

Part 1. The update process and highlights: 2015 Korean Guidelines for Cardiopulmonary Resuscitation

Sung Oh Hwang¹, Sung Phil Chung², Keun Jeong Song³, Hyun Kim¹,
Tae Ho Rho⁴, Kyu Nam Park⁵, Young-Min Kim⁵, June Dong Park⁶,
Ai-Rhan Ellen Kim⁷, Hyuk Jun Yang⁸

¹Department of Emergency Medicine, Yonsei University Wonju College of Medicine, Wonju, Korea

²Department of Emergency Medicine, Yonsei University College of Medicine, Seoul, Korea

³Department of Emergency Medicine, Sungkyunkwan University College of Medicine, Seoul, Korea

⁴Department of Internal Medicine, The Catholic University of Korea College of Medicine, Seoul, Korea

⁵Department of Emergency Medicine, The Catholic University of Korea College of Medicine, Seoul, Korea

⁶Department of Pediatrics, Seoul National University College of Medicine, Seoul, Korea

⁷Department of Pediatrics, University of Ulsan College of Medicine, Seoul, Korea

⁸Department of Emergency Medicine, Gachon University College of Medicine, Incheon, Korea

THE BACKGROUND AND UPDATE PROCESS OF THE GUIDELINES FOR CARDIOPULMONARY RESUSCITATION

1. The background of the guidelines for cardiopulmonary resuscitation

Cardiac arrest can occur inside medical institutions (in-hospital) and outside of medical institutions (out-of-hospital), such as home or public place. The incidence of cardiac arrest varies according to ethnicity, country, and region, ranging from 24 to 186 per 100,000 population.¹ In South Korea, annual surveys have been performed since which revealed that the incidence increased from 37.5 per 100,000 population in 2006 to 46.8 in 2010.² The average survival rate for out-of-hospital cardiac arrest was 3.0% between 2006 and 2010 in South Korea, and only 0.9% of cardiac arrest cases experienced good neurologic recovery.³ The survival rate for out-of-hospital cardiac arrest has subsequently increased to approximately 5% in South Korea, although this rate is still lower than those in the US, Europe, and Japan.⁴⁻⁶ The prevention of cardiac arrest is the most important factor for increasing this survival rate. Furthermore, bystanders should be able to recognize the onset of cardiac arrest, initiate cardiopulmonary resuscitation (CPR), and use an automated external defibrillator. Moreover, the emergency medical system should provide a rapid response, advanced care, and efficiently facilitate in-hospital treatment for cases of cardiac arrest.

Because CPR guidelines apply to the overall general public and healthcare providers, they should comply with each country's ethnicity, culture, laws, and medical environment. Thus, each country develops CPR guidelines based on the latest scientific knowledge, and provides these guidelines to healthcare providers and the general public to improve survival rates among patients with cardiac arrest. In 1966, the American Heart Association and the American Academy of Science developed the first CPR guidelines, which have periodically been updated based on the available data in the related areas.⁷⁻¹⁰ In 1993, the American Heart Association and European Re-

eISSN: 2383-4625

Received: 16 February 2016

Revised: 19 March 2016

Accepted: 19 March 2016

Correspondence to: Sung Oh Hwang
Department of Emergency Medicine,
Yonsei University Wonju College of
Medicine, 20 Ilsan-ro, Wonju 26426,
Korea

E-mail: shwang@yonsei.ac.kr



How to cite this article:

Hwang SO, Chung SP, Song KJ, Kim H,
Rho TH, Park KN, Kim YM, Park JD,
Kim AR, Yang HJ. Part 1. The update process
and highlights: 2015 Korean Guidelines for
Cardiopulmonary Resuscitation. Clin Exp
Emerg Med 2016;3(S):S1-S9.

This is an Open Access article distributed
under the terms of the Creative Commons
Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>).

suscitation Council played a pivotal role in organizing the International Liaison Committee on Resuscitation (ILCOR) to create internationally standardized CPR guidelines. The ILCOR applies newly scientific evidence to the existing CPR guidelines at 5-year intervals, and the results are published as the International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations.¹¹⁻¹³ This consensus document contains guidelines that are related to CPR, basic life support (BLS), advance life support (ALS), pediatric BLS, pediatric ALS, neonatal resuscitation (NR), education and implementation, acute coronary syndrome, and first aid.¹⁴ Therefore, when individual countries update or establish their guidelines for CPR, they use the ILCOR guidelines as a scientific basis, while also considering the country's specific medical, legal, and cultural characteristics.

