Emergency care with lay responders in underserved populations: a systematic review

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Objective To assess the individual and community health effects of task shifting for emergency care in low-resource settings and underserved populations worldwide.

Methods We systematically searched 13 databases and additional grey literature for studies published between 1984 and 2019. Eligible studies involved emergency care training for laypeople in underserved or low-resource populations, and any quantitative assessment of effects on the health of individuals or communities. We conducted duplicate assessments of study eligibility, data abstraction and quality. We synthesized findings in narrative and tabular format.

Findings Of 19 308 papers retrieved, 34 studies met the inclusion criteria from low- and middle-income countries (21 studies) and underserved populations in high-income countries (13 studies). Targeted emergency conditions included trauma, burns, cardiac arrest, opioid poisoning, malaria, paediatric communicable diseases and malnutrition. Trainees included the general public, non-health-care professionals, volunteers and close contacts of at-risk populations, all trained through in-class, peer and multimodal education and public awareness campaigns. Important clinical and policy outcomes included improvements in community capacity to manage emergencies (14 studies), patient outcomes (13 studies) and community health (seven studies). While substantial effects were observed for programmes to address paediatric malaria, trauma and opioid poisoning, most studies reported modest effect sizes and two reported null results. Most studies were of weak (24 studies) or moderate quality (nine studies).

Conclusion First aid education and task shifting to laypeople for emergency care may reduce patient morbidity and mortality and build community capacity to manage health emergencies for a variety of emergency conditions in underserved and low-resource settings.

Abstracts in العربية, 中文, Français, Русский и Español at the end of each article.

Introduction

Conditions that could be treated with prehospital and emergency care account for an estimated 24 million lives lost each year in low- and middle-income countries.1 Training lay providers and volunteer paramedics to respond to health emergencies is among the most cost-effective health interventions globally, at just United States dollars 6–14 per disability-adjusted life year saved.2 In May 2019, the World Health Organization (WHO) resolved to improve emergency care in all Member States, including through informal prehospital systems.3

International guidelines define first aid as “initial care provided for an acute illness or injury” or “help to a suddenly ill or injured person which is initiated as soon as possible and continued until that person has recovered or medical care is available”.4,4 Teaching first aid to laypeople is part of a 150-year medical humanitarian tradition and a vital component of both formal and informal prehospital care systems.5 Over 15 million people in 52 countries receive education in first aid each year from member organizations of the International Federation of Red Cross and Red Crescent Societies alone.6 First aid education enhances bystanders’ helping behaviours in emergencies, but it remains unclear what interventions can

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be delivered effectively by laypeople to save lives and reduce morbidity. Laypeople with training in first aid can improve access to care for underserved populations, and often deliver the only emergency health care services in low-resource settings. Where lay responders are taught first aid to enhance patients’ access to essential interventions, first aid education is a part of the broader concept of task shifting. WHO defines task shifting as “the rational redistribution of tasks within health workforce teams”, specifically from specialized professionals to providers with less training, lay caregivers and patients. Task shifting improves access to care and outcomes for maternal and child health, chronic and mental health conditions, and communicable diseases. Less is known, however, about task shifting in emergency health care.

The purpose of this systematic review was to identify the individual and community health effects of task shifting for emergency care in underserved populations and low-resource settings. We hoped to guide programme developers and policy-makers towards interventions that had been subject to evaluations with demonstrable health effects, and to help researchers and evaluators to understand and optimize these initiatives.

Methods

We developed, registered and published a systematic review protocol based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement (PROSPERO CRD42014009685). Our methods did not deviate from the protocol. We report our review according to the PRISMA guidelines and Synthesis without Meta-Analysis extension. Further details can be found in the authors’ data repository.

Eligibility criteria

We designed the research question for the review according to the Population, Intervention, Comparator, Outcome, Time (PICOT) framework. Studies were eligible for inclusion if they were conducted in underserved or low-resource populations with any emergency health condition; involved first aid or emergency care training or education for laypeople; made a comparison with no training or with any other forms of education; conferred any individual or community health benefit for emergency health conditions; and were conducted over any duration of time.

Box 1 shows the inclusion criteria and terms used to define the populations, interventions and outcomes of studies. Studies were included if they incorporated all of the criteria. We included studies published after 1984 with no language restrictions or other exclusion criteria. We included randomized trials, quasi-experimental and observational studies including case series and before-and-after designs, programme evaluations and quality-improvement studies.

Search strategy

We developed a search strategy to identify papers addressing first aid or prehospital emergency care by laypeople. We used a sample set of relevant articles to evaluate the recall and precision of search terms and refine our search strategy. Our search strategy is published elsewhere.

We searched the following databases: MEDLINE, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus, SocINDEX, PsycINFO, Education Resources Information Center (ERIC), Cochrane Database of Systematic Reviews (CDSR), African Index Medicus (AIM), Index Medicus for the WHO Eastern Mediterranean Region (IMEMR), Latin American and Caribbean Health Sciences Literature (LILACS), Index Medicus for South-East Asia Region (IMSEAR) and Transport Research International Documentation (TRID).

We adapted our search for grey literature using keywords that targeted the websites of humanitarian and global health agencies, academic grey literature databases, theses and dissertations, clinical trials registries and conference proceedings. We conducted our initial electronic search using the Google search engine on 17 March 2014 and searched all other sources on 3 May 2014. We later updated our search to include articles up to 16 December 2019. We also scanned the references of all included studies and manually searched references of first aid guidelines and reviews from the American Heart Association and the American Red Cross, European Resuscitation Council and International Liaison Committee on Resuscitation.

Study selection

We trained an international team of 18 reviewers with varied expertise in the subject matter and methods of the
review, using a video to familiarize them with the research question and inclusion criteria. All reviewers screened a test set of 70 papers selected from our search that included seven papers that met enough inclusion criteria to proceed to full-text review. We conducted an internal study on this test set to confirm substantial interrater agreement (Fleiss’ $\kappa > 0.61$) between reviewers. More details are in the authors’ data repository. The reviewers screened the titles and abstracts of studies retrieved through the electronic and manual searches, independently and in duplicate. We conducted independent and duplicate full-text review of all papers retained through screening. One of the two lead investigators resolved discrepancies. We documented reasons when papers were excluded at this stage. We assessed papers in Dutch, English, French, German and Norwegian languages. We used Google Translate (Google LLC, Mountain View, United States of America, USA) and Cochrane TaskExchange volunteers to review papers in other languages.

Data extraction

For each included paper, two investigators independently extracted information on the study objective, study design, population, details about the intervention and control groups (mode and duration of education; emergency health conditions treated; and role of the layperson), outcomes (type of health outcome; description of health outcome; type of emergency care provided; and effect size and confidence interval) and key conclusions. Where multiple publications reported on the same underlying study, we extracted data from all related papers and reported results from the most definitive paper.

We performed independent and duplicate assessment of study quality, including internal and external validity, selection and measurement biases, and confounding factors, using the Effective Public Health Practice Project quality assessment tool. This tool permits the appraisal of multiple types of studies and is designed and validated for the assessment of studies concerning health systems and population health interventions. We resolved discrepancies through consensus among the lead investigators.

Synthesis

We prepared a narrative and tabular synthesis of our findings. We grouped studies qualitatively according to the illnesses or conditions addressed, the role of lay providers, the type of educational intervention provided and the type of outcomes reported. We distinguished individual health outcomes such as survival to hospital discharge; community health outcomes such as all-cause mortality; and measures of community capacity to manage emergencies such as cardiac arrest response times. Our rationale for these groupings was first to underscore the emergency health conditions for which studies had been identified, and then to provide information to guide future task shifting and first aid training interventions. We drew on Cochrane Collaboration guidance on syntheses without meta-analysis to assess the risk of bias across studies, and considered the number of studies, consistency of effects and directness of findings to develop plain-language summary statements of the effects of interventions.

