|  |  |
| --- | --- |
| Question | |
| **Should a resuscitation strategy comprising cardiopulmonary resuscitation (ventilations and compressions) vs. compression only resuscitation be used for adults and children in cardiac arrest following drowning?** | |
| **Population:** | adults and children in cardiac arrest following drowning |
| **Intervention:** | a resuscitation strategy comprising cardiopulmonary resuscitation (ventilations and compressions) |
| **Comparison:** | compression only resuscitation |
| **Main outcomes:** | Survival w Favorable Neurological Outcome; 30 Day Survival/ Survival to hospital discharge; Return of spontaneous circulation |
| **Setting:** |  |
| **Perspective:** |  |
| **Background:** | There have been no previous systematic reviews of this question. |
| **Conflict of interests:** | None |

# Assessment

|  |  |  |
| --- | --- | --- |
| Problem Is the problem a priority? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know | Drowning is the third leading cause of unintentional injury related deaths around the world. Morbidity after initially successful resuscitation is high with many survivors experiencing unfavourable neurological outcomes due to brain hypoxia. Developing evidence-based treatment recommendations to aid those attempting to resuscitate people following drowning is therefore a high priority. |  |
| Desirable Effects How substantial are the desirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial ● Small ○ Moderate ○ Large ○ Varies ○ Don't know | Only two studies were found that addressed the question.[Fukada 2019 166; Tobin 2020 1]. Patients who received bystander cpr were compared by the type of CPR they received (compression-only or convention CPR with rescue breaths)  For **survival with a favourable neurological outcome** **at discharge/30-days,** there was no statistical difference in either study.  **For the critical outcome of survival to hospital discharge/30-days,**  Fukada et al [2019 166] reported no statistical difference between groups for survival 30 days.  **For the critical outcome of survival (return of spontaneous circulation) to hospital admission,** there was no statistical difference in either study for this outcome. | Both studies were retrospective and subject to high risk of bias.  A previous systematic review supports the concept that conventional CPR may offer a greater chance for neurologically favorable survival than CO-CPR in children aged <1 year; while a multicentered European study showed increased survival to hospital discharge when bystanders had performed ventilation (Ashoor 2017 112; Grässner 2019 218). |
| Undesirable Effects How substantial are the undesirable anticipated effects? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Large ○ Moderate ○ Small ○ Trivial ○ Varies ● Don't know | Tobin et al [2020 1], 71 (29.7%) in the conventional CPR group and 56 (18.1%) in the compression-only CPR group **survived to hospital discharge** (aOR=1.54; 95% CI, 1.01 to 2.36, p=0.046).  A post-hoc subgroup analysis by Tobin et al. [2020 1] showed conventional CPR was associated with greater adjusted odds of **favourable neurological outcome** in children aged 5 to 15 years (aOR=2.68; 95% CI, 1.10 to 6.77; p= 0.03). | Small sample size in Tobin et al [2020 1].  Unknown undesirable effects, particularly with regard to training, implementation, and infectious disease exposure risks to rescuers.  The cause of arrest in a drowned person includes cardiac etiologies. |
| Certainty of evidence What is the overall certainty of the evidence of effects? | | |
| Judgement | Research evidence | Additional considerations |
| ● Very low ○ Low ○ Moderate ○ High ○ No included studies | The evidence was assessed as very low certainty evidence due to very serious risk of bias, serious inconsistency and serious imprecision. | The significant finding in the subgroup data in children in the study by Tobin must be interpreted with caution due to the small sample size. |
| Values Is there important uncertainty about or variability in how much people value the main outcomes? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Important uncertainty or variability ○ Possibly important uncertainty or variability ○ Probably no important uncertainty or variability ● No important uncertainty or variability | COSCA has confirmed importance of these outcomes.  COSCA: Haywood K, Whitehead L, Nadkarni VM, Achana F, Beesems S, Bottiger BW, et al. COSCA (Core Outcome Set for Cardiac Arrest) in Adults: An Advisory Statement From the International Liaison Committee on Resuscitation. Resuscitation. 2018;127:147-63. |  |
| Balance of effects Does the balance between desirable and undesirable effects favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention  ○ Varies  ● Don't know | Existing evidence is insufficient to favor one from of CPR over another.  The Task Forces discussed the impact of one standard of basic life support training and the simplification using a single approach for teaching, learning and recalling how to perform CPR.  Bystanders are more likely to be willing to perform compression-only CPR (Bray 2017 58) and familiarity with chest compression-only CPR has become widespread in some parts of the world (Grassner 2019). It is simple to teach, learn, remember, and perform (Sayre 2008 2162, Nishiyama 2008 90, Iwami 2015 415, Fukuda 2016 2060). Nevertheless, conventional CPR with compressions and ventilations (CV-CPR) is preferred when the bystander is capable and trained. |  |
| Resources required How large are the resource requirements (costs)? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs ● Moderate costs ○ Negligible costs and savings ○ Moderate savings ○ Large savings ○ Varies ○ Don't know | The costs related primarily to adapting existing training programs and paradigms. |  |
| Certainty of evidence of required resources What is the certainty of the evidence of resource requirements (costs)? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Very low ● Low ○ Moderate ○ High ○ No included studies | Low certainty evidence. |  |
| Cost effectiveness Does the cost-effectiveness of the intervention favor the intervention or the comparison? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison ○ Probably favors the comparison ○ Does not favor either the intervention or the comparison ○ Probably favors the intervention ○ Favors the intervention ○ Varies ● No included studies | No evidence was found that examined the cost-effectiveness of this intervention in this group. |  |
| Equity What would be the impact on health equity? | | |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced ○ Probably reduced ○ Probably no impact ○ Probably increased ○ Increased ○ Varies ● Don't know | Evidence is emerging of inequities in bystanders providing CPR (e.g. to women). More research is required to understand these inequities. The public are more willing to provide compression-only CPR to strangers in hypothetical situations (Bray 2017 58). |  |
| Acceptability Is the intervention acceptable to key stakeholders? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know | Bystanders are more likely to be willing to perform compression-only CPR (Bray 2017 58) and familiarity with chest compression-only CPR has become widespread in some parts of the world (Grassner 2019). It is simple to teach, learn, remember, and perform (Sayre 2008 2162, Nishiyama 2008 90, Iwami 2015 415, Fukuda 2016 2060).  Nevertheless, conventional CPR with compressions and ventilations (CV-CPR) is preferred when the bystander is capable and trained. |  |
| Feasibility Is the intervention feasible to implement? | | |
| Judgement | Research evidence | Additional considerations |
| ○ No ○ Probably no ○ Probably yes ● Yes ○ Varies ○ Don't know | Further updating and clarifying the role of when to use compression only CPR vs conventional CPR is already a component of training programs and no additional infrastructure is needed. |  |