The Korean Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care were established in 2006 by the Korean Association of Cardiopulmonary Resuscitation, which is operated by participating academic societies and social organizations that have an interest in CPR. The Korean Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care were updated based on emerging scientific evidence in 2011, and have been used since that time. The ILCOR announced new Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science in October 2015, which led to the updating of the 2011 Korean Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.¹⁴

2. The development scope and process for updating the Korean Guidelines for Cardiopulmonary Resuscitation

The process for updating the 2011 Korean Guidelines for Cardiopulmonary Resuscitation focused on issues that are directly related to cardiac arrest care. Similar to the 2011 ILCOR guidelines, the 2015 ILCOR guidelines addressed CPR, BLS, ALS, pediatric life support (PLS), NR, and education and implementation. However, the guidelines for post-cardiac arrest care, which have contributed to an increased survival rate based on recent scientific evidence, were developed separately from the guidelines for ALS.

The Guidelines for Cardiopulmonary Resuscitation cover various disciplines, and required experts from all CPR-related academic societies to help develop the guidelines. Thus, the Korean Association of Cardiopulmonary Resuscitation requested the participation of expert members from the Korean Society of Emergency Medicine, the Korean Society of Cardiology, the Korean Pediatric Society, the Korean Society of Neonatology, the Korean Society of Anesthesiologists, the Korean Neurological Association, the Korean Society of Perinatology, the Korean Nurses Associa-

tion, the Korean Society of Emergency Medical Technicians, and Korean Red Cross. The development scope for the new Guidelines for Cardiopulmonary Resuscitation was defined using six areas (BLS, ALS, PLS, NR, post-cardiac arrest care, and education), and expert committees were established for each area. These committees consisted of 1 chairperson or 2 co-chairs and 6 to 10 expert members that were recommended by each academic society. A steering committee, which consisted of a principal researcher and the expert committee chairs, was also established to adjust and coordinate the entire development process. Moreover, to manage any perceived conflict of interest and perform a detailed review of the evidence, an evidence review committee was formed from 119 experts (10 to 25 experts per speciality) who were selected by the committee chairpersons.

Each expert committee selected items that required updating from the 2011 Korean Guidelines for Cardiopulmonary Resuscitation, and also identified updated items that were released by the ILCOR. These update items were classified into two types according to the review method: adaptation or hybrid updating. Items that were developed and reviewed by the ILCOR were reviewed as adaptation items. The hybrid updating items addressed topics that were described in the Korean literature or other relevant articles. Both sets of items were evaluated by the evidence review committee, who invited input from evidence review methodology experts during an educational seminar. These evidence review methodology experts provided instructions to the evidence review experts regarding the guideline update methodologies, which include the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) method; adaptation methodology; and clinical practice guideline development methodologies. The expert committees then held expert workshops to discuss the primary review results for each update item. The updates that were reviewed by the expert committees were further discussed at a consensus conference that was attended by all participating experts. The updated guidelines were developed at the consensus conference after being presented and discussed in an open forum that anyone could attend. Each expert committee created a writing committee to write the guidelines based on these discussions (Fig. 1).

3. Guidelines-related literature review methods

The literature reviewers were recommended by the related academic societies or expert committee chairperson, and all of these reviewers completed declarations regarding any potential conflict of interest that might be related to the review, such as employment, consultation, ownership of shares, research grants, and rewards. Based on feedback from the expert committee chairpersons, the guideline development committee extracted 126 items

