, high- fidelity manikins, in-situ training) to improve outcomes (eg, skills performance on manikins, skills performance in real arrests, willingness to perform) when compared with standard training (eg, low fidelity, education centre) in basic and advanced life support courses.

3. Course Format and Duration

Resuscitation training courses vary widely in their duration and how different elements of the curriculum are taught. This section examines the effect of course format and duration on learning outcomes.

1) BLS Course Duration

For basic life support providers (lay or HCP), does a longer-duration instructor-led course compared with a shorter course improve skill acquisition and retention?

A single, randomized manikin LOE 1[Andresen, 2008, 419] study demonstrated that a seven-hour basic life support (with AED) instructor-led course resulted in better initial skill acquisition than a four-hour instructor-led course; and a four-hour instructor-led course resulted in better skill acquisition than a two-hour course. Re-testing at six months after a two-hour course resulted in skill retention at 12 months that was equivalent to a seven-hour course with no intermediate testing.

This study along with two LOE 2 [Yakel, 1989, 520] [Gombeski, 1982, 849]manikin studies demonstrated that over periods of between four and twelve months, skill retention is higher for longer courses, but deterioration is at similar rates. The differences in learning outcomes for courses of different durations may not be significant, particularly if assessment and refresher training are undertaken.

It is reasonable to consider shortening the duration of traditional instructor-led basic life support courses. Brief re-assessment (eg, at 6 months) should be considered to improve skill and retention. (Class Ⅱa) The optimal duration of an instructor-led basic life support course has not been determined. New course formats should be assessed to ensure that they achieve their objectives. (Class Ⅰ)

2） Non-traditional Scheduling Formats　ALS Course Timetable

In participants undergoing advanced life support courses, does the use of non-traditional scheduling formats such as random scheduling (introducing station cases in a random manner) or modular courses as opposed to traditional scheduling improve outcomes (eg, skills performance)?

There are no published studies addressing the impact of different ALS course scheduling formats compared with the traditional two-day course format that demonstrated improved learning outcomes (knowledge and skill acquisition and/or retention).

There is insufficient evidence to support or refute alternative advanced life support course scheduling formats compared with the traditional two-day provider course format.

4. Retraining Intervals

It is recognized that knowledge and skill retention declines within weeks after initial resuscitation training. Refresher training is invariably required to maintain knowledge and skills; however, the optimal frequency for refresher training is unclear. This section examines the evidence addressing the optimal frequency for refresher training to maintain adequate knowledge and skills.

1) Specific Intervals for Basic Life Support

For basic life support providers (lay and HCP) (P), are there any specific intervals for update/retraining compared with standard practice (ie, 12 or 24 monthly) that increase outcomes (eg, skill acquisition and retention)?

Six studies (LOE 1 [Einspruch, 2007, 476] [Spooner, 2007, 417], LOE 2[Andresen, 2008, 419], and LOE 4[Roppolo, 2007, 276] [Smith, 2008, 59] [Woollard, 2004, 17]) using different training approaches demonstrated that CPR skills (eg, alerting EMS, chest compressions, ventilations) decay rapidly (within three to six months) after initial training. Two studies (LOE 1 [Berden, 1993, 1576]and LOE 4[Woollard, 2006, 237]) reported skill decay within 7 to 12 months after initial training. Four studies (LOE 2[Andresen, 2008, 419],LOE 4[Castle, 2007, 664] [Wik, 2005, 27] [Christenson, 2007, 52]) demonstrated that CPR performance is retained or improved with re-evaluation, refresher, and/or retraining after as little as three months. Three LOE 2[Beckers, 2007, 444] [Andresen, 2008, 419] [Riegel, 2006, 254] studies demonstrated that AED skills are retained longer than CPR skills. One LOE 2[Riegel, 2006, 254] study reported higher levels of retention from a program that achieved initial training to a high (mastery) level. However, deterioration of CPR skills was still reported at three months.

For basic life support providers (lay and HCP) skills assessment and, if required, a skills refresher should be undertaken more often than the current commonly recommended training interval of twelve to twenty-four months. (Class I)

2) Specific Intervals for Advanced Life Support

For adult and pediatric advanced life support providers, do any specific intervals for update/retraining compared with standard practice (ie, 12 or 24 monthly) increase outcomes (eg, skill acquisition and retention)?

One LOE 1[Stross, 1983, 3339] trial and one LOE 3[Nadel, 2000, 1049] study suggested that refresher training may enhance resuscitation knowledge retention but does not maintain motor skills. Two randomized controlled trials showed no benefit of refresher training (LOE 1[Kaczorowski, 1998, 705] [Su, 2000, 779]).

Nine studies (LOE 3[Duran, 2008, 644], LOE 4[Smith, 2008, 59][Anthonypillai, 1992, 180] [Boonmak, 2004, 1311] [Kaye, 1990, 51] [Semeraro, 2006, 101] [Skidmore, 2001, 31] [Trevisanuto, 2005, 944] [Young, 2000, 7] reported decreased resuscitation knowledge and/or skills performance when tested three to six months after initial training. Two LOE 4[Grant, 2007, 433] [O'Steen, 1996, 66] studies reported decreased performance when tested seven to twelve months following training. One LOE 4[Hammond, 2000, 99] study[175] reported decay of practical skill performance when participants were tested 18 months after training.

For advanced life support providers there should be more frequent assessment of skill performance and/or refresher training than is currently recommended in established advanced life support programs. (Class I) There is insufficient evidence to recommend an optimal interval and form of assessment and/or refresher training.

5. Assessment

1) Written Examination

For students of adult and pediatric advanced level courses, does success in the written examination when compared with lack of success predict success in completing the practical skills testing associated with the course or in cardiac arrest management performance in actual or simulated cardiac arrest events?

Four observational studies (LOE P4 [Nadel, 2000, 73] [Napier, 2009, 1034] [White, 1998, 1232] [Rodgers, 2010, 453]) do not support the ability of a written test to predict clinical skill performance in an advanced life support course. Twelve LOE P5 [Bishop, 2001, 234] [Gerrow, 2003, 896] [Jansen, 1995, 247] [Kramer, 2002, 812] [Ram, 1999, 197] [Remmen, 2001, 29] [Schwid, 2002, 1434] [Stillman, 1991, 393] [Verhoeven, 2000, 525] [Van der Vleuten, 1989, 97] [Willoughby, 1979, 453] [van Dalen, 2002, 148] studies supported using written tests as a predictor of non-resuscitation clinical skills with variable levels of correlation ranging from 0.19 to 0.65. Three LOE P5 [Jansen, 1996, 339] [Sivarajan, 1984, 603] [Stillman, 1987, 1981] studies were either neutral or did not support the ability of a written test to predict clinical skills performance.

A written test in an advanced life support course should not be used as a substitute for demonstration of clinical skill performance.

2) Final test and evaluation and feedback during the training course

Testing versus Continuous Assessment

For participants undergoing basic or advanced life support courses, does end-of-course testing as opposed to continuous assessment and feedback improve outcomes (eg. improve learning/performance)?

Assessment versus No Assessment

For lay and HCP (P) does the use of assessment as opposed to no such assessment improve knowledge, skills and learning/retention?

No studies have compared outcomes of continuous versus end-of-course assessments for resuscitation training.

One LOE 1 [Kromann, 2009, 21] manikin study showed that including assessment during advanced life support training, compared with a control group without assessment, moderately improved performance at the two-week post-course scenario assessment. In another LOE 1 [Kromann, 2009, 395] study, performance assessment after six months was better in the 'testing' group compared with the control group, although this failed to achieve statistical significance.

Summative assessment at the end of advanced life support training should be considered as a strategy to improve learning outcomes.（ClassⅡa） There is insufficient evidence to recommend an optimal method of assessment during life support training.

Education Knowledge gaps

- Effect of targeting training to family and friends of those at ‘high risk’ of cardiac arrests.
- Potential for tailoring preparation and training to individual learning styles.
- Optimal assessment tools and strategy to promote learning resuscitation skills.
- Optimal format and duration of self-instruction.
- Impact of resuscitation training on performance in actual cardiac arrests.
- Motivating bystanders to use AEDs.
- Optimal training (alternative, minimal, no training, standardized instructor-led training) for use of AEDs in actual events.
- The governmental, social, political measures that are needed to improve public participation in life support programs.

□ Optimal ways to teach and assess leadership and team skills.

□ Specific techniques to optimize complete chest recoil during CPR without impacting depth, rate and duty cycle of compression.

□ Optimal method to implement feedback devices into practice.

□ Specific advantages of prompt devices versus feedback devices and feedback timing (real time or immediately post event)

□ Optimal method for learning and retention of knowledge/skills.

□ Standardization in simulation nomenclature and research methods.

□ Influence of equipment or manikin fidelity, environmental fidelity, and psychological fidelity on learning outcomes.

□ The optimal length of an instructor-led course

□ Comparison of different course formats eg, a two-day course versus four (half-day a week) modules.

□ The effect of ongoing clinical experience on retention of skills and need for assessment and/or refresher training.

□ The optimal interval and form for assessment.

□ The optimal form for refresher training when the need is identified.

□ The effect of type of measurement/assessment.

□ The effect of complexity on retention.

□ Optimal intervals and strategies for refresher courses for various populations.

□ Levels of knowledge/skill deterioration tolerable (clinically significant) before refresher course is needed.

□ Correlation between knowledge/skill competencies and patient survival.

□ Modalities to increase knowledge/skill retention (clinical exposure, simulation, video learning).

□ Economy and logistics of shorter intervals for update/retraining.

□ The optimal form and timing of assessment to optimize learning, retention, and application of resuscitation skills.

■3 RISKS OF CPR

1. RISKS AND EFFECTS ON THE RESCUER OF CPR TRAINING AND ACTUAL CPR PERFORMANCE

The safety of rescuers is an essential during training and actual CPR performance. Adverse events possibly occurring to providers (lay or HCP) during training or actual use of CPR or defibrillators (manual or AED) are stated in this section. Regarding the risk of disease transmission, refer to the chapter on basic life support.

1) Physical Effects

CPR is very rarely associated with adverse events to the rescuer during training or actual performance. An observational study (LOE 4 [Peberdy, 2006, 59] [Hallstrom, 2004, 637]) reported one muscle strain during a large public access defibrillation trial. One prospective observational study (LOE 4 [Cheung, 2009, 1351]) described 5 musculoskeletal injuries (four back-related) associated with performing chest compressions in 1265 medical emergency team (MET) call participants. Two retrospective surveys of nurses and ambulance officers (LOE 4 [Jones, 2004, 63] [Jones, 2005, 332]) reported a high incidence of back symptoms attributed to performing CPR. Three small simulation studies (LOE 4 [Thierbach, 2005, 185] [Thierbach, 2003, 269] [Walker, 2001, 179]) using a greater number of ventilations per minute than the currently recommended ventilation to compression ratio (30:2) described hyperventilation-related symptoms during rescue breathing. Five single or small case series (LOE 5 [Macauley, 1978, 17] [Memon, 1982, 322] [Shimokawa, 2001, 290] [Sullivan, 2000, 64] [Greenberg, 1983, 194]) described isolated adverse events from training or performing actual CPR (myocardial infarction, pneumothorax, chest pain, shortness of breath, nerve injury, allergy, vertigo). In one case report (LOE 5 [Steinhoff, 2001, 159]) a rescuer suffered a puncture wound to her left hand from a victim's sternotomy wires when performing chest compressions. One simulation study (LOE 5 [Lonergan, 1981, 793]) of 6 physicians (aged 25-40 years) and another study of 10 healthy medical students (LOE 5 [Salzer, 1983, 195]) showed that performing chest compressions increased rescuer oxygen consumption. The authors considered that this increase in oxygen consumption was sufficient to cause myocardial ischemia in individuals with coronary heart disease. A small randomized trial of cardiac rehabilitation patients (LOE 5 [Ingram, 2006, 89]) however reported no adverse physical events during CPR training.

CPR training and actual performance is safe in most circumstances. Learners and rescuers should consider personal and environmental risks before starting CPR (Class I). Individuals undertaking CPR training should be advised of the nature and extent of the physical activity required during the training program. Learners who develop significant symptoms (eg, chest pain, severe shortness of breath) during CPR should be advised to stop (Class I).

Rescuers who develop significant symptoms during actual CPR should consider stopping CPR (Class I).