Results

Our database searches yielded 19,308 unique papers. We retained 415 papers for full-text review, resulting in 43 eligible papers from 34 unique studies (Fig. 1). Grey literature and manual searches did not yield additional publications. Interrater agreement between the screening authors was good for study inclusion (Fleiss’ $\kappa = 0.75$). Studies excluded at full-text review are described in the authors’ data repository.

Study characteristics

Table 1 (available at: http://www.who.int/bulletin/volumes/99/7/20-270249) summarizes the studies that met the inclusion criteria, grouped by emergency medical condition, including cardiac arrest (four studies), trauma (three studies), burns (two studies), malaria (10 studies), severe malnutrition (one study), opioid poisoning (seven studies), paediatric communicable diseases (five studies), snakebites (seven studies), and various other emergencies (one study). The authors’ data repository provides more details of secondary outcomes and
data from multiple reports arising from the same study.17

Most studies used observational or quasi-experimental designs, including 11 uncontrolled before-and-after studies, 35–37,40,43,45,46,64 five controlled before-and-after studies, 42,44,47,57,65 one prospective cohort study,65 four retrospective cohort studies, 43,51,52,64 four case series, 52–54,65 three non-randomized cluster trials, 48,50,59 one interrupted time-series analysis 69 and one cross-sectional study.67 Experimental studies included two randomized controlled trials,39,43 and two cluster randomized controlled trials.42,45

The populations studied included rural, urban and underserved populations from North America, Europe, Asia, Africa and Australia and Oceania. Sample sizes ranged from under 300 people to population-based studies of over 5 million people (Table 1). Table 2 and Fig. 2 provide a description of the training interventions, demonstrating the diversity of populations, interventions, target trainees, provider roles and primary outcome types for each study across each emergency health condition.66 Twenty-one studies (62%) were conducted in low- and middle-income countries, including all studies concerning interventions for malaria, paediatric communicable diseases, malnutrition and trauma.36,38–44,64 Studies conducted in high-income countries studied underserved rural populations and marginalized communities such as people who use drugs or Indigenous peoples.32–35,37,49–53,65 With the exception of burns, which was studied in both a middle-income country (India) and an underserved population in a high-income country (New Zealand Maori and Pacific Islanders), interventions were studied in either low- and middle-income countries or high-income countries, but not both.36,67 For example, all studies concerning cardiac arrest were in high-income countries, while all studies concerning physical trauma were in low- and middle-income countries.

Study interventions

The included studies described a variety of educational approaches, including public campaigns (three studies), in-class training programmes (17 studies), peer or individual training (seven studies) and multimodal training programmes (seven studies). A total of 33 studies assessed targeted interventions addressing priority emergency health conditions in the given population, such as opioid poisoning among people who use drugs or trauma management in regions with an elevated incidence of trauma from landmines. One study assessed a comprehensive training initiative designed to enhance responses to diverse conditions among Indigenous hunters and trappers in remote Canada (Fig. 2).65

Trainees included the general public (five studies), non-health-care professionals such as drug retailers and flight attendants (five studies), community volunteers (10 studies) and family members and close contacts of at-risk populations such as people who use opioids or children at risk of malaria (14 studies; Fig. 2). We identified five studies evaluating the impact of training mothers to respond to emergency health conditions in children, including malaria and malnutrition.36,39,42,43,48

Trainees were taught to attend to emergencies as sole providers (seven studies), as sole providers with responsibility for transferring selected patients to other professionals (20 studies), or as responders in a community chain-of-survival involving routine patient transfer to other providers (seven studies; Fig. 2).

Studies reported most commonly on measures of community capacity to manage health emergencies (14 studies), while 13 studies reported on individual health and seven reported on community health outcomes (Fig. 2).

Outcomes

Most studies reported small effect sizes (Table 1). Some studies reported statistically significant and clinically important effects on measures of individual and community health. For example, one study reported an absolute reduction of 20.4 per 1000 in all-cause under-5 mortality in a randomized trial of malaria peer education for mothers in Ethiopia.68 Another study comprising 2788 patients treated for trauma reported a reduction in mortality from 17% to 4% in a before-and-after study of a community first-responder programme in Iraq.64 Through a cohort and modelling study, researchers estimated that opioid overdose education and naloxone distribution in British Columbia, Canada, averted 1650 deaths in 20 months.51

Two included papers reported null or equivocal results. A cluster randomized controlled trial of a malaria education and management programme for women’s groups observed no effect on the prevalence of severe malaria-associated anaemia in children.60 A cohort study of overdose education and naloxone distribution among emergency department patients in Ohio, USA, found no statistically significant reduction in the composite outcome of overdose-related emergency department visits, hospitalizations or deaths.54

Table 3 summarizes our findings across studies for each health condition and provides a global synthesis across all included conditions, with the risk of bias across studies for each summary statement. Studies were predominantly of weak (24 studies) or moderate (nine studies) quality. We included one study with methods rated as strong quality concerning prehospital trauma care (Table 1). The authors’ data repository provides detailed component quality ratings.17,30

Discussion

We found that first aid education and task shifting to laypeople may reduce morbidity and mortality, and enhance community capacity to manage health emergencies for a variety of emergency conditions. The studies include cardiac arrest, burns, malaria, malnutrition, opioid poisoning, paediatric communicable diseases, snakebites and trauma. All of the included studies evaluated targeted training for priority local emergency conditions; there were no eligible studies concerning courses with general, untargeted first aid curricula. The overall weak quality of studies in our review underscores the limitations in the available science, the need for rigorous studies in this field, and the challenges inherent in evaluating complex population health interventions such as task shifting.69

The widespread practice of training laypeople to deliver lifesaving interventions for acute health emergencies in underserved settings arises from sound logic and humanitarian principles.6,25 Our review shows that there is limited empirical evidence to demonstrate an individual or community health benefit arising from this practice.

Previous reviews demonstrate the effectiveness of first aid education by reporting on knowledge, skills, helping behaviours or confidence among trainees.9 Guidelines and curricula for first aid generally derive interventions
### Table 2. Summary of training interventions for first aid by laypeople in low-resource settings and underserved populations