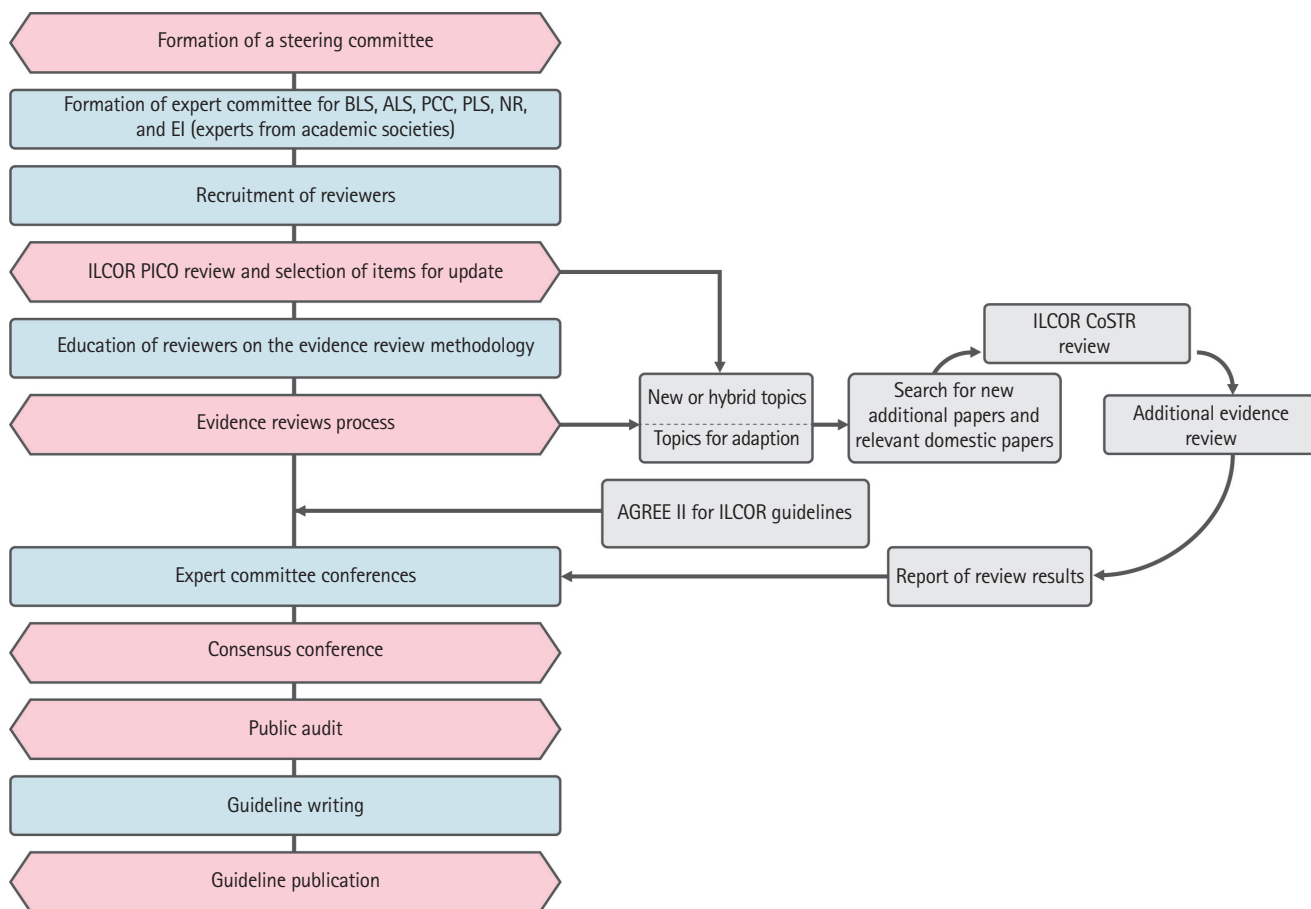


Fig. 1. The developmental process of the Korean guidelines 2015 for cardiopulmonary resuscitation and emergency cardiac care. BLS, basic life support; ALS, advanced life support; PCC, post-cardiac arrest care; PLS, pediatric life support; NR, neonatal resuscitation; EI, education, implementation; ILCOR, International Liaison Committee on Resuscitation; PICO, population, intervention, comparator, outcome; AGREE, Appraisal of Guidelines for Research and Evaluation; CoSTR, Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations.

(BLS, 24 items; ALS, 24 items; post-cardiac arrest care, 16 items; PLS, 21 items; NR, 25 items; education, 16 items) that have a high clinical importance and are relevant to the Korean CPR guidelines; these items are among the population, intervention, comparator, and outcome (PICO) items that were reviewed until January 2015 by ILCOR.¹⁵⁻¹⁹ One primary reviewer or question owner and 1 to 2 other reviewers were assigned to each of the extracted PICO items, and these reviewers applied the GRADE method that was used to develop the 2015 ILCOR Guidelines for Cardiopulmonary Resuscitation.²⁰ Only clinical research papers were considered in the literature review, and non-clinical research papers (e.g., animal studies or simulation studies) were not included. The individual expert committees evaluated the identified papers for relevance and applicability to the Korean population. New international and domestic papers that were published after January 2015 (after the ILCOR review was terminated) were also considered in the evidence review process. The reviewers submitted a draft of the Korean evidence summary and recommendations (or