2) Rescuer Fatigue

A single LOE 4 in-hospital patient study [Sugerman, 2009, 981] of 3 minutes of continuous chest compressions with real-time feedback to the rescuer showed that the mean depth of compression deteriorated between 90 and 180 sec, but compression rate was maintained. Three LOE 5 studies showed that some rescuers were unable to complete 5 minutes (laypeople) [Odegaard, 2006, 335], 5-6 minutes (lay females) [Trowbridge, 2009, 6], or 18 minutes (healthcare professionals) [Lucia, 1999, 158] of continuous chest compressions because of physical exhaustion. Two manikin studies (LOE 5 [Lucia, 1999, 158] [Riera, 2007, 108]) demonstrated performing chest compressions increases heart rate and oxygen consumption in HCPs. Two randomized manikin studies (LOE 5[Odegaard, 2006, 335] [Trowbridge, 2009, 6]) demonstrated that greater than 5 to 10 minutes of continuous chest compressions by laypeople resulted in significantly less compression depth compared with standard 30:2 CPR, and no difference in compression rate. One RCT targeted at laypeople (J-LOE1 [Nishiyama, 2010, 1152]) showed that one minute after the initiation, chest compression-only CPR resulted in shallower compressions than CPR with rescue breathing In one LOE 5 manikin study [Manders, 2009, 1015] experienced paramedics demonstrated no decline in chest compression quality below guideline recommendations during 10 min of BLS with any of three different compression to ventilation ratios (15:2. 30:2, and 50:2). Four manikin studies (LOE 5 [Ashton, 2002, 151] [Hightower, 1995, 300] [Huseyin, 2002, 57] [Ochoa, 1998, 149]) showed a time-related deterioration in chest compression quality (mainly depth) during continuous compressions by HCPs. A single manikin study (LOE 5 [Heidenreich, 2006, 1020]) demonstrated that medical students performed better quality chest compressions during the first 2 minutes of continuous chest compression compared with15:2 CPR, although there was deterioration in quality after 2 minutes. A LOE 5 manikin study of HCPs [Manders, 2009, 1015] showed that the number of effective compressions (depth > 38 mm) was the same if the rescuer changed every minute or every 2 minutes during 8 minutes of continuous chest compressions. Fatigue was reported more frequently after a two-minute period of compressions.

When performing chest compressions, if feasible, it is reasonable to consider changing rescuers after about 2 minutes to prevent rescuer fatigue (demonstrated by deterioration in chest compression quality, in particular, depth of compressions) (Class IIb). There is a need to heed the fact that chest compression-only CPR tends to quickly lead to shallow compressions. The change of rescuers performing chest compressions should be done with minimum interruption to the compression (Class I).

3) Risks During Defibrillation Attempts

Harm to the rescuer or a bystander is extremely rare during defibrillation attempts. A large randomized trial of public access defibrillation (LOE 1 [Hallstrom, 2004, 637]) and 4 prospective studies of first responder AED use (LOE 4 [Cappato, 2006, 553] [Capucci, 2003, 12] [Page, 2000, 1210])、LOE 5 [Jorgenson, 2003, 225]) demonstrated that AEDs can be used safely by lay persons and first responders. One LOE 4 manikin study [Hosmans, 2008, 216] observed that laypeople using an AED touched the manikin during shock delivery in one third of defibrillation attempts. An observational study of 43 patients undergoing cardioversion measured only a small current leakage through 'mock rescuers' wearing polyethylene gloves and simulating chest compression during shock delivery (LOE 4 [Lloyd, 2008, 2510]). One LOE 5 systematic review [Hoke, 2009, 395] identified 8 articles that reported a total of 29 adverse events associated with defibrillation. Only one case (LOE 5 [Dickinson, 2008, 489]) has been published since 1997. A 150 joule biphasic shock was delivered during chest compressions. The rescuer doing chest compressions felt the electrical discharge and did not suffer any harm. Seven cases were due to accidental or intentional defibrillator misuse (LOE 5 [No authors listed, 1988, 68] [Cooper, 1994, 91] [Montauk, 1997, 825] [Iserson, 1979, 24] [Grumet, 1989, 512]), 1 due to device malfunction (LOE 5 [Gibbs, 1990, 101]), and 4 occurred during training/maintenance procedures (LOE 5 [Gibbs, 1990, 101] [Trimble, 1976, 543]). A case series (LOE 5 [Gibbs, 1990, 101]) identified fourteen adverse events during actual resuscitation which caused only minor harm.
The risks to individuals in contact with a patient during implantable cardioverter defibrillator (ICD) discharge are difficult to quantify.
Four single case reports described shocks to the rescuer from discharging ICDs (LOE 5 [Lechleuthner, 1995, 253] [Clements, 2003, 379] [Siniorakis, 2009, 293] [Stockwell, 2009, 832]). ICD discharge was associated with a significant jolt to rescuers and in one case [Stockwell, 2009, 832] resulted in a peripheral nerve injury.
Three animal studies suggest the use of defibrillators in wet environments is safe (LOE 5 [Klock-Frezot, 2006, 4028] [Schratter, 2007, 420] [Lyster, 2003, 307]). There are no reports of harm to rescuers from attempting defibrillation in wet environments.

The risks associated with defibrillation are less than previously thought. There is insufficient evidence to recommend that continuing manual chest compressions during shock delivery for defibrillation is safe. It is reasonable for rescuers to wear gloves when performing CPR and attempting defibrillation (manual and/or AED) (Class Ⅱb) but resuscitation should not be delayed/withheld if gloves are not available. However, it is reasonable to emphasize rescuer safety at training courses (Class Ⅱb). There is insufficient evidence to make a recommendation on the safety of contacting a patient during ICD discharge. There is insufficient evidence to make a recommendation about the best method of avoiding accidental shocks to the rescuer from an ICD discharge during CPR.

Although there are no reports of harm to rescuers, there is insufficient evidence to make a recommendation regarding the safety of defibrillation in wet environments.

4) Psychological Effects

One large prospective trial of public access defibrillation reported a small number of adverse psychological effects requiring intervention associated with CPR or AED use (LOE 4 [Peberdy, 2006, 59]). One prospective analysis of stress reactions associated with a trial of public access defibrillation reported low levels of stress in those responding to an emergency in this setting (LOE 4 [Riegel, 2006, 98]). One prospective observational study of 1265 medical emergency team (MET) calls described "psychological injury" related to CPR performance in one rescuer (LOE 4 [Cheung, 2009, 1351]). Two large, retrospective, questionnaire-based reports relating to performance of CPR by a bystander reported that nearly all respondents regarded their intervention as positive experience (LOE 4 [Axelsson, 1996, 3] [Axelsson, 1998, 13]). Two small, retrospective studies of nurses involved in delivery of CPR noted the stress involved, and the importance of its recognition and management (LOE 4 [Laws, 2001, 76]、 LOE5 [Gamble, 2001, 157]).

There are few reports of psychological harm to rescuers after being involved in a resuscitation attempt. There is insufficient evidence to support or refute any recommendation on minimizing the incidence of psychological harm to rescuers.

▲Knowledge gaps

・ Safety of hands-on defibrillation.
・ CPR in patients with ICDs
・ Measures against psychological harm to rescuers

■4 RESCUER WILLINGNESS TO RESPOND

1. Factors involved in the willingness to perform CPR

Increasing the willingness of individuals to respond to a cardiac arrest with early recognition, calling for help and starting CPR is essential to improve survival rates. What could stimulate bystander willingness?

Sixteen LOE 4 studies [Swor, 2006, 596] [Riegel, 2006, 98] [Axelsson, 2000, 27] [Hubble, 2003, 219] [Swor, 2003, 171] [Vaillancourt, 2008, 51] [Boucek, 2009, 849] [Caves, 2006, 93] [Coons, 2009, 334] [Dwyer, 2008, 157] [Jelinek, 2001, 239] [Johnston, 2003, 67] [Kuramoto, 2008, 475] [Omi, 2008, 340] [Shibata, 2000, 187] [Taniguchi, 2007, 82] have suggested that many factors decrease the willingness of bystanders to start CPR, including bystander characteristics (panic, fear of disease, harming the victim or performing CPR incorrectly) and victim characteristics (stranger, being unkempt, evidence of drug use, blood or vomit). Two studies (LOE 1 [Perkins, 2006, 432], LOE 4 [Bobrow, 2008, 2550]) have suggested that training rescuers to recognise gasping as a sign of cardiac arrest improves identification of cardiac arrest victims. Ten studies (LOE 2 [Moser, 1999, 326], LOE 4 [Swor, 2006, 596] [Axelsson, 2000, 27] [Swor, 2003, 171] [Jelinek, 2001, 239] [Johnston, 2003, 67] [Kuramoto, 2008, 475] [Donohoe, 2006, 70] [Hamasu, 2009, 359] [Parnell, 2006, 899]) showed increased bystander CPR rates in those trained in CPR, especially if training occurred within 5 years. One study (J- LOE 5 [Nishiyama, 2009, 1164]) showed that video-based self-instructing contributed to an increase in bystander motivation to perform CPR and use an AED. Three LOE 5 studies [Axelsson, 2000, 27] [Vaillancourt, 2008, 51] [Culley, 1991, 362] showed that willingness to perform CPR is increased when emergency dispatchers provide telephone CPR instructions. Eight LOE 4 studies [Hubble, 2003, 219] [Caves, 2006, 93] [Jelinek, 2001, 239] [Shibata, 2000, 187] [Taniguchi, 2007, 82] [Donohoe, 2006, 70] [Lam, 2007, 325] [Locke, 1995, 938] provided evidence that potential rescuers would be more likely to start CPR if they had the option to use compressions-only CPR.

To increase willingness to perform CPR:

□ Laypeople should receive training in CPR(Class Ⅰ). This training should include the recognition of gasping or abnormal breathing as a sign of cardiac arrest when other signs of life are absent(Class Ⅰ).

□ Laypeople should be trained to start resuscitation with chest compressions in adult and pediatric victims(Class Ⅰ).

□ If unwilling or unable to perform ventilations, rescuers should be instructed to continue compression-only CPR(Class Ⅰ).

□ EMS dispatchers should provide CPR instructions to callers who report cardiac arrest(Class Ⅰ).

□ When providing CPR instructions, EMS dispatchers should include recognition of gasping and abnormal breathing(Class Ⅰ).

▲*Knowledge gaps*

□ Optimal method to teach recognition of cardiac arrest including gasping, agonal, and abnormal breathing.

□ Optimal method for laypeople to recognize the return of a spontaneous circulation.

□ Optimal methods for mass education of laypeople.

□ Policy and measures of local communities to encourage laypeople to participate in an emergency life saving program

■5 IMPLEMENTATION AND TEAMS

The best scientific evidence for resuscitation will have little impact on patient outcomes if it is not effectively translated into clinical practice. Successful implementation is dependent on effective educational strategies to ensure that resuscitation providers have the necessary knowledge and skills in combination with the provision of necessary infrastructure and resources[Chamberlain, 2003, 11]. Education itself is only one strategy for implementing changes. This section addresses the need for a framework for successful implementation of guidelines, including broad implementation strategies that include educational activities.

1. Implementation Strategies

Little is known about what strategies work best for implementing evidence-based guidelines in communities, institutions or units. Implementation of the 2005 resuscitation guidelines in emergency medical services agencies was reported to take a mean of 416+172 days in the Resuscitation Outcomes Consortium (ROC) [Bigham, 2010, 355] and 18 months in the Netherlands[Berdowski, 2009, 1336]. Identified barriers to rapid implementation include delays in getting staff trained, equipment delays, and organizational decision-making[Bigham, 2010, 355] [Berdowski, 2009, 1336]. This section provides insight into several elements that appear to facilitate successful implementation.

1) Implementation Factors

In communities where processes/guidelines are being implemented, does the use of any specific factors, compared with no such use improve outcomes (eg, success of implementation)?

Using the implementation of therapeutic hypothermia as an example, 2 LOE 3[Rittenberger, 2008, 198] [Sunde, 2007, 29] and 1 LOE 5 single institution interventional studies[Koran, 2009, 48] support the use of a written protocol, pathway, or standard operating procedure as part of a comprehensive approach to implementing the therapeutic hypothermia guideline. One LOE 2 survey[Kennedy, 2008, 125] and 1 LOE 3 single institution intervention[Hay, 2008, 15] also support the use of written protocols, though Hay only briefly describes co-interventions used.

A wide spectrum of evidence supports the use of a comprehensive, multifaceted approach to guideline implementation, including identification and use of clinical champions, a consensus- building process, multidisciplinary involvement, written protocols, detailed process descriptions, practical logistic support, multi-modality/multi-level education, and rapid cycle improvement (eg, Plan, Do, Study, Act) to respond to problems as they arise. The evidence supporting this multifaceted approach includes 1 LOE 3 study[Rittenberger, 2008, 198], 1 LOE 5 intervention description[Koran, 2009, 48], 2 LOE 5 theoretical reviews[Brooks, 2008, 286] [Brach, 2008, Brach C, Lenfestey N, Roussel A, Amoozegar J, Sorensen A. Will It Work Here? A Decisionmaker's Guide to Adopting Innovations. Prepared by RTI International under Contract No. 233-02-0090. Agency for Healthcare Research and Quality (AHRQ) Publication No. 08-0051. Rockville, MD: AHRQ; September 2008.] and 4 LOE 5 studies extrapolated from non-hypothermia, non-arrest settings (2 randomized controlled trials[Ornstein, 2004, 523] [Soumerai, 1998, 1358], 1 concurrent controlled trial[Jackson, 2004, 1794], and 1 retrospective controlled trial[Wojner-Alexandrov, 2005, 1512]).

Institutions or communities planning to implement complex guidelines, such as therapeutic hypothermia, should consider using a comprehensive, multifaceted approach, including: clinical champions; a consensus-building process; multidisciplinary involvement; written protocols; detailed process description; practical logistic support; multi-modality, multi-level education; and rapid cycle improvement methods（Class Ⅱa）.

Investigators studying implementation of guidelines should consider using a framework for implementing guidelines (eg, Brach-AHRQ, 2008) and report if results were measured or estimated, and if they were sustained（Class Ⅰ）.

