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| Question |
| **Should any particular factor in search-and-rescue operations (eg, duration of submersion, salinity of water, water temperature, age of victim) be used to diagnose favourable outcome in In adults and children who are submerged in water ?** |
| **Population:** | In adults and children who are submerged in water  |
| **Intervention:** | any particular factor in search-and-rescue operations (eg, duration of submersion, salinity of water, water temperature, age of victim) |
| **Purpose of the test:** | Provide guidance for Search and Rescue services responsible for drowning victims  |
| **Role of the test:** | Provide guidance for Search and Rescue services responsible for drowning victims |
| **Linked treatments:** |  |
| **Anticipated outcomes:** | Associations between progostic factors and survival outcomes |
| **Setting:** | Any resource setting |
| **Perspective:** |  |
| **Background:** | This question was initiated in 2014 in response to a request that ILCOR review the evidence for prognostic factors that predict outcome in relation to a drowning incident. Drowning is the third leading cause of unintentional injury death worldwide, accounting for over 360 000 deaths annually.[ https://www.who.int/news-room/fact-sheets/detail/drowning] Care of a submersion victim in high-resource countries often involves a multiagency approach, with several different organizations being independently responsible for different phases of the victim’s care, from the initial aquatic rescue, on-scene resuscitation, transfer to hospital, and hospital and rehabilitative care. Attempting to rescue a submerged victim has substantial resource implications and may place rescuers at risk themselves. |
| **Subgroups:** | (1) age, (2) EMS response time, (3) salinity, (4) submersion duration, and (5) water temperature (6) whether the submersion was witnessed. |
| **Conflict of interests:** | None |

