Review

Stepwise approach to skills teaching in resuscitation: A systematic review

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Abstract

Aim: To compare the effectiveness of Peyton’s four-step approach for teaching resuscitation skills with alternative approaches.

Methods: For this systematic review, we followed the PICOST format (population, intervention, comparison, outcome, study design, timeframe) using Peyton’s four-step approach as the standard. We included all studies analyzing skills training related to resuscitation and First Aid in any educational setting. Eligible were randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, published conference abstracts, and case series where n ≥ 5). We excluded unpublished results (e.g. trial protocols), commentaries, editorials, reviews. Medline, Embase, PsycINFO, ERIC, CINAHL, and Cochrane were searched from inception until November 10, 2020 (updated November 25, 2022) for publications in all languages as long as there was an English abstract. Titles and abstracts of the papers retrieved were screened, and eligible publications were analysed in full text. From the final set of papers, data were extracted into a spreadsheet, subsequently risk of bias assessment was performed (using RoB2 and ROBINS-I), and the certainty of evidence (using GRADE) for each paper was assessed. Screening of studies, data extraction, risk-of-bias assessment, and assessment of certainty of evidence were all performed by two independent researchers. This review was conducted in adherence with PRISMA standards and was registered with PROSPERO (CRD42023377398).

Results: Overall, the search identified 2,574 studies from which 17 were included in the final analysis (14 RCTs, and 3 non-RCTs). The studies involved a total of 2,906 participants from various populations (from lay persons to health care professionals) and analysed nine different resuscitation skills being taught (ranging from chest compressions to needle cricotomy). The alternative teaching approaches ranged from two-steps to five-steps with various modifications of single steps. High methodological and clinical heterogeneity precluded a meta-analysis from being conducted. The risk of bias assessment showed considerable variation between the studies ranging from ‘low’ to ‘serious’. Across all studies, certainty of evidence was rated as very low due to imprecision and inconsistency. Overall, 14 out of 17 studies showed no difference in skill acquisition or retention when comparing Peyton’s four steps to other stepwise approaches.

Conclusions: Very low certainty evidence suggest that Peyton’s four-step approach was not more effective in resuscitation skills training compared to alternative approaches.

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Keywords: Resuscitation skills, Skills teaching, Four-step-approach, Peyton, Stepwise skills teaching, Medical education

Introduction

Skills teaching is an integral component of resuscitation training with the aim of cardiac arrest patients receiving high quality cardiopulmonary resuscitation (CPR). The instructional approach for skills teaching is likely to impact later performance, and various methods have been described. Walker and Peyton proposed that a step-wise approach for skills teaching would be more effective than other approaches. Peyton’s ‘four-steps’ have a firm foundation in educational theory and consist of the steps ‘demonstration’ (skill is shown), ‘deconstruction’ (skill is shown and explained step
by step), ‘comprehension’ (learner gives instructions to instructor to perform the skill), and ‘practice’ (learners practice individually and receive feedback). Peyton’s four-step approach to teach skills is applied in the standard course formats of the European Resuscitation Council (ERC),10 the Australian Resuscitation Council, and various National Resuscitation Councils in Europe while the American Heart Association does not use the approach. However, it is not clear in the literature whether a four-step approach to teach skills is superior to such modifications as using less than four steps, or substituting single steps by e.g., video11 or lecture12 or to no sequencing at all.13

To date, no systematic review has specifically focussed on the Peyton’s four-step approach for resuscitation training. While one recent systematic review analyzed the value of Peyton’s four-step approach in the education of health professionals,14 the results of this review were less useful for the field of resuscitation since the review included a broad variety of skills with heterogeneous complexities (e.g. laparoscopic procedures). The present systematic review sought to compare the educational and clinical outcomes of using the Peyton’s four-step approach in resuscitation training with alternative approaches, including modifications of the four-step approach.

Methods

The review was undertaken as part of the continuous evidence evaluation process of the International Liaison Committee on Resuscitation (ILCOR) Task Force on Education, Implementation, and Teams (EIT). The review was registered at the Prospective Registry for Systematic Reviews (PROSPERO CRD42023377398). We report this review in accordance with the PRISMA Preferred Reporting Items for a Systematic Review and Meta-Analysis.15

The research question was structured as a ‘PICOST’ (Population, Intervention, Comparison, Outcome, Study design, Timeframe) question:

- ‘For adults and children undertaking skills training related to resuscitation and First Aid in any educational setting (Population),
- do approaches to skills teaching that are not the ‘Peyton four-steps’ (Intervention),
- if compared to the ‘Peyton four-step’ approach for skills teaching (Comparison),
- improve ‘skills performed appropriately on real patient after the course’, ‘skill retention measured ≥3 months after training’, ‘skill performance at end of course’, ‘participants’ confidence to perform the skill on patients’, ‘participants’ preference of teaching method’, and ‘instructors’ preference of training method’ (Outcomes).

- Eligibility for inclusion: randomized controlled trials (RCTs) and non-randomized studies (non-RCTs, interrupted time series, controlled pre-/post studies, cohort studies, published conference abstracts, and case series with n ≥ 5). Studies were excluded if they reported unpublished results (e.g. trial protocols, conference abstracts), or were commentaries, editorials, or reviews (Study design).