▲*Knowledge gaps*

 Which specific factors (such as consensus-building, logistic support, rapid cycle improvement)
are most critical for successful implementation?
 Differences between in-hospital and EMS implementations.
 Effectiveness of a multi-level approach (country, community, organization, unit, individual).
 Importance of describing all co-interventions during implementation studies.
 Repeat surveys over time with same population to assess progress in implementation, and to identify success factors and barriers.

2. System Factors

There are two prominent factors affecting dissemination of the CPR guideline and practice, and life support of cardiac arrest victims: the system factor and the individual factor. This section describes broader resuscitation programs and implementation strategies at the system level.

1) Measure for social popularization of CPR in Japan

Cooperation from lay rescuers is essential to improve neurologically intact survival for out-of-hospital cardiac arrest victims.

Eleven observational studies（J-LOE 5 [Swor, 2006, 596] [Axelsson, 2000, 27][Swor, 2003, 171][Johnston, 2003, 67][Kuramoto, 2008, 475][Hamasu, 2009, 359][Parenell, 2006, 899] [Moser, 1999, 326][Jelinek, 2001, 239][Donohoe, 2006, 70][Nishiyama, 2008, 271, Journal of Japanese Society for Emergency Medicine, 2008, 271） show that lay rescuers' awareness of life support was raised by training, and bystander CPR rates were improved as well.

In Japan, fire departments and the Japanese Red Cross Society take the lead in familiarizing people with CPR. It is estimated that approximately two million people per year take CPR training [http://www.fdma.go.jp/neuter/topics/houdou/2112/01_houdoushiryou.pdf] [http://www.jrc.or.jp/about/jrc/gensei/index.html].

These efforts have led to higher bystander CPR rates, and neurologically intact survival for out-of-hospital cardiac arrest victims have been remarkably improved in recent years [http://www.fdma.go.jp/neuter/topics/houdou/2112/02_honbun.pdf][Iwami, 2007, 2900][Iwami, 2009, 728][Kitamura, 2010, 994].

Although they have improved, however, neurologically intact survival for witnessed cardiogenic out-of-hospital cardiac arrest victims are still low as 10 percent [Iwami, 2007, 2900][Iwami, 2009, 728][Kitamura, 2010, 994]. It is necessary to strategically develop CPR training, to evaluate their effects, and to study how the training should function in the future, so that lay rescuers on the scene of cardiac arrest can perform high-quality CPR.

(1) Systematical development of CPR training

Current CPR training is for people who wish to receive the training. This approach limits the popularization of CPR. Making CPR known even more widely across the nation including among people who have yet to participate in any CPR training requires developing training systematically, not depending only on efforts from various organizations.

In Japan, CPR training has been incorporated in driving school programs and school education curriculum. It started at driving schools in 1994 in cooperation with the Japanese Red Cross Society and the Japanese Association for Acute Medicine. It is not fully functional yet in school education at the moment, but still, schools are expected to become one of the pillars of CPR popularization. Although the curriculum guidelines of junior high and high schools include CPR education, it is not really implemented due to several barriers such as difficulty of securing the class hours, teachers' inadequate experience in CPR education, and lack of training equipment and materials. On the other hand, AEDs have been rapidly installed in schools in Japan. If enhanced CPR training using these AEDs can be conducted at schools, public awareness can be increased through the students who have taken the training. An attempt to remove these barriers has already started [http://jsem.umin.ac.jp/about/schoolBLScons_100527.pdf].

As an approach for strategic development of CPR training, introducing CPR training in school education in cooperation with the academic society, fire departments, the Japanese Red Cross Society and other CPR promotion organizations is recommended (Class Ⅰ).

(2) New CPR training for CPR popularization

Current standard CPR training conducted by fire departments has a few to ten trainees and lasts three to four hours where a resuscitation manikin and an instructor are present. This sort of training imposes a burden both on instructors and attendees in terms of time and finance, and is considered a factor impeding CPR popularization [Wik, 1995, 119]. In this section, training approaches for further popularization of CPR in society are examined.

① CPR training using video instructions and simplified manikin

Does introduction of videos and simplified manikins lead to more bystander CPR?

Twelve studies (LOE 1 [Lynch, 2005, 31][Todd, 1998, 364][Einspruch, 2007, 476][Todd, 1999, 730][Reder, 2006, 443][Roppolo, 2007, 276]; LOE 2 or 3[Batcheller, 2000, 101][Braslow, 1997, 207][Isbye, 2006, 435][Moule, 2008, 427][Liberman, 2000, 249][Jones, 2007, 350]) demonstrated that basic life support skills can be acquired and retained at least as well and, in some cases, better using video-based self-instruction ("practice-while-you-watch") compared with traditional instructor-led courses. Four studies (LOE 1C [Lynch, 2005, 31][Roppolo, 2007, 276][Todd, 1999, 730][Reder, 2006, 443]) reported that CPR skills can be acquired in a shorter time at a large training class, using video-based self-instruction and simplified manikins.

Considering the Japanese situations related to the EMS system, more efficient and effective training programs where trainees can learn how to use an AED, of the existence of dispatcher instructions over the phone, and how to utilize them, should be developed and their effects need to be examined (Class I).

② Simplified compression-only CPR training

Standard CPR consists of chest compressions and rescue breathing. The importance of continuous chest compressions has been emphasized, and therefore increasing the number of lay rescuers who are capable of at least chest compressions is a key issue. Is it possible to produce more bystander CPR by providing simplified, shorter compression-only CPR training in addition to conventional CPR training?

Eight studies (J-LOE 5 [Hubble, 2003, 219][Caves, 2006, 93][Jelinek, 2001, 239][Shibata, 2000, 187][Taniguchi, 2007, 82][Donohoe, 2006, 70][Lam, 2007, 325][Locke, 1995, 938]) show that compression-only CPR increased the rescuers' willingness to perform CPR. Two of these studies from Japan suggest that an aversion to mouth-to-mouth breathing possibly influences this [Shibata, 2000, 187][Taniguchi, 2007, 82].

Four studies (J-LOE 5 [Nishiyama, 2008, 90] [Nishiyama, 2009, 1164] [Heidenreich, 2004, 123] [Assar, 2000, 7]) reported that the simplicity of compression-only CPR made it easier to acquire skills for correct chest compressions. In one RCT targeted at lay rescuers [Nishiyama, 2008, 90], shorter (120 min) simplified training focusing on compression-only CPR and AED use equipped participants with skills as well as or better than the standard training (180 min). Another RCT [Nishiyama, 2009, 1164] showed that skills for compression-only CPR and AED use can be acquired in a 60-minute training session. In another RCT targeted at medical students [Heidenreich, 2004, 123], those who had participated in compression-only CPR training performed more accurate chest compressions when tested 18 months later. In another RCT targeted at lay rescuers comparing conventional training with the 3-step training program [Assar, 2000, 7], participants of the training where they learn compression-only CPR as the first step of the three could perform more chest compressions with a shorter interruption time, compared to those in the conventional training where they learn rescue breathing as well. On the other hand, in another RCT targeted at lay rescuers with an average age of 70 (J-LOE 5[Swor, 2003, 177]), no evaluation criterion of their CPR skills tested 3 months later showed a significant difference between compression-only CPR training and conventional one.

As for lay people-targeted CPR training aiming at realization of more bystander CPR, compression-only CPR training can be of use when participation in conventional training is difficult due to time and age constraints (Class Ⅱa). In the case of cardiac arrest due to non-cardiac etiology, especially in a child victim, improvement in neurologically intact survival by conventional CPR with rescue breathing is reported [Kitamura, 2010, 1347]. In compression-only CPR training, it is necessary to tell the participants about the type of cardiac arrest that needs rescue breathing, and to recommend taking another training course that includes practicing of airway maintenance and rescue breathing (Class Ⅰ). In conjunction with that, an instruction method that allows participants to learn rescue breathing skills efficiently and effectively should be studied.

▲knowledge gaps

- Impact that the usage of video-based self-instruction and simplified manikin has on bystander CPR popularization
- Impact that providing local residents with simplified compression-only CPR training in addition to conventional training has on bystander CPR popularization
- Clinical impact of those practices mentioned above on neurologically intact survival from cardiac arrest in local community

- Impact of developing simplified compression-only CPR training on survival for victims who need rescue breathing
- What kind of efforts are necessary to arrange a training method in which participants can learn CPR including rescue breathing efficiently in shorter time, and can acquire high-quality CPR skills to perform
- Cost-effectiveness of CPR training

2) PAD program

Since the Japanese government authorized the lay use of AEDs in 2004, a number of AEDs not seen in other countries have been installed across the nation, which has been expected to contribute to improvement in rates of neurologically intact survival from out-of-hospital cardiac arrest [Kitamura, 2010, 994]. Moreover, the dissemination of AEDs has raised the general public's interest in overall life support, which probably led to the larger number of participants in CPR training. Installations of AEDs that have been carried out so far, however, have not been well-designed or well-managed. Hereafter, efficient and effective installations of AEDs need to be planned, and improving and correctly managing environments that allow more CPR training to result in more proper usage of an AED by citizens when in emergency, is required. Here, the AED installation and the plan and management for proper usage of the AED are collectively called the PAD program.

(1) Outcomes of AED Programs

Types of programs for effective use of AED on the scene, and their outcomes need to be considered.

In adults and children with out-of-hospital cardiac arrest (including residential settings), does implementation of a public access AED program as opposed to traditional EMS response improve successful outcomes (eg, ROSC)?

One RCT (LOE 1[Hallstrom, 2004, 637]) 4 prospective controlled cohort studies (LOE 2[Colquhoun, 2008, 275] [Capucci, 2002, 1065] [Sanna, 2008, 226] [Kuisma, 2003, 149]),1 study using historical controls (LOE 3[Fleischhackl, 2008, 195]), 9 observational studies (LOE 4[Page, 2000, 1210] [Jorgenson, 2003, 225] [Culley, 2004, 1859] [Caffrey, 2002, 1242] [Valenzuela, 2000, 1206] [Davies, 2005, 1299] [O'Rourke, 1997, 2849] [Kitamura, 2010, 994] [Weisfeldt, 2010, 1713]) and 1 mathematical modelling study (LOE 5[Pell, 2002, 515]) showed that AED programs are safe and feasible and significantly increase survival from out-of-hospital VF cardiac arrest if the emergency response plan is effectively implemented and sustained.

For EMS programs, 10 studies (LOE 1[Vukov, 1988, 318], LOE 2 [Capucci, 2002, 1065], LOE 3 [Cappato, 2006, 553] [Kajino, 2009, 492] [Stiell, 1999, 1175], and LOE 4[Cobbe, 1991, 1517] [Cobbe, 1991, 545] [Heber, 1983, 456] [Sedgwick, 1993, 75] [Weaver, 1986, 1017]) supported AED use;11 studies (LOE 2[Stults, 1986, 701] [Sweeney, 1998, 234], LOE 3[Richless, 1993, 127] [Shuster, 1993, 721] [Stotz, 2003, 277] [Walters, 1990, 563] and LOE 4[Gray, 1987, 1133] [Holmberg, 1998, 29] [Jakobsson, 1989, 297] [Lim, 2005, 49] [Stapczynski, 1997, 552]) were neutral, and 2 meta-analyses[Sanna, 2008, 226] [Smith, 2000, 384] suggested benefit.

For first responder use, 2 studies (LOE 2[Weaver, 1988, 661] and LOE 3[Myerburg, 2002, 1058]) supported use of AEDs by fire or police first responders, but 6 studies (LOE 1[van Alem, 2003, 1312], LOE 2[Kellermann, 1993, 1708], LOE 3[Groh, 2001, 324] [Mosesso, 1998, 200] [Weaver, 1984, 943], and LOE 4[Callaham, 1993, 1664]) were neutral.

In public access trials, 6 studies (LOE 1[Hallstrom, 2004, 637], LOE 2[Colquhoun, 2008, 275], LOE 3[Fleischhackl, 2008, 195] [Culley, 2004, 1859], and LOE 4[Davies, 2005, 1299] [Kitamura, 2010, 994]) supported public access defibrillation (PAD). Two studies (LOE 3[Moore, 2008, 1614] and LOE 5[Folke, 2009, 510]) are neutral.

Five LOE 4 [Page, 2000, 1210] [Caffrey, 2002, 1242] [Valenzuela, 2000, 1206] [Bertrand, 2004, 175] [O'Rourke, 1995, 515] studies demonstrated survival attributed to AED programs in casinos, airplanes or airports. One LOE 4 study[MacDonald, 2002, 1] was neutral.

For home AED deployment, 3 studies (LOE 1[Hallstrom, 2004, 637] [Bardy, 2008, 1793] and LOE 2[Eisenberg, 1989, 443]) showed that home AED programs are safe and feasible but are unlikely to result in a significant increase in survival from out-of-hospital VF cardiac arrest.