# Assessment

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| ProblemIs 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 death worldwide, accounting for over 360 000 deaths annually. As a serious and urgent medical emergency often afflicting young people, strategies to save more lives from drowning has high priority  |  |
| Test accuracyHow accurate is the test? |
| Judgement | Research evidence | Additional considerations |
| ○ Very inaccurate○ Inaccurate○ Accurate○ Very accurate● Varies○ Don't know | There is limited evidence to assess test accuracy. The components of the test (or search and rescue - SAR criteria) thought to be most important in predicting outcome are: (1) age, (2) EMS response time, (3) salinity, (4) submersion duration, and (5) water temperature (6) whether the submersion was witnessed. The factors have varying degrees of associations with outcomes, but none of them provide a clear cut off value in terms of when it is reasonable to stop SAR efforts. The strongest predictor for poor outcome is submersion > 25 minutes, but the 3 studies evaluating this predictor reported only 1/71 favourable neurological outcomes - small numbers to support definitive recommendations to withdraw rescue efforts.  |  |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small○ Moderate● Large○ Varies○ Don't know | Correctly identifying search and rescue criteria for drowning victims has the potential to ensure successful resuscitation from an otherwise deadly emergency. Successful resuscitation of a drowning victim has great value on both an individual and a population basis, and a high degree of benefit or individual improvements are expected for those successfully resuscitated. Undesirable effects of attempting to rescue a submerged victim are related to substantial resource implications and may place rescuers at risk themselves. Care of a submersion victim in high-income countries often involves a multiagency approach, with several different organizations being independently responsible for different phases of the victim’s care, from the initial aquatic rescue, on-scene resuscitation, transfer to hospital, and hospital and rehabilitative care. But perhaps most importantly, prolonged search and rescue operations in difficult conditions may involve unacceptable risks to rescuers.  |  |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ● Large○ Moderate○ Small○ Trivial○ Varies○ Don't know | Correctly identifying search and rescue criteria for drowning victims has the potential to ensure successful resuscitation from an otherwise deadly emergency. Successful resuscitation of a drowning victim has great value on both an individual and a population basis, and a high degree of benefit or individual improvements are expected for those successfully resuscitated. Undesirable effects of attempting to rescue a submerged victim are related to (i) substantial resource implications and may place rescuers at risk themselves (ii) the risk of survival with an adverse neurological outcome. (i) Care of a submersion victim in high-income countries often involves a multiagency approach, with several different organizations being independently responsible for different phases of the victim’s care, from the initial aquatic rescue, on-scene resuscitation, transfer to hospital, and hospital and rehabilitative care. But perhaps most importantly, prolonged search and rescue operations in difficult conditions may involve unacceptable risks to rescuers. (ii) The longer the submersion duration the greater the chances of survival with an adverse neurological outcome which creates substantial personal and societal costs |  |
| Certainty of the evidence of test accuracyWhat is the overall certainty of the evidence of test accuracy? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low● Moderate○ High○ No included studies | The evidence evaluating the association between submersion duration and outcome is of moderate certainty, and submersion durations of less than 10 minutes are associated with a very high chance of favorable outcome whereas submersion durations more than 25 minutes are associated with a low chance of favorable outcomes. Still, submersion duration is an estimation based on information of various certainty during search and rescue efforts. It is also possible the final patient outcomes influence what is subsequently recorded as estimated submersion duration in registries and patient records. The evidence evaluating the association between age, EMS interval, salinity, witnessed status, water temperature and outcome is all low- or very-low-certainty due to a range of risks for bias, inconsistency, indirectness, and imprecision.  |  |
| Certainty of the evidence of test's effectsWhat is the overall certainty of the evidence for any critical or important direct benefits, adverse effects or burden of the test? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low○ Moderate● High○ No included studies | Specific search and rescue criteria will vary between Search and Rescue and EMS organisations, but any criteria used within an organisation will have direct consequences for both drowning victims and rescue personnel. Criteria suggesting continued search and rescue efforts has the potential to directly benefit drowning victims, while criteria suggesting efforts should be discontinued will have directly adverse effects for drowning victims.  | None of the studies reviewed reported on safety or harm to those involved in rescue attempts.  |
| Certainty of the evidence of management's effectsWhat is the overall certainty of the evidence of effects of the management that is guided by the test results? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low○ Moderate● High○ No included studies | Specific search and rescue criteria will vary between Search and Rescue and EMS organisations, but any criteria used within an organization will direct management of drowning incidents.  |  |
| Certainty of the evidence of test result/managementHow certain is the link between test results and management decisions? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low● Moderate○ High○ No included studies | As Search and Rescue operations may put rescuers at risk of harm, and prolonged operations will drain limited resources within Search and Rescue and EMS organisations that could be needed elsewhere, it is assumed that there will be a reasonable link between the criteria used in a rescue organization and their management decisions.  |  |
| Certainty of effectsWhat is the overall certainty of the evidence of effects of the test? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low○ Moderate○ High● No included studies | No studies have specifically evaluated the effects of specific criteria to guide Search and Rescue efforts. |  |
| ValuesIs 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 | The review defined survival with a favourable neurological outcome and survival as critical outcomes. As the duration of submersion increases the chances of favourable neurological outcome and survival decreases. There is likely to be variability in the value which individuals and communities places on survival with favourable neurological outcome compared to survival alone.  |  |
| Balance of effectsDoes 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 | There is significant risk of both desirable and undesirable effects for drowning victims, as well as risk of undesirable effects for rescuers during search and rescue efforts. Specific criteria to guide search and rescue efforts need to be balanced against available resources within individual rescue services.  |  |
| Resources requiredHow 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 | Care of a submersion victim in high-income countries often involves a multiagency approach, with several different organizations being independently responsible for different phases of the victim’s care, from the initial aquatic rescue, on-scene resuscitation, transfer to hospital, and hospital and rehabilitative care.  |  |
| Certainty of evidence of required resourcesWhat is the certainty of the evidence of resource requirements (costs)? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low○ Moderate○ High● No included studies | No specific studies were identified that evaluated resource requirements for Search and Rescue for drowning victims.  |  |
| Cost effectivenessDoes 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 specific studies were identified that evaluated cost effectiveness for Search and Rescue for drowning victims.  |  |
| EquityWhat 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 | Prolonged search and rescue will not be feasible in resource limited settings. There is also likely to be large differences in advanced in- and out-of-hospital treatment provided from services with different levels of resources. While some services may provide ECMO as a bridge to spontaneous circulation and resource demanding organ support, other systems may not have access to basic intensive care treatment. The availability of resources after initial resuscitation will impact on the absolute effectiveness of search and rescue on survival outcomes.  |  |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes○ Yes● Varies○ Don't know | Implementation of criteria for Search and Rescue efforts are feasible, but the specific criteria needs to be balanced against available resources within various rescue services.  |  |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes○ Yes● Varies○ Don't know | Implementation of criteria for Search and Rescue efforts are feasible, but the specific criteria needs to be balanced against available resources within various rescue services.  |  |

