



Simulation and education

Evidence-based educational pathway for the integration of first aid training in school curricula[☆]



Emmy De Buck^{a,*}, Hans Van Remoortel^a, Tessa Dieltjens^a, Hans Verstraeten^a,
Matthieu Clarysse^a, Olaf Moens^b, Philippe Vandekerckhove^{a,c,d}

^a Belgian Red Cross-Flanders, Mechelen, Belgium

^b Flemish Institute for Health Promotion and Disease Prevention (VIGeZ), Brussels, Belgium

^c Department of Public Health and Primary Care, Faculty of Medicine, Catholic University of Leuven, Leuven, Belgium

^d Faculty of Medicine, University of Ghent, Ghent, Belgium

ARTICLE INFO

Article history:

Received 24 April 2015

Received in revised form 26 May 2015

Accepted 5 June 2015

Keywords:

First aid training

Children

First aid knowledge

First aid skills

Helping behaviour

Evidence-based practice

ABSTRACT

Background: “Calling for help, performing first aid and providing Cardiopulmonary Resuscitation (CPR)” is part of the educational goals in secondary schools in Belgium (Flanders). However, for teachers it is not always clear at what age children can be taught which aspects of first aid. In addition, it is not clear what constitutes “performing first aid” and we strongly advocate that the first aid curriculum is broader than CPR training alone.

Objectives: To develop an evidence-based educational pathway to enable the integration of first aid into the school curriculum by defining the goals to be achieved for knowledge, skills and attitudes, for different age groups.

Methods: Studies were identified through electronic databases research (The Cochrane Library, MEDLINE, Embase). We included studies on first aid education for children and adolescents up to 18 years old. A multidisciplinary expert panel formulated their practice experience and expert opinion and discussed the available evidence.

Results: We identified 5822 references and finally retained 30 studies (13 experimental and 17 observational studies), including studies concerning emergency call (7 studies), cardiopulmonary resuscitation (18 studies), AED (Automated External Defibrillator) use (6 studies), recovery position (5 studies), choking (2 studies), injuries (5 studies), and poisoning (2 studies). Recommendations (educational goals) were derived after carefully discussing the currently available evidence in the literature and balancing the skills and attitudes of children of different ages.

Conclusions: An evidence-based educational pathway with educational goals concerning learning first aid for each age group was developed. This educational pathway can be used for the integration of first aid training in school curricula.

© 2015 The Authors. Published by Elsevier Ireland Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Bystanders can play a vital role in delivering help in case of a sudden injury or illness, before professional help arrives, and first aid training is a way to improve this initial response by laypeople.

The frequency of first aid given by laypeople to trauma casualties worldwide ranges from 10.7% to 65%, and incorrect first aid is being given in up to 83.7% of the cases, according to a systematic review

including 10 studies from all over the world.¹ In a 2013 USA survey it was shown that only 20% of laypeople knew about hands-only CPR, while 75% would be willing to perform it.² More specifically in Belgium, a population-based survey in 2011 showed that only 39% of the participants would start resuscitating in case a casualty would collapse, and less than 50% of the participants knew what the function of an AED (Automated External Defibrillator) was.³ Therefore, wider dissemination of first aid training might effectively increase the proportion of bystanders likely to perform first aid.

In a recent study it was shown that instructing schoolchildren to teach CPR to their relatives and friends results in a more positive attitude towards bystander CPR.⁴ Currently in Flanders (Belgium), “calling for help, performing first aid and performing CPR” is part of the educational goals in secondary schools. However, for teachers

[☆] A Spanish translated version of the abstract of this article appears as Appendix in the final online version at doi:10.1016/j.resuscitation.2015.06.008.

* Corresponding author. Fax: +32 15443311.

E-mail address: Emmy.DeBuck@rodekruis.be (E. De Buck).

it is not always clear at what age children can learn the different aspects of resuscitation, AED use and/or other aspects regarding first aid, and teachers often feel uncomfortable in teaching this matter.^{4,5} In addition, it is not clear what is part of “performing first aid” and we strongly advocate that the first aid curriculum is defined more broadly than CPR training alone. Therefore, the aim of this project was to develop evidence-based an educational pathway to enable first aid to be integrated into primary and secondary education, by defining the goals to be achieved for knowledge, skills and attitudes.

2. Methods

An evidence-based educational pathway was developed based on evidence identified in systematic literature searches and practice experience of a multidisciplinary expert panel, according to our methodological charter and the principles of AGREE II.^{6,7} The reporting of the systematic literature reviews was done according to the PRISMA statements (PRISMA checklist see Supplementary material, Appendix 1).⁸ No protocol for the systematic literature searches was published beforehand.

2.1. Selection of educational pathway content

The following 12 topics were selected: calling the emergency number, resuscitation, AED use, choking, Rautek technique (emergency removal of a casualty that is in danger, whereby the casualty is dragged backwards), placing a victim in recovery position, cuts and grazes, burns, bleeding, fainting, injuries to muscles/joints/bones and poisoning. The PICO question can be formulated as follows: Is first aid education (related to one of the above topics) (Intervention) an effective intervention in children (3–18 years) (Population) to improve first aid knowledge, first aid skills and/or first aid attitudes (Outcome) compared to no first aid training (Comparison)? In addition, we searched for evidence about the helping behaviour of children.

2.2. Systematic literature search

2.2.1. Search strategy

Since this project was initially started (in 2012) with the intention of developing evidence-based first aid manuals for children (with only a limited number of topics included), and in a second phase (in 2014) was extended to develop evidence-based educational materials (with a broader scope and more extensive number of topics relevant for schools), we performed searches on two separate moments. However, if the included papers for the second set of questions also included relevant data for the first set of topics, these data were also extracted. We searched Medline (PubMed interface) and Embase (Embase.com) from the date of inception until 10/01/2012 for a first set of questions (emergency number, resuscitation, AED use, choking, Rautek, recovery position, and helping behaviour) and until 25/03/2014 for a second set of questions (cuts and grazes, burns, bleeding, fainting, injuries to muscles/joints/bones and poisoning). The search strategy can be found in the Supplementary material (Appendix 2). Study selection was performed by one reviewer. Titles and abstracts of the references identified by the search were scanned. When a relevant article was found, full texts were retrieved, and studies meeting the selection criteria were included. The citation and reference lists of included studies were searched, and the first 20 related items in PubMed were scanned for other potentially relevant studies.

2.2.2. Selection criteria

We used the following inclusion and exclusion criteria for selection of articles:

Population: We included studies with children or adolescents up to 18 years old. Children with disabilities were excluded.

Intervention: We included studies on first aid education concerning the topics described above. Studies where (part of) the training was given at the hospital were also included. Since AEDs have been developed to be used without formal training, studies on AED use by children were also included even if no training was provided. Studies on helping behaviour were also included if no training was provided, since our aim was to have an overview of current (barriers influencing) helping behaviour. Studies evaluating online training only were excluded.

Control: We included studies with a control group or baseline measurement, or comparing different age groups. Studies on AED use and helping behaviour were also included even if no control group or baseline measurement was included.

Outcome: We included studies that measured first aid knowledge, skills, attitudes, or (factors influencing) helping behaviour.

Study design: We included (randomized) controlled trials, (controlled) before and after studies, case-control studies and cohort studies. For studies on AED use and helping behaviour, we also included cross-sectional studies and case series. We excluded conference abstracts.

Language: We only included studies in English.