# Summary of judgements

|  | **Judgement** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Problem** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |
| **Desirable Effects** | Trivial | **Small** | Moderate | Large |  | Varies | Don't know |
| **Undesirable Effects** | Large | Moderate | Small | Trivial |  | Varies | **Don't know** |
| **Certainty of evidence** | **Very low** | Low | Moderate | High |  |  | No included studies |
| **Values** | Important uncertainty or variability | **Possibly important uncertainty or variability** | Probably no important uncertainty or variability | No important uncertainty or variability |  |  |  |
| **Balance of effects** | Favors the comparison | Probably favors the comparison | **Does not favor either the intervention or the comparison** | Probably favors the intervention | Favors the intervention | Varies | Don't know |
| **Resources required** | Large costs | Moderate costs | **Negligible costs and savings** | Moderate savings | Large savings | Varies | Don't know |
| **Certainty of evidence of required resources** | **Very low** | Low | Moderate | High |  |  | No included studies |
| **Cost effectiveness** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | Varies | **No included studies** |
| **Equity** | Reduced | Probably reduced | Probably no impact | Probably increased | Increased | Varies | **Don't know** |
| **Acceptability** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |
| **Feasibility** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |

# Type of recommendation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Strong recommendation against the intervention | Conditional recommendation against the intervention | Conditional recommendation for either the intervention or the comparison | Conditional recommendation for the intervention | Strong recommendation for the intervention |
| ○ |  | **●** | ○ | ○ |

# Conclusions

|  |
| --- |
| Recommendation |
| **Treatment Recommendations**  For lay responders, the treatment recommendation for CPR in drowned OHCA patients who have been removed from the water remains consistent with CPR for all patients in cardiac arrest [Maconochie 2020 S410; Olasveengen 2020 S41] (Good Practice Statement):  Adults:   * We suggest that bystanders commence CPR with compressions rather than ventilations in adults with cardiac arrest [Olasveengen 2020 S41]. * We suggest that bystanders who are trained, able, and willing to give rescue breaths and chest compressions do so for all adult patients in cardiac arrest [Olasveengen 2020 S41].   Children:   * We suggest that bystanders provide CPR with ventilation for infants and children younger than 18 years with OHCA [Maconochie 2020 S410]. * We recommend that if bystanders cannot provide rescue breaths as part of CPR for infants and children younger than 18 years with OHCA, they should at least provide chest compressions [Maconochie 2020 S410].   For healthcare professionals and those with a duty to respond to drowning (e.g. lifeguards), we recommend providing ventilations in addition to chest compressions if they have been trained and are able and willing to do so (Good Practice Statement). |
|  |