For on-site AEDs in public places,11 studies (LOE 1[Hallstrom, 2004, 637], LOE 2[Colquhoun, 2008, 275], LOE 3[Nichol, 2008, 1423], [Fleischhackl, 2008, 195] [Culley, 2004, 1859] and LOE 4[Page, 2000, 1210] [Caffrey, 2002, 1242] [Valenzuela, 2000, 1206] [Davies, 2005, 1299] [O'Rourke, 1997, 2849] [Whitfield, 2005, 269]) supported on-site AEDs. This approach demonstrates high survival at low deployment rates. Four studies (LOE 1[van Alem, 2003, 1312], LOE 2[White, 1996, 480], and LOE 3[Mosesso, 1998, 200] [Weaver, 1984, 943]) did not demonstrate improvement in survival to discharge compared with EMS, despite better response time.

For mobile AEDs,3 studies (LOE 2[Colquhoun, 2008, 275] [Capucci, 2002, 1065] and LOE 3[Myerburg, 2002, 1058]) reported that community first responders (CFRs) equipped with AEDs achieved improvement in survival when they arrive at the patient's side sooner.
In one LOE 2 study[Capucci, 2002, 1065], first responders were trained only in AED use; however, most survivors received CPR and AED, suggesting a role for CPR. There is no evidence to support a specific type of rescuer as better than another. One LOE 3 study[Fleischhackl, 2008, 195] noted that even untrained bystanders achieved good results. One LOE 3 study[Moore, 2008, 1614] reported that use of a restrictive dispatch protocol (unresponsive and not breathing) to summon first responders reduced the frequency of deployment, by reducing not only false alarms (false positives) but also legitimate calls (true positives). In contrast, in one LOE 2[Capucci, 2002, 1065] a less restrictive dispatch protocol (unresponsive patient) yielded a more false positives as part of a wider involvement of first responders and increased survival. No difference in response interval appears to be related to instrument of dispatch (telephone compared with pager).
Implementation of AED programs in public settings should be based on the characteristics of published reports of successful programs in similar settings（Class Ⅰ）.
Home AED use, for high-risk individuals who do not have an ICD, is safe and feasible and may be considered on an individual basis, but has not been shown to change overall survival rates（Class Ⅱb）. Because population (eg, rates of witnessed arrest) and program (eg, response time) characteristics affect survival, when implementing an AED program, community and program leaders should consider factors such as location, development of a team with a responsibility for monitoring and maintaining the devices, training and retraining programs for those who are likely to use the AED, coordination with the local EMS, and identification of a group of paid or volunteer individuals who are committed to using the AED for victims of arrest（Class Ⅰ）.

(2) AED Training Interventions

For basic life support providers (lay or HCP) requiring AED training, are there any specific training interventions compared with traditional lecture/practice sessions that increase outcomes (eg, skill acquisition and retention, actual AED use)?

One LOE 2 study[Rea, 2006, 2760] demonstrated that training delivered by laypeople is as effective as training by HCPs. One LOE 1[Cromie,2008,1578] study reported instruction by nurses, as compared to physicians, resulted in better skill acquisition. Four studies (LOE

2[Reder, 2006, 443], [Moule, 2008, 427], [Risdal, 2008, 60]; LOE 4[Losert, 2007, 221]),reported that the use of computer-based AED training improved skill acquisition and retention, particularly when combined with manikin practice. One LOE 1 study[Roppolo, 2007, 276] supported the use of video-self instruction when compared to instructor-led training. Three LOE 1[Meischke, 2001, 216][Mancini, 2009, 159][de Vries, 2010, 1004]studies showed that the use of video self-instruction is less effective for some elements when compared to instructor-led training.

In a study testing the AED use of 182 laypeople (J-LOE 5) [Nishiyama, 2009, 1164], those who studied with 7-minute video self-instruction showed increased number of people who tried to use an AED, improved pad positioning and time management to the initial defibrillation.

One LOE 1[de Vries, 2008, 76] study supported the use of a training poster and manikin for learning AED skills.

Three studies (LOE 2[Reder, 2006, 443][Mattei, 2002, 277], LOE 4[Gundry, 1999, 1703]) reported that laypeople and HCPs can use an AED without training. Three LOE 2 [Beckers, 2005, R110][Beckers, 2007, 444][Mitchell, 2008, 301]studies reported that untrained individuals could deliver a shock with an AED. However, even minimal training (15 minute lecture, 1 hour lecture with manikin practice, or reading instructions) improved performance (eg, time to shock delivery, correct pad placement, safety).

AED use should not be restricted to trained personnel（Class Ⅰ）. Allowing use of AEDs by individuals without prior formal training can be beneficial and may be life saving. Since even brief training improves performance, (eg, speed of use, correct pad placement) it is recommended that training in the use of AEDs be provided(Class Ⅱa).

Laypeople can be used as AED instructors(Class Ⅱb).

Short video/computer self-instruction (with minimal or no instructor coaching) that includes synchronous hands-on practice in AED use may be considered as an effective alternative to instructor-led AED courses（Class Ⅱb）.

▲*Knowledge gaps*

- Communities with an effective PAD program and their characteristics
- Assessment of first responder dispatch criteria and protocol
- Communities' responsibilities for cardiac arrest surveillance for location selection for AED installation
- Ways to enhance bystanders' willingness to use an AED

- Effective training method to promote more AED use on the scene of cardiac arrest
- Policy and measures of local communities to encourage laypeople to participate in an emergency life saving program

3) Role of pre-hospital life support systems for cardiac arrest victims

To increase neurologically intact survival for cardiac arrest victims, not only quality improvement of paramedics' treatment but also amelioration of the overall prehospital life support system in many respects is necessary. Focusing on the life support procedure before paramedics arrive, this section describes some issues to be studied and measures for their resolution. Fire departments are largely responsible for the prehospital life support system, and therefore the major considerations are measures for EMS dispatcher instructions and recognition of cardiac arrest by them, improvement and retention of bystanders' life support skills, a system for reduction of response interval between EMS activation and their arrival on the scene, and medical control. Dissemination of the existence of dispatcher telephone instructions to the public, which has hardly been carried out so far, is also referred to.

(1) EMS activation

Activation of EMS (calling 119) is usually the first action to take when seeing a victim who has collapsed. It is not easy for laypeople to recognize cardiac arrest as the cause of collapse, and it is difficult as well for EMS dispatchers to obtain important information from the caller. Failure in recognition of cardiac arrest may prevent bystander CPR and dispatcher telephone instruction, and can lead to delay of P-A tiered response (tiered response by pumper and ambulance) and EMS personnel's arrival. It is reported that approximately 50% of cardiac arrests are not recognized, and this is associated with low survival rates.

(2) Recognition of cardiac arrest by dispatchers

Description of symptoms characteristically observed in out-of-hospital cardiac arrest victims by the caller may aid in better recognition of a cardiac arrest by the dispatcher.

One before-and-after trial (LOE D3[Heward, 2004, 115]) demonstrated a significant increase from 15% to 50% in cardiac arrest recognition after the implementation of a protocol requiring that EMS dispatchers assess absence of consciousness and quality of breathing (normal/not normal).

Many descriptive studies (LOE D4[Hauff, 2003, 731] [Bang, 1999, 175] [Cairns, 2008, 349] [Castren, 2001, 265] [Clark, 1994, 1022] [Eisenberg, 1985, 47] [Flynn, 2006, 72] [Garza, 2003, 955] [Kuisma, 2005, 89] [Ma, 2007, 236]) using a similar protocol to identify cardiac arrest report a sensitivity on the order of 70%, ranging from 38%[Eisenberg, 1985, 47] to 97%[Ma, 2007, 236], and a high specificity ranging from 95% [Clark, 1994, 1022]to 99%[Flynn, 2006, 72].

One case-control trial (LOE D3[Berdowski, 2009, 2096]), 1 before-and-after trial (LOE D3[Vaillancourt, 2007, 877]), and 4 observational studies (LOE D4[Bohm, 2007, 256] [Bobrow, 2008, 2550] [Hallstrom, 2003, 123] [Nurmi, 2006, 463]) describe agonal gasps or abnormal breathing as a significant barrier to cardiac arrest recognition by emergency medical dispatchers.

Two before-and-after trials (LOE D3[Roppolo, 2009, 769][Bohm, 2009, 1025]) improved the recognition of abnormal breathing using education or counting of breaths. Information spontaneously provided by the caller about the quality of breathing and other information such as facial color or describing the victim as “dead” can aid in identifying cardiac arrest cases (LOE D3[Berdowski, 2009, 2096] [Roppolo, 2009, 769] [Bohm, 2009, 1025]).

One descriptive study (LOE D4[Clawson, 2008, 290]) suggests that in cases where the victim’s problem is “unknown” to the EMS dispatcher, inquiring about the victim’s level of activity (standing, sitting, moving, or talking) helps to identify cases who are not in cardiac arrest.

Two descriptive studies (LOE D4[Nurmi, 2006, 463] [Clawson, 2007, 298]) suggest that confirming the absence of a past medical history of seizure may increase the likelihood of recognizing cardiac arrest among victims presenting with seizure activity.

A case-control study (LOE D3[Clawson, 2008, 257]) suggests that asking about regularity of breathing may help to recognize cardiac arrest among callers reporting seizure activity.

EMS dispatchers should inquire about a victim’s absence of consciousness and quality of breathing (normal/not normal) when attempting to identify cardiac arrest victims（Class I）.

If the victim is unresponsive, it is reasonable to assume that the victim is in cardiac arrest when callers report that breathing is not normal（Class Ⅱa）.

Dispatchers should be specifically educated about identification of abnormal breathing in order to improve cardiac arrest recognition（Class I）.

A method for dispatchers to improve their skills in recognizing cardiac arrest, and a way to teach this method, must be studied (Class I).

The correct identification of cardiac arrest may be increased by careful attention to the caller’s spontaneous comments and by focused questions about seizures（class Ⅱb）.

(3) Dispatcher CPR instructions (Instructions via telephone from the dispatcher to the caller)

Dispatcher CPR instructions refer to instructions for first-aid treatment such as CPR provided by dispatcher or paramedics on the way to bystanders. The Advanced Emergency Service System Review Committee in 1999 issued the Practice Standards on Dispatcher Instructions (Item 176, Fire and Ambulance Service Division, July 6, 1999), based on which more than 90 percent of over 800 Fire Fighting Head Offices nationwide formulated a protocol in the context of the actual situations of each community, referring to adult and child cardiac arrest, choking, blood stanching and burn injuries, and they have implemented dispatcher CPR instruction.

In Western countries, dispatcher instructions cover stroke and acute coronary syndromes. Japanese dispatcher instructions, however, are confined to the four or five kinds mentioned above, and also vary from community to community. So far, the existence of dispatcher instructions is not well known to the public (Tanaka, 2008, Research commissioned by Fire and Disaster Management Agency). This section deals with dispatcher instructions on cardiac arrest.

①Dispatcher telephone CPR instruction content and methods

The Fire and Disaster Management Agency protocol suggests the dispatcher give compression-only CPR instructions without rescue breathing if necessary depending on the skills of the bystander who has witnessed an adult sudden cardiac arrest.

There are several studies investigating whether or not dispatcher telephone CPR instructions affect improvement in outcomes of cardiac arrest.

Three studies (LOE 2[Berdowski, 2009, 2096] [Kuisma, 2005, 89] [Rea, 2001, 2513]) provide evidence that dispatcher telephone CPR instructions may improve survival from OHCA.

In 3 randomized trial (LOE 1[Hallstrom, 2000, 1546],J-LOE1[Sevensson, 2010, 434], [Rea, 2010, 423]), compression-only dispatcher telephone CPR instruction produced survival to discharge at least equivalent to compression plus ventilation dispatcher telephone CPR instruction.

Five additional simulation studies (LOE 5[Woollard, 2003, 123] [Dorph, 2003, 265] [Williams, 2006, 247] [Mirza, 2008, 97] [Dias, 2007, 108]) demonstrated that simplified chest compression–only telephone instructions in CPR reduce barriers to achieving reasonable-quality bystander CPR.

One RCT (J-LOE 1[Sevensson, 2010, 434]) shows that having the choice of compression-only CPR available to a bystander can make it easier for the bystander to perform CPR. One simulation study targeted at laypeople who had never performed rescue breathing reported only about 15 percent of them managed to provide proper ventilation (J-LOE 5 [Tanaka, 2008, Research commissioned by Fire and Disaster Management Agency]). Another study suggests not offering telephone CPR instruction including rescue breathing to an untrained rescuer, for it ends up taking much more time to start the CPR (LOE 3 [Berdowski, 2009, 2096]).

In 4 simulation studies (LOE 5[Johnsen, 2008, 320] [Yang, 2008, 327] [Yang, 2009, 490] [Choa, 2008, 87]), video-enabled cell phone delivery of visual CPR instructions enhanced performance of CPR.

Another simulation study targeted at adult rescuers (LOE 5 [Dawkins, 2008, 63]), however, shows that with the assistance of cell-phone CPR instructions, only 23 percent of the lay rescuers performed proper rescue breathing, and only 37 percent performed adequate chest compressions. Another simulation study (J-LOE 5[Bolle, 2009, 116]) shows that CPR instructions using a video-enabled cell phone requires sufficiently experienced EMS dispatchers to produce clear effects. On the other hand, there is also another study (J-LOE 5 [Tanaka, 2008, Research commissioned by Fire and Disaster Management Agency]) reporting that visual CPR instructions using a video-enabled cell phone, while taking up a little more time watching the screen before starting CPR, enables lay rescuers to perform more correct chest compressions and rescue ventilation than audio-only instructions.