2.2.3. Data extraction

Data concerning study design, study population, outcomes, effect measures (expressed as risk ratio, odds ratio, or mean/median differences), and study quality were extracted by one reviewer. Review Manager 5 was used to calculate effect measures, if not reported in the study and if possible. The GRADE approach was used to assess the overall quality of evidence (going from high to very low) included in these guidelines. According to GRADE, the initial level of evidence is high for experimental studies and low for observational studies. The level of evidence was further downgraded because of limitations in study design (risk of bias), inconsistency, indirectness, imprecision or publication bias. Limitations in study design were analysed at the study level using the items listed by GRADE.⁹

2.3. Formulation of evidence-based recommendations

We composed a multidisciplinary expert panel of primary and secondary school teachers, educational advisers, experts in first aid education (including Red Cross employees and volunteers), an expert in health promotion, experts in evidence-based practice, a medical doctor and a child psychologist. We held two consensus meetings (1/02/2012 and 6/05/2014) with the same expert panel. During the first meeting a short training in Evidence-Based Practice was given and a first set of PICO questions was presented and discussed. During the second meeting, a second set of PICO questions and the draft educational pathway (prepared by the Red Cross Youth and First Aid Department) was presented. Where evidence was lacking and consensus was reached about “good practice”, “Good Practice Points” were formulated. Consensus was reached about the educational pathway, using informal consensus methods. The final version of the educational pathway was finally approved by all panel members.

3. Results

3.1. Study identification

We retrieved 5822 references in total, and 30 studies were finally retained as a basis for the recommendations in the guideline (see [Fig. 1](#) for study selection flowchart). A list of the excluded

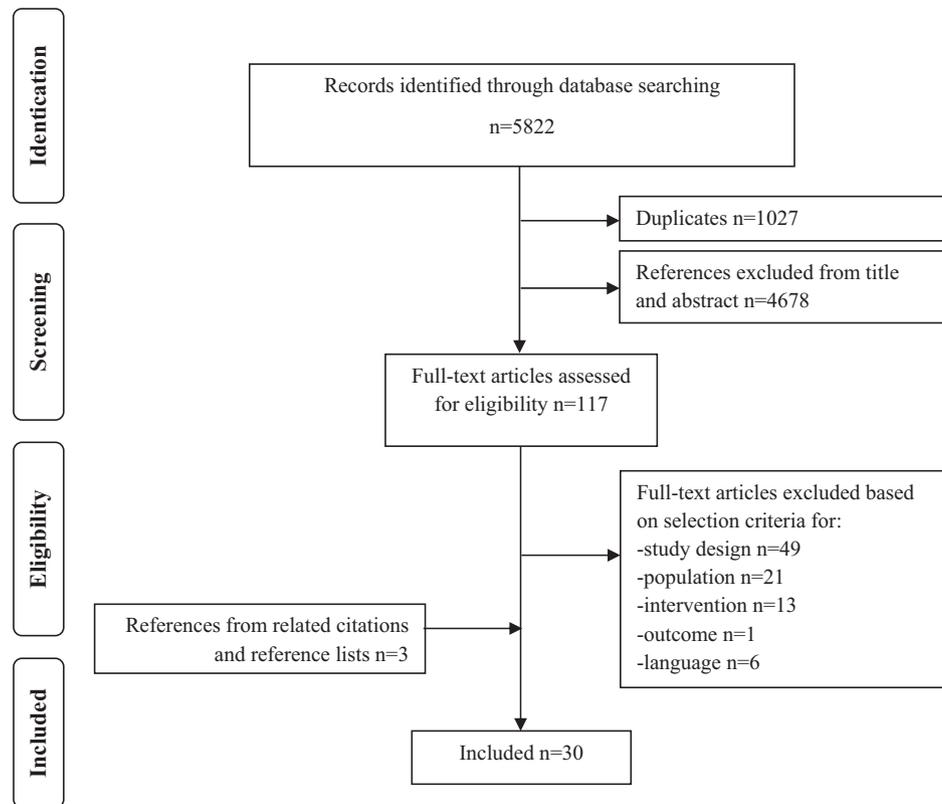


Fig. 1. PRISMA flowchart of identification and selection of studies.

studies with their reason for exclusion can be found in the Supplementary material (Appendix 3). The major reason for exclusion was study design (56%) as many studies did not include a control group or performed a baseline measurement, or references were references were opinion pieces, letters, or comments.

The 30 studies finally retained include 15 European studies (Austria, Norway, Spain, UK),^{10–24} 7 studies from the USA,^{25–31} 3 studies from Australasia (Australia and New-Zealand),^{32–34} 2 African studies (Egypt and Zambia),^{35,36} and 3 Asian studies (Japan, Pakistan, India).^{37–39} Only for Rautek and fainting, no evidence could be identified. The 30 studies included 13 experimental studies and 17 observational studies (see Table 1). Detailed characteristics of the included studies are given in Table 1 and Appendix 4 (Supplementary material).

3.2. Conclusions of the best available evidence

Below we describe the results of 4 of the 13 selected topics (including quality assessment of the studies), as an illustration of the process followed. Results on a 5th topic, AED use, were published earlier.⁴⁰ Appendix 5 shows the findings of all 30 included studies, and Appendix 6 gives an overview of the limitations in study design (Supplementary materials).

3.2.1. Helping behaviour

We found 6 studies measuring helping behaviour, including one randomized controlled trial,¹² 2 cross sectional studies,^{33,38} and 3 case series.^{18,19,27} For overall willingness to help, in children from 11 to 19 years, 27% to 38% is willing to provide basic life support,^{19,38} 31% to 55% is willing to provide chest compressions,^{27,38} 43% is willing to provide mouth-to-mouth ventilations,²⁷ and 32% is willing to use an AED.²⁷ According to one study, willingness to perform CPR did not correlate with theory score or independent skills assessment (raw data were not presented),¹⁸ however in two

other studies it was shown that training statistically significantly increased willingness to help or to perform CPR.^{12,38}

In two studies self-efficacy or confidence in helping was measured. After training, 54% of children aged 11–12 years thought they would be capable of saving a life¹⁸ and the self-efficacy in children of 13–14 years old was significantly higher.¹²

Factors that negatively influence attitudes and behaviour regarding helping were found to be: fear of failing as a rescuer,³⁸ fear of hurting the victim,^{27,38} fear of disease transmission,^{18,19,27,38} a dirty casualty (vomit, an unpleasant smell),^{18,19,27} bleeding (in/around the mouth),^{18,19,27} serious injuries,^{18,19} dangers to the rescuer,^{19,27} the victim being a stranger,^{18,19,27,33,38} or drug user,²⁷ being in a public place,¹⁹ fear of being sued.²⁷ Factors that positively influence attitudes and behaviour regarding helping are: the victim being a relative,^{18,27,33,38} the victim being another child,^{18,27,38} previous first aid training.³⁸

We can conclude that children from 11 to 19 years are willing to provide help, and first aid training is useful to increase their confidence or self-efficacy. During such training it is important to address factors that could influence the attitude of children to provide help.

Since the majority of the studies ($n=5$) was observational, the initial level of evidence was “low”. The level of evidence was further downgraded to “very low”, because 5 studies did not include a control group and did not control for confounding (see Supplementary material, Appendix 6).^{18,19,27,33,38} In addition, we detected indirectness, since the included studies did not measure actual behaviour, but rather a surrogate for behaviour by using a questionnaire and a hypothetical emergency scenario.

3.2.2. Emergency call

Seven different studies measured knowledge and skills concerning calling the emergency number.^{10,11,14,20,24,25,29} In the only study with children of 5 and 6 years old, a difference in knowledge

Table 1
Characteristics of included studies for evidence review concerning helping behaviour, emergency call, choking and recovery position.