| Medical condition and study | Study setting | Education modality | Target trainees | Provider roles | Primary outcome type | Training description (study design) |
|-----------------------------|---------------|--------------------|-----------------|----------------|----------------------|--------------------------------------|
| **Cardiac arrest**          |               |                    |                 |                |                      |                                      |
| Roberts et al., 1999        | Rural or remote population in high-income country | In-class training | Community volunteers | Chain-of-survival | Community capacity | 8-hour cardiopulmonary resuscitation and first aid course. (Case series, no control) |
| Page et al., 2000           | Rural or remote population in high-income country | In-class training | Non-health-care professionals | Transfer as required | Individual health | 4-hour cardiopulmonary resuscitation and automated external defibrillator workshop, and 1.5-hour refresher for commercial aircraft flight attendants. (Case series, no control) |
| Rørtveit & Meland, 2010     | Rural or remote population in high-income country | In-class training | Community volunteers | Chain-of-survival | Community capacity | Basic life support and automated external defibrillator course; course duration: NR. (Case series, no control) |
| Nielsen et al., 2013        | Rural or remote population in high-income country | Public campaign | General public | Chain-of-survival | Community capacity | 24-minutes long video-based basic life support self-training kits offered year-long; 4-hour basic life support and automated external defibrillator course; local news broadcasted cardiac arrest information and course offerings. (No separate control training) |
| **Burns**                   |               |                    |                 |                |                      |                                      |
| Sunder & Bharat, 1998       | Low-or middle-income country | Public campaign | Non-health-care professionals | Sole providers | Community capacity | Annual 75-minute audio-visual session for industrial steel workers on burns safety and first aid; 6 sessions per year. (No separate control training) |
| Skinner et al., 2004        | Marginalized community in high-income country | In-class training | General public | Sole providers | Community capacity | Multimedia advertisements including television, radio, billboards, newspapers and magazines on burn injuries and first aid; campaign duration: NR. (No separate control training) |
| **Malaria**                 |               |                    |                 |                |                      |                                      |
| Kidane & Morrow, 2000       | Low-or middle-income country | Peer training | Family and close contacts | Transfer as required | Community health | Mothers taught to recognize malaria, to administer chloroquine and recognize adverse reactions; referrals through mother trainers; training duration: NR. (No peer education) |
| Ajayi et al., 2008          | Low-or middle-income country | Peer training | Family and close contacts | Transfer as required | Community capacity | Mothers trained on malaria treatment; pictorial guideline distributed; training duration: NR. (No peer education) |
| Koyyaté et al., 2008        | Low-or middle-income country | In-class training | Family and close contacts | Transfer as required | Individual health | 5-day training course and 1-day refresher for mothers; discussions and role-play on malaria management and chloroquine administration. (No community-based malaria education and management) |
| Ndlaye et al., 2013         | Low-or middle-income country | In-class training | Non-health-care professionals | Sole providers | Community capacity | 3-day classroom teaching and 15-day training at health post on malaria identification, use of rapid malaria tests, artemisinin-based combination therapy, and to recognize adverse reactions. (Case series, no control) |
| Tobin-West & Briggs, 2013   | Low-or middle-income country | Peer training | Family and close contacts | Sole providers | Individual health | 12 hours of training over 4 days for mothers, covering malaria prevention, recognition and management. (No training or drugs provided) |

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Aaron M Orkin et al.

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| Medical condition and study | Study setting* | Education modality | Target trainees | Provider roles | Primary outcome type | Training description (study design) |
|----------------------------|----------------|-------------------|-----------------|----------------|---------------------|-------------------------------------|
| Warsame et al., 2016        | Low- or middle-income country | Public campaign | Family and close contacts | Transfer as required | Community capacity | Community posters on recognition of severe malaria, suppository administration and referral; campaign duration: NR. (Usual practice by community health workers) |
| Kitutu et al., 2017         | Low- or middle-income country | In-class training | Non-health-care professionals | Sole providers | Community capacity | Drug sellers trained to test for and treat uncomplicated malaria, pneumonia symptoms and non-bloody diarrhoea; training duration: NR. (No community-based training) |
| Linn et al., 2018           | Low- or middle-income country | In-class training | Community volunteers | Transfer as required | Community capacity | 5-day modular training on screening, testing and management of malaria, including referrals provided to village health volunteers. (No separate control training) |
| Green et al., 2019          | Low- or middle-income country | In-class training | Community volunteers | Transfer as required | Community health | Volunteers trained to administer rectal artesunate to children showing signs of severe malaria and refer appropriately, and train-the-trainer cascade model; training duration: NR. (No separate control training) |
| Minn et al., 2019           | Low- or middle-income country | In-class training | Community volunteers | Transfer as required | Community capacity | 9-day training on the danger signs, diagnosis, treatment and recording/reporting of malaria, as well as the signs and symptoms of tuberculosis; health education on dengue, filariasis, sexually transmitted infection, HIV and leprosy; with annual refresher training. (No separate control training) |
| Ale et al., 2016            | Low- or middle-income country | Multimodal       | Family and close contacts | Transfer as required | Community health | Group sessions of <1 day with up to 30 mothers or caretakers; brief home-based training on consent and screening for malnutrition. (Community health workers received theory and practical training on malnutrition screening, awareness, and referral) |
| Opioid poisoning            | Marginalized community in high-income country | Multimodal       | Family and close contacts | Transfer as required | Community health | 10–60 minutes of overdose education and naloxone distribution training conducted in groups or individually, focusing on overdose prevention and naloxone administration for people who use opioids or are likely to witness overdose. (No separate control training) |
| Walley et al., 2013         | Marginalized community in high-income country | Multimodal       | Family and close contacts | Transfer as required | Individual health | 10–15 minutes of in-person, face-to-face education on intramuscular administration of naloxone and overdose first aid for people who use opioids or are likely to witness overdose. (No separate control training) |
| Bird et al., 2016           | Marginalized community in high-income country | Multimodal       | Family and close contacts | Transfer as required | Individual health | British Columbia’s take-home naloxone kit programme for people who use opioids or are likely to witness an overdose; training duration: NR. (No separate control training) |
| Irvine et al., 2019         | Marginalized community in high-income country | Multimodal       | Family and close contacts | Transfer as required | Individual health | State-sponsored education on overdose recognition, contacting emergency medical services and how to assemble and administer an intranasal naloxone device; training duration: NR. (No separate control training) |
| Mahonski et al., 2020       | Marginalized community in high-income country | Multimodal       | Family and close contacts | Transfer as required | Individual health | (continues . . .) |
| Medical condition and study | Study setting¹ | Education modality | Target trainees | Provider roles | Primary outcome type | Training description (study design) |
|-----------------------------|----------------|-------------------|----------------|---------------|----------------------|-------------------------------------|
| Naumann et al., 2019¹⁶      | Marginalized community in high-income country | Peer training | Family and close contacts | Transfer as required | Community health | Community-based education on overdose and naloxone administration, education on Good Samaritan law; training duration: NR. (No separate control training) |
| Papp et al., 2019⁴⁸         | Marginalized community in high-income country | Peer training | Family and close contacts | Transfer as required | Individual health | One-on-one hospital-based overdose education and naloxone distribution for people treated for heroin overdose in the emergency department; training duration: NR. (No overdose education and naloxone distribution) |
| Rowe et al., 2019⁴⁸         | Marginalized community in high-income country | Peer training | Family and close contacts | Transfer as required | Community health | Community-based education on identifying and managing an opioid overdose and intramuscular or intranasal naloxone administration; training duration: NR. (No separate control training) |
| **Paediatric communicable diseases** | | | | | | |
| Bang et al., 1994⁵⁶         | Low- or middle-income country | In-class training | Non-health-care professionals | Transfer as required | Community health | Six classes of 1.5 hours each to train traditional birth attendants who did not traditionally provide baby care to recognize childhood pneumonia, administer pharmacotherapy, and refer as needed. (No separate control training) |
| Holloway et al., 2009⁵⁷     | Low- or middle-income country | Multimodal | General public | Sole providers | Community capacity | 3-day training for teachers and district health staff, 10-day workshop for students and other community members. Community posters and street theatre about acute respiratory infections. (No separate control training) |
| Yansaneh et al., 2014⁵⁸     | Low- or middle-income country | In-class training | Community volunteers | Transfer as required | Community capacity | 1-week training on symptomatic malaria, pneumonia and diarrhoea and appropriate treatment for each. Also trained to recognize severe symptoms and refer to health centres. (No separate control training) |
| Langston et al., 2019⁵⁹     | Low- or middle-income country | In-class training | Community volunteers | Transfer as required | Community capacity | 6-day training on simplified version of curriculum (four data collection tools) for various paediatric illnesses; focused on practical training through role-play and discussions. (Similar to intervention, but standard version of curriculum which includes seven data collection tools) |
| Oresanya et al., 2019⁵⁹     | Low- or middle-income country | Multimodal | General public | Transfer as required | Community capacity | Community volunteers trained to recognize, treat, document and refer children as needed; community mobilization efforts including mass media campaigns, and community dialogues were also undertaken to promote care-seeking, uptake of services, and promote services offered by community volunteers. (No separate control training) |
| **Snakebites**              | | | | | | |
| Sharma et al., 2013⁹⁹       | Low- or middle-income country | Multimodal | General public | Chain-of-survival | Individual health | Snakebite awareness sessions, leaflets, banners and posters. Emphasis on rapid transport of victims to the nearest treatment centre. <1 day of training for motorcycle drivers; two to three snakebite awareness sessions for other community members. (No separate control training) |

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Systematic reviews

Emergency care with lay responders in underserved populations

Aaron M Orkin et al.

for the lay public by adapting practices from professional prehospital practice and health-care research.21,26 Database searches that rely on the keywords “first aid” or “layperson” to retrieve studies concerning first aid may overlook papers concerning interventions that do not use these terms but are thematically aligned with first aid. In comparison with other reviews on first aid, ours covers a greater breadth of research concerning interventions provided by laypeople to address emergency medical problems in underserved populations and low-resource settings.68,69

Like other task-shifting strategies, first aid education is a complex, system-level intervention that requires its own foundation of evidence.70 Clinical interventions that may be effective when implemented by professionals may not produce the same results when implemented by other providers. The adaptation of professional practices and the assessment of educational outcomes among people trained in first aid is insufficient to establish the effectiveness and safety of first aid interventions for target patients, programmes or communities.