the Korean CPR clinical practice guidelines) to their specific expert committee, and these drafts contained the ILCOR's evidence summary and recommendations, the reviewers' comments, any update recommendations and justifications, domestic recommendations, and the related references. The submitted contents were reviewed by each expert committee, and then a guideline development committee workshop was organized to revise the contents based on the discussions and consensus from all committee members and reviewers who were in attendance. Three experts assessed the acceptability of the 2015 ILCOR guidelines as source guidelines, using version II of the Appraisal of Guidelines for Research & Evaluation tool.²¹

4. Suggestions for the recommendations grading

The updated recommendations for the Korean CPR clinical practice guidelines were classified into four categories, based on direction (for or against an action) and strength (strong and weak recommendations), as recommended by the GRADE method.²⁰ To deter-

mine the recommendation grading, the following factors were considered. First, strong recommendations were based on items with a high level of evidence, as determined according to the GRADE method for each item; the overall evidence level for each item was defined as the lowest evidence level among the key outcome variables. Second, strong recommendations were based on items with a large difference between the desirable and undesirable effects of each item. Third, weak recommendations were based on low levels of reliability in an individual patient's values and preferences. Fourth, weak recommendations were based on a greater requirement for medical resources. During the process of writing the updates, strong recommendations were indicated using the phrases "recommend" or "should do", and weak recommendations were indicated using the phrases "suggest" or "can do".

HIGHLIGHTS OF THE 2015 KOREAN GUIDELINES FOR CARDIOPULMONARY RESUSCITATION

The major updates of the 2015 Korean Guidelines for Cardiopulmonary Resuscitation included: 1) a new concept regarding the Chain of Survival (introducing the importance of prevention and early detection of cardiac arrest), 2) the importance of identifying cardiac arrest during the treatment of out-of-hospital cardiac arrest and the role of emergency medical dispatchers in the CPR process, 3) chest compression-only CPR for lay rescuers, 4) an adjustment of the chest compression methods, 5) the usefulness of end-tidal carbon dioxide measurement during ALS, 6) targeted temperature management and coronary angiography during the process of post-cardiac arrest care, and 7) recommendations regarding mechanical and extracorporeal CPR.

1. The importance of prevention and early detection of cardiac arrest

In the 2015 Korean Guidelines for Cardiopulmonary Resuscitation, the Chain of Survival includes five links: prevention and early detection of cardiac arrest, early access, early CPR, early defibrillation, effective ALS and post-cardiac arrest care. The first link is prevention and early detection of cardiac arrest, which is newly introduced in the 2015 guidelines. This is because the survival rate is low after cardiac arrest, even if CPR is performed, and preventing the occurrence of cardiac arrest is the most effective method to reduce the number of cardiac arrest-related deaths among adults and children. Efforts to reduce the risk of cardiovascular disease at the individual and national levels are needed to reduce the occurrence of out-of-hospital cardiac arrests. Therefore, public relations activities and public education should be

used to enhance public awareness regarding the association between cardiovascular disease and cardiac arrest, and to encourage individuals to reduce their risk of cardiovascular disease. In addition, bystander response to cardiac arrest can be improved using public education regarding the premonitory symptoms of cardiac arrest, how to recognize cardiac arrest, and what to do when he or she witnesses cardiac arrest.

The occurrence of in-hospital cardiac arrests can be reduced by identifying patients who have a high risk of cardiac arrest, and by rapidly responding to cases of cardiac arrest.²² Therefore, medical institutions with trained medical personnel can reduce the occurrence of in-hospital cardiac arrests by maintaining rapid response or medical emergency teams. Furthermore, cardiac arrest in children is often caused by an accident or injury, and the prevention of accidents or injuries can reduce the number of cardiac arrest-related deaths among children.