Author, year, country	Study design	Population	Intervention	Outcome(s)
Bollig, 2009, Norway ¹⁰	Experimental study: randomized controlled trial	<i>Number of participants:</i> 228 children (126 boys, 102 girls); <i>intervention:</i> n = 117, control: n = 111 <i>Age:</i> 6–7 years	Intervention: <i>Program:</i> theoretical and practical first aid/CPR training given by first aid instructors of the Norwegian Red Cross using a glove puppet <i>Content:</i> the body and its functions, assessment of consciousness and breathing, wound treatment, bleeding, recovery position, behaviour in emergency situations, emergency call, first aid scenarios <i>Duration:</i> 5 lessons (45 min each, one lesson a week) Control: no training	Outcomes were measured immediately and 6 months after the intervention: <i>Knowledge:</i> knowledge emergency number (measured in test scenario described below) <i>Skills:</i> measured in a test scenario where first aid should be given to an unconscious victim after a cycle accident; the following items were evaluated: correct assessment of consciousness/breathing; giving correct emergency information; correct recovery position; correct airway management
Campbell, 2001, USA ²⁵	Experimental study: randomized controlled trial	<i>Number of participants:</i> 660 children (51% boys, 49% girls); <i>intervention:</i> n = 293, control: n = 367 <i>Age:</i> 11–16 years	Intervention: <i>Program:</i> first aid and home safety training, led by 23 trained group leaders (derived from American Red Cross training courses) <i>Content:</i> focus on responding to emergency situations (first aid) and on prevention of injuries: emergency care, fever and first aid kit, controlling bleeding and treating burns, fractures, dislocations and sudden illness, sport injury and prevention, poisoning, bites, stings and allergies, first aid review and household safety <i>Duration:</i> 8 educational sessions (2 h each) over a 7-to-10 week period. Session format (welcome and session overview, check-in, brief review of previous session, group leader lecture presentation, break, skills demonstration and practice, homework assignments, closure) Control: <i>Program:</i> tobacco and alcohol prevention program, led by 23 trained group leaders <i>Content:</i> listening skills, communication skills, health effects of smoking and peer pressure, health effects of alcohol and decision making, societal influences and refusal skills. <i>Duration:</i> 8 sessions (2 h each) over a 7-to-10 week period	Outcomes that were measured before, immediately and 1 year after the intervention: <i>Knowledge:</i> the following items were asked for in a survey: Knowledge of correct emergency response procedures (check-call-care) Knowledge of items that should be included in a first aid kit Knowledge of distinct items in the kit <i>Attitudes:</i> Changes in the availability of a first aid kit at home (attitude) [these data were not extracted] Outcomes that were measured before and 1 year after the training: <i>Attitudes:</i> Response to two audio-recorded scenarios that involved accident victims (scenario 1: respond to a severe wound from glass; scenario 2: respond to a severe burn injury to a toddler). It was noted if the respondents stated that they would check the scene and victim (response 1), call 911 (response 2), and care for the victim (response 3). If all three responses were given, it was noted if the adolescent listed these three steps in the correct order (i.e., check, call, and care)
Connolly, 2007, UK ¹¹	Experimental study: controlled before after study	<i>Number of participants:</i> 79; <i>intervention:</i> n = 46, control: n = 33 <i>Age:</i> 10–12 years	Intervention: <i>Program:</i> single course of instruction in cardiopulmonary resuscitation ('ABC for life' programme) <i>Content:</i> A session consisted of 4 stages, with the use of cartoons, simple language and memory aids: (1) video, (2) small group teaching, (3) demonstration manikin, (4) supervised practice. The teaching was divided in three parts: approach, CPR, recovery position. <i>Duration:</i> duration of less than 2 h for each teaching session Control: no training	Outcomes were measured before, immediately (only intervention group) and 6 months after the intervention: <i>Knowledge</i> was measured using a 22 point multiple choice questionnaire (8 questions about patient approach)

Table 1 (Continued)

Author, year, country	Study design	Population	Intervention	Outcome(s)
Engeland, 2002, Norway ¹²	Experimental study: randomized controlled trial	<i>Number of participants:</i> 893 adolescents (50% boys, 50% girls); <i>intervention:</i> n = 741, <i>control:</i> n = 152 <i>Age:</i> 13–14 years	Intervention: <i>Program:</i> first aid training program 'Do Something' <i>Content:</i> -a textbook to teach following topics: get ready for action, obtain an overview of the situation, perform plan ABC (Airway, Breathing and Circulation), give first aid and finish first aid. -a video containing 7 episodes dealing with chest pain/cardiac arrest, serious epileptic seizure, injuries to the head or neck, burn injuries, internal bleeding, obstruction of the airways and drowning. <i>Duration:</i> about 6 months Control: no intervention	Outcomes were measured before and 6 months after the intervention: <i>Knowledge</i> of first aid was measured via 17 questions (53 items). One score was calculated for each main question. The score for each student ranged from 0 (none of the answers correct) to 100 (all the answers were correct). [these data were not extracted, since no separate data on separate first aid topics were available] <i>Attitude</i> towards giving first aid was calculated based on 3 questions <i>Attitude</i> towards learning first aid was calculated based on 3 questions
Frederick, 2000, UK ¹⁴	Experimental study: controlled before after study	<i>Number of participants:</i> 1292 children; <i>intervention:</i> n = 657, <i>control:</i> n = 635 <i>Age:</i> 10–11 years	Intervention: <i>Name of the program:</i> Injury Minimization Program for Schools (IMPS) <i>Content:</i> (1) education resource pack providing teaching materials exploring all aspects of risks and safety of following areas: road safety, accidents in the home, fire, electricity, poisons and waterways. (2) hospital visit with three learning opportunities: (i) basic life support and resuscitation skills, (ii) interactive video about common accidents (burns, cuts, electrocution, first aid responses), (iii) a tour of an accident and emergency department. <i>Duration:</i> program is delivered within school curriculum (packs are available during whole academic year). Control: no training	Outcomes that were measured before and 5 months after the intervention: <i>Knowledge</i> was tested using a specifically developed quiz, which after coding into categories (correct, incorrect, missing, and not applicable) produced nominal level data. Outcomes measured 5 months after the intervention: <i>Attitude</i> (stopping risky behaviour) was tested with a validated research tool ("draw and write"); a video was shown, depicting an evolving story of a group of children engaged in both subtle and obviously dangerous activities near a canal. Children recorded their observations and further developed the story by drawing and/or writing on a response sheet
Frederick, 2002, UK ¹⁵	Experimental study: controlled before after study	<i>Number of participants:</i> 1292 children; <i>intervention:</i> n = 657, <i>control:</i> n = 635 <i>Age:</i> 10–11 years	Intervention: Injury Minimization Program for Schools (IMPS) (see Frederick, 2000) Control: no training	Outcomes were measured 5 months after the intervention: <i>Skills:</i> CPR skills during a simulated emergency scenario, using a manikin (they were asked to imagine that the manikin was their neighbour who had collapsed) <i>Attitude:</i> during a simulated emergency scenario
Hubble, 2003, USA ²⁷	Observational study: case series	<i>Number of participants:</i> 683 students <i>Age:</i> 13–19 years	Intervention: watching a video about the operation of an AED and 6 video clips with different cardiac arrest scenarios	Outcomes were measured immediately after the intervention: <i>Attitude:</i> willingness to perform chest compressions, mouth-to-mouth resuscitation and automated external defibrillation, prior knowledge and experiences with CPR and AED and possible reasons for not intervening were evaluated using a 35-item survey
Lester, 1996, UK ¹⁸	Observational study: case series	<i>Number of participants:</i> 41 children (24 girls, 17 boys) <i>Age:</i> 11–12 years	Intervention: <i>Program:</i> CPR training <i>Content:</i> first a video was shown, showing emergency situations and CPR techniques; instruction in CPR skills was given by a trained teacher using a manikin; a discussion of the ethical and practical issues was held using 4 scenarios where life support techniques were used <i>Duration:</i> 3 1 h lessons	Outcomes were measured immediately and 9 days (only skills) after the training: <i>Knowledge</i> was measured using a multiple choice questionnaire <i>Skills:</i> assessment of practical ability using training manikins and an 11-point checklist <i>Attitude</i> was measured using a questionnaire [only data about attitude were extracted]

Table 1 (Continued)