Dispatchers should assertively provide compression-only CPR instructions to untrained rescuers for adults with suspected OHCA without any delay（Class I）.

If dispatchers suspect asphyxial arrest, it is reasonable to provide instructions on rescue breathing followed by chest compressions(Class Ⅱa).

Dispatchers need to instruct bystanders to continue CPR until EMS personnel arrive to take over (Class I).

There is not enough evidence supporting the effectiveness of telephone CPR instructions using a video-enabled cell phone.

② Establishment of an educational system for dispatcher telephone CPR instructions

In Japan, dispatcher telephone CPR instructions are supposed to be offered at all fire departments. However, not every fire department has a telephone CPR instruction protocol, and situations differ from one community to another ([Tanaka, 2008, Research commissioned by Fire and Disaster Management Agency]). For effective functioning of dispatcher CPR instructions, it is necessary to create a protocol based on each community and to have it reviewed periodically by the government, the medical control conference and Fire Fighting Head Offices (Class I).

Fire department staff who are in charge of EMS dispatching have few opportunities to acquire medical knowledge and access to medical control. A portion of EMS dispatching staff needs to be composed of paramedics with medical knowledge or those qualified as emergency life-saving technicians or skilled in emergency services, such as first-aid instructors. Dispatching service, conforming to medical control concept, also requires periodic training and evaluation by instructing medical doctors (Class I).

It is reasonable to evaluate dispatchers' skill in recognizing cardiac arrest and correctness and celerity of the CPR instructions so as to improve the quality of dispatcher telephone CPR instructions (Class Ⅱa). One study (J-LOE 5 [Ikeda, 2009, 478, Journal of Japanese Society for Emergency Medicine]) reports that recording dispatcher instructions for examination at a later time helps improve the quality of dispatcher telephone CPR instructions and can lead to ROSC. Hereafter there is a need for the Fire Fighting Head Offices across the nation to record dispatcher telephone CPR instructions and examine them afterwards (Class Ⅱa).

③Dissemination of the existence of dispatcher instructions among the public and education

At training courses for lay people so far, the importance of early EMS activation has been taught while the fact that dispatcher CPR instructions are available over the phone has never been fully introduced. Four studies (LOE 4[Clawson, 2008, 290] [Nurmi, 2006, 463] [Clawson, 2007, 298]、 LOE 3[Clowson, 2008, 257]) suggest that instructing lay rescuers about what to tell the dispatcher, such as the victim's response and respiratory status, is desirable. For smooth dispatcher instructions on the scene, familiarizing the public with the dispatcher telephone CPR instructions, their content and key words for the initiation of dispatcher instructions is necessary (Class Ⅱa).

(4) Reduction of response interval (notification-arrival interval)

Response interval (time between EMS activation and their arrival on the scene) is a crucial factor contributing to survival rates for OHCA victims. Two meta-analyses (J-LOE 2) [Nichol, 1996, 700] [Nichol, 1999, 517] show a strong association between response interval and survival rates for sudden cardiogenic cardiac arrest victims. Average response interval in the region surveyed in these studies was 5.7-6.7 minutes. If response interval were reduced by one minute, OHCA survival rates could increase by 0.4-0.7 percent. In one controlled before-and-after trial studying the influence of response interval on survival rates for cardiac arrest victims (J-LOE 3) [Stiell, 1999, 1175], reduction in average response interval from 6.7 to 5.3 minutes improved survival rates for all the cardiac arrest victims by 1.4 percent. According to the Emergency resuscitation survival statistics by the Fire and Disaster Management Agency, in cases of witnessed cardiogenic cardiac arrest victims, an interval between collapse and CPR initiation by paramedics of 10-15 minutes resulted in neurologically intact survival of 3.5 percent, while an interval of 5-10 minutes resulted in neurologically intact survival of 6.5 percent. Neurologically intact survival for victims whose initial rhythm was VF were 11.3% and 18.2% respectively.

（http://www.fdma.go.jp/neuter/topics/houdou/2112/02_honbun.pdf）

Although the response interval mentioned above is not officially defined, in general it is equivalent to the time needed between EMS notification and arrival on the scene. The definition of notification time is, based on the Utstein style, when the 119 call comes into the EMS operating center (The Advanced Emergency Service System Review Committee, Fire and Disaster Management Agency, Oct. 2002). Due to the system organization of Fire Fighting Head Offices, however, some communities still use the time when the case is identified as an emergency as the notification time.

At present, this "notification-arrival interval" is reportedly a national average of 7.7 minutes, which has been on a lengthening trend recently ([The 2009 Present State of Emergency and Rescue Service, Fire and Disaster Management Agency]). It takes a few more minutes from ambulance arrival to EMS personnel's contact with the victim. Plus, a few minutes pass before the 119 call after a victim collapses [Iwami, 2009, 728]. In the case that bystander CPR is unavailable, the time between EMS activation and paramedics' contact with the victim is important in terms of improving victim's outcomes. It might be necessary to release the information on not only "notification-arrival interval" but also "notification-contact interval"[漢那, 2009,22, International Association of Traffic and Safety Sciences].

For improvement in neurologically intact survival for cardiac arrest victims, it is necessary to continue trying to reduce the time required between EMS activation and emergency personnel's (including firefighters) arrival on the scene by enhancing dispatchers' skill in accurately collecting necessary information from a caller, the communication system of quickly locating the source of the 119 call, the system of controlling ambulances and fire engines in real time, and the system of dispatching the nearest fire engine or ambulance. Advancing efforts to reduce the nothing-but-waiting time, such as through early EMS activation, fostering of bystanders skilled in CPR, reduction in the communication time between the caller and the dispatcher, and assistance for the prompt start of CPR by giving telephone instructions is also important (Class I).

(5) Pre-hospital medical procedures on cardiac arrest victims; studies and problems

In Japan, pre-hospital medical procedures have been examined, compiling OHCA resuscitation records, based on the universal guideline of the Utstein style in all fire fighting organizations across the nation since the notice issued by the Fire and Disaster Management Agency in 2005. It was reported that the latest Utstein style resulted in bystander CPR practice in 48.8 percent of the cardiac arrest cases [The 2008 Emergency Resuscitation Index, Fire and Disaster Management Agency]. However, criteria for identifying bystander CPR may differ from community to community ([Tanaka, 2008, Research commissioned by Fire and Disaster Management Agency]) and besides, the quality of CPR performance has not been fully evaluated. For the future, clarifying the definition of "bystander CPR positive", and training to keep the recording quality consistent among all the fire organizations nationwide is necessary.

Performance Measurement Systems

For resuscitation systems (pre-hospital and in-hospital), does the use of a performance measurement system (eg, Utstein template of outcome assessment) improve and/or allow for
comparison of system outcomes (patient level and system level variables)?

One LOE 3 before-and-after intervention study found no statistically significant improvement
in CPR quality or patient survival from providing information about CPR performance to the
training teams of three different ambulance services. One LOE 4 case series study found a

positive psychologic effect on EMS personnel of reporting cardiac arrest outcomes back to them
and presenting the results to the media.

There is insufficient evidence to make recommendations supporting or refuting the effectiveness
of specific performance measurement interventions to improve processes of care and/or clinical
outcomes in resuscitation systems.

▲*Knowledge gaps*

 The optimal system to monitor and improve the quality of care delivered within a resuscitation
system.

 Does providing feedback to emergency medical personnel about their performance (individually and/or at a system level) improve patient outcomes?

(6) Conclusion

It has been about twenty years since the establishment of the Emergency Life-saving Technicians Act with the aim of organizing and enhancing the pre-hospital life support systems. It seems undeniable that so far the focus has been almost exclusively on specific medical practices by emergency life-saving technicians. Hereafter, it is crucially important to develop education systems not only for paramedics but all the fire department staff engaged in the pre-hospital life support systems, where dispatchers acquire skills to meet the crucial requirements of accurate recognition of cardiac arrest and prompt telephone CPR instructions. Therefore, establishment of the systems including periodical reviews of the protocols and education for dispatchers under the medical control system is essential. At the same time, familiarizing the public with the existence of the dispatcher CPR instructions is necessary so as to gain their voluntary cooperation.

4) Cardiac Arrest Centers

In Japan, most cardiac arrest victims are transported, as is the case with other emergency illnesses, to a local emergency medical care center or base hospital. On the other hand in North America, there has been an attempt to launch systems of specialized care for out-of-hospital cardiac arrest with the goal of survival rate improvement, in which cardiac arrest victims are transported to the cardiac arrest center that deals specially with patients who have gained ROSC to receive systematic post resuscitation care including therapeutic hypothermia.

In adults and children with out-of-hospital cardiac arrest, does transport to a specialist cardiac arrest center compared with no such directed transport improve outcome (eg, survival)?

Seven observational studies showed wide variability in survival to hospital discharge（LOE 4 [Engdahl, 2000, 201] [Langhelle, 2003, 247] [Carr, 2009, 505] [Liu, 2008, 339] [Carr, 2009, 30]）, 1 month survival（LOE 4 [Herlitz, 2006, 404]）, or length of ICU stay（LOE 4 [Keenan, 2007, 836]） among hospitals caring for patients after resuscitation from cardiac arrest. One North American observational study[Carr, 2009, 30] showed that higher volume centres (greater than 50 ICU admissions following cardiac arrest per year) had a better survival to hospital discharge than low volume centres (less than 20 cases admitted to ICU following cardiac arrest) for patients treated for either in- or out-of-hospital cardiac arrest. Another observational study（LOE 4 [Callaway, 2010, 524]） showed that unadjusted survival to discharge was greater in hospitals that received ≥40 cardiac arrest patients/year compared with those that received <40 per year, but this difference disappeared after adjustment for patient factors.

One Japanese study (J-LOE 2 [Kajino, 2010, 549]) reported that among out-of-hospital cardiac arrest victims who had failed to achieve ROSC in the pre-hospital care, those transported to emergency medical care centers had higher neurologically intact survival than those who did not.

Three LOE 3 observational studies with historic control groups [Sunde, 2007, 29] [Knafelj, 2007, 227] [Oddo, 2006, 1865] showed improved survival after implementation of a comprehensive package of post resuscitation care that included therapeutic hypothermia and percutaneous coronary intervention. Two LOE 3 small observational studies [Wolfrum, 2008, 1780] [Gaieski, 2009, 418] demonstrated a trend toward improvement that was not statistically significant when comparing historic controls with the introduction of a comprehensive package of post resuscitation care which included therapeutic hypothermia, percutaneous coronary intervention and goal directed therapy. One LOE 4 observational study[Carr, 2009, 505] suggested improved survival to discharge after out of hospital cardiac arrest in large hospitals with cardiac catheter facilities compared with smaller hospitals with no cardiac catheter facilities. Another LOE 4 observational study[Callaway, 2010, 524] also showed improved outcome in hospitals with cardiac catheter facilities that was not statistically significant after adjustment for other variables. Three LOE 3 studies of out-of-hospital adult cardiac arrest with short transport intervals (3 to 11 minutes) [Davis, 2007, 44][Spaite, 2008, 61][Spaite, 2009, 248] failed to demonstrate any effect of transport interval from the scene to the receiving hospital on survival to hospital discharge if return of spontaneous circulation was achieved at the scene.

Although there is no direct evidence that regional cardiac resuscitation systems of care (SOC) improve outcome compared with no SOC, extrapolation from multiple studies (LOE 5 for this question) evaluating SOC for other acute time-sensitive conditions suggests a potential benefit. High quality randomized trials and prospective observational studies of ST elevation myocardial infarction (STEMI) SOC demonstrate improved [Vermeer, 1999, 426] [Widimsky, 2000, 823] [Widimsky, 2003, 94] [Le May, 2008, 231]) or neutral[Andersen, 2003, 733] [Bonnefoy, 2002, 825] [Grines, 2002, 1713] [Henry, 2007, 721] [Jollis, 2007, 2371] [Ting, 2007, 729] outcomes compared with no SOC. Many case control studies of regionalized care for trauma patients demonstrated improved[Abernathy, 2002, 182] [Clemmer, 1985, 861] [Culica, 2007, SR9] [Hannan, 2005, 584] [Harrington, 2005, 961] [Liberman, 2004, 1330] [MacKenzie, 2006, 366] [Mann, 2001, 1111] [Mullins, 1996, 536] [Mullins, 1998, 609] [Mullins, 1994, 1919] [Mullner, 1978, 140] [Mullner, 1978, 103] [Nathens, 2000, 25] [Nathens, 2003, 444] [Nicholl, 1997, 1349] [Potoka, 2000, 237] [Sampalis, 1995, 232] [Sampalis, 1997, 288] or neutral[Boyd, 1975, 25] [de Jongh, 2008, 1007] [Goldberg, 1981, 547] [Hulka, 1997, 514] [Kane, 1992, 576] [Norwood, 1995, 240] [Young, 1998, 88] outcomes when comparing a SOC with no SOC. One study that evaluated a trauma SOC[Reilly, 2004, 509] showed a higher mortality in the trauma center. Observational studies and randomized trials[LaMonte, 2009, 319] show that organized care improves outcomes after acute stroke.