- Publications from all years and all languages were included as long as an English abstract was available (Timeframe).

In contrast to the prior Prospero registration, we adapted the threshold of the educational outcome of ‘mid-to long-term retention’ from >6 months to ≥3 months after training. We found this important since after the first screening of papers no study had analyzed skill retention at >6 months, and no study would have been included for this outcome. As there is no rigid threshold for ‘mid- to long-term retention’ in the literature, this change appeared reasonable. We also added the outcome ‘instructors’ preference of training method’ as we found this aspect to be important from an instructor’s perspective.

We searched Medline, Embase, PsycINFO, ERIC, CINAH, and Cochrane from inception until 20 Nov, 2020, and updated on 25 Nov, 2022. The Medline search was undertaken in addition to what was indicated in the prior Progress registration. An information specialist of ILCOR developed the search strategy. The updated search was undertaken by the University of Zurich using the same search strategy. The detailed search strategy is shown in Supplemental File 1.

Definitions

We defined Peyton’s four-step approach to skills teaching as a sequence of (a) ‘demonstration’ (of the skill, at normal pace, without commenting), (b) ‘deconstruction’ (of the skill, i.e., demonstration in slow motion, with detailed explanations for the learner with a special focus on critical steps), (c) ‘comprehension’ (by the learner, e.g., by explaining each step while talking the teacher through the skill), (d) ‘performing and practicing’ (of the skill by the learner, ideally until performance is sufficient).8 We defined the intervention as any approach to skills teaching with distinct stages or using modified ‘Peyton four-step’ approaches with more or less than four steps, or with delivering one or more steps by alternative methods, e.g. video. The specific skills of interest included all skills related to resuscitation, such as chest compressions, bag-mask-ventilation, defibrillation, or tracheal intubation. Critical clinical outcome was defined as ‘Skills performed appropriately on real patient after the course’ and the critical educational outcome as ‘Skill retention measured ≥3 months after training’. Important educational outcomes were ‘Skill performance at end of course measured as less than three months after the course’, ‘Participants’ confidence to perform the skill on patients’, ‘Participants’ preference of teaching method’, and ‘Instructors’ preference of training method’.

Potential subgroup analyses were considered for: teaching simple vs. more complex skills; teaching adults vs. children; laypersons vs. health care professionals.

Eligibility criteria

The inclusion criteria were studies with: i) adults and children undertaking skills training related to resuscitation and First Aid in any educational setting, ii) reporting a skill teaching strategy of Peyton four-step approach compared to alternative skills teaching approaches, and iii) studies that reported educational outcomes, outcomes on the patient level and/or on the participant level.