Author, year, country	Study design	Population	Intervention	Outcome(s)
Lester, 1997, UK ¹⁹	Observational study: case series	<i>Number of participants:</i> 243 children <i>Age:</i> 11–12 years	Intervention: <i>Program:</i> CPR training from a teacher <i>Content:</i> short video and hands-on practice course using a manikin; one lesson discussing the ethics of CPR <i>Duration:</i> 2 h lessons + lesson on ethics (duration not known) [the data about CPR training from a teacher assisted by an older pupil, were not used in this analysis]	Outcomes were measured immediately after the training: <i>Knowledge</i> was measured using a 10-point multiple choice questionnaire <i>Skills:</i> assessment of practical ability using training manikins; an overall score was calculated by counting the individual points for each component of CPR and converting this to a percentage. <i>Attitude</i> was measured using a questionnaire; a Likert scale was used for some questions, and an open-ended question was also included. An overall score was calculated by counting the individual points on the questions with the Likert scale and converting this to a percentage ('definitely would' scored 10 points, 'probably would' 5 points, 'probably would not' 1 point and 'definitely would not' 0 Points). This percentage score which was placed into one of four categories (less than 50% 'unlikely to respond', 50–69% 'possibly would', 70–89% 'probably would' and 90% or more 'very probably would respond'). [only data about attitude were extracted]
Loem, 2008, Norway ²⁰	Observational study: before after study	<i>Number of participants:</i> 102 children <i>Age:</i> 12 years	Intervention: <i>Program:</i> CPR training by teachers <i>Content:</i> CPR training using a DVD, an inflatable manikin, a cardboard phone and an information folder <i>Duration:</i> 45 min (30 min DVD) [the data about family members and friends (adults) that were trained at home with children as facilitators, were not used in this analysis]	Outcomes were measured before and 1 week after the training: <i>Skills</i> were measured using a manikin. The children were told that an adult had collapsed in front of them. Compression depth and tidal volume were measured by a reporting system accompanying the manikin, and other outcomes were registered using video recording. Skills were scored on a scale from 14 (worst) to 56 (best) based on a revised Cardiff test Outcomes were measured before and 6 months after the intervention: <i>Knowledge</i> was measured using a questionnaire consisting of 3 sections: how to cross the street (3 questions), how to recognize an emergency and dial 911 (3 questions), and how to avoid strangers (4 questions). [only data about calling 911 were used in this analysis]
Luria, 2000, USA ²⁹	Experimental study: randomized controlled trial	<i>Number of participants:</i> 246 children; intervention: <i>n</i> = 122, control: <i>n</i> = 124 <i>Age:</i> 5–6 years	Intervention: <i>Program:</i> Safety city program <i>Content:</i> safety education program about how to cross the street, call 911 in an emergency and avoid strangers; each session consist of a lecture and a practical part (e.g. crossing the street, a board game concerning stranger avoidance, and using a fake telephone); at the end of the course the children receive a coloring book and a rock concert reinforcing the teaching objectives <i>Duration:</i> approximately 20 min per topic; half-day course Control: no training	Outcomes were measured before and 6 months after the intervention: <i>Knowledge</i> was measured using a questionnaire consisting of 3 sections: how to cross the street (3 questions), how to recognize an emergency and dial 911 (3 questions), and how to avoid strangers (4 questions). [only data about calling 911 were used in this analysis]
Omi, 2008, Japan ³⁸	Observational study: cross sectional study	<i>Number of participants:</i> 3316 children (51% boys, 49% girls) <i>Age:</i> 15–17 years	Intervention: questionnaire	The following outcomes were measured: <i>Attitude:</i> questionnaire regarding their willingness to perform CPR with 5 hypothetical scenarios with cardiac arrest (stranger, trauma, child, elderly and relative); they were asked about their actions after summoning help and possible reasons not to perform full CPR

Table 1 (Continued)

Author, year, country	Study design	Population	Intervention	Outcome(s)
Parnell, 2006, New Zealand ³³	Observational study: cross sectional study	<i>Number of participants:</i> 494 students <i>Age:</i> 16–17 years	Intervention: questionnaire	The following outcomes were measured: <i>Knowledge:</i> questionnaire with questions concerning their theoretical knowledge on FA and resuscitation <i>Attitude:</i> questionnaire about their attitude towards first aid and resuscitation. The following aspects were asked for: their attitude to first aid and CPR, their confidence in performing CPR in a real-life situation, if they would perform ventilation on a member of their family or stranger, how widely CPR should be taught in the community, whether first aid education should be compulsory for drivers or gun licensing, what they felt was associated with first aid, their previous first-aid education, and whether they think family or friends would like to get first aid training. 26 questions in total, not clear how many questions on knowledge/attitude. A combination of open questions, yes/no and categorical questions was used. [only data about attitude were extracted]
Plotnikoff, 1989, Australia ³⁴	Experimental study: controlled before after study	<i>Number of participants:</i> 45 children; intervention: <i>n</i> = 20, control: <i>n</i> = 25 <i>Age:</i> 11–12 years	Intervention: CPR training (see Moore, 1992) Control: no instructions	Outcomes were measured before, immediately after and 5 months after the intervention: <i>Knowledge</i> was measured using a multiple choice 22-item questionnaire <i>Skills:</i> children had to perform CPR on a manikin Outcomes were measured before and immediately after the intervention: <i>Knowledge</i> was evaluated using a cartoon-style questionnaire which depicted emergency-related actions. The children were asked to place three cartoon-like illustrations in the correct sequence. They were also asked to complete the task with their parents as part of their homework.
Uray, 2003, Austria ²³	Observational study: before after study	<i>Number of participants:</i> 47 children <i>Age:</i> 6–7 years old	Intervention: <i>Program:</i> Life-supporting first aid training provided by medical students and emergency physicians <i>Content:</i> 5 important stages: calling an ambulance, CPR, automated external defibrillation, recovery position, minimizing bleeding and burns. First aid interventions were taught in a hands-on, practice-based way using manikins, and simulation to demonstrate scenarios and wounds. <i>Duration:</i> 1 week	Outcomes were measured before and immediately after the intervention: <i>Knowledge</i> was evaluated using a cartoon-style questionnaire which depicted emergency-related actions. The children were asked to place three cartoon-like illustrations in the correct sequence. They were also asked to complete the task with their parents as part of their homework.
Younas, 2006, UK ²⁴	Experimental study: non-randomized controlled trial	<i>Number of participants:</i> 59 children <i>Age:</i> 13–16 years	Intervention: <i>Program:</i> CPR/AED training program <i>Content:</i> CPR and AED training using a manikin, training defibrillator and telephone <i>Duration:</i> no information available Control: no training program	Outcomes were measured 6 months after the training: <i>Skills:</i> performance assessed during mock scenario (an adult collapsed in front of the children), using a 10-item checklist. Students scoring insufficiently for a certain component received half a mark for that component

and skills concerning calling the emergency number could not be demonstrated when comparing children who received training with children without any training (RR: 1.06, 95% CI [0.86;1.32]).²⁹ In two studies, with children of 6–7 years and 10–12 years old, the knowledge of the emergency number (measured at 5 or 6 months after training) improved significantly after training, for example from 16% to 77% in the children of 6–7 years old.^{10,14} However,

this was not the case in one study with children at the age of 11–12 years.¹¹ The children with the age of 6–7 had significantly improved skills 5 months after training. More in detail, 50% gave correct emergency call information, compared to 6% in children without any training.¹⁰ The children of 11 to 12 years old showed significant improvement in calling the emergency number at a satisfactory manner after training, from 35% to 69% 1 week after

Table 2
Synthesis of findings for emergency call, choking and recovery position.