While extrapolation from randomized and observational studies of systems of care for other acute time-sensitive conditions (trauma, ST elevation MI, stroke) suggests that specialist cardiac arrest centers and systems of care may be effective, there is insufficient direct evidence to recommend for or against their use.

▲*Knowledge gaps*

- Safe journey time or distance for patient transport under various conditions.
- Essential treatments a cardiac resuscitation center should offer.
- Role of secondary transport from receiving hospital to a regional center.

 Ethics of conducting randomised controlled trial of standard care versus transport to a cardiac resuscitation center.
 Conditions under which a cardiac resuscitation centres is worthwhile (eg, in areas where the other links in the chain of survival are optimized).
 Cost effectiveness of cardiac arrest centers.

5) What resuscitation training interventions are practical, feasible and effective in low-income countries?
(1) **Trauma resuscitation.**
Trauma resuscitation studies constitute extrapolated evidence (LOE 5) for cardiac arrest patients. One study in Tanzania, 2 studies in Trinidad and Tobago and Ecuador, and 1 study in Nigeria reported that implementation of standard Advanced Trauma Life Support (ATLS) or trauma team training and modified trauma training programs are effective in developing trauma skill competencies in hospital providers. A study from Trinidad and Tobago, and 2 studies comparing Cambodia and Northern Iraq, demonstrated that the delivery of standard or appropriately modified ATLS training to the local community improved hospital mortality from trauma. Another study in Trinidad and Tobago showed no difference in 6-hour mortality after standard ATLS training when compared with pre training.
One study in Trinidad and Tobago showed implementation of standard Pre-Hospital Life Support (PHTLS) programs are effective in imparting competency in trauma skills to pre-hospital providers. Another study in Trinidad and Tobago and 1 study in Mexico demonstrated improved trauma patient survival to hospital admission when pre-hospital providers were trained in PHTLS and Basic Trauma Life Support (BTLS).
(2) **Neonatal resuscitation**.
One LOE 3 study in India and 1 LOE 3 study in Zambia demonstrated that neonatal resuscitation training improved neonatal mortality when incorporated into neonatal care training of midwives and traditional birth attendants, respectively. One LOE 2 study in Argentina, the Democratic Republic of Congo, Guatemala, Pakistan, and Zambia and 1 LOE 3 study in 14 centers in India did not demonstrate similar mortality reductions when training hospital physicians and nurses in neonatal resuscitation. In one LOE 3 study in Kenya health care workers significantly improved operational performance immediately after a 1-day modified Resuscitation Council (UK) neonatal resuscitation course. One LOE 3 study in Zambia demonstrated that midwives trained in neonatal resuscitation (American

Academy of Pediatrics and American Heart Association Neonatal Resuscitation Program) maintain their psychomotor skills at 6 months, while cognitive skills declined to baseline.

(3) **Pediatric advanced, adult cardiac, basic life, first aid.**

Currently, there is little evidence to address the hypothesis that basic, adult cardiac or pediatric advance life support training programs provide the necessary training for the learners to achieve the significant improvement in cognitive, psychomotor or team skills required to impact self-efficacy, competence, operational performance or patient outcomes in developing countries. One LOE 2 Study in Brazil demonstrated a significant improvement in ROSC if a member of the resuscitation team was trained in ACLS, but survival hospital discharge was not significantly different. One LOE 2 study showed implementation of standard ACLS in addition to BTLS training of pre-hospital providers in Mexico was not more effective in improving pre-hospital mortality from trauma when compared to PHTLS alone.

One LOE 1 study in Brazil demonstrated that video training was effective in training laypeople in basic skills of first aid, but was not effective in training the more complex skill of CPR.

There is insufficient evidence to recommend for or against pediatric or adult basic or advanced level life support training programs in low-income countries. However, there is evidence that emergency medical training programs in neonatal and trauma resuscitation should be considered in these countries.

When delivering programs in low-income countries, consideration should be given to local adaptation of training, utilizing existing and sustainable resources for both care and training, and the development of a dedicated local infrastructure.

▲*Knowledge gaps*

- Which strategies of conducting sustainable emergency medical training programs in low-income countries are cost-effective?
- Validated educational assessment tools tailored to low-income countries.
- Relative effectiveness of various training methods in low-income countries.
- Which educational interventions improve clinical outcomes in low-income countries?

3. Individual and Team Factors

Individual and team factors impact performance during resuscitation attempts. This section describes specific factors that have an impact on performance during simulated or actual cardiac arrests.

1) Prehospital physicians

In Japan, Doctor Cars and Doctor Helicopters have been introduced with the efforts from communities and local faculties, which enable physicians to go to the scene and work on resuscitation as part of the team. However, there have not been enough studies of Doctor Cars and Helicopters yet.

In adult cardiac arrest (prehospital), does the performance of advanced life support procedures by experienced physicians (I) as opposed to standard care (without physicians) improve outcome (eg, ROSC, survival)?

In adult cardiac arrest, physician presence during resuscitation, compared with paramedics alone, has been reported to increase compliance with guidelines (LOE 2[Olasveengen, 2009, 1248]; LOE 4[Kirves, 2007, 75]) and physicians in some systems can perform advanced resuscitation procedures more successfully (LOE 2[Olasveengen, 2009, 1248] [Schneider, 1994, 207] and LOE 4[Arntz, 2008, 180] [Bell, 2006, 389] [Lossius, 2002, 771]).

When compared within individual systems, 5 studies suggested improved survival to hospital discharge when physicians were part of the resuscitation team (LOE 2[Dickinson, 1997, 132] [Soo, 1999, 47], LOE 3[Frandsen, 1991, 256] [Sipria, 2000, 469]) and 10 studies suggest no difference in survival of the event (LOE 2[Olasveengen, 2009, 1248] [Dickinson, 1997,132]) or survival to hospital discharge(LOE 2[Olasveengen, 2009, 1248] [Frandsen, 1991, 256] [Estner, 2007, 792] [Eisenburger, 2001, 39] [Gottschalk, 2002, 15] [Hampton, 1977, 526] [Schneider, 1994, 197] [Soo, 1999, 535] [Yen, 2006, 1001]). One study found lower survival of the event when physicians were part of the resuscitation team (LOE 2[Yen, 2006, 1001]).

Studies indirectly comparing resuscitation outcomes between physician-staffed and other systems are difficult to interpret because of the extremely high variability between systems, independent of physician-staffing (LOE 5[Nichol, 2008, 1423]). High survival rates after cardiac arrest have been reported from systems that employ experienced physicians as part of the EMS response (LOE 3[Fischer, 2003, 630] [Bottiger, 1999, 674]; LOE 4[Arntz, 2008, 180] [Lossius, 2002, 771] [Bjornsson, 2006, 591]) and these survival rates may be higher than in systems that rely on non-physician providers (LOE 2[Mitchell, 1997, 225] and LOE 3[Fischer, 2003, 630] [Bottiger, 1999, 674] [Lafuente-Lafuente, 2004, CD002751]). Other comparisons noted no difference in survival between systems using paramedics or physicians as part of the response (LOE 3[Lewis, 1979, 1902] [Silfvast, 1996, 101]).

Well-organized non-physician systems with highly trained paramedics also reported high survival rates (LOE 5[Nichol, 2008, 1423]). There are no randomized controlled trials to address this question.

Some studies report that the Doctor Car/Helicopter systems are helpful in Japan when targeted at external injuries (J-LOE 5 [Sakamoto,2010,356, Journal of Japanese Society for Emergency Medicine][Arata, 2007, 69, Journal of Japanese Association for Acute Medicine]).

There is insufficient evidence to recommend for or against physicians versus non-physician providers of ALS during prehospital cardiopulmonary resuscitation.

Systems using physicians experienced in pre-hospital care of external injury and acute disease as part of the response can be helpful, and may be applicable depending on situations of local communities.

▲*Knowledge gaps*

More data are required to determine the training required to achieve best outcomes, the level of training and experience required to maintain competence in procedural skills, and the cost effectiveness of physicians compared with non-physicians.

2) Advanced Life Support Checklists

Does the use of a checklist during adult and pediatric advanced life support as opposed to no checklist improve outcomes (eg, compliance with guidelines, other outcomes)?

Four LOE 5 randomized trials of cognitive aids/checklists for simulated basic life support[Choa, 2008, 87] [Ertl, 2007, 286] [Choa, 2009, 680] [Ward, 1997, 221],-3 LOE 5 randomized trials of cognitive aids in simulated anesthetic emergencies or advanced resuscitation[Berkenstadt, 2006, 530][Lerner, 2009, 703] [Schneider, 1995, 358], and 1 LOE 5 observational study[Harrison, 2006, 551] showed improvement in proxy outcomes (eg, proper dosing of medications or performance of correct CPR procedures).

One randomized[Dyson, 2004, 457] and 1 non-randomized[McCallum, 2004, 477] trial (LOE 5) of cognitive aids showed improved recall of factual information important for effective advanced life support. Two LOE 4 surveys[Mills, 2004, 488] [Neily, 2007, 502] on the use of checklists in actual resuscitations reported that physicians perceive cognitive aids to be useful. One LOE 5 retrospective analysis of actual anesthesia emergencies[Runciman, 1993, 579] suggested that a cognitive aid algorithm might be helpful in diagnosis and management. One LOE 5, 3-armed study of simulated basic life support[Ward, 1997, 221] demonstrated no difference in CPR performance between the short checklist arm and the no-checklist arm, but a positive outcome in the long checklist arm. One LOE 5 study of neonatal resuscitation[Bould, 2009, 570] did not demonstrate any benefit from using a poster prompt.

Potential harm was found in one LOE 5 randomized trial of simulated basic life support[Zanner, 2007, 487] in which participants with a mobile phone cognitive aid had longer than 1-minute delay in starting CPR. A LOE 5 simulated PALS study[Nelson, 2008, 138] showed potential harm because a significant portion of hand-held cognitive aid users applied the wrong algorithm. The outcome of using a cognitive aid such as a checklist may be specific to the aid or the situation.

It is reasonable to use cognitive aids (eg, checklists) during resuscitation provided they do not delay the start of resuscitation efforts（Class Ⅱa）. Aids should be validated using simulation or patient trials, both before and after implementation to guide rapid cycle improvement（Class I）.

▲*Knowledge gaps*

- The value of cognitive aids in simulated and actual resuscitations.
- The potential for unintended consequences associated with the use of a cognitive aide (especially delay to initiation of intervention or use of incorrect algorithm).
- The utility of specific cognitive aids with specific providers or in specific situations.
- Human factors issues in solo and team resuscitations.
- The optimal model for follow-up quality assurance (assessment of efficacy and rapid cycle improvement) after introduction of a cognitive aid
- Transferability or generalizability of cognitive aids across settings
- Can cognitive aids, such as simple checklists, be used without training?

3) Briefings/Debriefings

For resuscitation teams, do briefings/debriefings, when compared to no briefings/debriefings improve performance or outcomes?

For healthcare professionals, do briefings (prior to) and/or debriefings (after a learning or patient care experience), when compared to no briefings or debriefings, improve the acquisition of content knowledge, technical skills and behavioral skills required for effective and safe resuscitation?

The terms briefing, debriefing and feedback are often used interchangeably in studies and have therefore been grouped as briefings/debriefings in the consensus on science. Debriefings tend to occur after the event. Debriefing is an integral part of the actual

training intervention in many studies. This makes it difficult to measure the effect of the debriefing.
Evidence from 1 LOE 1 prospective randomized controlled study [Savoldelli, 2006, 279] and 16 other studies (LOE 3 to 4 [DeVita, 2005, 326] [Edelson, 2008, 1063] [Dine, 2008, 2817] [Mayo, 2004, 2422] [Wayne, 2008, 56] [Wayne, 2005, 210] [Clay, 2007, 738] [Falcone, 2008, 1065] [Goffman, 2008, 294] [Hoyt, 1988, 435] [Mikrogianakis, 2008, 761] [Morgan, 2009, 531] [Pope, 2003, 650] [Scherer, 2003, 516] [Townsend, 1993, 133] [Townsend, 2004, 137]) of briefings/debriefings documented improvement with briefings/debriefings in the acquisition of the content knowledge, technical skills and/or behavioral skills required for effective and safe resuscitation. One LOE 4 study [Blum, 2005, 1375] revealed no effect of briefings/debriefings on performance. No studies indicated that the use of briefings and/or debriefings had any negative effect.
It is reasonable to recommend the use of briefings and debriefings during both learning and actual clinical activities（Class Ⅱa）.

▲*Knowledge gaps*
 Relative benefits of team versus individual briefings/debriefings.
 Differential effectiveness of video, verbal, and other measures of feedback.
 Effects of debriefings on technical versus non-technical skills.

4. Recognition and Prevention

Patients who have cardiac arrest often have unrecognized or untreated warning signs. This section describes strategies to predict, recognize, and prevent cardiorespiratory arrest including the role of education.

(1)Specific symptoms in apparently healthy young adults and children.