Data extraction

Each article title and abstract was assessed by the first author and one of the co-authors independently to exclude all papers which were clearly not relevant to the research question by using Rayyan.16 Disagreements were sorted out in consensus or with the advice of another member of the author group. Each of the remaining papers was analyzed in full text by two authors independently, and the study characteristics and outcome data were extracted into a spreadsheet file (years of publication and of data acquisition, countries of studies, skills and populations taught, alternative approaches to Peyton’s four-steps, trainee-to-instructor ratio, time points of outcomes).
<table>
<thead>
<tr>
<th>Author, country, study type</th>
<th>skill</th>
<th>Population/sample size</th>
<th>design</th>
<th>Student to teacher ratio</th>
<th>Teaching times comparable</th>
<th>primary outcome</th>
<th>secondary outcomes</th>
<th>main results</th>
<th>additional results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Archer, 2015 (South Africa) RCT</td>
<td>manual defibrillation</td>
<td>1 year med stud</td>
<td>3 groups: – 2 steps – 4 steps 5 steps (with peer feedback)</td>
<td>20 to 1</td>
<td>40 min for all groups</td>
<td>composite score for defib skills</td>
<td>retention at 2 months; questionnaire for study perception of knowledge &amp; skill acquisition and retention</td>
<td>all 3 approaches equivalent for acquisition and retention; differences in ‘total score’; mean 76.6% (80%, 77%, 73%) ( p = 0.37 )</td>
<td>including peer-teaching (5-step) is feasible</td>
</tr>
<tr>
<td>2 Bjørnshave, 2018 (Denmark) RCT</td>
<td>single rescuer BLS/AED</td>
<td>laypersons (mean age 40.5 y)</td>
<td>2 groups: – 2 steps – 4 steps</td>
<td>6 to 1</td>
<td>2 steps: 3 h 15’ 4 steps: 4 h 00’</td>
<td>passing a scenario test (17 of 17 skills)</td>
<td>CC rates and depths, ventilations</td>
<td>2 steps non-inferior to 4 steps; pass rate 2 steps: 57% vs. 4 steps: 59%</td>
<td>CC rate 114 vs. 115; CC depth 47 vs. 48 mm, rescue breaths 1.7 vs. 1.6</td>
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<td>3 Bomholt, 2019 (Denmark) RCT</td>
<td>single rescuer BLS/AED</td>
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<td>6 to 1</td>
<td>2 steps: 3 h 15’ 4 steps: 4 h 00’</td>
<td>passing a scenario test (17 of 17 skills)</td>
<td>CC rates and depths, ventilations</td>
<td>2 steps non-inferior to 4 steps; pass rate (for 17 of 17 skills): 2 steps 11% vs. 4 steps 11%</td>
<td>CC rate 108 vs. 107; CC depth 43 vs. 46 mm, rescue breaths 1.6 vs. 1.6</td>
</tr>
<tr>
<td>4 Frangez, 2017 (Slovenia) RCT</td>
<td>BLS</td>
<td>1 year med stud</td>
<td>2 groups: – 2 steps (steps 2 &amp; 4); 4 steps</td>
<td>not known</td>
<td>4 h 00’ for both groups</td>
<td>correct steps of BLS scenario</td>
<td>differences between teaching according to guidelines 2000 and 2005</td>
<td>4 steps superior for the elements: ‘call for help’, ‘open airway’, ‘CC hand position’, ‘CCs correct’ (all ( p &lt; 0.01 ))</td>
<td>more pronounced effects for 2000 guidelines (compared to 2005 which were perceived as ‘simpler’)</td>
</tr>
<tr>
<td>5 Greif, 2010 (Switzerland) RCT</td>
<td>(needle) cricothyrotomy</td>
<td>4th year med stud</td>
<td>4 groups: - tradit. - no step 2 - no step 3–4 steps</td>
<td>not known</td>
<td>not known</td>
<td>time until ventilation (percentage of par-ticipants reaching &lt; 60 sec; point of no further improvement)</td>
<td>learning curves (50% of cohort reaching &lt; 60 sec; and ‘learning curves’)</td>
<td>all approaches equivalent (percentage of participants achieving ventilation in less than 60 sec; and ‘learning curves’)</td>
<td></td>
</tr>
<tr>
<td>6 Hansen, 2020 (Denmark) RCT</td>
<td>BLS/AED</td>
<td>1 year med stud</td>
<td>2 groups: – steps 1 &amp; 2 as a lecture – 4 steps</td>
<td>8–12 to 1 (lecture); 4–6 to 1 (4 steps group)</td>
<td>3 h 30’ for both groups</td>
<td>pass rate for skills test</td>
<td>participants: self-perceived skills, preference of teaching method</td>
<td>equivalence of both approaches (pass rate 63% in both groups, ( p = 1.00 ))</td>
<td>‘lecture’ group: tidal volumes better, CC rates worse, confidence lower. Preferred method: ‘demonstration’</td>
</tr>
<tr>
<td>7 Herrmann-Werner, 2011 (Germany) RCT</td>
<td>nasogastral intubation;</td>
<td>1 year med stud</td>
<td>4 groups: - BP-SL*</td>
<td>3 to 1</td>
<td>length of teaching identical</td>
<td>binary and global assessment</td>
<td>assessment in skills lab scenario at 6 months; ‘clinical’ BP-SL* more effective than traditional approach (checklist ratings &amp; global assessment) at all</td>
<td>BP-SL* group showed higher ‘clinical competence’</td>
<td></td>
</tr>
<tr>
<td>Author, year, country, study type</td>
<td>skill</td>
<td>Population/sample size</td>
<td>design</td>
<td>Student to teacher ratio</td>
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<td>Jenko, 2012 (Slovenia)</td>
<td>CCs</td>
<td>1st year med stud</td>
<td>n = 94</td>
<td>3 months</td>
<td>scales in skills lab scenario at 3 months</td>
<td>BP-SL* at 6 months</td>
<td>Tradit. at 3 months</td>
<td>no difference overall; percentage of students with all variables correct: 13% for 2 steps vs. 15% for 4 steps ((p = 0.741)). No difference for CC rate, CC depth, correct hand position.</td>
<td>no difference overall; percentage of students with all variables correct: 13% for 2 steps vs. 15% for 4 steps ((p = 0.741)). No difference for CC rate, CC depth, correct hand position. 4 steps with better CC rate/min ((p = 0.02))</td>
</tr>
<tr>
<td>Krautter, 2011 (Germany)</td>
<td>nasogastral intubation</td>
<td>2nd/3rd year med stud</td>
<td>n = 34</td>
<td>2 groups: step 2 &amp; 4 - 4 steps</td>
<td>equal instruction time</td>
<td>scenario testing</td>
<td>time to complete task; assessment of ‘professionalism’ and communication</td>
<td>no difference in ‘correct stepwise performance of the procedure’, assessed by checklist ((p &lt; 0.002))</td>
<td>no correlation between actual (assessed) and self-evaluated knowledge</td>
</tr>
<tr>
<td>Lapucci, 2018 (Italy)</td>
<td>BLS</td>
<td>nursing students</td>
<td>n = 60</td>
<td>2 groups: step 2 - 4 steps</td>
<td>equal instruction time</td>
<td>BLS (CCs, ventilations)</td>
<td>end-of-course</td>
<td>no difference (effective CCs for 2-steps: 75.2 vs. 73.3 for 4 steps ((p = 0.885))</td>
<td>no correlation between actual (assessed) and self-evaluated knowledge</td>
</tr>
<tr>
<td>Münster, 2016 (Germany)</td>
<td>CCs</td>
<td>1st/2nd year med stud</td>
<td>n = 134</td>
<td>3 groups: step 3 standard (steps 2 &amp; 4)</td>
<td>not stated</td>
<td>CC rate, CC depth at 1 week</td>
<td>retention at 5–6 months</td>
<td>no difference at 1 week (no significant difference for ‘correct checklist items’ between the groups; (p = 0.487))</td>
<td>no correlation between actual (assessed) and self-evaluated knowledge</td>
</tr>
</tbody>
</table>