2. The important role of emergency medical dispatchers

In the 2015 guidelines, emphasis was placed on the role of emergency medical dispatchers in helping lay rescuers identify cardiac arrest and begin CPR. This is because most cases of cardiac arrest are witnessed by lay individuals, who are typically not trained to manage cardiac arrest and may require time and instruction to identify cardiac arrest and perform CPR. In this context, emergency medical dispatchers can provide telephone guidance to help lay rescuers identify cardiac arrest and perform CPR. This technique is associated with a higher probability of the lay rescuer initiating CPR and shortens the time to CPR initiation.^{23,24} Therefore, emergency medical dispatchers should be trained to guide bystanders in the identification of cardiac arrest and performance of CPR.

3. Chest compression-only CPR recommended for lay rescuers

Chest compression-only CPR refers to chest compressions without rescue breathing. At the beginning of cardiac arrest, there is no difference in the survival rates for chest compression-only CPR or conventional CPR (rescue breathing and chest compressions), and performing only chest compressions improves the survival rate compared to that for when CPR is not performed.²⁵⁻²⁷ Even if they have received CPR training, many lay persons do not perform adequate mouth-to-mouth rescue breathing, and they may not attempt CPR due to their reluctance to perform rescue breathing. Therefore, the 2015 guidelines recommend chest compression-only CPR for lay rescuers, although conventional CPR is recommended for rescuers who are able to perform rescue breathing and intend to do so. Furthermore, chest compression-only CPR is recommended when emergency medical dispatchers

guide lay rescuers in the performance of CPR.

4. Adjustment of chest compression depth and rate

The 2015 guidelines recommend high-quality CPR that provides adequate chest compression depth and rate, sufficient relaxation, and minimal interruptions. The recommendations regarding chest compression depth and rate were updated in the new guidelines based on the scientific evidence and expert opinion.^{28,29} The 2011 guidelines recommend compression depths of 4 cm for infants, 5 cm for children, and ≥ 5 cm for adults (up to 6 cm). In contrast, the 2015 guidelines recommend compression depths of 4 cm for infants, 4 to 5 cm for children, and approximately 5 cm for adults. Furthermore, the 2011 guidelines recommend a chest compression rate of ≥ 100 times per minute (up to 120 times per minute) for adults and children, whereas the 2015 guidelines recommend a rate of 100 to 120 times per minute for adults and children. However, the recommendations regarding the location of chest compression, chest compression to ventilation ratio, sufficient relaxation after chest compression, and minimizing interruptions remain the same as those in the 2011 guidelines.

5. Emphasizing the usefulness of end-tidal carbon dioxide measurement during ALS

There are few methods for evaluating a patient's hemodynamic status during CPR or the effectiveness of the CPR. However, the partial pressure of end-tidal carbon dioxide (the partial pressure of carbon dioxide in exhaled air) changes in response to the proportion of lung perfusion during CPR. Therefore, this pressure can be used to assess the adequacy of chest compressions and the possibility of the return of spontaneous circulation (ROSC).^{30,31} In addition, the partial pressure of end-tidal carbon dioxide can be used to check whether an intubated tube is correctly placed after endotracheal intubation.³² Therefore, the 2015 guidelines recommend using the partial pressure of end-tidal carbon dioxide to assess the effectiveness of CPR, estimate the possibility of ROSC, and locate the endotracheal tube.

6. Recommendations regarding targeted temperature management and coronary angiography during post-cardiac arrest care

Updates were made to the items for hypothermia and coronary angiography, which are the main treatments during post-cardiac arrest care. The 2011 guidelines recommended targeted temperature management at 32°C to 34°C, whereas the 2015 guidelines were updated to recommend a target of 32°C to 36°C for ≥ 24 hours among adults who are unresponsive after ROSC, based on recent evidence regarding core temperature control.³³⁻³⁵ The 2015

guidelines also recommend considering temperature management during post-cardiac care for pediatric patients who are unresponsive after ROSC due to cardiac arrest, and especially to prevent fever among children.

Coronary angiography is performed to identify coronary artery disease as the main cause of cardiac arrest, and appropriate coronary interventions are important treatments that can increase the post-cardiac arrest survival rate.^{36,37} The 2015 guidelines recommend performing emergency coronary angiography if ST elevation is observed on an electrocardiogram, regardless of the patient's state of consciousness after ROSC, and suggest considering emergency coronary angiography in cases that may be caused by acute coronary syndrome, even if ST elevation is not observed. In addition, the 2015 guidelines recommend that patients who achieve ROSC after cardiac arrest should be treated at hospitals where targeted temperature management and coronary interventions are available 24 hr/day (i.e., a post-cardiac arrest care center).