There are no studies specifically examining the nature of syncope in apparently healthy children and young adults and their risk of sudden cardiac death (SCD). In one LOE P3 study [Colman, 2009, 937] a family history of syncope or SCD, palpitations as a symptom, supine syncope and syncope associated with exercise and emotional stress were more common in patients with Long QT Syndrome (LQTS). Two LOE P5 studies [Oh, 1999, 375] [Calkins, 1995, 365] in older adults identified the absence of nausea and vomiting before syncope and ECG abnormalities as independent predictors of arrhythmic syncope. Less

than 5 seconds of warning signs before syncope and less than 2 syncope episodes were predictors of syncope due to ventricular tachycardia (VT) or atrio-ventricular (AV) block.
A post-mortem case study (LOE P5) [Tester, 2005, 596] highlighted that inexplicable drowning and drowning in a strong swimmer may be due to LQTS or *Catecholaminergic Polymorphic Ventricular Tachycardia (*CPVT). Two LOE P5 studies [Johnson, 2009, 224] [MacCormick, 2009, 26] identified an association between LQTS and presentation with seizure phenotype.

(2)Screening for risk of SCD in apparently healthy young adults and children.
Evidence from 2 large prospective screening trials (LOE P1) [Wilson, 2008, 207] [Tanaka, 2006, 2] failed to identify any symptoms alone as a predictor of SCD in apparently healthy children and young adults. There was strong evidence in one of these trials [Wilson, 2008, 207] for use of 12-lead ECG when screening for cardiac disease.
In Japan, all children have cardiac screening when they enter elementary school, junior high, and high school. This system is unique to Japan, and reportedly it protects Japanese children from sudden cardiac death. At school cardiac examinations, one in every 1,200 students in the first year of junior high school has a conclusive diagnosis of Long QT Syndrome. Prediction of cardiac illness in child Long QT Syndrome patients is required in Japan [Japan Circulation Society, Guidelines for Diagnosis and Management of Patients with Long QT Syndrome and Brugada Syndrome, Circulation Journal Vol.71, Suppl. IV, 2007 1205].

(3)Prodromal symptoms in victims of sudden death and SCD.
Eight LOE P5 studies [Amital, 2004, 528] [Basso, 2000, 1493] [Corrado, 2001, 399] [Drory, 1991, 1388] [Kramer, 1988, 345] [Quigley, 2005, 232] [Wisten, 2002, 529] [Wisten, 2005, 137] [Wisten, 2005, 143] examined the prodromal symptoms in victims of sudden death and SCD. Many patients complained of cardiac symptoms including syncope/pre-syncope, chest pain and palpitations prior to death.

(4)Risk of SCD in patients with known cardiac disease.
In patients with a known diagnosis of cardiac disease 11 studies (LOE P4 [Nava, 2000, 2226] ; LOE P5 [Brugada, 2003, 3092] [Elliott, 2000, 2212] [Goldenberg, 2008, 2184] [Hobbs, 2006, 1249] [Hulot, 2004, 1879] [Kofflard, 2003, 987] [Peters, 2007, 521] [Priori, 2002, 1342] [Spirito, 2009, 1703] [Sumitomo, 2003, 66]) showed that syncope (with or without prodrome

- particularly recent or recurrent) was invariably identified as an independent risk factor for increased risk death. Chest pain on exertion only, and palpitations associated with syncope only, were associated with hypertrophic cardiomyopathy, coronary abnormalities, Wolff-Parkinson-White, and arrhythmogenic right ventricular cardiomyopathy.

(5)Screening of family members.

Five LOE P4 studies [Nava, 2000, 2226][Behr, 2008, 1670] [Brothers, 2008, 2062] [Gimeno, 2009, 406] [Tan, 2005, 207] examining the systematic evaluation of family members of patients with cardiac diseases associated with SCD and victims of SCD demonstrated a high yield of families affected by syndromes associated with SCD.

Children and young adults presenting with characteristic symptoms of arrhythmic syncope should have a specialist cardiology assessment, which should include an ECG and in most cases an echocardiogram and exercise test（Class Ⅰ）. Characteristics of arrhythmic syncope include: syncope in the supine position, occurring during or after exercise, with no or only brief prodromal symptoms, repetitive episodes, or in individuals with a family history of sudden death. In addition, non-pleuritic chest pain, palpitations associated with syncope, seizures (when resistant to treatment, occurring at night or precipitated by exercise, syncope, or loud noise), and drowning in a competent swimmer should raise suspicion of increased risk（Class Ⅰ）. Systematic evaluation in a clinic specializing in the care of those at risk for SCD is recommended in family members of young victims of SCD or those with a known cardiac disorder resulting in an increased risk of SCD（Class Ⅰ）.

▲*Knowledge gaps*

 Efficacy, elements, and patient selection criteria for dedicated cardiac screening clinics for relatives of patients with inheritable cardiac disease or SCD victims.

 Outcomes in children and young people specifically investigated for cardiac symptoms potentially related to risk of SCD.

 Incidence of warning signs in those who have suffered Sudden Unexpected Death in the Young (SUDY), compared to those who died from other causes, or a control population.

 Cardiac evaluation of children with seizure disorders without definite cerebral disease and recalcitrant to therapy.

2) Early Recognition and Response Systems to Prevent In-Hospital Cardiac Arrests

In adults admitted to hospital, does use of early warning systems/rapid response team (RRT) systems or medical emergency team (MET) systems compared with no such responses reduce cardiac and respiratory arrests?

A single LOE 1 study [Hillman, 2005, 2091] involving 23 hospitals did not show a reduction in cardiac arrest rate after introduction of a MET when analyzed on an intention-to-treat basis. *Post hoc* analysis of that study [Chen, 2009, 148] showed there was a significant inverse relationship between frequency of team activation and cardiac arrest and unexpected mortality rate. A LOE 2 multi-center study [Bristow, 2000, 236] did not show a reduction in cardiac arrest numbers after implementation of a MET. Seven additional LOE 3 studies [Chan, 2008, 2506] [Kenward, 2004, 257] [King, 2006, 296] [McFarlan, 2007, 307] [Rothschild, 2008, 417] [Story, 2004, 762] [Story, 2006, 24] did not show a reduction in cardiac arrest rates associated with the introduction of a RRT/MET.

A meta-analysis [Chan, 2010, 18] showed RRT/MET systems were associated with a reduction in rates of cardiopulmonary arrest outside the intensive care unit but not associated with lower hospital mortality rates.

Seventeen LOE 3 single center studies [Baxter, 2008, 223] [Bellomo, 2003, 283] [Benson, 2008, 743] [Bertaut, 2008, 37] [[Buist, 2002, 387]] [Buist, 2007, 1210] [Chamberlain, 2009, 11] [Dacey, 2007, 2076] [DeVita, 2004, 251] [Hatler, 2009, 84] [Jones, 2005, R808] [Jones, 2006, 1352] [Moldenhauer, 2009, 164] [Offner, 2007, 1223] [Gould, 2007, 26] [Jolley, 2007, 253] [Konrad, 2010, 100] reported reduced numbers of cardiac arrests after the implementation of RRT/MET systems. None of these studies addresses the impact of confounding factors on study outcomes.

A single center LOE 3 study [Subbe, 2003, 797] was unable to demonstrate a reduction in cardiac arrest rates after the implementation of an early warning scoring system (EWSS). After implementing an EWSS, cardiac arrest rate increased among patients who had higher early warning scores, compared to similar scored patients prior to the intervention.

In adult patients admitted to hospital, there is insufficient evidence to support or refute the use of early warning systems/rapid response team (RRT) systems or medical emergency team (MET) systems (compared with no such systems) to reduce cardiac and respiratory arrests and hospital mortality. However, it is reasonable for hospitals to provide a system of care that includes: (a) staff education about the signs of patient deterioration, (b) appropriate and regular vital signs monitoring of patients, (c) clear guidance (eg, via calling criteria or early warning scores) to assist staff in the early detection of patient deterioration, (d) a clear, uniform system of calling for assistance, and (e) a clinical response to calls for assistance（Class Ⅱa）.

There is insufficient evidence to identify the best methods for the delivery of these components and, based on current evidence, this should be based on local circumstances （Class I）.

3)Prediction of Cardiac Arrest in Adult Patients in Hospital

In hospital in-patients (adult), does the presence of any specific factors compared with no such factors predict occurrence of cardiac arrest (or other outcome)?

Outcome: cardiac arrest .

One LOE P3 multicenter cross-sectional survey [Jacques, 2006, 175], 1 LOE P2 multicenter matched case-control study utilizing pooled outcomes (cardiac arrest, unplanned ICU admission and death) [Cretikos, 2007, 62] and 2 single-hospital retrospective case control studies (LOE P3 [Hodgetts, 2002, 125] and LOE P4 [Fieselmann, 1993, 354]) supported the ability of alterations in physiological variables, singly or in combination, to predict the occurrence of cardiac arrest. Single variables included heart rate, respiratory rate, systolic blood pressure and decrease in level of consciousness. Combined elements included variably pooled and scored data (MEWS [Modified Early Warning Score]), with different cut-off points (MET [Medical Emergency Team] criteria and MEWS score). Sensitivity ranged from 49% to 89% and specificity from 77% to 99%.

A LOE P3 multicenter, prospective, observational study [Kause, 2004, 275] measured the incidence of cardiac arrests, unplanned ICU admissions and deaths, with or without antecedents recorded on charts: 60% of primary events had antecedents, the most frequent being decreases in systolic blood pressure and Glasgow Coma Scale (GCS) score.

Opposing evidence from 1 LOE P2 multicenter matched case-control [Cretikos, 2007, 62] and 1 LOE P2 single-hospital retrospective case-control study [Fieselmann, 1993, 354] reported that single variables and cut-offs do not correlate with the occurrence of cardiac arrest. Data were insufficient to define which variables and cut-offs are best predictors of the occurrence of cardiac arrest.

Outcome: unexpected ICU admission.

One LOE P3 multicenter cross-sectional survey [Jacques, 2006, 175], 1 LOE P2 multicenter matched case-control study [Cretikos, 2007, 62] using pooled outcome (cardiac arrest, unplanned ICU admission and death), 1 LOE P3 single institution retrospective observational study [Cuthbertson, 2007, 402], and 1 LOE P2 single center, prospective cohort study [Subbe, 2001, 521] suggested that for in-hospital patients altered vital signs were associated with unplanned ICU admission. Different criteria for ICU admission between studies make this a less useful endpoint.

Outcome: mortality (Predicted on admission to hospital)

Six studies (LOE P2, LOE P3, LOE P4) supported the value of combinations of demographic, physiologic and/or laboratory variables recorded on admission in predicting death in specific patient populations. Three studies (LOE P2, LOE P3, and LOE P4) supported the value of combinations of demographic, physiological and laboratory variables recorded on admission in predicting death in specific patient populations.

Eleven studies (LOE P1 [Duckitt, 2007, 769] [Kellett, 2006, 771] [Prytherch, 2005, 203] [Smith, 2008, 170] [Smith, 2008, 109] [Smith, 2008, 11]、LOE P2 [Subbe, 2001, 521], [Olsson, 2004, 579] [Prytherch, 2003, 1300]、LOE P3 [Goodacre, 2006, 372] [Paterson, 2006, 281]) supported the value of different combinations of demographic, physiological and/or laboratory value derangement recorded at admission to hospital in predicting death with a sensitivity and specificity in the range of 0.6 to 0.8, but the best combination of variables and cut-off levels is still to be identified.

Prediction during hospital stay on ordinary wards.

Eleven studies (LOE P1 prospective, multicenter observational study [Buist, 2004, 137]; LOE P1 prospective, single center cohort [Fuhrmann, 2008, 325] [Goldhill, 2004, 882]; LOE P3 multicenter cross-sectional survey [Jacques, 2006, 175] [Harrison, 2006, 327]; LOE P2 multicenter matched case-control utilizing pooled outcome (cardiac arrest, unplanned ICU admission and death) [Cretikos, 2007, 62]; LOE P2 single center, prospective, observational [Bell, 2006, 66] [Gardner-Thorpe, 2006, 571] [Quarterman, 2005, 133]; LOE P3 multicenter, prospective study in a selected population of patients with greater illness severity [Goldhill, 2004, 1908]; LOE P3 single center retrospective, observational study [Goldhill, 2005, 547]) supported the ability of physiologic derangements measured in adult ward patients to predict death. The more abnormalities, the higher the risk of death, with a positive predictive value ranging from 11 to 70%. The best combination of variables and cut-off points is still to be identified.

Best variables to predict outcome.

One LOE P2 cohort study on existing datasets [Gao, 2007, 667], and 3 LOE P1 single-center, prospective studies [Smith, 2008, 170] [Smith, 2008, 109] [Smith, 2008, 11] evaluating different variables showed a marked variation in their sensitivity and positive predictive value. For aggregate-weighted scoring systems, inclusion of heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), AVPU (alert, vocalizing, pain, unresponsive), temperature, age, and oxygen saturation achieved the best predictive value (area under Receiver Operating Characteristic curve 0.782, 95% CI 0.767-0.797). For single parameter track and trigger systems, cut-off points of HR < 35 and > 140 /min; RR < 6 and > 32 /min; and SBP < 80 mm Hg achieved the best positive predictive value. The inclusion of age improved the predictive value of both aggregate and single parameter scoring systems. Hospitals should use a system validated for their specific patient population to identify individuals at increased risk of serious clinical deterioration, cardiac arrest, or death, both on admission and during hospital stay（Class Ⅰ）.

