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| Question |
| **Should Spaced vs. Massed learning be used for Resuscitation Training?** |
| **Population:** | Resuscitation Training |
| **Intervention:** | Spaced Learning |
| **Comparison:** | Massed learning |
| **Main outcomes:** | Number of students able to provide good quality chest compressions at 1 year; Number of students able to provide good quality chest compressions at 1 year - Spaced Learning Subgroup; Number of students able to provide good quality chest compressions at 1 year - Booster Learning Subgroup; Number of students able to provide chest compressions of adequate depth at 1 year; Number of students able to provide chest compressions of adequate depth at 1 year - Spaced Learning Subgroup; Number of students able to provide chest compressions of adequate depth at 1 year - Booster Learning Subgroup; Number of students able to provide chest compression of adequate depth at 6 months; Number of students able to provide chest compression of adequate depth at 6 months - Spaced Learning Subgroup; Number of students able to provide chest compression of adequate depth at 6 months - Booster Learning Subgroup; |
| **Setting:** | Resuscitation training courses, basic life support, advanced life support, adult and paediatric resuscitation |
| **Perspective:** |  |
| **Background:** | Effective resuscitation training is important to improve patient survival from cardiac arrests. Educational theory strongly supports advantages of “spaced learning” and training formats employing “spaced” learning are increasingly being developed in the field of resuscitation. The aim is to enhance educational impact and flexibility of teaching. Effective mechanisms contributing to the superiority of “spaced” learning over “massed” learning include the additional time to reflect and elaborate on the learning content between the learning sessions (e.g. constructivist theories), and memory consolidation effects by recall/re-training. If “spacing” effects could be shown to be superior also in resuscitation training, it would be important to recommend respective formats for the improvement of all kinds of resuscitation training. |
| **Conflict of interests:** | COI of following EIT taskforce members have been managed through AHA ILCOR processes: A Lockey, A Cheng, F Bhanji and J Breckwoldt |