Our review advances novel conceptual ties between first aid and task shifting. Lay emergency care and volunteer paramedic interventions are among the most cost-effective ways to reduce avoidable mortality worldwide, but unlike other task-shifting interventions, first aid has not been widely characterized or evaluated based on broad public health impacts.7 The connection between first aid education programmes and task shifting underscores how first aid interventions and lay emergency care might contribute to addressing priority global health challenges such as opioid poisoning, trauma or malaria.

We have summarized the breadth of contexts and conditions where lay responders, bystanders or friends and family can provide first aid. Leading international guidelines define first aid as “the initial care provided for an acute illness or injury” that “can be initiated by anyone in any situation.”9 The interventions and acute conditions included in this review conform with this definition, but many of the included studies concerned conditions and interventions that are mostly absent from conventional first aid training, such as lay assistance for acute malnutrition, opioid poisoning or paediatric communicable diseases. The appropriate scope of first aid and the set of interventions cap-

### Table

| Medical condition and study | Study setting | Education modality | Primary outcome type | Provider roles | Target trainees | Training description (study design) |
|----------------------------|---------------|--------------------|----------------------|---------------|----------------|-------------------------------------|
| Trauma                     | Low- or middle-income country | In-class training | Individual health | Community volunteers | Community volunteers | 2-day course on basic first aid for village first responders; 1-day training for medical training at 0-12 months. (No separate control training) |
| HIV                        | Low- or middle-income country | In-class training | Individual health | Community volunteers | Community volunteers | 15-hour basic trauma care courses for people with higher education and layperson courses every 6 months. (No separate control training) |
| HIV                        | Low- or middle-income country | In-class training | Individual health | Community volunteers | Community volunteers | 2-day instructional class for lay responders on basic trauma care (Paramedics were trained to provide trauma life support in the field during evaucations and we were also trained to reach basic life support to laypersons) |
| Various emergencies        | Rural or remote population in high-income country | In-class training | Community capacity | Sole providers | Family and close contacts | 30-hour training course and manual in bush kits for hunters and trapirs. (No training and bush kits provided) |

HIV: human immunodeficiency virus; NR: not reported.

a Income groups are World Bank classifications.

b Studies with null findings.

Continued from previous page.
tured in those studies may be determined based on the care that can be initiated by anyone to provide initial care for an acute illness or injury in a safe and clinically effective manner. First aid need not be defined based on the set of interventions included in standard courses or curricula.

The strength of this review is its breadth, including a search of multiple databases and inclusive search terminology to synthesize the wide range of experimental and observational research concerning task shifting for emergency care in low-resource and underserved settings worldwide. By training and assessing interrater reliability of an international team of reviewers we were able to achieve a manual review of over 19,000 studies. Our approach to populations including both low- and middle-income countries and underserved subpopulations in high-income countries is a conceptual strength aligned with global approaches to health equity.71 Our review also has limitations. We excluded studies conducted in well-resourced populations because interventions that are effective in well-resourced settings cannot be presumed to work in contexts with fewer resources. For example, systematic reviews have demonstrated the efficacy of mental health first aid in high-income countries.72,73 Although mental health first aid has been studied in lower resource settings, we did not identify studies on mental health first aid reporting on an eligible health outcome in underserved populations. Our review uncovered only two studies reporting null results. This may reflect publication bias, though study heterogeneity prohibited testing of this hypothesis. The paucity of negative studies may reflect limitations in the methods of the included studies or that the interventions are broadly effective.

In conclusion, first aid for laypeople may have its greatest impact when approached as a series of targeted interventions that equip the public to respond to the health emergencies that they are likely to encounter in their everyday lives and communities. More work is needed to orient first aid education to deliver the greatest effects on patient and community health, and to identify the modalities that are best suited to specific contexts, populations, clinical conditions and public health priorities. Task shifting to laypeople for emergency care may save lives, reduce morbidity and enhance community capacity to address acute health problems in low-resource settings.

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### Table 1

| Characteristic | Type of emergency |
|---------------|-------------------|
|               | Cardiac arrest (n = 4) | Burns (n = 1) | Malaria (n = 10) | Malnutrition (n = 1) | Opioid poisoning (n = 7) | Paediatric communicable diseases (n = 5) | Snakebite (n = 1) | Trauma (n = 3) | Various emergencies (n = 1) |
| Population    |                   |               |                 |                   |                     |                             |                |                |                           |
| High-income country, rural or remote | ■ ■ ■ ■ ■ | | | | | | | | |
| High-income country, marginalized | | | | | | | | | |
| Low- and middle-income country | ■ ■ ■ ■ ■ ■ | | | | | | | | |
| Education method | | | | | | | | | |
| In-class training | ■ ■ ■ ■ ■ | ■ | ■ ■ ■ ■ ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Multimodal | ■ ■ ■ ■ ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Peer training | ■ ■ ■ ■ ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Public campaign | ■ ■ | | | | | | | | |
| Target trainees | | | | | | | | | |
| Community volunteers | ■ ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |
| Family & close contacts | ■ ■ ■ ■ ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| General public | ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |
| Non-health-care professionals | ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |
| Provider roles | | | | | | | | | |
| Chain-of-survival | ■ ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |
| Sole providers | ■ ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |
| Transfer as required | ■ | | ■ ■ ■ ■ ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Primary outcome type | | | | | | | | | |
| Community capacity | ■ ■ | | ■ ■ ■ ■ ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Community health | ■ ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |
| Individual health | ■ | | ■ | | ■ | ■ | ■ | ■ | ■ |