7. Recommendations regarding automatic mechanical CPR devices and extracorporeal CPR

Automatic mechanical CPR devices eliminate the need for manual chest compressions, although the survival rates were not significantly different when studies compared automatic mechanical CPR devices and manual CPR.³⁸⁻⁴⁰ Based on these results, the 2015 guidelines do not recommend the use of automatic mechanical CPR devices as a routine alternative to the current CPR protocol. However, automatic mechanical CPR devices may be useful while transferring patients in an ambulance or helicopter, or while performing angiography or extracorporeal CPR.

Extracorporeal CPR maintains artificial circulation using an extracorporeal device in patients with cardiac arrest who do not respond to conventional CPR, and this method can improve the survival rate when it is selectively used by trained personnel in properly equipped hospitals.^{41,42} The 2015 guidelines recommend that, in hospitals with trained personnel who are capable of using extracorporeal devices, extracorporeal CPR should be considered for patients with cardiac arrest who do not achieve ROSC despite receiving conventional ALS.

CONFLICT OF INTEREST

All authors of the 2015 Korean Guidelines for Cardiopulmonary Resuscitation have documented and signed their declaration of conflicts of interest. Reported conflicts of interest are listed on Appendix 1.

ACKNOWLEDGMENTS

This work was supported by a grant of Korea Centers for Disease Control and Prevention, Republic of Korea. We thank Eun-Ju Park and Mi-Ae Shin from the Office of Korean Association of Cardiopulmonary Resuscitation for their administrative support to this work.

REFERENCES

- Berdowski J, Berg RA, Tijssen JG, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: systematic review of 67 prospective studies. *Resuscitation* 2010;81:1479-87.
- Ro YS, Shin SD, Song KJ, et al. A trend in epidemiology and outcomes of out-of-hospital cardiac arrest by urbanization level: a nationwide observational study from 2006 to 2010 in South Korea. *Resuscitation* 2013;84:547-57.
- Ro YS, Hwang SS, Shin SD, et al. Presumed regional incidence rate of out-of-hospital cardiac arrest in Korea. *J Korean Med Sci* 2015;30:1396-404.
- Chan PS, McNally B, Tang F, Kellermann A; CARES Surveillance Group. Recent trends in survival from out-of-hospital cardiac arrest in the United States. *Circulation* 2014;130:1876-82.
- Stromsoe A, Svensson L, Axelsson AB, et al. Improved outcome in Sweden after out-of-hospital cardiac arrest and possible association with improvements in every link in the chain of survival. *Eur Heart J* 2015;36:863-71.
- Kitamura T, Iwami T, Kawamura T, et al. Nationwide improvements in survival from out-of-hospital cardiac arrest in Japan. *Circulation* 2012;126:2834-43.
- Cardiopulmonary resuscitation. *JAMA* 1966;198:372-9.
- Proceedings of the 1985 National Conference on Standards and Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care. July 11-13, Dallas, Texas. *Circulation* 1986; 74(6 Pt 2):IV1-153.
- National Conference on Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). Standards and guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiac care (ECC). Part VIII: medicolegal considerations and recommendations. *JAMA* 1986;255:2979-84.
- Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. Part I: introduction. *JAMA* 1992;268:2171-83.
- Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 3: adult basic life support. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation. *Circulation* 2000;102(8 Suppl):I22-59.
- International Liaison Committee on Resuscitation. 2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Part 1: introduction. *Resuscitation* 2005;67: 181-6.
- Hazinski MF, Nolan JP, Billi JE, et al. Part 1. Executive summary: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation* 2010;122(16 Suppl 2):S250-75.
- Hazinski MF, Nolan JP, Aickin R, et al. Part 1. Executive Summary: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation* 2015;132(16 Suppl 1):S2-39.
- Finn JC, Bhanji F, Lockey A, et al. Part 8. Education, implementation, and teams: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2015;95:e203-24.
- Soar J, Callaway CW, Aibiki M, et al. Part 4. Advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2015;95:e71-120.
- Perkins GD, Travers AH, Berg RA, et al. Part 3. Adult basic life support and automated external defibrillation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2015;95:e43-69.
- Wyllie J, Perlman JM, Kattwinkel J, et al. Part 7. Neonatal resuscitation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2015;95:e169-201.
- Maconochie IK, de Caen AR, Aickin R, et al. Part 6. Pediatric basic life support and pediatric advanced life support: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2015;95:e147-68.
- Schunemann H, Brozek J, Guyatt G, Oxman A. GRADE handbook (SA version) [Internet]. [place unknown]: McMaster University and Evidence Prime; 2013 [cited 2015 Dec 4]. Available from: http://gdt.guidelinedevelopment.org/central_prod/_design/client/handbook/handbook.html.
- Brouwers MC, Kho ME, Browman GP, et al. AGREE II: advancing