|  |
| --- |
| Justification |
| In making the decision to follow standard BLS treatment recommendations the review group and Task Force considered the following:   * Cardiac arrest from drowning is due primarily to anoxia (Bierens 2016 147; Vanden Hoek 2010 e405; Soar 2010 1407). Therefore, as with pediatric out-of-hospital cardiac arrest where asphyxia is the predominant etiology (Atkins 2009 1484, Young 2004 157, Sirbaugh 1999 174, Kuisma 1995 141), providing ventilation in OHCA due to drowning is important (Szpilman 2004 25). * Whilst no randomized clinical trial (RCT) was found, the two observational studies that examined the effect of conventional versus compression-only CPR in OHCA due to drowning were subject to a high risk of bias and were considered very low certainty of evidence. * The significant finding in the subgroup data in children in the study by Tobin must be interpreted with caution due to the small sample size. * As noted in the 2020 CoSTR publication, simulation and observational studies favor commencing CPR with compressions over airway and breathing, including two of three simulation RCTs reporting faster times to commencement of rescue breaths when starting with compressions. (Olasveengen 2020 S41) * A previous systematic review supports the concept that conventional CPR may offer a greater chance for neurologically favorable survival than CO-CPR in children aged <1 year; while a multicentered European study showed increased survival to hospital discharge when bystanders had performed ventilation (Ashoor 2017 112; Grässner 2019 218). * The impact of one standard of basic life support training and the simplification using a single approach for teaching, learning and recalling how to perform CPR. * Bystanders are more likely to be willing to perform compression-only CPR (Bray 2017 58) and familiarity with chest compression-only CPR has become widespread in some parts of the world (Grassner 2019). It is simple to teach, learn, remember, and perform (Sayre 2008 2162, Nishiyama 2008 90, Iwami 2015 415, Fukuda 2016 2060). Nevertheless, conventional CPR with compressions and ventilations (CV-CPR) is preferred when the bystander is capable and trained. |

|  |
| --- |
| Subgroup considerations |
| Most cardiac arrest in children is hypoxic in nature. Further analysis and future studies should include specific evaluation of children, adolescents, and the aged as distinct subgroups. The two observational studies had significantly different populations. The mean age for Fukada [Fukada 2019 166] was 72.4 years with a standard deviation of 21.6 years. Once propensity matched, then the mean age in the conventional CPR group was 65 years (SD=26.29) and 65.9 years (SD= 26.7) for the compression only group. Tobin [Tobin 2020 1] had an average age of 23.72years (SD = 25.12) in the conventional CPR group and 32.02 years (SD=26.38) in the compression only CPR Group. |

|  |
| --- |
| Implementation considerations |
| Public education, training, instruction, and public health messaging materials should reflect the most appropriate method for performing CPR. |

|  |
| --- |
| Monitoring and evaluation |
| N/A |

|  |
| --- |
| Research priorities |
| High-quality evidence is required to examine the impact of the type of CPR on OHCA patient outcomes overall and in subgroups (e.g. children). |

# References Summary

Atkins DL, Everson-Stewart S, Sears GK, Daya M, Osmond MH, Warden CR, Berg RA, Resuscitation Outcomes Consortium Investigators. Epidemiology and outcomes from out-of-hospital cardiac arrest in children: the Resuscitation Outcomes Consortium Epistry-Cardiac Arrest. Circulation. 2009;119:1484-91

Ashoor HM, Lillie E, Zarin W, Pham B, Khan PA, Nincic V, Yazdi F, Ghassemi M, Ivory J, Cardoso R, Perkins GD, de Caen AR, Tricco AC; ILCOR Basic Life Support Task Force. Effectiveness of different compression-to-ventilation methods for cardiopulmonary resuscitation: A systematic review. Resuscitation. 2017;118:112–125.