*BP-SL*" at 6 months
<table>
<thead>
<tr>
<th>Author, year, country, study type</th>
<th>skill</th>
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</thead>
<tbody>
<tr>
<td>Nourkan-Tutdibi, 2020 (Germany)</td>
<td>Newborn life support</td>
<td>4th/5th year med stud, n = 123</td>
<td>2 groups: 4 steps/step 3 with ‘functional verbalisation’</td>
<td>3–4 to 1</td>
<td>similar teaching time in both groups</td>
<td>megacode score on day 4 end-of-course</td>
<td>megacode score at 6 months follow-up</td>
<td>equal levels of knowledge acquisition (megacode score control group: 27.3 ± 2.6 vs. trial group: 27.6 ± 2.3; p &lt; 0.527)</td>
<td>total scores at 6 months: 4 steps: 25.6 ± 4.3 vs. trial group (modif. 4 steps): 25.1 ± 4.3, p &lt; 0.748</td>
</tr>
<tr>
<td>Orde, 2010 (Australia)</td>
<td>Laryngeal mask insertion</td>
<td>final year med stud, crit care and ICU nursing stud, n = 120</td>
<td>2 groups: 2 steps (steps 2 &amp; 4)- 4 steps</td>
<td>1 to 1</td>
<td>Overall teaching times not stated</td>
<td>proportion of participants with successful ‘ventil. In &lt; 30 sec’ testing at end-of-training</td>
<td>follow-up at ‘a number of weeks later’ (mean: 71 days): same outcomes as at end-of-training</td>
<td>no statistical difference at end-of-training (mean time to LMA insertion 44.3 s for 2 steps vs. 42.5 s for 4-steps teaching; p &gt; 0.05)</td>
<td>No statistically significant differences at 2 months after training, slight advantages in secondary outcomes for 4 steps</td>
</tr>
<tr>
<td>Schauwinhold, 2022 (Germany)</td>
<td>CCs</td>
<td>1st year med stud, n = 346</td>
<td>2 groups: 4 steps-tele-instruction (online course elements)</td>
<td>unclear (online): approx. 4–8 to 1</td>
<td>not stated</td>
<td>BLS skills (CC depth and rate)</td>
<td>performance of BLS algorithm; self-reported confidence for BLS skills</td>
<td>tele-instructor method non-inferior (demonstrated for CC rate, CC depth)</td>
<td>Non-inferiority for secondary outcomes (BLS algorithm, confidence to perform BLS)</td>
</tr>
<tr>
<td>Schwerdtfeger, 2014 (Germany)</td>
<td>ATLS (steps ABC), trauma management</td>
<td>med stud (advanced), n = 313</td>
<td>2 groups: 4 steps-video for steps 1 &amp; 2</td>
<td>not stated, presumed 6 to 1</td>
<td>‘similar’ times</td>
<td>OSCE score (5 min ATLS: ABC, 9 items + global rating)</td>
<td>subjective evaluation by participants (global score)</td>
<td>no difference of median OSCE score (control group: median 9, IQR 8–9; study group: median 9, IQR 8–9; p = 0.29)</td>
<td>global score: modif. 4 steps better (median 1/6 vs. 2/6; 1 is best); subjective evaluation by students: modif. 4 steps better</td>
</tr>
<tr>
<td>Sopka, 2012 (Germany)</td>
<td>CCs (only)</td>
<td>1st year med stud, n = 220</td>
<td>2 groups: 4 steps-podcast for steps 1 &amp; 2</td>
<td>not stated</td>
<td>‘same course duration’</td>
<td>CC quality at 6 months; self-rated selfconfidence</td>
<td>no difference for all outcomes (except from modif. 4 steps with deeper CCs at end-of-course)</td>
<td>self confidence: ‘no difference’ between groups (only 120 questionnaires)</td>
<td></td>
</tr>
<tr>
<td>Zamani, 2020 (Iran)</td>
<td>Endotracheal intubation (ETI)</td>
<td>advanced med stud (interns), n = 124</td>
<td>2 groups: 2 steps (control)-modif. 4 steps</td>
<td>10 to 1</td>
<td>not stated</td>
<td>ETI score (range 0–32); assessment at end-of-semester</td>
<td>satisfaction score (from 18-90)</td>
<td>modified 4 steps better for ETI score (0–32); modif. 4 steps: 30.1 pts. vs. 2 steps: 26.6 pts. (p &lt; 0.001)</td>
<td>modif. 4 steps with higher satisfaction score (range 18–90); modif. 4 steps: 74.5 pts vs. 2 steps: 57.7 pts (p &lt; 0.001)</td>
</tr>
</tbody>
</table>

**Abbreviations:** AED: automated external defibrillator; ATLS: Advanced Trauma Life Support; BLS: basic life support; *BP-SL: Best-Practice Skills Lab; CC: Chest compressions; ETI: Endotracheal intubation; modif.: modified; OSCE: objective structured clinical examination.
Table 2 – Overview of study characteristics.