Outcome	Intervention	Effect size	No. of studies, No. of participants	Reference
Emergency call				
	First aid training (versus no training or before training) to children of			
2-point increase in test score for knowledge and skills concerning the emergency number	• 5–6 years	6 months after training: 60/90 (67%) vs 57/91 (63%) RR: 1.06, 95% CI [0.86; 1.32] ($p=0.57$) [†]	1, 246	Luria ²⁹
Knowledge emergency number	• 6–7 years	6 months after training: 77% vs 16% [§] ($p<0.001$)	1, 228	Bollig ¹⁰
Skills: giving correct emergency call information		6 months after training: 50% vs 6% [§] ($p<0.001$)		
Knowledge emergency number (total score, maximum score not known)	• 10–12 years	5 months after training: Intervention group: 3.0 ± 1.0 vs 2.7 ± 1.1 [§] ($p<0.01$) Control: 2.8 ± 1.0 vs 2.8 ± 1.1 [§] ($p>0.05$)	1, 1292	Frederick ¹⁴
Knowledge emergency number	• 11–12 years	Immediately after training: 100% vs 97.8% [§] ($p>0.05$)	1, 79	Connolly ¹¹
Skills: calling the emergency number at a satisfactory manner		1 week after training: 36/52 (69%) vs 19/50 (35%) [§] ($p=0.004$)	1, 102	Loem ²⁰
Skills: call and give necessary information	• 13–16 years	6 months after training: 28/34 (82.4%) vs 22/25 (88%) RR: 0.94, 95% CI [0.76; 1.16] ($p=0.54$) [†]	1, 59	Younas ²⁴
Skills: calling the emergency number in a specific scenario	• 11–16 years	1 year after training: Scenario 1: 95/147 (65%) vs 119/221 (54%) RR: 1.20, 95% CI [1.01; 1.42] ($p=0.04$) [†] Scenario 2: 50/147 (34%) vs 63/221 (29%) RR: 1.19, 95% CI [0.88; 1.62] ($p=0.26$) [†]	1, 95	Campbell ²⁵
Choking				
	First aid training (versus no training or before training) to children of			
Knowledge about first aid for choking (total score, maximum score not known)	• 10–12 years	Intervention group: 1.6 ± 1.0 vs 1.2 ± 1.0 [§] ($p<0.01$) Control: 1.3 ± 1.0 vs 1.2 ± 1.0 [§] ($p<0.01$)	1, 1292	Frederick ¹⁴
Knowledge about first aid for choking	• 11–16 years	Immediately after training: 100/100 vs 0/100 [§] ($p<0.001$) 2 months after training: 100/100 vs 0/100 [§] ($p<0.001$)	1, 100	Wafik ³⁶
Skills: first aid for choking		Immediately after training: 95/100 vs 0/100 [§] ($p<0.001$) 2 months after training: 67/100 vs 0/100 [§] ($p<0.001$)		
Recovery position				
	First aid training (versus no training or before training) to children of			
Skills: performance of correct recovery position	• 6–7 years	Immediately after training: 87% vs 1% [§] ($p<0.001$) 6 months after training: 56% vs 1% [§] ($p<0.001$)	1, 228	Bollig ¹⁰
Knowledge: Improvement in giving correct answers about correct recovery position (%)		Immediately after training: 18, 95% CI [6; 28] (data from graph) No p -value reported	1, 47	Uray ²³
Knowledge about correct recovery position	• 10–12 years	Immediately after training: 89.1% vs 56.6% [§] ($p<0.001$)	1, 79	Connolly ¹¹
Skills: performance of correct recovery position	• 10–11 years	5 months after training: 40/534 (8%) vs 10/581 (2%) RR: 4.35, 95% CI [2.20; 8.62] ($p<0.00001$) [†]	1, 1292	Frederick ¹⁵
	• 11–12 years	1 day after training: 12/20 (60%) vs 2/25 (8%) RR: 7.51, 95% CI [1.89; 29.71] ($p=0.004$) [†] 5 months after training: 10/20 (50%) vs 2/25 (8%) RR: 6.25, 95% CI [1.54; 25.34] ($p=0.01$) [†]	1, 45	Plotnikoff ²⁴

* Effect measure calculated by the reviewer(s) using Review Manager software.

§ Effect measure and confidence interval not available.

training.²⁰ A significant improvement in giving the necessary information could not be shown for children between 13 and 16 years who followed CPR training, compared to children who did not receive a training program (RR: 0.94, 95% CI [0.76;1.16]).²⁴ One year after first aid training, the ability to call the emergency number depended on the specific scenario for children between 11 and 16 years.²⁵ Overall, we can conclude that children from 6 to 16 years are capable of calling the emergency number. In Table 2 an overview of all data concerning the emergency number is given.

Since the majority of studies ($n=6$) are experimental studies, the initial level of evidence was “high”. We downgraded this level to “low”, because of limitations in study design (no randomization in 3 studies,^{11,14,24} unclear lack of allocation concealment in 3 studies,^{10,25,29} unclear blinding in 2 studies,^{10,24} and no control group in 1 study²⁰, see Supplementary material, Appendix 6), and because of imprecision (lack of data,^{10,11,14,20} large variability in results,²⁵ or low number of participants^{10,11,24,25,29}).

3.2.3. Choking

In two studies it was shown that in children from 10 to 12 and 11 to 16 years, knowledge about first aid for choking improved significantly after training, for example from 0% to 100% for the 11–16 years old group of children.^{14,36} In one study a significant increase in skills was also shown for children with the age of 11–16 years, from 0% to 95% of the children immediately after training, and 67% of the children 2 months after training.³⁶ Details on the data from these studies can be found in Table 2.

Since one of the included studies is an experimental study (controlled before after study), the initial level of evidence was “high”. However, this level was downgraded to “low”, because of limitations in study design (no randomization,¹⁴ and no control for confounding³⁶, see Supplementary material, Appendix 6) and imprecision (lack of data,^{14,36} and low number of participants³⁶).

3.2.4. Recovery position

In five studies it was shown that the knowledge concerning the recovery position, and the skills to place a victim in a correct recovery position, improved significantly following training of children of 6–7 and 10 to 12 years old.^{10,11,15,23,34} In children of 11–12 years for example, the skills to perform a correct recovery position improved from 8% to 50%, 5 months after training.³⁴ Detailed data extraction is given in Table 2.

Since the majority of studies are experimental studies, the initial level of evidence was “high”. We downgraded this level to “low”, because of limitations in design (no randomization in 3 studies,^{11,15,34} unclear allocation concealment in 1 study,¹⁰ unclear blinding in 3 studies,^{10,15,34} and no control for confounding in 1 study²³, see Supplementary material, Appendix 6) and imprecision (lack of data,^{10,11,23} or low number of participants^{10,11,23,34}).

3.3. From evidence to an educational pathway

Below, the practice experience of the panel members is described for the selected examples, which, together with the available evidence led to the final educational pathway, containing educational goals for different age groups (see Table 3 for the educational pathway based on all selected topics). In Table 3 it is indicated when a child could be encouraged to learn about certain first aid interventions (indicated as ‘E’), should achieve the educational goals (indicated as ‘K’) and should repeat the content (indicated as ‘R’).

3.3.1. Helping behaviour

Based on the evidence it was shown that children experience a lot of barriers to provide help.^{12,18,19,27,33,38} The expert panel therefore stressed that it is important to deal with these barriers as much

as possible (e.g. by explaining how to avoid infections, using disposable gloves, etc.) and to stress the importance of getting help from an adult in case of fear of helping themselves. These aspects are included throughout the whole educational pathway, for example: as part of the “General educational goals” it was added to the educational pathway that children of 7–8 years (1st grade primary school) should be prepared to fetch an adult in case of an emergency, a goal that should be repeated until the age of 15–16 years (2nd grade secondary school). An overview of the final educational pathway, taking into account all the aspects of helping behaviour, can be found in Table 3.

3.3.2. Emergency call

In addition to the available evidence,^{10,11,14,20,24,25,29} the expert panel discussed that to be able to call the emergency number, a child should be able to technically use a phone, to know and explain where he is oriented, and to synthesize a certain situation, which is at the age of 9–10 years old. In addition, the expert panel stressed that retraining is very important, since children can forget certain actions in a stressing situation. The panel also formulated some Good Practice Points concerning knowledge of the symbols and tasks of the emergency services.