■ Study with findings  ■ Study with null findings

Note: Each individual study is represented by a block.
### Table 3. Summary of findings of the systematic review of first aid by lay responders in low-resource settings and underserved populations

| Medical condition, outcome type and outcome | No. of studies per outcome | Impact | Overall quality* |
|--------------------------------------------|---------------------------|--------|------------------|
| **Cardiac arrest**                         |                           |        |                  |
| **Community capacity**                     |                           |        |                  |
| Willingness to use an automated external defibrillator | 1 | Community-wide training on basic life support or automated external defibrillator use in rural and remote settings may improve public willingness to provide some aspects of cardiopulmonary resuscitation and automated external defibrillator use | Weak |
| First response time                        | 2 | Lay responders with training on basic life support may provide faster cardiac arrest response times than professional responders in rural settings | Weak |
| **Individual health**                      |                           |        |                  |
| Survival at hospital discharge             | 1 | Training on automated external defibrillator use by flight attendants may improve cardiac arrest survival on commercial aircraft | Weak |
| **Burns**                                  |                           |        |                  |
| **Community capacity**                     |                           |        |                  |
| Appropriate initial first aid              | 2 | Burns education campaigns may improve appropriate first aid for burns in underserved populations and people at elevated occupational risk of burns | Weak |
| **Malaria**                                |                           |        |                  |
| **Community health**                       |                           |        |                  |
| Under-5 all-cause mortality                | 1 | Peer and volunteer education on paediatric malaria recognition and treatment may reduce all-cause under-5 mortality and case-fatality rates in rural low-income malaria-endemic settings | Weak |
| Under-5 malaria case fatality rate         | 1 |                  |                  |
| **Community capacity**                     |                           |        |                  |
| Appropriate diagnosis and treatment of paediatric malaria | 6 | Training laypeople such as mothers, community volunteers and lay drug vendors to identify and treat acute paediatric malaria may improve local capacity to diagnose and treat malaria appropriately in low-income settings | Weak |
| **Individual health**                      |                           |        |                  |
| Proportion of moderate to severe anaemia in children under 5 years old (null findings) | 1 | The evidence does not refute and may support the effectiveness of community-based acute malaria education and management programmes to improve malaria severity and cure rates in low-income malaria-endemic settings | Weak |
| Number of patients cured of malaria        | 1 |                  |                  |
| **Malnutrition**                           |                           |        |                  |
| **Community health**                       |                           |        |                  |
| Hospitalization                            | 1 | Training mothers and caretakers to screen for severe paediatric malnutrition in low-income settings may reduce hospitalization rates for severe malnutrition | Weak |
| **Opioid poisoning**                       |                           |        |                  |
| **Community health**                       |                           |        |                  |
| Overdose-related deaths                    | 2 | Naloxone distribution programmes may result in lower rates of opioid-overdose deaths and more opioid poisoning reversals than communities with less naloxone distribution uptake | Weak |
| Opioid poisoning reversals                 | 1 |                  |                  |
| **Individual health**                      |                           |        |                  |
| Overdose deaths                            | 2 | Naloxone distribution programmes may result in the prehospital reversal of opioid poisonings and avert opioid-related deaths | Weak |
| Composite of repeat overdose-related emergency department visit, hospitalization, or death (null findings) | 1 |                  |                  |
| % of opioid poisoning cases reversed       | 1 |                  |                  |
| **Paediatric communicable diseases**       |                           |        |                  |
| **Community health**                       |                           |        |                  |
| Pneumonia-specific fatality rate           | 1 | Community-wide education and management of paediatric acute respiratory infections may reduce pneumonia-specific fatality rates and improve access to treatment services in rural settings | Weak |

(continues . . )
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Emergency care with lay responders in underserved populations

Aaron M Orkin et al.

Objectif Évaluer l'impact, sur la santé individuelle et collective, du transfert des interventions de premiers secours dans les endroits disposant de ressources limitées et au sein des populations défavorisées à travers le monde.

Méthodes Nous avons analysé systématiquement 13 bases de données ainsi que toute littérature grise complémentaire pour y trouver des études publiées entre 1984 et 2019. Les études retenues devaient respecter les critères d'inclusion propres aux pays à faibles et moyens revenus (21 études) et aux populations défavorisées dans les pays à hauts revenus (13 études). De plus, nous avons synthétisé les résultats sous forme de textes et de tableaux.

Résultats Sur 19 308 articles récupérés, 34 études étaient pertinentes pour répondre à notre question: pour les populations défavorisées, le transfert des premiers secours est-il associé à des conséquences positives pour les patients et la santé collective ?

Conclusion La formation des premiers secours dans les endroits disposant de ressources limitées peut contribuer à réduire les disparités de santé et à améliorer la qualité de la santé dans les populations défavorisées.

Résumé

Premiers secours prodigués par des intervenants non professionnels au sein des populations défavorisées: revue systématique

La formation aux premiers secours et le transfert des interventions non professionnels à des populations défavorisées peuvent avoir un impact positif sur la santé des individus et de la collectivité. Cependant, des études systématiques ont été menées pour évaluer l'efficacité de ces interventions dans des contextes de santé défavorisés.

6. Evaluate the impact of improving maternal and child health care in underserved communities and rural areas through the training of lay people and the distribution of emergency equipment.

7. Improve access to basic health services in remote and rural areas through the training of lay people and the distribution of emergency equipment.

8. Enhance emergency response capacity in underserved communities and rural areas through the training of lay people and the distribution of emergency equipment.

9. Strengthen the link between emergency response and primary health care in underserved communities and rural areas through the training of lay people and the distribution of emergency equipment.

10. Address the needs of underserved communities and rural areas through the training of lay people and the distribution of emergency equipment.
Resumen

Atención de emergencia con respondedores no profesionales en poblaciones subatendidas: una revisión sistemática

Objetivo Evaluar los efectos en la salud individual y comunitaria del cambio de tareas para la atención de emergencia en entornos con bajos recursos y poblaciones desatendidas a nivel mundial.

Métodos Se realizaron búsquedas sistemáticas en 13 bases de datos y en la literatura gris adicional de estudios publicados entre 1984 y 2019. Los estudios elegibles involucraron la formación en atención de emergencia para personas no profesionales en poblaciones subatendidas o de bajos recursos, y cualquier evaluación cuantitativa de los efectos en la salud de los individuos o las comunidades. Se realizaron evaluaciones duplicadas de la elegibilidad de los estudios, la abstracción de datos y la calidad. Se sintetizaron los resultados en formato narrativo y tabular.

Resultados De los 19.308 documentos recuperados, 34 estudios cumplieron los criterios de inclusión de países con ingresos bajos y medios (21 estudios) y de poblaciones desatendidas con ingresos altos (13 estudios). Las condiciones de emergencia a las que se dirigían incluían traumatismos, quemaduras, paros cardíacos, intoxicación por opioides, malaria, enfermedades pediátricas transmisibles y desnutrición. Entre los alumnos se encontraban el público en general, los profesionales no sanitarios, los voluntarios y los contactos cercanos de las poblaciones de riesgo, todos ellos formados a través de campañas de educación y concienciación pública presenciales, entre compañeros y multimodales. Los resultados clínicos y políticos más importantes fueron la mejora de la capacidad de la comunidad para gestionar emergencias (14 estudios), los resultados de los pacientes (13 estudios) y la salud de la comunidad (7 estudios). Aunque no se observaron efectos sustanciales en los programas para abordar la malaria pediátrica, los traumatismos y la intoxicación por opioides, la mayoría de los estudios informaron de resultados nulos. La mayoría de los estudios fueron de calidad débil (24 estudios) o moderada (9 estudios).

Conclusión La formación de personas en primeros auxilios y la transferencia de tareas a los legos para la atención de emergencias pueden reducir la morbilidad y la mortalidad de los pacientes y fomentar la capacidad de la comunidad para gestionar las emergencias sanitarias en una variedad de condiciones de emergencia en entornos desatendidos y de bajos recursos.