Bierens J, Abelairas-Gomez C, Barcala Furelos R, Beerman S, Claesson A, Dunne C, Elsenga HE, Morgan P, Mecrow T, Pereira JC, Scapigliati A, Seesink J, Schmidt A, Sempsrott J, Szpilman D, Warner DS, Webber J, Johnson S, Olasveengen T, Morley PT, Perkins GD. Resuscitation and emergency care in drowning: A scoping review. Resuscitation. 2021 May;162:205-217. doi: 10.1016/j.resuscitation.2021.01.033. Epub 2021 Feb 4. PMID: 33549689.

Fukuda T, Ohashi-Fukuda N, Kobayashi H, Gunshin M, Sera T, Kondo Y, Yahagi N. Conventional Versus Compression-Only Versus No-Bystander Cardiopulmonary Resuscitation for Pediatric Out-of-Hospital Cardiac Arrest. Circulation. 2016;134:2060-2070.

Fukuda T, Ohashi-Fukuda N, Hayashida K, Kondo Y, Kukita I. Bystander-initiated conventional vs compression-only cardiopulmonary resuscitation and outcomes after out-of-hospital cardiac arrest due to drowning. Resuscitation. 2019;145:166-174.

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.

Kuisma M, Suominen P, Korpela R. Paediatric out-of-hospital cardiac arrests--epidemiology and outcome. Resuscitation. 1995;30:141-50.

Nishiyama C, Iwami T, Kawamura T, Ando M, Yonemoto N, Hiraide A, Nonogi H. Effectiveness of simplified chest compression-only CPR training for the general public: a randomized controlled trial. Resuscitation. 2008;79:90-6.

Olasveengen TM, Mancini ME, Perkins GD, Avis S, Brooks S, Castrén M, Chung SP, Considine J, Couper K, Escalante R, Hatanaka T, Hung KKC, Kudenchuk P, Lim SH, Nishiyama C, Ristagno G, Semeraro F, Smith CM, Smyth MA, Vaillancourt C, Nolan JP, Hazinski MF, Morley PT; Adult Basic Life Support Collaborators. Adult Basic Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2020;142(suppl\_1):S41-S91.

Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, Berg RA, Bingham RM, Brooks SC, Castrén M, Chung SP, Considine J, Couto TB, Escalante R, Gazmuri RJ, Guerguerian AM, Hatanaka T, Koster RW, Kudenchuk PJ, Lang E, Lim SH, Løfgren B, Meaney PA, Montgomery WH, Morley PT, Morrison LJ, Nation KJ, Ng KC, Nadkarni VM, Nishiyama C, Nuthall G, Ong GY, Perkins GD, Reis AG, Ristagno G, Sakamoto T, Sayre MR, Schexnayder SM, Sierra AF, Singletary EM, Shimizu N, Smyth MA, Stanton D, Tijssen JA, Travers A, Vaillancourt C, Van de Voorde P, Hazinski MF, Nolan JP; ILCOR Collabo- rators. 2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. *Resuscitation.* 2017;121:201–214. doi: 10.1016/j.resuscitation.2017.10.021

Olasveengen TM, de Caen AR, Mancini ME, Maconochie IK, Aickin R, Atkins DL, Berg RA, Bingham RM, Brooks SC, Castrén M, Chung SP, Considine J, Couto TB, Escalante R, Gazmuri RJ, Guerguerian AM, Hatanaka T, Koster RW, Kudenchuk PJ, Lang E, Lim SH, Løfgren B, Meaney PA, Montgomery WH, Morley PT, Morrison LJ, Nation KJ, Ng KC, Nadkarni VM, Nishiyama C, Nuthall G, Ong GY, Perkins GD, Reis AG, Ristagno G, Sakamoto T, Sayre MR, Schexnayder SM, Sierra AF, Singletary EM, Shimizu N, Smyth MA, Stanton D, Tijssen JA, Travers A, Vaillancourt C, Van de Voorde P, Hazinski MF, Nolan JP; ILCOR Collaborators. 2017 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommen- dations Summary. *Circulation.* 2017;136:e424–e440. doi: 10.1161/CIR. 0000000000000541

Ogawa T, Akahane M, Koike S, Tanabe S, Mizoguchi T, Imamura T. Outcomes of chest compression only CPR versus conventional CPR conducted by lay people in patients with out of hospital cardiopulmonary arrest witnessed by bystanders: nationwide population based observational study. BMJ. 2011;342:c7106.