Based on the evidence and the expert opinion of the expert panel, it was decided to add to the educational pathway that (1) children of 7–8 years (1st grade primary school) should know the emergency number, (2) children of 9–10 years (2nd grade primary school) should be able to alert the emergency services correctly and to recognize the importance of alerting the emergency services, and (3) children of 11–12 years (3rd grade primary school) should know the tasks of the emergency services and recognize the emergency services symbols (see Table 3).

3.3.3. Choking

In addition to the available evidence,^{14,36} the expert panel discussed the difference between the “back slap” and “abdominal thrust” technique as first aid interventions for choking, the latter being more difficult and therefore only feasible by older children. In addition, a Good Practice Point was formulated concerning knowing the difference between mild and serious choking. This resulted in the following goals in the educational pathway: (1) children of 11–12 years (3rd grade primary school) should know the difference between mild and serious choking, administer first aid for choking correctly, and correctly apply the “back slap” technique; (2) children of 13–14 years (1st grade secondary school) should be able to correctly apply the “abdominal thrust” technique for choking (see Table 3).

3.3.4. Recovery position

The expert panel discussed which basic requirements (such as being able to assess breathing) are necessary to be able to place a victim in the recovery position, in addition to the available evidence.^{10,11,15,23,34} One study showed that children from 6 to 7 years on would be able to learn how to place a victim in the recovery position, however medical experts in the expert panel argued that if victims were placed in a recovery position wrongly, this could result in harming the victim. Therefore, based on the evidence and expert opinion, it was decided to add to the educational program that children of 13–14 years (1st grade secondary school) should be able to know when and how they should place a victim in a stable recovery position (see Table 3).

4. Discussion

With this project we developed an evidence-based educational pathway for the integration of first aid training in school

Table 3

Educational pathway, indicating the goals to be achieved for knowledge, skills and attitudes, for preschoolers and every grade in primary school (PS) and secondary school (SS).

E: Encourage K: Know/Know How R: Repeat	Pre-school (3–6 years)	First grade PS (7–8 years)	Second grade PS (9–10 years)	Third grade PS (11–12 years)	First grade SS (13–14 years)	Second grade SS (15–16 years)	Third grade SS (17–18 years)
1. General							
<i>Knowledge</i>							
The pupils:							
• Know why they must find help as quickly as possible from an adult in an emergency situation	E	K	R	R			
• Know the general emergency number		K	R	R	R		
• Know the six basic principles of first aid				K	R	R	
• Know what each emergency service does			E	K			
<i>Skills</i>							
The pupils can:							
• Wash their hands	K	R					
• Put on disposable gloves		K	R	R			
• Use the six basic first aid principles when looking after a victim				K	R	R	R
• Recognize the emergency services symbols			E	K			
<i>Attitudes</i>							
The pupils are prepared:							
• To help	E	K	R	R	R	R	R
• To comfort the victim	E	K	R	R	R	R	R
• To ensure their own safety	E	K	R	R	R		
• To fetch an adult	E	K	R	R	R	R	
The pupils recognize the importance of:							
• Fetching an adult	E	K	R	R			
• Alerting the emergency services		E	K	R			
• The pupils are prepared to touch a person unknown to them		E	R	R	R		
The pupils recognize the importance of:							
• Avoiding infection				K	R	R	R
• Making the victim comfortable				E	K	R	R
2. Four steps in first aid							
<i>Knowledge</i>							
The pupils:							
• Know the four steps in first aid		E	E	K	R	R	R
• Know which wound must be treated first when giving first aid				K	R	R	
• Know the importance of the free passage of air				K	R	R	
• Know when they should place a victim in a stable recovery position				E	K	R	R
<i>Skills</i>							
The pupils ensure the safety of:							
• Themselves	E	K	R	R			
• The victim and bystanders		E	K	R	R		
The pupils can:							
• Call an adult in an emergency situation	E	K	R	R			
• Alert the emergency services correctly		E	K	R	R		
• Establish whether the victim is conscious and breathing				K	R	R	R
• Tip the head and tilt the chin correctly [technique]				K	R	R	R
• Lay the victim in a stable recovery position				E	K	R	R
• Apply further first aid		E	E	E	K	R	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
The pupils:							
• Appreciate the importance of ensuring their own safety	E	K	R	R	R		
• Appreciate that it is also important to ensure the safety of the victim and the bystanders		E	K	R	R		
• Recognize the importance of fetching an adult	E	K	R	R			
• Recognize the importance of the correct and complete application of the four steps of first aid		E	E	K	R		
• Are ready to apply further first aid where able		E	E	E	K	R	R

Table 3 (Continued)

E: Encourage K: Know/Know How R: Repeat	Pre-school (3–6 years)	First grade PS (7–8 years)	Second grade PS (9–10 years)	Third grade PS (11–12 years)	First grade SS (13–14 years)	Second grade SS (15–16 years)	Third grade SS (17–18 years)
3. Resuscitation and defibrillation							
<i>Knowledge</i>							
The pupils:							
• Recognize the AED pictogram			E	K	R	R	
• Know that they must always call the emergency services if the victim is unconscious (and when the AED box alarm goes off)			E	K	R	R	
• Know the purpose of an AED			E	K	R	R	
• Know and understand the instructions for the device			E	K	R	R	
• Know in what situation an AED should be used				E	K	R	R
• Know where and where not to stick the electrodes					K	R	R
• Know that an AED is safe when used properly and that it will never deliver a shock unless necessary				E	K	R	R
• Know that the use of an AED is no substitute for resuscitation (but complements this process)				E	K	R	R
<i>Skills</i>							
The pupils can:							
• Correctly resuscitate an unconscious victim who is not breathing normally				E	K	R	R
• Correctly carry out heart massages [technique]				E	K	R	R
• Correctly administer mouth-to-mouth resuscitation [technique]				E	K	R	R
• Correctly apply the instructions for an AED					E	K	R
• Combine resuscitation with the correct use of an AED					E	K	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
The pupils:							
• Recognize the importance of using an AED				E	K	R	R
• Are prepared to use an AED				E	K	R	R
4. Choking							
<i>Knowledge</i>							
The pupils know the difference between mild and serious choking							
<i>Skills</i>							
The pupils can:							
• Administer first aid correctly in the event of a choking incident				K	R	R	
• Correctly apply the 'back slap' technique [technique]				K	R	R	
• Correctly apply the 'abdominal thrust' [technique]				E	K	R	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
5. Skin wound							
<i>Knowledge</i>							
The pupils:							
• Recognize a skin wound	E	K	R	R			
• Know which equipment is needed for treating a skin wound	E	K	R	R			
• Know when a skin wound is serious and when to refer the victim to the doctor			K	R	R		
• Recognize a graze, a cut and a stab wound			E	K	R	R	
• Know the importance of vaccinations			E	K	R	R	
• Know why tetanus is dangerous and be aware of the link with skin wounds				K	R	R	
• Know that a victim with a foreign body in the wound must always be referred to the doctor				E	K	R	R
• Know when to refer someone with a splinter to the doctor				E	K	R	R

Table 3 (Continued)