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### Table 1. Characteristics of studies included in the systematic review of health effects of first aid by lay responders in low-resource settings and underserved populations

| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|-----------------------------|---------|--------------------------|------------------------------|-------------|---------|--------------------------------|----------------|
| **Cardiac arrest**          |         |                          |                              |             |         |                                |                |
| Roberts et al., 1999        | UK      | Population: approximately 30 000 people. Age: NR | Case series. Study period: 1 year | Intervention: training on basic life support for lay first responders. Participants: 83 people trained; 134 cardiac arrest patients treated | Control: none | Difference in mean response time to cardiac arrest calls between first responders and ambulances: 7.6 minutes<sup>e</sup> | Weak           |
| Page et al., 2000           | USA and international airline flight routes | Population: 627 956 flights, 70 801 874 passengers. Age: mean 58 years, patients treated | Case series. Study period: 12.5 months | Intervention: appropriate use of automated external defibrillator on flights. Participants: 24,000 flight attendants trained; 200 patients treated, 15 of whom were defibrillated | Control: none | Percentage of patients alive at hospital discharge: 99/200 patients were unconscious; 40% (6/15 patients) survived neurologically intact to hospital discharge<sup>b</sup> | Weak           |
| Rørtveit & Meland, 2010     | Norway  | Population: 4 400 people. Age: 36–92 years, patients treated | Case series. Study period: 5 years | Intervention: basic life support and defibrillation initiated by laypeople. Participants: 42 people trained; 17 patients treated among 24 cardiac arrest calls | Control: none | Median time from first responder arrival until ambulance or doctor arrival: 22.5 minutes<sup>b</sup> | Weak           |
| Nielsen et al., 2013        | Denmark | Population: 42 000 community members, 600 000 seasonal tourists annually. Age: > 15 years | Before-and-after study, uncontrolled. Study period: 1 year | Intervention: community-wide basic life support and automated external defibrillator use. Participants, number of people trained and treated: NR | Control: none | Percentage of community members willing to use an automated external defibrillator on a stranger: 63% (520/824 people) pre-intervention versus 82% (669/815 people) post-intervention (χ<sup>2</sup> test P < 0.0001; OR: 2.86; 95% CI: 2.26–3.63)<sup>d</sup> | Weak           |
| Burns                       | India   | Population: unknown. Age: 53.5% of inpatients age 25–35 years (frequencies not specified) | Before-and-after study, uncontrolled. Study period: 4 years | Intervention: occupational burn prevention and treatment education. Participants: 590 steel workers trained; 142 inpatients and 673 outpatients treated | Control: none | Percentage of burn patients with < 20% total body surface area burns receiving appropriate first aid: 37.8% (14/37 patients) pre-intervention versus 25.0% (4/16 patients) post-intervention (OR: 3.75; 95% CI: 0.88–19.53)<sup>d</sup> | Weak           |
| Skinner et al., 2004        | New Zealand | Population: NR. Age: pre-intervention patients, 3 months to 77 years; post-intervention patients, 3 months to 83 years | Before-and-after study, uncontrolled. Study period: two 4-month study intervals, 44 months apart | Intervention: public first aid campaign for burn injuries. Participants: general public, number of people treated: NA | Control: none | Percentage of patients receiving adequate first aid: 33% (11/33<sup>e</sup> people) pre-intervention versus 61% (22/36<sup>e</sup> people) post-intervention (P = 0.02) among Pacific Islanders; 25% (6/24<sup>e</sup> people) versus 48% (13/27<sup>e</sup> people) post-intervention (P = 0.08) among Maori people | Moderate        |

(continues. . .)
| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|----------------------------|---------|--------------------------|-------------------------------|--------------|---------|--------------------------------|---------------|
| Malaria                    | Ethiopia| Population: 37 regions, each with a population of 1000–3000 people; 14001 children aged < 5 years. Age: < 5 years | Randomized controlled trial. Study period: 12 months | Intervention: peer education for mothers on recognition and treatment of paediatric malaria. Participants: 12 regions with 6383 children aged < 5 years; number of children treated: NR | Control: no peer education. Participants: 12 regions with 7294 children aged < 5 years; number of children treated: NR | Absolute rate reduction in all-cause mortality in children < 5 years: 20.4 per 1 000 (95% CI: 13.9–26.9) | Weak |
|                           | Nigeria | Population: 147 847 people, including 33 126 children and 33 576 women of childbearing age. Age: ≤ 10 years | Randomized controlled trial. Study period: 12 months | Intervention: peer education for mothers on paediatric malaria recognition and treatment. Participants: 330 mothers trained; 247 paediatric malaria cases treated | Control: no peer education. Participants: 281 mothers, 266 paediatric malaria cases | Percentage of children receiving chloroquine according to guideline on febrile illness for children at home: 2.6% (3/116 children) pre-intervention versus 52.3% (69/132 children) post-intervention (P < 0.001) in intervention group; 4.1% (3/72 children) pre-intervention versus 15.8% (9/57 children) post-intervention (P = 0.05) in control group | Weak |
|                           | Burkina Faso | Population: NR. Age: < 5 years | Cluster randomized controlled trial. Study period: 2 years | Intervention: community-based malaria education and management. Participants: 70 women group leaders trained across 6 villages; 542 children treated at baseline and 496 children treated at follow-up | Control: no community-based malaria education and management. Participants: seven villages; 541 children treated at baseline and 510 children at follow-up | Percentage of children younger than 5 years with malaria with moderate to severe anaemia: 28% (152 children) pre-intervention versus 17% (83 children) post-intervention in intervention group; 30% (162 children) versus 15% (74 children) post-intervention in control group (P = 0.03; OR: 1.18; 95% CI: 0.83–1.69) | Weak |
|                           | Senegal | Population: 40 000 people. Age: all ages | Case series. Study period: 4 years | Intervention: nurse-led education on malaria recognition and treatment. Participants: 31 community medicine distributors and 21 community health workers trained; 5384 consultations given by community medicine distributors and 16 757 by community health workers | Control: none | Percentage of eligible patients receiving rapid malaria tests: 93.5% (5036/5384 patients) treated by community medicine distributors; 56.8% (9518/16 757 patients) treated by community health workers | Weak |
### Systematic reviews

**Emergency care with lay responders in underserved populations**

**Aaron M Orkin et al.**

| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating* |
|-----------------------------|---------|--------------------------|-------------------------------|--------------|---------|---------------------------------|----------------|
| Tobin-West & Briggs, 2015⁶⁶ | Nigeria | Population: 2 187 people. Age: < 5 years | Before-and-after, controlled. Study period: 12 months | Intervention: community-based education on treatment of malaria. Participants: 184 mothers trained pre-intervention and 173 trained post-intervention; number treated: NR | Control: no training or drugs provided. Participants: 184 mothers pre-intervention and 169 post-intervention; number treated: NR | Percentage of mothers reporting their child was cured of malaria: 47.3% (87 mothers) pre-intervention versus 84.4% (146 mothers) post-intervention in intervention group (P < 0.0001); 50.0% (92 mothers) pre-intervention versus 49.1% (83 mothers) post-intervention in control group (P = 0.94) | Weak |
| Warsame et al., 2016⁶³ | Ghana, Guinea-Bissau, Uganda and United Republic of Tanzania | Population: 26 994 households, 346 villages; 58 771 children aged < 5 years; intervention: 141 clusters, 12 297 households; control: 136 clusters, 10 531 households. Age: < 5 years | Cluster randomized controlled trial. Study period: 19 months | Intervention: community-based treatment for severe malaria before hospital referral. Participants: 687 mothers, traditional healers and others trained; 2464 children treated | Control: usual practice from community health workers. Participants: 1469 children treated | Odds ratio of initiation of malaria treatment in the community before hospital referral for severe malaria: 1.84 (95% CI: 1.20–2.83) trained mothers versus controls | Moderate |
| Kitutu et al., 2017⁷⁴ | Uganda | Population: 472 629 people; population aged < 5 years: NR. Age: < 5 years | Before-and-after, controlled. Study period: 12 months | Intervention: community-based treatment of various paediatric illnesses. Participants: owners and attendants at 61 drug shops trained; 212 caretaker–child pairs treated at baseline and 285 pairs treated at endline | Control: no community-based training. Participants: 23 drug shops; 216 caretaker–child pairs treated at baseline and 268 pairs treated at endline | Percentage of children younger than 5 years receiving guideline-based treatment for uncomplicated malaria: 8.3% (11/133 children) pre-intervention versus 57.5% (108/188 children) post-intervention in intervention group; 31.9% (38/119 children) pre-intervention versus 0.9% (1/112 children) post-intervention in control group. Difference between groups: 80.2% (95% CI: 53.2–107.2) of children received treatment | Weak |
| Linn et al., 2018⁶⁵ | Myanmar | Population: 978 735 people. Age: < 5 years (9.5%); 5–14 years (18.6%); > 15 years (72.0%) | Cohort study, retrospective. Study period: 1 year | Intervention: screening, testing and management of malaria by village health volunteers, with referrals as needed. Participants: 270 155 volunteers trained; 23 503 (80.9%) patients received complete treatment | Control: similar to intervention, but conducted by basic health staff. Participants: 708 580 volunteers trained; 64 879 patients (88.2%) received complete treatment | Adjusted prevalence ratio of receiving malaria treatment among eligible patients in intervention versus control: 1.02 (95% CI: 1.015–1.020) | Weak |