<table>
<thead>
<tr>
<th>Years of publication</th>
<th>2010–2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of data acquisition</td>
<td>2004–2020</td>
</tr>
<tr>
<td>Countries of studies</td>
<td>14 Europe (7 Germany, 6 centres); 3 Denmark (1 centre); 2 Slovenia (1 centre); 1 Switzerland; 1 Italy; 1 South Africa; 1 Australia; 1 Iran</td>
</tr>
<tr>
<td>Alternatives to Peyton’s four-steps</td>
<td>o 2 steps (‘see one – do one’); o omission of Peyton step 2, or Peyton step 3; o podcast for Peyton step 1 and 2; o lecture for Peyton step 1 and 2; o tele-instruction omitting Peyton step 3; o functional verbalisation added to Peyton step 3; o video for Peyton step 1 and 2; o Peyton step four (step 5: with or without peer feedback)</td>
</tr>
<tr>
<td>Trainee-to-instructor ratio</td>
<td>From 1 : 1 to 1 : 20; unknown in 5 studies</td>
</tr>
<tr>
<td>Time points of outcomes</td>
<td>o End-of-course only (n = 9)</td>
</tr>
<tr>
<td>Skills taught</td>
<td>o Manual defibrillation (n = 1)</td>
</tr>
<tr>
<td>Populations taught</td>
<td>o Novice medical students (n = 8)</td>
</tr>
</tbody>
</table>

Table 3 – Overview of the types of outcomes, the overall findings, risk of bias (RoB) assessments for the alternative intervention compared to the classical Peyton four-steps approach (primary outcomes).

| No of studies | Neutral In favour of Alternative approach Four-step approach RoB of single studies |
|---------------|-----------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Skill performance after ≥3 months | 5 | 4 | 1<sup>a</sup> | low’ to ‘serious’ |
| Skill performance at end-of-course | 14 | 12<sup>b</sup> | 2<sup>d</sup> | ‘low’ to ‘serious’ |
| Participants’ confidence to perform skill on patients | 6 | 5<sup>e</sup> | 1<sup>f</sup> | ‘some concerns’ to ‘serious’ |
| Participants’ preference of teaching method | 4 | 2<sup>g</sup> | 1<sup>h</sup> | ‘some concerns’ to ‘serious’ |
| Skills performed appropriately on real patient | 0 | - | - | - |

<sup>a</sup> – references (Table 4) 27,31,32,35.<br>
<sup>b</sup> – four-steps approach as one element of a ‘Best practice skills lab teaching’ including ‘feedback’, ‘manikin practice’.23.<br>
<sup>c</sup> – references (Table 5) 12,21,22,24–26,28–30,32–35.<br>
<sup>d</sup> – references (Table 5) 28,36.<br>
<sup>e</sup> – references (Table 6) 21,27,29,34,35.<br>
<sup>f</sup> – as compared to ‘lecture’ for Peyton steps 1 and 2.12.<br>
<sup>g</sup> – references (Table 6) 12,20.<br>
<sup>h</sup> – reference (Table 6) 31.<br>
<sup>i</sup> – reference (Table 6) 36.
In the primary search, we identified 2,199 records. After removal of duplicates and screening of titles and abstracts, 36 studies remained for full text analysis. Twenty-two of these did not meet the predefined inclusion criteria. Studies excluded at this stage had analysed skills not related to resuscitation (such as surgery, intramuscular injection, physiotherapy; n = 3), had compared instructor-led training to other learning formats (such as web-based learning, blended learning, Virtual Reality, or self-instruction; n = 4), other stepwise teaching methods than Peyton (n = 2), influences of learning styles, or gender (n = 2), or had been a survey (n = 1). While hand search based on article bibliographies yielded another ten potentially eligible studies, one of these could be included into the final analysis with 15 articles. From the updated search on November 22nd 2022 we retrieved 375 more records. Out of this update, two more articles were identified to be included leaving us with 17 studies for the final analysis (for the flow diagram, see Supplemental File 2). Study characteristics, designs, and main outcomes are described in Table 1. Fourteen studies were RCTs,12,21–33 and 3 non-RCTs34–36 with a total number of 2,906 participants. Publication dates ranged from 2010 to 2022 (with data acquisition between 2004 and 2020). Fourteen studies (82%) were undertaken in Europe, and the studies analyzed nine different skills related to resuscitation. Fourteen studies12,21,22,24–26,28–30,32–36 reported short term outcomes (up to less than 3 months), while five studies35 reported mid- to long-term retention (from 3 months up to 6 months post training). We found a wide range of target populations with 15 studies investigating various groups of healthcare professionals,12,21–25,28–36 and two studies investigating lay persons26,27 (Tables 1 and 2). All studies had been undertaken in adult learner populations. All studies reported educational outcomes only, and no patient related outcomes were included. For a summary table of study characteristics including the alternative interventions,12,21–36 see Table 2.