- ing guideline development, reporting and evaluation in health care. *CMAJ* 2010;182:E839-42.
22. Maharaj R, Raffaele I, Wendon J. Rapid response systems: a systematic review and meta-analysis. *Crit Care* 2015;19:254.
 23. Lewis M, Stubbs BA, Eisenberg MS. Dispatcher-assisted cardiopulmonary resuscitation: time to identify cardiac arrest and deliver chest compression instructions. *Circulation* 2013;128:1522-30.
 24. Bohm K, Stalhandske B, Rosenqvist M, Ulfvarson J, Hollenberg J, Svensson L. Tuiton of emergency medical dispatchers in the recognition of agonal respiration increases the use of telephone assisted CPR. *Resuscitation* 2009;80:1025-8.
 25. Rea TD, Fahrenbruch C, Culley L, et al. CPR with chest compression alone or with rescue breathing. *N Engl J Med* 2010;363:423-33.
 26. Svensson L, Bohm K, Castren M, et al. Compression-only CPR or standard CPR in out-of-hospital cardiac arrest. *N Engl J Med* 2010;363:434-42.
 27. Iwami T, Kitamura T, Kiyohara K, Kawamura T. Dissemination of chest compression-only cardiopulmonary resuscitation and survival after out-of-hospital cardiac arrest. *Circulation* 2015;132:415-22.
 28. Stiell IG, Brown SP, Nichol G, et al. What is the optimal chest compression depth during out-of-hospital cardiac arrest resuscitation of adult patients? *Circulation* 2014;130:1962-70.
 29. Idris AH, Guffey D, Pepe PE, et al. Chest compression rates and survival following out-of-hospital cardiac arrest. *Crit Care Med* 2015;43:840-8.
 30. Pearce AK, Davis DP, Minokadeh A, Sell RE. Initial end-tidal carbon dioxide as a prognostic indicator for inpatient PEA arrest. *Resuscitation* 2015;92:77-81.
 31. Levine RL, Wayne MA, Miller CC. End-tidal carbon dioxide and outcome of out-of-hospital cardiac arrest. *N Engl J Med* 1997;337:301-6.
 32. Silvestri S, Ralls GA, Krauss B, et al. The effectiveness of out-of-hospital use of continuous end-tidal carbon dioxide monitoring on the rate of unrecognized misplaced intubation within a regional emergency medical services system. *Ann Emerg Med* 2005;45:497-503.
 33. Hypothermia After Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *N Engl J Med* 2002;346:549-56.
 34. Bernard SA, Gray TW, Buist MD, et al. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. *N Engl J Med* 2002;346:557-63.
 35. Nielsen N, Wetterslev J, Cronberg T, et al. Targeted temperature management at 33°C versus 36°C after cardiac arrest. *N Engl J Med* 2013;369:2197-206.
 36. Hollenbeck RD, McPherson JA, Mooney MR, et al. Early cardiac catheterization is associated with improved survival in comatose survivors of cardiac arrest without STEMI. *Resuscitation* 2014;85:88-95.
 37. Strote JA, Maynard C, Olsufka M, et al. Comparison of role of early (less than six hours) to later (more than six hours) or no cardiac catheterization after resuscitation from out-of-hospital cardiac arrest. *Am J Cardiol* 2012;109:451-4.
 38. Wik L, Olsen JA, Persse D, et al. Manual vs. integrated automatic load-distributing band CPR with equal survival after out of hospital cardiac arrest: the randomized CIRC trial. *Resuscitation* 2014;85:741-8.
 39. Rubertsson S, Lindgren E, Smekal D, et al. Mechanical chest compressions and simultaneous defibrillation vs conventional cardiopulmonary resuscitation in out-of-hospital cardiac arrest: the LINC randomized trial. *JAMA* 2014;311:53-61.
 40. Perkins GD, Lall R, Quinn T, et al. Mechanical versus manual chest compression for out-of-hospital cardiac arrest (PARAMEDIC): a pragmatic, cluster randomised controlled trial. *Lancet* 2015;385:947-55.
 41. Sakamoto T, Morimura N, Nagao K, et al. Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with out-of-hospital cardiac arrest: a prospective observational study. *Resuscitation* 2014;85:762-8.
 42. Chen YS, Lin JW, Yu HY, et al. Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis. *Lancet* 2008;372:554-61.