Maconochie IK, Richard Aickin R, Mary Fran Hazinski MF, Dianne L Atkins DL, Robert Bingham R, Thomaz Bittencourt Couto TB, Anne-Marie Guerguerian A, Vinay M Nadkarni VM, Kee-Chong Ng KC, Gabrielle A Nuthall GA, Gene Y K Ong GYK, Amelia G Reis AG, Stephen M Schexnayder SM, Barnaby R Scholefield BR, Janice A Tijssen JA, Jerry P Nolan JP, Peter T Morley PT, Patrick Van de Voorde PV, Arno L Zaritsky AL, Allan R de Caen AR, Pediatric Life Support Collaborators. Pediatric Life Support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2020;142(suppl 1):S140–S184

Sayre MR, Berg RA, Cave DM, Page RL, Potts J, White RD. American Heart Association Emergency Cardiovascular Care Committee. Hands-only (compression-only) cardiopulmonary resuscitation: a call to action for bystander response to adults who experience out-of-hospital sudden cardiac arrest: a science advisory for the public from the American Heart Association Emergency Cardiovascular Care Committee. Circulation. 2008;117:2162-7.

Sirbaugh PE, Pepe PE, Shook JE, Kimball KT, Goldman MJ, Ward MA, Mann DM. A prospective, population-based study of the demographics, epidemiology, management, and outcome of out-of-hospital pediatric cardiopulmonary arrest. Ann Emerg Med. 1999;33:174-84.

Soar J, Perkins GD, Abbas G, Alfonzo A, Barelli A, Bierens JJ, Brugger H, Deakin CD, Dunning J, Georgiou M, Handley AJ, Lockey DJ, Paal P, Sandroni C, Thies KC, Zideman DA, Nolan JP. European Resuscitation Council Guidelines for Resuscitation 2010 Section 8. Cardiac arrest in special circumstances: Electrolyte abnormalities, poisoning, drowning, accidental hypothermia, hyperthermia, asthma, anaphylaxis, cardiac surgery, trauma, pregnancy, electrocution. Resuscitation. 2010 Oct;81(10):1400-33. doi: 10.1016/j.resuscitation.2010.08.015. PMID: 20956045.

Szpilman D, Soares M. In-water resuscitation— is it worthwhile? Resuscitation 2004;63:25-31.

Tobin JM, Ramos WD, Greenshields J, Dickinson S et all. Outcome of Conventional Bystander Cardiopulmonary Resuscitation in Cardiac Arrest Following Drowning. CARES Surveillance Group. Prehospital and Disaster Medicine. 2020;35:141-147.

Tobin JM, Ramos WD, Greenshields J, Dickinson S, Rossano JW, Wernicki PG, Markenson D, Vellano K, McNally B; CARES Surveillance Group. Outcome of Conventional Bystander Cardiopulmonary Resuscitation in Cardiac Arrest Following Drowning. Prehosp Disaster Med. 2020 Apr;35(2):141-147. doi: 10.1017/S1049023X20000060. Epub 2020 Jan 24. PMID: 31973778.

Travers AH, Perkins GD, Berg RA, Castren M, Considine J, Escalante R, Gazmuri RJ, Koster RW, Lim SH, Nation KJ, Olasveengen TM, Sakamoto T, Sayre MR, Sierra A, Smyth MA, Stanton D, Vaillancourt C; Basic Life Support Chapter Collaborators. Part 3: Adult Basic Life Support and Automated External Defibrillation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation. 2015 Oct 20;132(16 Suppl 1):S51-83. doi: 10.1161/CIR.0000000000000272. PMID: 26472859.

Vanden Hoek TL, Morrison LJ, Shuster M, Donnino M, Sinz E, Lavonas EJ, Jeejeebhoy FM, Gabrielli A. Part 12: cardiac arrest in special situations: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2010 Nov 2;122(18 Suppl 3):S829-61. doi: 10.1161/CIRCULATIONAHA.110.971069. Erratum in: Circulation. 2011 Feb 15;123(6):e239. Erratum in: Circulation. 2011 Oct 11;124(15):e405. PMID: 20956228.

Young KD, Gausche-Hill M, McClung CD, Lewis RJ. A prospective, population-based study of the epidemiology and outcome of out-of-hospital pediatric cardiopulmonary arrest. Pediatrics. 2004;114:157–64.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Survival with favourable neurological outcome | Pre-hospital ROSC | Survival to discharge | 30 day survival |
| Fukada  (95% CI) | RR 1.15 (.82-1.60) | RR 1.18 (.89-1.56) |  | RR 1.21 (.91-1.61) |
| Tobin  (95% CI) | OR 1.70 (1.11 – 2.60) | OR 1.50 (1.07-2.11) | OR 1.54 (1.01 – 2.36) |  |