# Summary of judgements

|  | **Judgement** |
| --- | --- |
| **Problem** | **No** | Probably no | Probably yes | Yes |  | Varies | Don't know |
| **Test accuracy** | Very inaccurate | Inaccurate | Accurate | Very accurate |  | **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 the evidence of test accuracy** | Very low | Low | **Moderate** | High |  |  | No included studies |
| **Certainty of the evidence of test's effects** | Very low | Low | Moderate | **High** |  |  | No included studies |
| **Certainty of the evidence of management's effects** | Very low | Low | Moderate | **High** |  |  | No included studies |
| **Certainty of the evidence of test result/management** | Very low | Low | **Moderate** | High |  |  | No included studies |
| **Certainty of effects** | 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

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| --- | --- | --- | --- | --- |
| 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

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| Recommendation |
| We recommend that submersion duration be used as a prognostic indicator when making decisions surrounding search and rescue resource management/operations (strong recommendation, moderate-certainty evidence for prognostic significance).We suggest against the use of age, EMS response time, water type (fresh or salt), water temperature, and witness status when making prognostic decisions (weak recommendation, very-low-certainty evidence for prognostic significance).We acknowledge that this review excluded exceptional and rare case reports that identify good outcomes after prolonged submersion in icy cold water. |
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| Justification |
| The 2015 Consensus on Science and Treatment Recommendation benefitted from significant feedback from ILCOR Task Forces and through public consultation, the drowning research and clinical community. In making the original recommendations, the task force placed priority on producing simple guidance that may assist those responsible for managing search and rescue operations. The public comments highlighted the difficult moral dilemmas facing the rescuer in these often emotionally charged and fast-moving environments requiring dynamic risk assessments which consider the likelihood a favourable outcome with the risks posed to those undertaking the rescue. The key finding of the 2015 review was that submersion durations of less than 10 minutes are associated with a very high chance of favorable outcome, and submersion durations more than 25 minutes are associated with a low chance of favorable outcomes.The findings from the six new papers identified in this update,(Al-Quareshi 2017; Jeong 2016 123; Omar 2017 237; Joanknecht 2015 123; Shenoi 2016 669; Tobin 2017 39;] are consistent with the 2015 treatment recommendation. The previously identified limitations of this review (exclusion of factors after the victim is rescued e.g. bystander CPR (Fukuda 2019 111; Tobin 2017 39; Fukuda 2019 166) and specialist interventions e.g. ECMO (Bauman 2019 29; Biermann 2018 e751; Draggan 2016 86; Romlin 1995 e521; Hilmo 2014 1204; Seodudy 2017; Burke 2016 19; Weuster 2016 157) lack of prospective validation of submersion duration as a clinical decision rule) persist. Similarly, rare and exceptional case reports of survival after prolonged (>30 minutes) submersion continue to be reported.(Mann 2019; Romlin 2015 e-521; Draggan 2016 86), highlighting the need for individual, case by case decisions which balance risk and potential for benefit. |

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| Subgroup considerations |
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| Implementation considerations |
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| Monitoring and evaluation |
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| Research priorities |
| Submersion period should be assessed in all future drowning studies and part of multivariate analyses. To better clarify the value of this predictor, studies should include all patients rescued from the water and not only sub-categories.  |