**Risk of bias assessment**

The first author and one of the co-authors independently analyzed the included papers using the ‘Risk of Bias 2 (RoB 2) tool’ for RCTs17 and ‘risk of bias in non-randomised studies of interventions (ROBINS-I)’ tool for non-RCTs18. If the reviewers disagreed on any domain, consensus was reached by discussion and the involvement of a third reviewer. Three authors (AL, RG, KGL) were excluded from bias assessment of the studies they had published.

**Synthesis method**

The overall certainty of evidence was assessed according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology.15 Meta-analysis was not undertaken due to significant methodological and clinical heterogeneity. We followed the Synthesis Without Meta-Analysis (SWiM) reporting guidelines20 and we stratified into the predefined outcomes.

**Results**

In the primary search, we identified 2,199 records. After removal of duplicates and screening of titles and abstracts, 36 studies remained for full text analysis. Twenty-two of these did not meet the predefined inclusion criteria. Studies excluded at this stage had analysed skills not related to resuscitation (such as surgery, intramuscular injection, physiotherapy; n = 3), had compared instructor-led training to other learning formats (such as web-based learning, blended learning, Virtual Reality, or self-instruction; n = 10), had analysed new course content or structure (n = 4), other stepwise teaching methods than Peyton (n = 2), influences of learning styles, or gender (n = 2), or had been a survey (n = 1). While hand search based on article bibliographies yielded another ten potentially eligible studies, one of these could be included into the final analysis with 15 articles. From the updated search on November 22nd 2022 we retrieved 375 more records. Out of this update, two more articles were identified to be included leaving us with 17 studies for the final analysis (for the flow diagram, see Supplemental File 2). Study characteristics, designs, and main outcomes are described in Table 1. Fourteen studies were RCTs,12,21–33 and 3 non-RCTs34–36 with a total number of 2,906 participants. Publication dates ranged from 2010 to 2022 (with data acquisition between 2004 and 2020). Fourteen studies (82%) were undertaken in Europe, and the studies analyzed nine different skills related to resuscitation. Fourteen studies12,21,22,24–26,28–30,32–36 reported short term outcomes (up to less than 3 months), while five studies35 reported mid- to long-term retention (from 3 months up to 6 months post training). We found a wide range of target populations with 15 studies investigating various groups of healthcare professionals,12,21–25,28–36 and two studies investigating lay persons26,27 (Tables 1 and 2). All studies had been undertaken in adult learner populations. All studies reported educational outcomes only, and no patient related outcomes were included. For a summary table of study characteristics including the alternative interventions,12,21–36 see Table 2.

**Risk of bias assessment and certainty of evidence**

Risk of bias for single studies varied from ‘low’ to ‘serious’ (for details, see Supplemental File 3). Overall, the studies showed high heterogeneity regarding the skills and populations taught, student-to-instructor ratios, and interventions being compared to Peyton’s four-step approach (Table 2). Overall certainty of evidence was rated as very low being downgraded due to indirectness, imprecision, risk of bias, and inconsistency.