(continued...)
| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|-----------------------------|---------|--------------------------|-----------------------------|-------------|---------|---------------------------------|---------------|
| Emergency care with lay responders in underserved populations | Green et al., 2019<sup>46</sup> | Zambia | Population: intervention area of 54000 people in Serenje district. Age: < 5 years | Before-and-after study, uncontrolled. Study period: 12 months | Intervention: treatment and transport of children with severe paediatric malaria by community volunteers. Participants: 180 Safe Motherhood Action Group volunteers and 45 volunteers trained in integrated community case management, and 66 bicycle ambulance riders trained in emergency transport; 224 children treated before intervention and 619 children during intervention | Control: none | Malaria case fatality rate in children younger than 5 years: 8% (18/224 children) before intervention: 0.5% (3/619 children) during intervention<sup>48</sup> | Weak |
| Malnutrition | Minn et al., 2019<sup>47</sup> | Myanmar | Population: 257 700 people. Age: all ages | Cross-sectional. Study period: 1 year | Intervention: malaria screening, diagnosis and treatment services by integrated community malaria volunteers, with referrals as appropriate. Participants: 632 volunteers trained; 2279/2881 (79%) of malaria-positive patients treated | Control: care from basic health staff at health posts | Adjusted probability ratio of receiving incorrect treatment for malaria from volunteers versus care at health posts: 0.5 (95% CI: 0.30–0.83) | Weak |
| | Alé et al., 2016<sup>48</sup> | Niger | Population: intervention group, 37 389 people and 9908 children aged < 5 years; control group, 33 449 people and 8867 children aged < 5 years. Age: < 5 years | Non-randomized cluster trial. Study period: 11 months | Intervention: training on screening for severe acute malnutrition by mothers and caretakers. Participants: 12893 mothers and caretakers trained; 1371 children admitted to malnutrition treatment | Control: screening for severe acute malnutrition by community health workers. Participants: 36 community health workers trained; 988 children admitted to malnutrition treatment | Percentage of children hospitalized for malnutrition treatment: 7.2% (99/1371 children) in intervention group versus 11.8% (117/988 children) in control group. Relative risk ratio of hospitalization: 0.61 (95% CI: 0.47–0.79); risk difference: −4.62% (95% CI: −7.06 to −2.18) | Weak |
| Opioid poisoning | Walley et al., 2013<sup>49</sup> | USA | Population: 30% of population of Massachusetts State. Age: NR | Time-series analysis. Study period: 8 years, 2002–2009 | Intervention: overdose education and naloxone distribution. Participants: 2912 people enrolled in training; 327 rescue attempts made | Control: none | Adjusted rate ratio relative to reference population with 0 enrolments per 100 000 population: 0.73 (95% CI: 0.57–0.91) in regions with 1–100 enrolments in training per 100 000 population; 0.54 (95% CI: 0.39–0.76) in regions with > 100 enrolments in training per 100 000 population | Weak |
### Systematic reviews

#### Emergency care with lay responders in underserved populations

**Aaron M Orkin et al.**

| Medical condition and study | Country                  | Study population and age | Study design and study period | Intervention                                                                 | Control                  | Primary outcome and effect size                                                                 | Quality rating |
|-----------------------------|--------------------------|--------------------------|-------------------------------|-------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------------------------------------------|----------------|
| Bird et al., 2016          | Scotland, United Kingdom | Population: about 5.1 million people; affected sub-population size: NR. Age: NR | Before-and-after study, uncontrolled. Study period: 2006–2010 pre-intervention, 2011–2013 post-intervention | Intervention: nationwide education on opioid overdose and naloxone distribution programme. Participants: 11 898 kits issued by community and prisons; numbers of patients treated unknown | Control: none | Percentage of opioid-related deaths with a 4-week antecedent of prison release: 9.8% (193/1970 people) pre-intervention versus 6.3% (76/1212 people) post-intervention (absolute difference: 3.5%; 95% CI: 1.6–5.4%) | Moderate |
| Irvine et al., 2019        | British Columbia, Canada | Population: not specified (population of British Columbia). Age: NR | Cohort study, retrospective, with Markov chain modelling. Study period: about 20 months (Apr 2016–Dec 2017) | Intervention: provincial distribution of naloxone kits, as well as provincial overdose prevention and supervised consumption services and opioid agonist therapy. Participants: 88 300 naloxone kits distributed in 2017; number of patients treated unknown | Control: none | Number of opioid-related-deaths averted: 1650 (95% CrI: 1540–1850); 11 kits used per death averted (95% CrI: 10–13) | Moderate |
| Mahonski et al., 2020      | Maryland, USA            | Population: 1139 people with opioid poisoning and community naloxone administration. Age: all ages, mean age 34.3 years | Cohort study, retrospective. Study period: 24 months, Jan 2015–Oct 2017 | Intervention: overdose education and naloxone distribution. Participants: 70 992 people trained in 2015–2017, including 6031 law enforcement officers; 1139 patients treated | Control: none | Percentage of opioid poisoning cases reversed: 79.2% of 886 poisoning cases overall; decrease from 82.1% (66/117 patients) in 2015 to 76.4% (441/577 patients) in 2017 (P = 0.04) | Weak |
| Naumann et al., 2019       | North Carolina, USA      | Population: not specified (population of North Carolina State). Age: NR | Before-and-after, uncontrolled. Study period: 2000–2016 | Intervention: overdose education and naloxone distribution. Participants: 39 449 naloxone kits distributed; numbers treated unknown | Control: none | Rate ratio of opioid poisoning deaths in intervention counties compared with counties not receiving naloxone kits: 0.90 (95% CI: 0.78–1.04) in counties with 1–100 kits distributed per 100 000 population; 0.88 (95% CI: 0.7–1.02) in counties with > 100 kits distributed per 100 000 population | Weak |
| Papp et al., 2019          | North-east Ohio, USA     | Population: 291 people who use opioids. Age: median 34 years | Cohort study, retrospective. Study period: 3 and 6 months from hospital discharge | Intervention: hospital-based overdose education and naloxone distribution. Participants: 208 (71%) overdose survivors trained; treatment outcome reported among trainees | Control: no overdose education or naloxone distribution. Participants: 83 overdose survivors untrained; number of patients treated: NA | Percentage of patients experiencing repeat overdose-related emergency department visit, hospitalization or death (composite of events): 6.0% (5/83 patients in control group versus 7.7% (16/208 patients) in intervention group over 3 months (P = 0.9); 4.8% (4/83 patients) in control group versus 6.7% (14/208 patients) in intervention group over 6 months (P = 0.99) | Weak |