E: Encourage K: Know/Know How R: Repeat	Pre-school (3–6 years)	First grade PS (7–8 years)	Second grade PS (9–10 years)	Third grade PS (11–12 years)	First grade SS (13–14 years)	Second grade SS (15–16 years)	Third grade SS (17–18 years)
<i>Skills</i>							
The pupils can:							
• Correctly treat a skin wound when water is available	E	K	R	R	R		
• Correctly apply a spiral bandage [technique]		K	R	R	R		
• Stem the bleeding of a wound that does not stop bleeding by itself		E	K	R	R		
• Correctly treat a skin wound if there is no clean water or too little			E	E	K	R	R
• Correctly treat a wound that contains a foreign object					K	R	R
• Correctly remove a splinter					K	R	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
The pupils recognize the importance of:							
• Using disinfectant (if there is no clean water or too little available)				E	K	R	R
• Correctly treating a wound containing a foreign object				E	K	R	R
6. Burns							
<i>Knowledge</i>							
The pupils:							
• Recognize a burn	E	K	R	R	R		
• Know what to do in the event of a burn (regardless of the degree of the burn)	E	K	R	R	R		
• Know when a burn is serious and when to refer the victim to a doctor		E	K	R	R		
• Know the difference between a first, second and third degree burn				E	K	R	R
• Know that they must alert the emergency services if the burn is serious			E	E	K	R	R
• Know what can cause a burn (heat, chemicals, . . .)	E	E	E	E	K	R	R
<i>Skills</i>							
The pupils can:							
• Correctly treat a burn	E	K	R	R	R		
• Alert the emergency services if the burn is serious			E	E	K	R	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
• The pupils recognize the importance of continuously applying water to a burn	E	K	R	R	R		
7. Bleeding							
<i>Knowledge</i>							
The pupils know:							
• What they have to do in the event of a nosebleed	E	K	R	R	R		
• When to refer a victim with a nosebleed to a doctor		E	K	R	R		
• How to correctly stop bleeding			E	K	R	R	
• That the emergency services must always be alerted in the event of serious blood loss			E	K	R	R	
<i>Skills</i>							
The pupils can:							
• Correctly stop a nosebleed	E	K	R	R	R		
• Apply a compression bandage [technique]				K	R	R	
<i>Attitudes</i>							
• The pupils recognize the importance of stopping the bleeding as quickly as possible		E	K	R	R		
8. Injuries to bones, muscles or joints							
<i>Knowledge</i>							
The pupils:							
• Know that they must not move a part of the body that is seriously painful		E	K	R			
• Know three possible injuries to the motor system (sprain, dislocation, breakage)			E	K	R	R	

Table 3 (Continued)

E: Encourage K: Know/Know How R: Repeat	Pre-school (3–6 years)	First grade PS (7–8 years)	Second grade PS (9–10 years)	Third grade PS (11–12 years)	First grade SS (13–14 years)	Second grade SS (15–16 years)	Third grade SS (17–18 years)
• Recognize an injury to bones, muscles or joints			E	K	R	R	
• Know the difference between an open and closed injury					K	R	R
<i>Skills</i>							
The pupils can:							
• Correctly treat a minor injury to bones, muscles or joints				E	K	R	R
• Correctly apply a cross-bandage to a hand or foot [technique]				E	K	R	R
• Administer first aid to a victim with an open break					K	R	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
9. Poisoning							
<i>Knowledge</i>							
The pupils know:							
• The symptoms of poisoning					K	R	R
• Some of the causes of poisoning (alcohol, drugs, toxic substances . . .) and how it can be prevented				E	K	R	R
• The dangers of CO poisoning					K	R	R
• Some of the causes of CO poisoning and how it can be prevented					K	R	R
• The phone number of the Anti-Poison Centre				E	K	R	R
• Toxic substances (that are poisonous when swallowed)	E	E	K	R	R		
<i>Skills</i>							
The pupils can:							
• Gather information on the nature and seriousness of the poisoning incident					K	R	R
• Contact the Anti-Poison Centre				E	K	R	R
• Follow instructions given by the Anti-Poison Centre				E	K	R	R
<i>Attitudes</i>							
See Attitudes general learning trajectory							
The pupils are aware of:							
• The importance of assessing their own safety, that of the victim and the bystanders in the case of CO poisoning					K	R	R
• The danger of hypothermia in somebody who is drunk						K	R

curricula. We included 30 studies, concerning emergency call, cardiopulmonary resuscitation, AED use, recovery position, choking, injuries and poisoning. The studies showed that children and adolescents from 5 to 18 years old are able to learn certain first aid techniques.^{10,11,13–17,20–26,28–32,34–37,39} In addition, it was shown that children/adolescents from 11 to 18 years are willing to provide help,^{12,18,19,27,33,38} and that first aid training is useful to increase their confidence or self-efficacy.³⁸

A strength of our project is that for the first time all the available evidence concerning the effectiveness of first aid training to children on knowledge, skills and attitudes, including evidence on their helping behaviour, is brought together into one document, which was used to develop an educational scheme based on current knowledge and practice. A second strength of our approach is the cooperation with a multidisciplinary expert panel, since teaching first aid to children involves many aspects. Another strength is that gaps in research were identified: future research could focus on specific first aid interventions, specific age groups, and interventions that could be useful to influence attitudes and behaviour regarding helping.

This project however also has several limitations. First of all, there was a lot of heterogeneity between the studies, in terms of age of the children, educational methods, content of the training,

time points for outcome measurement and study types. Therefore, it was impossible to pool the studies in meta-analyses. A second limitation is that based on the evidence in some cases it was very difficult to decide from which age certain first aid interventions should be trained. In addition, for some topics (such as choking) the available evidence was very limited. In those cases we used the practice experience of the expert panel, to translate the evidence into recommendations, i.e. specific learning goals for different ages.

The educational pathway can be seen as a guiding tool for schools. The educational goals in the pathway should be translated into concrete practices, didactical materials, educational tools, etc. by each specific school, according to its didactical principles. In the pathway three different “codes” are being used: (1) “Encourage” means that the teacher should actively pay attention to this educational goal; (2) “Know” means that pupils should achieve a certain content (knowledge), skills or attitude; (3) “Repeat” indicates when the achieved goals should be repeated.

In addition to teaching first aid, it is important that schools support the concept of giving first aid by providing the necessary equipment (e.g. first aid kit, AED) and creating an environment in which everybody (teachers, personnel, children) is stimulated to provide first aid. In a survey among 1000 school nurses in the USA, examining the preparedness of schools to respond to emergencies in

children, it was shown that schools are in compliance with many of the recommendations for emergency preparedness, but that there are also areas of improvement, such as increasing the availability of AEDs.⁴¹ However, funding and time constraints are the main barriers to teaching first aid to children.⁴² According to a British study, 89–99% of the pupils enjoyed first aid training, and 98% of the parents believed it was important for their children to learn first aid.⁴³

This educational pathway could be a useful tool to advocate at the level of policy makers for compulsory first aid training to children in primary and secondary school, which is currently only the case in 19% of European countries.⁴² When first aid training is not compulsory, uptake in schools is low, even if teachers are convinced of its importance.⁴²

Based on this pathway, Belgian Red Cross-Flanders also developed several didactical materials, such as manuals (including exercises) that are specifically adapted to certain age groups (every grade of primary and secondary school).

In conclusion, an evidence-based educational pathway with educational goals concerning learning first aid for different age groups was developed. This educational pathway can be used for the integration of first aid training in school curricula.

Conflict of interest statement

All authors, except OM, are in employment at Belgian Red Cross-Flanders and receive no other funding. One of the activities of Belgian Red Cross-Flanders is providing first aid training to laypeople.

Acknowledgements

We would like to thank the members of the expert panel who did not co-author this paper: Annemie Baplu (Centre for Pupils Counselling), Melissa Bastiaen (primary school teacher, Education of the Flemish Community), Caroline Claessens (psychologist), Anny Devreker (Pedagogical Advisory Service, Education of the Flemish Community), Erwin Dhondt (Medical Doctor), Stephan Lauwers (Manager First Aid, Belgian Red Cross-Flanders), Danny Raemdonck (primary school teacher, Catholic Education), Axel Vande Veegaete (Scientific Coordinator, Belgian Red Cross-Flanders), Isabelle Vlieghe (secondary school teacher, Catholic Education).