**Overview of study outcomes**

Table 3 gives a summary of the overall findings for each outcome. For the critical educational outcome of skill retention,3 months after training, we identified very low certainty evidence from five stud-
### Table 5 – Important educational outcome: skill performance at end of course.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study type</th>
<th>Skill taught / primary outcome</th>
<th>Population taught</th>
<th>Type of alternative</th>
<th>Overall results</th>
<th>RoB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archer (2015) 21</td>
<td>RCT</td>
<td>Manual defibrillation / composite score for defibrillation skills end-of-course and at 2 months</td>
<td>1st year medical students</td>
<td>Traditional 2-steps and 5-steps approaches</td>
<td>overall study outcome: neutral</td>
<td>Serious b</td>
</tr>
<tr>
<td>Bjorshave (2018) 26</td>
<td>RCT</td>
<td>Single rescuer BLS plus AED/ pass rate at end-of-course</td>
<td>Laypersons</td>
<td>'Traditional' 2-steps approach</td>
<td>Neutral</td>
<td>Low</td>
</tr>
<tr>
<td>Frangez (2017) 28</td>
<td>RCT</td>
<td>BLS (without AED) / BLS scenario test at end-of-course</td>
<td>1st year medical students</td>
<td>'Conventional' 2-steps approach</td>
<td>4-step approach superior</td>
<td>Low</td>
</tr>
<tr>
<td>Greif (2010) 25</td>
<td>RCT</td>
<td>Needle crico-thyroidotomy / time needed to successful ventilation at end-of-course</td>
<td>4th year medical students</td>
<td>3 alternatives: traditional 2 steps; step 2 omitted; step 3 omitted</td>
<td>Neutral (for all 4 approaches)</td>
<td>Some concerns</td>
</tr>
<tr>
<td>Hansen (2020) 12</td>
<td>RCT</td>
<td>BLS and AED / scenario test at end-of-course</td>
<td>1st year medical students</td>
<td>Lecture as a substitute for steps 1 and 2</td>
<td>Neutral</td>
<td>Some concerns f</td>
</tr>
<tr>
<td>Jenko (2012) 29</td>
<td>RCT</td>
<td>Chest compressions / BLS scenario test at end-of-course</td>
<td>1st year medical students</td>
<td>2-step approach</td>
<td>Neutral</td>
<td>Concerns g</td>
</tr>
<tr>
<td>Krautter (2011) 24</td>
<td>RCT</td>
<td>Inserting a naso-gastric tube / performing steps of the procedure at end-of-course</td>
<td>2nd and 3rd year medical students</td>
<td>2-steps approach</td>
<td>Neutral h</td>
<td>Low</td>
</tr>
<tr>
<td>Lapucci (2018) 30</td>
<td>RCT</td>
<td>Chest compressions and ventilations /</td>
<td>Nursing students</td>
<td>2-steps approach</td>
<td>Neutral</td>
<td>Some concerns l</td>
</tr>
<tr>
<td>Nourkami-Tuttidibi (2020) 32</td>
<td>RCT</td>
<td>Neonatal Life Support / megacode scenario at 4 days after intervention</td>
<td>Advanced medical students</td>
<td>Modified 4 steps (step 3)</td>
<td>Neutral</td>
<td>Concerns k</td>
</tr>
<tr>
<td>Orde (2010) 33</td>
<td>RCT</td>
<td>Laryngeal mask insertion / proportion of participants achieving ventilation &lt; 30 seconds</td>
<td>Critical care nurses, ICU nursing stud., final year med. Students</td>
<td>2 steps approach</td>
<td>Neutral</td>
<td>Concerns l</td>
</tr>
<tr>
<td>Schauwinhold (2022) 34</td>
<td>Non-RCT</td>
<td>BLS / chest compression rate and depth at end-of-course</td>
<td>1st year medical, dentistry and physiotherapy students</td>
<td>3 steps with 'tele-instructor supported peer feedback'</td>
<td>Neutral (non-inferiority of the TSP group)</td>
<td>Serious m</td>
</tr>
<tr>
<td>Schwerdtfeiger (2014) 22</td>
<td>RCT</td>
<td>Advanced Trauma Life Support / Median OSCE score at end-of-course</td>
<td>Advanced medical students</td>
<td>Modified 4-steps approach (steps 1 and 2 by video)</td>
<td>Neutral</td>
<td>Concerns o</td>
</tr>
<tr>
<td>Sopka (2012) 35</td>
<td>Non-RCT</td>
<td>BLS (CC only) / chest compression quality at end-of-course</td>
<td>1st year medical students</td>
<td>Modified 4-steps approach</td>
<td>Neutral</td>
<td>Some concerns q</td>
</tr>
<tr>
<td>Zamani (2020) 36</td>
<td>Non-RCT</td>
<td>Endotracheal intubation (ETI) / ETI score at ‘end-of-semester’</td>
<td>Advanced medical students</td>
<td>2 steps</td>
<td>4-step approach superior</td>
<td>Serious r</td>
</tr>
</tbody>
</table>

a – for direct statistical comparison between 2 steps and 4 steps, the 2-step approach was superior.
b – due to high drop-out rate.
d – the study analyzed students trained with the guidelines 2000 and with the guidelines 2005. The authors found more pronounced effects of the 4-step approach for 2000 guidelines (compared to 2005, perceived as ‘simpler’).
E – due to deviations from the intended intervention, measurement of the outcome (intervention included elements of mastery learning).
f – due to deviations of the measurement of the outcome.
g – due to randomization.
h – for primary outcome; for three secondary outcomes advantages for the 4-step approach (‘time to complete insertion’, ‘professionalism’, ‘communication’).
i – due to selection of reported results.
j – step 3 including additional functional verbalization by the student.
k– due to measurement of the outcome.
l– due to drop-out rate, and different teaching times between groups.
m– due to selection bias with differing learning conditions between groups (Covid-19), and measurement of outcomes.
n– neutral for performance score (OSCE); global score (secondary outcome) superior for intervention.
o– due to missing baseline data, drop-out rate and measurement of outcomes.
p– podcast for steps 1 and 2.
q – due to confounding, deviations from intended intervention.
r– due to confounding, selection bias, measurement of the outcomes.
Four studies showed no difference, but one found superior results using Peyton's four-step approach as compared to the alternative. However, in this study, the four-step approach was only one element of a bundle of 'best practice skills lab' strategies and the alternative was a traditional two-step approach.