# 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 | The spaced learning principle is supported by evidence from both the cognitive science and neuroscience literature {Kramar 2012 5131}. Education and training is important in skill acquisition and skill retention of CPR providers. There is paucity of evidence to support which method of resuscitation training is the most effective {Finn 2015 e205}. Formats employing “spaced” learning are increasingly being developed with the aim is to enhance educational impact and flexibility of teaching. Educational theory strongly supports advantages of “spaced learning” {Benjamin 2010 228; Cepeda 2006 354 ; Cepeda 2008 1095; Seabrook 2005 107; Shebilske 1999 413}. Potential advantages may include the additional time to reflect and elaborate on the learning content between the learning sessions (e.g. constructivist theories), and memory consolidation effects by recall/re-training. If “spacing” effects could be shown to be superior also in resuscitation training, it would be important to recommend respective formats for the improvement of all kinds of resuscitation training. | Description of “spaced” training:“*Spaced or distributed practice involves the separation of training into several discrete sessions over a prolonged period with measurable intervals between training sessions (typically weeks to months), whereas massed practice involves a single period of training without rest over hours or days. In spaced practice, the content is distributed across different sessions or repeated at each session. The number of repetitions and time intervals between repetitions can vary. The term booster training has been used to describe spaced practice after initial completion of training and is generally related to low-frequency tasks such as the provision of CPR. The terms just-in-time training, just-in-place training, and refreshers describe training that is conducted in temporal or spatial proximity to performance.”* {Cheng 2018 282}  |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small● Moderate○ Large○ Varies○ Don't know | There is very low certainty of evidence that spaced learning can improve skill retention (performance 1 year after course conclusion), skill performance (performance between course completion and 1 year) and knowledge at course completion. We did not find any evidence to support either spaced or massed learning in skill performance during actual resuscitations or patient outcomes. | By moving away from massed learning doctrine and rethinking learning, spaced learning may provide more flexible learning opportunities for the learner. These may include in-situ workplace training that can be adapted to learners' job role or experience. |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Large○ Moderate● Small○ Trivial○ Varies○ Don't know | There was higher rate of drop out in number of students undertaking courses that are spaced over time {Andersen 2019 153}. Our review did not find any statistically significant evidence of harm in relation to the intervention for any important or critical outcome. There was higher rate of drop out in number of students undertaking courses that are spaced over time. | The flexible approach in spaced learning must not lead to compromised quality in resuscitation education. Input from educationist is required to ensure that learning objectives are met. Regular feedback and evaluation from learners about their learning experience is encouraged. |
| Certainty of evidenceWhat is the overall certainty of the evidence of effects? |
| Judgement | Research evidence | Additional considerations |
| ● Very low○ Low○ Moderate○ High○ No included studies | Across all outcomes, the certainty of evidence is very low. Certainty of evidence was downgraded for risk of bias, inconsistency and imprecision. There was limited data extraction due to substantial heterogeneity in reported outcomes. Of note, the included studies examined spaced learning in basic life support, pediatric advanced life support and neonatal life support courses only. | Included studies have substantial heterogeneity in types of intervention in spaced learning and booster training. Interventions included instructor-led training, self-directed learning with or without audio-visual feedback/manikin, brief hands on practice, in-situ simulation, scenario testing, observing scenarios and rolling refreshers. |
| 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 | Skill acquisition and prevention of skill decay is recognised problem in CPR providers {Finn 2015 e205}. Effective resuscitation training is highly valued by healthcare providers, patients and public.  | The focus of included studies were educational benefits and measured CPR performance post training under simulation setting. There were no studies reporting CPR performance in clinical setting. There was a lack of studies that addressed critical and important patient outcomes.  |
| 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 | Based on highly valued desirable effects and lack of harmful/undesirable effects, the balance of effects probably favors spaced learning. |  |
| 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 | Large dropout rate in attendance was reported in studies comparing frequent brief booster training {Andersen 2019 153}. This may reflect increased burden on the students to attend training sessions or the need to maintain motivation. There are no studies that reported resources or cost requirements.  | The duration and design of each training session, the interval between sessions, and the number of repetitions should be tailored to context, learner type, objectives, and prior experiences. As a result, resources required for spaced learning may vary depending on the specific format, context, frequency and duration of learning.  |
| 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 | There were no included studies on required resources. |  |
| 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 | There are no studies that reported on costs associated with spaced and massed learning.  | Increased training frequency could result in increased costs from equipment depreciation, time spent to train staff members, and loss of clinical hours by health care providers. {Andersen 2019 153}There is report from institutions that have implemented spaced training in CPR that it has resulted in cost savings {Baylor Scott & White Surgical Hospital–Fort Worth, Resuscitation Quality Improvement 2018}. |
| 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 | There are no studies that addressed potential impact on health equity. | Spaced learning may require organisation of faculty, equipment and learners. It is not known whether spaced learning will improve or worsen accessibility to courses for learners. |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes○ Yes○ Varies○ Don't know | There is evidence that spaced learning is acceptable to students. Studies have reported high students satisfaction, confidence and self-efficacy scores {Montgomery 2012 9; Cepeda Brito 2017 1; Patocka 2019 73} | Organisations responsible for resuscitation training are exploring how technology can enable alternative methods to massed training. Existing examples included modular courses and blended learning. It is likely that flexible training approaches such as spaced learning are acceptable to organisations. |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no● Probably yes○ Yes○ Varies○ Don't know | There is evidence that spaced learning in resuscitation is feasible. There were seventeen studies included in the review reporting different formats of spaced learning in different resuscitation courses, in different healthcare organisations and countries.  | Participation in spaced learning requires ongoing motivation. It may be challenging to engage providers in repeated, effortful practice.The optimal interval of training is unknown for most skills, so learning management systems will have to be used to inform the interval for individual providers.Although in situ simulation and debriefing after real events offer workplace-based opportunities for spaced practice, these techniques are limited to providers working in institutions where resources and personnel are available to support these activities.  |