This project was funded by Belgian Red Cross-Flanders.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.resuscitation.2015.06.008>

References

- Tannvik TD, Bakke HK, Wisborg T. A systematic literature review on first aid provided by laypeople to trauma victims. *Acta Anaesthesiol Scand* 2012;56:1222–7.
- Urban J, Thode H, Stapleton E, Singer AJ. Current knowledge of and willingness to perform Hands-Only CPR in laypersons. *Resuscitation* 2013;84:1574–8.
- Driesen A, Nies P. Eerste Hulp: tijd om uw kennis een tweede adem te geven. *Test Gezond* 2011;106:10–4.
- Stroobants J, Monsieurs K, Devriendt B, Dreezen C, Vets P, Mols P. Schoolchildren as BLS instructors for relatives and friends: impact on attitude towards bystander CPR. *Resuscitation* 2014;85:1769–74.
- Mpotos N, Vekeman E, Monsieurs K, Derese A, Valcke M. Knowledge and willingness to teach cardiopulmonary resuscitation: a survey amongst 4273 teachers. *Resuscitation* 2013;84:496–500.
- De Buck E, Pauwels NS, Dieltjens T, Vandekerckhove P. Use of evidence-based practice in an aid organisation: a proposal to deal with the variety in terminology and methodology. *Int J Evid Based Healthc* 2014;12:39–49.
- Brouwers MC, Kho ME, Browman GP, et al. AGREE II: advancing guideline development, reporting and evaluation in health care. *CMAJ* 2010;182:E839–42.
- Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;6:e1000097.
- Atkins D, Best D, Briss PA, et al. Grading quality of evidence and strength of recommendations. *BMJ* 2004;328:1490.
- Bollig G, Wahl HA, Svendsen MV. Primary school children are able to perform basic life-saving first aid measures. *Resuscitation* 2009;80:689–92.
- Connolly M, Toner P, Connolly D, McCluskey DR. The 'ABC for life' programme—teaching basic life support in schools. *Resuscitation* 2007;72:270–9.
- Engeland A, Roysamb E, Smedslund G, Sogaard AJ. Effects of first-aid training in junior high schools. *Inj Control Saf Promot* 2002;9:99–106.
- Fleischhackl R, Nuernberger A, Sterz F, et al. School children sufficiently apply life supporting first aid: a prospective investigation. *Crit Care* 2009;13:R127.
- Frederick K, Bixby E, Orzel MN, Stewart-Brown S, Willett K. An evaluation of the effectiveness of the Injury Minimization Programme for Schools (IMPS). *Inj Prev* 2000;6:92–5.
- Frederick K, Bixby E, Orzel M-N, Stewart-Brown S, Willett K. Will changing the emphasis from 'pulseless' to 'no signs of circulation' improve the recall scores for effective life support skills in children? *Resuscitation* 2002;55:255–61.
- Jimenez-Fabrega X, Escalada-Roig X, Sanchez M, et al. Results achieved by emergency physicians in teaching basic cardiopulmonary resuscitation to secondary school students. *Eur J Emerg Med* 2009;16:139–44.
- Jones I, Whitfield R, Colquhoun M, Chamberlain D, Vetter N, Newcombe R. At what age can schoolchildren provide effective chest compressions? An observational study from the Heartstart UK schools training programme. *Br Med J* 2007;334:1201–3.
- Lester C, Donnelly P, Weston C, Morgan M. Teaching schoolchildren cardiopulmonary resuscitation. *Resuscitation* 1996;31:33–8.
- Lester C, Donnelly P, Weston C. Is peer tutoring beneficial in the context of school resuscitation training? *Health Educ Res* 1997;12:347–54.
- Loem T, Palm A, Wik L. Impact of a self-instruction CPR kit on 7th graders' and adults' skills and CPR performance. *Resuscitation* 2008;79:103–8.
- Sherif C, Erdos J, Sohm M, et al. Comparison of mouth-to-mouth resuscitation and Combitube ventilation in a bench model. *Wien Klin Wochenschr* 2005;117:769–75.
- Toner P, Connolly M, Laverty L, McGrath P, Connolly D, McCluskey DR. Teaching basic life support to school children using medical students and teachers in a 'peer-training' model—results of the 'ABC for life' programme. *Resuscitation* 2007;75:169–75.
- Uray T, Lunzer A, Ochsenhofer A, et al. Feasibility of life-supporting first-aid (LSFA) training as a mandatory subject in primary schools. *Resuscitation* 2003;59:211–20.
- Younas S, Raynes A, Morton S, Mackway-Jones K. An evaluation of the effectiveness of the Opportunities for Resuscitation and Citizen Safety (ORCS) defibrillator training programme designed for older school children. *Resuscitation* 2006;71:222–8.
- Campbell NR, Ayala GX, Litrownik AJ, Slymen DJ, Zavala F, Elder JP. Evaluation of a first aid and home safety program for Hispanic migrant adolescents. *Am J Prev Med* 2001;20:258–65.
- Gundry JW, Comess KA, DeRook FA, Jorgenson D, Bardy GH. Comparison of naive sixth-grade children with trained professionals in the use of an automated external defibrillator. *Circulation* 1999;100:1703–7.
- Hubble MW, Bachman M, Price R, Martin N, Huie D. Willingness of high school students to perform cardiopulmonary resuscitation and automated external defibrillation. *Prehosp Emerg Care* 2003;7:219–24.
- Lawson SL, Munoz-Rojas D, Gutman LS, Siman MN. Changing attitudes and perceptions of Hispanic men ages 18 to 25 about rape and rape prevention. *Issues Ment Health Nurs* 2012;33:864–70.
- Luria JW, Smith GA, Chapman JL. An evaluation of a safety education program for kindergarten and elementary school children. *Arch Pediatr Adolesc Med* 2000;154:227–31.
- Moore JB. Effects of assertion training and first aid instruction on children's autonomy and self-care agency. *Res Nurs Health* 1987;10:101–9.
- Reder S, Cummings P, Quan L. Comparison of three instructional methods for teaching cardiopulmonary resuscitation and use of an automatic external defibrillator to high school students. *Resuscitation* 2006;69:443–53.
- Moore PJ, Plotnikoff RC, Preston GD. A study of school students' long term retention of expired air resuscitation knowledge and skills. *Resuscitation* 1992;24:17–25.
- Parnell MM, Pearson J, Galletly DC, Larsen PD. Knowledge of and attitudes towards resuscitation in New Zealand high-school students. *Emerg Med J* 2006;23:899–902.
- Plotnikoff R, Moore PJ. Retention of cardiopulmonary resuscitation knowledge and skills by 11- and 12-year-old children. *Med J Aust* 1989;150 (296, 298–9, 302).
- Heard JP, Latenser BA, Liao J. Burn prevention in Zambia: a work in progress. *J Burn Care Res* 2013;34:598–606.
- Wafik W, Tork H. Effectiveness of a first-aid intervention program applied by undergraduate nursing students to preparatory school children. *Nurs Health Sci* 2014;16:112–8.
- Naqvi S, Siddiqi R, Hussain SA, Batool H, Arshad H. School children training for basic life support. *J Coll Physicians Surg Pak* 2011;21:611–5.

38. Omi W, Taniguchi T, Kaburaki T, et al. The attitudes of Japanese high school students toward cardiopulmonary resuscitation. *Resuscitation* 2008;78:340–5.
39. Parashar AK. Effective planned teaching programme on knowledge & practice of basic life support among students in Mangalore. *Nurs J India* 2010;101:40–1.
40. Dieltjens T, De BE, Verstraeten H, et al. Evidence-based recommendations on automated external defibrillator training for children and young people in Flanders-Belgium. *Resuscitation* 2013;84:1304–9.
41. Olympia RP, Wan E, Avner JR. The preparedness of schools to respond to emergencies in children: a national survey of school nurses. *Pediatrics* 2005;116:e738–45.
42. Campbell S. Supporting mandatory first aid training in primary schools. *Nurs Stand* 2012;27:35–9.
43. Cooper J. Right place, right time: first aid—an integral part of science education. *J Emergent Sci* 2012;4:25–31.