Appendix 1. The 2015 Korean Guidelines Writing Group disclosure of COI

Author name	COI
Ai-Rhan Ellen Kim	Chair, neonatal resuscitation taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2011, 2015) Chair, neonatal resuscitation committee, Korean Association of Cardiopulmonary Resuscitation
Bongjin Lee	No COI reported
Byung Kook Lee	No COI reported
Chang Hee Lee	No COI reported
Chanwoong Kim	No COI reported
Do Kyun Kim	No COI reported
Dong Jin Oh	No COI reported
Dong Yeon Kim	Consultant, Elsevier nursing skills education program (2012)
Eun Sun Kim	No COI reported
Gi Beom Kim	No COI reported
Gi Woon Kim	No COI reported
Gu Hyun Kang	No COI reported
Gyu Chong Cho	No COI reported
Han Suk Kim	2015 ILCOR evidence reviewer, neonatal resuscitation
Hee Jo Yoon	No COI reported
Hye Won Park	No COI reported
Hyuk Jun Yang	2015 ILCOR First aid taskforce member, 2015 ILCOR question owner
Hyun Kim	Co-chair, ALS taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2015) Chair, ALS committee, Korean Association of Cardiopulmonary Resuscitation
Hyun Kyung Park	No COI reported
Jae-Bum Kim	No COI reported
Jeongmin Kim	No COI reported
Ji Hoon Kim	No COI reported
Ji Sook Lee	No COI reported
Ji Yun Ahn	No COI reported
Jin Wi	No COI reported
Jinhee Kim	No COI reported
Jin-Tae Kim	No COI reported
June Dong Park	Chair, PLS taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2011, 2015) Chair, PLS committee, Korean Association of Cardiopulmonary Resuscitation
June Huh	No COI reported
June Soo Kim	Chair, publication committee, Korean Association of Cardiopulmonary Resuscitation
Keun Jeong Song	Chair, BLS taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2011, 2015) Chair, BLS committee, Korean Association of Cardiopulmonary Resuscitation
Kyu Nam Park	Co-chair, post-cardiac arrest care taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2011, 2015) Chair, planning and coordinating committee, Korean Association of Cardiopulmonary Resuscitation
Kyungil Park	No COI reported
Mi Jin Lee	No COI reported
Moon Sung Park	No COI reported
Sang Gyun Rho	No COI reported
Sangmo Je	No COI reported
Seil Oh	No COI reported
Seung Pihl Choi	No COI reported
Su Jin Cho	No COI reported
Sun Young Park	No COI reported
Sung Oh Hwang	Chair, Korean Guidelines for Cardiopulmonary Resuscitation (2006, 2011, 2015) General secretary, Korean Association of Cardiopulmonary Resuscitation Patent holder of an automatic cardiopulmonary resuscitation device No financial COI reported

(continued to the next page)

Appendix 1. Continued

Author name	COI
Sung Phil Chung	ILCOR evidence reviewer, BLS (2010, 2015) Chair, evidence review and COI management taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2015)
Tai Ho Rho	Co-chair, ALS taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2015)
Won Kyoung Jhang	No COI reported
Yang Ju Tak	No COI reported
Yeon Hee Kim	No COI reported
Yong Hoon Cheon	No COI reported
Yong Soo Jang	No COI reported
Yong Sung Choi	No COI reported
Yoon Hee Kim	No COI reported
Yoon Sil Chang	No COI reported
Young Han Kim	No COI reported
Young Min Kim	Co-chair, post-cardiac arrest care taskforce, Korean Guidelines for Cardiopulmonary Resuscitation (2015) Program director of Asia TTM master class sponsored by C. R. Bard, Inc. (2013, 2014)
Youngsuk Cho	No COI reported

COI, conflict of interest; ILCOR, International Liaison Committee on Resuscitation; ALS, advanced life support; PLS, pediatric life support; BLS, basic life support; TTM, targeted temperature management.