For the important educational outcome skill performance from end-of-course up to 3 months, we found 14 studies with overall very low certainty of evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) including a total of 2,683 students (Table 5). Twelve studies did not show differences for this outcome, whereas two studies found an advantage of Peyton's four-step approach. Both stud-
ies compared four-steps to a traditional two-steps approach. One study of 266 Slovenian 1st year medical students learning BLS found that four of the BLS elements were executed better using Peyton’s four-step approach, whereas the other study of 67 Iranian advanced medical students found that a modified four-step approach led to significantly better scores for tracheal intubation skills (30.1 ± 1.2 points of an observational score with a maximum of 32 points, compared to 26.6 ± 1.24 points in the control group (p < 0.001)).

For the important educational outcome of participants’ confidence to perform the skill on patients, we found very low certainty evidence from six studies (downgraded for risk of bias, inconsistency, indirectness and imprecision) including a total of 1,368 students (Table 6). Five of these studies showed no differences between the groups. The sixth study found higher confidence to perform the skill after Peyton’s four-step approach as compared to a lecture substituting steps one and two of Peyton’s four-steps (the highest level of self-confidence was reported in 72% as compared to 54% in the alternative group, p = 0.009).

Regarding the important educational outcome of participants’ preference of teaching method, we found very low certainty evidence from four studies (downgraded for risk of bias, inconsistency, indirectness and imprecision) including a total of 813 students (Table 6). One study examining tracheal intubation skills in advanced medical students reported higher satisfaction with Peyton’s four-step approach compared to two steps and found additional advantages such as more student interactions and cooperative learning. Another study analysing manual defibrillation skills found that all study groups wanted more practice, but the Peyton 4-step group wanted it most. In this study students rated ‘Demonstration with explanation’ and ‘Practice session with feedback’ as the most useful parts. In the two remaining studies, there were no differences in participants’ preference.

With regard to the outcome ‘instructors’ preference of training method’ we did not find any evidence.

**Discussion**

Several Resuscitation Councils rely on Peyton’s four-step approach for skills training. However, the efficiency of Peyton’s four-steps has not been fully proven and it is suspected that some instructors do not adhere to the four-step approach in their teaching. We identified seventeen studies investigating nine different skills related to resuscitation and the overall results showed no differences between the effectiveness of Peyton’s four-step approach and varying approaches of stepwise training. While the overall certainty was very low, our findings suggest that Peyton’s four-step approach is not superior to other stepwise approaches.

Despite no identified superiority of Peyton’s four-step approach, educational theory provides a solid foundation that stepwise training approaches to teach psychomotor skills are of value. Of note, the only three studies in this review showing advantages of Peyton’s four-step approach compared it to ‘two-step’ approaches. Hermann-Werner et al. compared ‘traditional skills teaching with four-steps’, the ‘Learn, see, practice, prove, do, maintain’ framework proposed by Sawyer et al. In any case, weak evidence indicates that stepwise skills training should be limited to skills of low to moderate complexity with less than seven steps.

**Limitations of the SR**

This systematic review was limited to papers analyzing Peyton’s four-step approach. Studies comparing other stepwise approaches to each other could have come to different results.

**Limitations of the results, knowledge gaps and future research**

This systematic review has highlighted several limitations. Firstly, heterogeneity of the studies was high therefore it was not possible to conduct a meta-analysis. For the same reason, we were unable to perform any of the pre-planned subgroup analyses. Secondly, almost all studies investigated health care professionals at various stages of training. Findings may only relate to training of healthcare professionals and training approaches for other populations, such as lay persons, children, or elderly citizens, might differ from those included in this review. An additional observational note is that most studies were conducted in Europe, with limited evidence from non-European countries. A crucial and severe limitation pertaining to all studies was that no study reported on the teaching quality of individual instructors. Teacher performance is known to have substantial influence on learning success, and could have differed between study and control groups. This potential effect modifier should be controlled for in future studies. As a further knowledge gap, no studies considered how stepwise approaches to skills teaching could alter the future performance of course participants when treating patients in real cardiac arrest. Finally, reporting of educational outcomes in resuscitation science guidelines was not at all uniform. It would be of great value if an Utstein-like uniform reporting of educational outcomes in resuscitation science guidelines could be developed to allow comparative summaries of such studies, as is done for a number of other contexts.
Conclusions

This systematic review identified very low certainty evidence finding no difference on learning outcomes between Peyton’s four-step approach and the alternative stepwise skill teaching strategies. We recommend that a stepwise approach to skills teaching is used for resuscitation training but that Peyton’s four-step approach may not always be the preferred one depending on context.

Availability of data sources

All data retrieved is included in the article and the supplemental files. A review protocol can be accessed from the first author upon reasonable request.

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Disclaimers

None.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: JB, AC, KGL, AL, JY an RG are members of the ILCOR EIT Task Force (RG is chair, AC is vice-chair). RG is ERC Director of Guidelines and ILCOR. AL is the President of the Resuscitation Council UK. RG, AL and KGL declared an intellectual conflict of interest and were excluded from data extraction and Risk of Bias assessment of the studies they co-authored.15,25 AC, AL, RG, and KGL are Editorial Board members of ‘Resuscitation Plus’.

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Appendix A

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Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2023.100457.

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REFERENCES