# Summary of judgements

|  | **Judgement** |
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| **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

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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 |
| *For learners undertaking resuscitation courses, we suggest that spaced learning (training or retraining distributed over time) may be used instead of massed learning (training provided at one single time point) (weak recommendation, very low certainty of evidence).*  |

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| Justification |
| There is growing evidence that spaced learning can improve skill retention (performance 1 year after course conclusion), skill performance (performance between course completion and 1 year) and knowledge at course completion. We did not find any evidence to support either spaced or massed learning in skill performance during actual resuscitations or patient outcomes. In making the above recommendation, the EIT taskforce (working in collaboration with NLS taskforce) considered the following:* Our review has only found low certainty evidence to support spaced learning in resuscitation education. Nevertheless, the taskforce is of the opinion that the benefits of spaced learning demonstrated in other areas of education would also apply in resuscitation training.
* Our review did not examine the effect of different retraining intervals in resuscitation training.
* Our review did not examine the optimal format of spaced learning. Any training intervention will require input from educationist and should be designed to deliver the learning objectives specific to a course. It is unlikely that one specific format, interval or duration would fit all resuscitation training courses.
* There was evidence from one observational study in neonatal resuscitation that survival at 24 hours improved with spaced learning {Mduma 2015 1}. The study assessed the impact of frequent brief (3–5 min weekly) on-site simulation training on newborn resuscitation practices in the delivery room and the potential impact on 24hr neonatal mortality. The number of stimulated neonates increased from 712(14.5%) to 785(16.3%) (p = 0.016), those suctioned increased from 634(13.0%) to 762(15.8%) (p ≤ 0.0005). Mortality at 24hr decreased from 11.1/1000 to 7.2/1000 (p = 0.040).
* There was limited data from two studies which reported improved human factors with spaced learning {Kurosawa 2014 61; Bender 2014 664}.

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| Subgroup considerations |
| * There were no included studies that examined spaced learning in adult advanced life support.
* It was not possible to assess the impact of spaced learning on laypeople versus healthcare professionals.
* It was not possible to assess the impact of spaced learning in initial skill acquisition versus skill maintenance/prevention of skill decay.
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| Implementation considerations |
| * There may be concerns about increased costs or resource use due to organisation required for faculty, equipment and learners to implement spaced learning {Andersen 2019 153}.
* There is evidence from grey literature that spaced learning can lead to cost savings {Baylor Scott & White Surgical Hospital–Fort Worth, Resuscitation Quality Improvement 2018}.
* Input from educationist is required to ensure that learning objectives are met in spaced learning.
* The duration and design of each training session, the interval between sessions, and the number of repetitions should be tailored to context, learner type, objectives, and prior experiences. As a result, resources required for spaced learning may vary depending on the specific format, context, frequency and duration of learning
* Participation in spaced learning requires ongoing motivation. It may be challenging to engage providers in repeated, effortful practice.

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| Monitoring and evaluation |
| * Regular feedback and evaluation from learners about their learning experience is encouraged.
* Quality control in resuscitation courses should be maintained regardless of the format.
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| Research priorities |
| * There was a lack of data on the impact of spaced learning in adult advanced life support
* There was a lack of data on the impact of spaced learning on quality of performance in actual resuscitations
* There was a lack of data on impact of spaced learning on patient survival with favourable neurological outcome. In neonates, there was limited data on infant mortality at 24 hours post-delivery. There is currently no data on survival to hospital discharge or long term survival in neonates.
* There was insufficient data to examine the effectiveness of spaced learning on skill acquisition compared to maintaining skill performance and or preventing skill decay.
* There was limited data on impact of spaced learning on human factors (team behaviors and non-technical skills)
* No evidence on cost effectiveness and resource implications of spaced learning.
* There is a need to understand how to address high attrition rates in spaced learning. In order for spaced learning to be effective, we will need to learners’ motivation and reduce their burden.
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