4) Educational Strategies to Improve Outcomes

For hospital staff, does the use of any specific educational strategies, compared with no such strategies, improve outcomes (eg, early recognition and rescue of the deteriorating patient at risk of cardiac /respiratory arrest)?

There are no randomized controlled studies addressing the impact of a specific educational intervention on improvement of outcomes such as the earlier recognition or rescue of the deteriorating patient at risk of cardiac or respiratory arrest.

One LOE 3 multicenter before/after study [Spearpoint, 2009, 638] found that the number of cardiac arrest calls decreased while pre-arrest calls increased after implementing a standardized educational program in 2 hospitals; the intervention was associated with a decrease in true arrests, and increase in initial survival after cardiac arrest and survival to discharge. A prospective LOE 3 single center trial [Fuhrmann, 2009, 1357] of a simulation-based educational program failed to yield such benefits.

There is insufficient evidence to identify specific educational strategies that improve outcomes (eg, early recognition and rescue of deteriorating patient at risk of cardiac/respiratory arrest). Educational efforts have a positive impact on knowledge, skills, attitudes/confidence, and increase the frequency of activation of a response and should therefore be considered（Class Ⅱa）.

▲*Knowledge gaps*

 Optimal risk stratification on admission and during hospital stay for clinical deterioration or death.

 Methods to identify patients most likely to benefit from early treatment escalation.

- Importance of various components of the rapid response system – education, monitoring, calling criteria, mechanism of calling, and response.
- Elements of required education – calling criteria, clinical skills, simulation training.
- Optimal frequency of vital signs monitoring to detect deterioration.
- Cost-benefits of physician-led versus non-physicians teams.
- Cost-benefits of rapid response team versus patient team responses.
- Do RRT/MET systems (or their individual components) improve outcomes other than cardiac arrest (eg, reduced hospital mortality, reduced length of stay)?
- Impact of other variables (eg, time of day, monitoring status) on risk.

■6 ETHICS, LEGAL ASPECTS AND OUTCOMES

1. Ethical principles and background

1) Ethical Principles

The decision to start, continue and terminate resuscitation efforts is based on the balance between the risks, benefits and burdens these interventions place on patients, family members
and healthcare providers. There are circumstances where resuscitation is inappropriate and
should not be provided. This includes when there is clear evidence that to start resuscitation
would be futile or against the expressed wishes of the patient. Systems should be established to
communicate these prospective decisions and simple algorithms should be developed to assist
rescuers in limiting the burden of unnecessary, potentially painful treatments.

2) Situations in Japan

Resuscitation is widely and internationally considered both a proper act of goodwill and as a voluntary action. However, the priority and underlying concepts differ between countries and areas. In the U.S., the patient's autonomy is respected while the healthcare professional's is given priority in Europe. In other regions, higher priority is given to the social benefit. In Japan, national consensus on application, initiation and termination of resuscitation is left vague, and there has been insufficient argument in the medical-services community, which will be an important issue from now on [Japan Foundation for Emergency Medicine, 2007, 163].

2. Ethical issues of CPR: when to start CPR and when to stop CPR out-of-hospital

1) When to start CPR and when to stop CPR out-of hospital

In Japan, EMS personnel cannot pronounce or “certify” people dead. In such circumstances emergency personnel are always compelled to undertake what may be considered a futile journey and procedure unless there are signs of irreversible death, such as rigor mortis or dependent lividity. Even when obvious signs of death are apparent, EMS personnel should transport the victim if family members are unwilling to accept the fact.

Generally accepted reasons for stopping CPR include the following:

- ☐ Continued CPR poses a danger to rescuers
- ☐ The rescuers are too exhausted to continue CPR

In the case of "obvious death" where it seems reasonable not to carry out CPR or transportation, or the case where it is difficult to decide, it is preferable to consult physicians through online medical control or to examine the decision afterwards in the medical control conference.

2) Ethical issues in Nursing and extended care facilities

In recent years, there has been growing number of emergency transportation cases from nursing and extended care facilities in Japan. In Tokyo, they account for approximately 2.7 percent of all the emergency transportation in 2007, which has grown 4.5 times compared with 1998 (J-LOE5 [Yahagi, N., 2008, 1]). There is also another report that approximately 10 percent of the all transportation was from nursing and extended care facilities (J-LOE5 [[Nakao, H., 2008, 428][Yamamoto, T., 2008, 385]]. In not a small number of these cases, family members indicated that they had not wished resuscitation. Therefore there is demand for clear indication or promotion of advance directives at the facilities (J-LOE 5 [Yokobori, M., 2010, 25][Moriwaki, Y., 2009, 564]). However, implementation of advance directives for those elderly for whom it is difficult to make a rational decision is likely to be influenced by concerned parties or society, and hence, careful system development and in-depth national debate are necessary.

3. Laws concerning resuscitation

1) Laws in the United States "Good Samaritan laws"

Good Samaritan laws generally provide that persons who render aid at the scene of an emergency will not be liable for civil damages if they act in good faith and are not specifically compensated for that aid [American Heart Association, 2004, 205, BLS for Healthcare Providers]. These laws are intended to encourage people to render aid in emergencies and are applied when aid is provided at the scene of the emergency [Higuchi, 2008, 382, Japanese Journal of Radiology].

All 50 states have enacted laws to protect persons who render aid in emergency from liability. The persons protected under these laws vary greatly from state to state [American Heart Association, 2004, 205, BLS for Healthcare Providers]. In Japan, there are no civil laws that quite correspond to Good Samaritan laws, so we don't know whether alternative laws really guarantee protection against liability.

2) Japanese laws concerning resuscitation

(1) Legal interpretation of resuscitation acts by laypeople

Article 698 of the Japanese civil code, concerning urgent management of business, states "If a Manager engages in the Management of Business in order to allow a principal to escape imminent danger to the principal's person, reputation or property, the Manager shall not be liable to compensate for damages resulting from the same unless he/she has acted in bad faith or with gross negligence." This is considered to be an equivalent of Good Samaritan laws. Also article 37 of the penal code, concerning averting present danger, stipulates "An act unavoidably performed to avert a present danger to the life, body, liberty or property of oneself or any other person is not punishable only when the harm produced by such act does not exceed the harm to be averted." Accordingly, resuscitation performed by laypeople is highly likely to be justified on the basis of urgent management business and averting present danger.

The Conference for AED Use by Non-Medical Professionals in 2003 deemed the use of defibrillator on cardiac arrest victims by laypeople not to violate the medical practitioners law, concluding that AED use by a layperson on the scene is not generally considered recurrent medical practice. As for civil and criminal liability, an act unavoidably performed for lifesaving does not impart liability in accordance with relevant laws and regulations. In the case of a layperson assumed to deal with a cardiac arrest victims at a certain frequency due to his/her duty or range of activity, he/she needs to meet the following four requirements: 1) the user is in a situation where prompt aid from medical workers is unavailable despite making an effort to acquire it, 2) the user has confirmed that the victim is unresponsive and not breathing, 3) the user has completed the necessary training courses on AED use, and 4) the AED to be used is approved as medical device under pharmaceutical law.

(2) Legal interpretation on resuscitation acts by healthcare professionals

Article 698 of the civil code mentioned above is based on the premise that the person commences the management of a business for another person without being obligated to do so (article 697). However, article 19 of the medical practitioners law says "When a request for medical examination and treatment is made, a physician engaged in medical treatment may not refuse to give it without justifiable reason." This can be interpreted as meaning that a physician is not necessarily "a Manager who is not obligated" [Higuchi, N., 2008, 382]. Article 37 of the penal code, concerning averting present danger also says "It does not apply to a person under special professional obligation," which can be interpreted as meaning that if a physician begins to give medical treatment to a victim on the street or on an aircraft, a compact is formed between the victim and the physician, and the physician will be liable for a failure to perform work obligations. And also, the absence of "gross negligence," which is the key to not being held liable for urgent management of business, needs to be proved by the rescuer, which can be a heavy burden of proof for the physician [Otsuka,Y., 2004, 57]. As seen from this, physicians' civil and criminal liability is not always discharged at present, and the possibility of dispute cannot be completely denied. If the physician's act cannot be justified, he/she could be accused of negligence or professional negligence or gross negligence causing injury and death [Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications, Department, the Fire and Disaster Management Agency, 1994, 83].

4. Resuscitation ethics at healthcare facilities

1) The influence of advance directives on resuscitation practices （CoSTR）

1）**Decisions Before Cardiac Arrest**

In adults and children with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]), does existence and use of advance directives (eg, "living wills" and "do not attempt resuscitation (DNAR)" orders) compared with no such directives improve outcome (eg, appropriate resuscitation efforts)?

In adults with out-of-hospital cardiac arrest, 5 studies (LOE 4 [Dunn PM, 1996, 785][Tolle SW, 1998, 1097][Lee MA, 2000, 1343]、LOE 5 [Schmidt TA, 2004, 1430][Hickman SE, 2009, 133]) supported the use of "Do Not Resuscitate" (DNR) orders and Physician Orders for Life Sustaining Treatment (POLST) forms compared with no such directives to improve outcome (eg, appropriate resuscitation efforts). One LOE4([Hammes BJ, 1998, 383])study supported the use of advance directives in the context of a community-wide approach. Two studies

(LOE 1 [Patrick DL, 1995, S27]、LOE 2 [Johnson RF, 1995, 752]) suggested that the presence of advance directives reduced resuscitation rates in patients.
In adult patients with cardiac arrest, 18 additional studies (LOE 1[Teno JM, 1997, 508][Schneiderman LJ, 1992, 599][Teno JM, 1998, 439][Teno J, 1997, 500]、LOE 2[Dobbins EH, 2007, 50][Kish Wallace S, 2001, 2294][Morrell ED, 2008, 642]、LOE 4[Becker LJ, 2003, 303][Danis M, 1991, 882][Dull SM, 1994, 997][Guru V, 1999, 1251][Weinick RM, 2008, 179][Mirarchi FL, 2007, 299] LOE 5[Corke C, 2009, 122][Hardin SB, 2004, 1531][Lerner EB, 2002, 425][Mirarchi FL, 2009, 105][Toller CA, 2006, 141]) did not support the use of advance directives (eg, 'living wills') compared with no such directives, to improve outcome defined as resuscitation efforts based on patient preference. Evidence from 1 LOE 3[Skrifvars MB, 2003, 65]study suggested that the presence of a DNR decreased cardiopulmonary resuscitation rates. No study was found that specifically addressed these issues in children.

Standardized orders for limitations on life-sustaining treatments (eg, DNAR, POLST) should be considered to decrease the incidence of futile resuscitation attempts and to ensure that adult patient wishes are honored. Instructions should be specific, detailed, transferable across health care settings, and easily understood. Processes, protocols, and systems should be developed that fit within local cultural norms and legal limitations to allow providers to honor patient wishes regarding resuscitation efforts.

▲*Knowledge gaps*

□ Implementation of DNAR/POLST in patients who move between different health care settings.

□ Relationship between DNAR/POLST decisions and patient preferences.

□ Critical elements for prehospital DNAR

2) Termination of Resuscitation Rules

Most survivors of out-of-hospital cardiogenic cardiac arrest achieved ROSC on the scene. Few victims who had no instance of return of circulation before ambulance, and were given CPR for the full duration of transfer to the hospital survived in a neurologically intact state [Kellermann, 1993, 1433] [ERC G2005, Section 8, 2005, S171].
For adult patients in any setting, is there a clinical decision rule that enables reliable prediction of ROSC (or futile resuscitation efforts)?

One high quality, LOE P1 [Morrison LJ, 2006, 478]prospective study demonstrated the 'basic life support termination of resuscitation rule' (no shockable rhythm, unwitnessed by EMS and no return of spontaneous circulation) is predictive of death when applied by defibrillation-only emergency medical technicians. The survival rate with the application of this rule is 0.5% (95%CI 0.2-0.9).
Subsequent studies including 2 LOE P1[Richman PB, 2008, 517][Morrison LJ, 2009, 324]studies showed external generalizability of this rule. Additional studies (LOE P1[Ong ME, 2006, 337]、 LOE P2[Morrison LJ, 2007, 266]、LOE P5[Bailey ED, 2000, 190]) showed associations with futility of certain variables such as no ROSC at scene; non-shockable rhythm; un-witnessed arrest; no bystander CPR, call response time and patient demographics.
Two in-hospital studies (LOE P1[van Walraven C, 2001, 1602]、LOE P2[van Walraven C, 1999, 129]) and 1 emergency department study (LOE P2[McCullough PA, 1998, 195]) showed that the reliability of termination of resuscitation rules is limited in these settings.
Prospectively validated termination of resuscitation rules such as the 'basic life support termination of resuscitation rule' are recommended to guide termination of pre-hospital CPR in
adults. Other rules for various provider levels, including in-hospital providers, may be helpful to reduce variability in decision making, however rules should be prospectively validated prior to
implementation.

▲*Knowledge gaps*

- When to start CPR in neonatal, pediatric, and adult patients?
- When to stop CPR for pediatric and neonatal patients?
- Prospectively validated termination of resuscitation rule for ALS providers.

3) Stopping CPR because of recovery

Stopping CPR is reasonable when the victim is pulsatile and regains adequate circulation, and begins to breathe normally without cyanosis and gasping.