(continues . . .)
Emergency care with lay responders in underserved populations

| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|-----------------------------|---------|--------------------------|------------------------------|--------------|---------|---------------------------------|---------------|
| Rowe et al., 2019<sup>9</sup> | San Francisco, USA | Population: not specified (population of San Francisco). Age: NR | Before-and-after, uncontrolled. Study period: 2014–2015 | Intervention: overdose education and naloxone distribution. Participants: 1023 overdose education and naloxone distribution trainees in 2014 and 1123 trainees in 2015; 326 people trained in 2014 and 504 trained in 2015 | Control: none | Number of opioid poisoning reversals reported: 326 in 2014 versus 504 in 2015 (P<0.001) | Weak |
| Paediatric communicable diseases

| Study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|-------|---------|--------------------------|------------------------------|--------------|---------|---------------------------------|---------------|
| Bang et al., 1994<sup>10</sup> | India | Population: 48 377 people in 58 villages in intervention area; 34 856 people in 44 villages in control area. Age: < 5 years | Non-randomized cluster trial. Study period: 3 years | Intervention: management of childhood pneumonia by lay community members. Participants: 30 paramedical workers, 25 village health workers and 86 traditional birth attendants trained (only traditional birth attendants met layperson inclusion criterion); traditional birth attendants managed 651 cases of pneumonia among children aged < 5 years and 50 cases among neonates | Control: existing care. Participants: no community members trained; number of children treated unknown | Pneumonia case fatality rate in children younger than 5 years: 2.0% (13/651 children) with care by traditional birth attendants versus 13.5% with existing care (frequencies: NR) | Moderate |
| Holloway et al., 2009<sup>11</sup> | Nepal | Population: 4 districts of 134 000–232 000 people each; population aged < 5 years unknown. Sample frame of 2231 households with a child aged < 5 years old who had acute respiratory infection in last 2 weeks. Age: < 5 years | Before-and-after, controlled. Study period: about 6 months | Intervention: community-wide education programme on recognizing and treating acute respiratory infections. Participants: community exposed to public campaign; 200 children aged < 5 years with severe acute respiratory infection treated | Control: existing care. Participants: community not exposed to campaign; 187 children aged < 5 years with severe acute respiratory infection treated | Absolute difference in percentage of children younger than 5 years with severe acute respiratory infection receiving consultation at a health post: 12.6% (test of interaction with intervention versus control group P=0.01) | Weak |
| Yansaneh et al., 2014<sup>12</sup> | Sierra Leone | Population: projected 57 000–76 000 children (19% of 300 000–400 000 people). Age: < 5 years | Before-and-after, controlled. Study period: 2 years | Intervention: treatment and referral of common childhood illnesses by lay volunteers. Participants: 219 volunteers trained; 1980 children brought for medical care at baseline and 1657 patients at endline | Control: existing care. Participants: no people trained; 1962 patients brought for care at baseline and 2102 patients at endline | Odds ratio of appropriate treatment: 0.45 (95% CI: 0.21–0.96) for childhood diarrhoea; 0.65 (95% CI: 0.32–1.34) for malaria; 2.05 (95% CI: 1.22–3.42) for pneumonia | Weak |
| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|-----------------------------|---------|--------------------------|--------------------------------|--------------|---------|---------------------------------|---------------|
| **Langston et al., 2019**<sup>29</sup> | Province of Tanganyika, Democratic Republic of the Congo | Population: 2 649 317 people. Age: NR | Non-randomized cluster trial. Study period: 11 months | Intervention: simplified teaching of integrated community case management for uncomplicated malaria, pneumonia and diarrhoea for children aged 2–59 months. Participants: 1 600 people trained and 78 lay providers assessed; 78 children assessed | Control: standard teaching for integrated community case management of uncomplicated malaria, pneumonia and diarrhoea. Participants: 74 lay providers assessed; 74 children assessed | Adjusted odds ratio of correct referral of children with danger signs: 24.2 (95% CI: 1.9–300.2) | Moderate |
| **Oresanya et al., 2019**<sup>30</sup> | Niger State, Nigeria | Population: 899 sick children from caregiver survey included at baseline and 680 sick children at endline. Age: < 5 years | Before-and-after, uncontrolled. Study period: from baseline 2014 to endline 2017 | Intervention: treatment and management of paediatric diarrhoea, pneumonia and fever by volunteer community caregivers. Participants: 1 320 volunteers trained; 161 patients treated | Control: none | Percentage of children younger than 5 years brought for care to an appropriate provider: for fever, 78% (322/413 children) at baseline versus 94% (283/301 children) at endline (P < 0.01); for diarrhoea, 72% (269/374 children) at baseline versus 91% (273/301 children) at endline (P < 0.01); for pneumonia, 76% (262/343 children) at baseline versus 89% (267/301 children) at endline (P < 0.05) | Moderate |
| **Snakebites** | **Sharma et al., 2013**<sup>31</sup> | Nepal | Population: 60 759 people pre-intervention; 59 383 people post-intervention. Age: NR | Before-and-after study, uncontrolled. Study period: Nov–Dec 2003 versus Nov–Dec 2004 | Intervention: community-wide campaign to promote snakebite awareness and rapid transport. Participants: 10 motorcycle drivers trained in each of four subregions; two to three public snakebite awareness programmes per subregion, numbers attending unspecified; leaflets, banners and posters distributed; 122/305 snakebite patients transported by motorcycle pre-intervention, 143/187 during intervention | Control: none | Snakebite case fatality rate: 10.5% (32/305 people) pre-intervention versus 0.51% (187 people) post-intervention, relative risk reduction: 0.95 (95% CI 0.70–0.99); absolute risk reduction: 10.04 (95% CI: 7.38–15.72) | Weak |
Emergency care with lay responders in underserved populations

| Medical condition and study | Country | Study population and age | Study design and study period | Intervention | Control | Primary outcome and effect size | Quality rating |
|-----------------------------|---------|--------------------------|-------------------------------|--------------|---------|---------------------------------|--------------|
| Trauma                      |         |                          |                               |              |         |                                 |              |
| Husum et al., 2003          | Cambodia and Iraq | Population: NR. Age: NR | Before-and-after study, uncontrolled. Study period: 5 years from 1997 to 2001 | Intervention: trauma first aid administered by lay responders. Participants: 135 paramedics and 5237 lay responders trained; 224/1285 emergency medical patients and 1061/1285 trauma patients treated | Control: none | Absolute change in physiological severity score from prehospital to hospital arrival: 0.3 at baseline versus 0.7 after intervention; difference in differences: 0.4 (95% CI: 0.2–0.6). | Strong |
| Saghafinia et al., 2009      | Iran (Islamic Republic of) | Population: not specified. Age: mean 31.9 years | Cohort study, prospective. Study period: 4 years | Intervention: pre-hospital first aid provided by lay individuals. Participants: 4834 lay villagers, nomads and various clinicians trained; 152/288 patients received prehospital care; 63/288 patients died before reaching hospital | Control: no prehospital treatment of injured people; patients moved directly to the hospital. Setting same as intervention group. Participants: no people trained; 73/288 patients sent directly to hospital. | Mean physiological severity scores: 6.40 prehospital versus 7.43 at hospital arrival (95% CI: −0.72 to −0.45) in intervention group; 5.97 in control group | Weak |
| Murad et al., 2012           | Iraq    | Population: NR. Age: mean 26 years in survivors, 27 years in non-survivors | Before-and-after study, uncontrolled. Study period: 10 years | Intervention: prehospital trauma care delivered by lay responders. Participants: 7000 layperson first helpers trained; 2788 patients treated | Control: none | Mortality among trauma patients receiving treatment: 17% (95% CI: 15–19) pre-intervention versus 4% (95% CI: 3.5–5) post-intervention (frequencies: NR) | Moderate |
| Various emergencies          | Canada  | Population: about 3000 people. Age: NR | Before-and-after study, controlled. Study period: 1 year | Intervention: distribution of medical kits and first aid training to Indigenous hunters in wilderness camps. Participants: 210 volunteers trained (49% participation rate across communities); number of people treated unknown | Control: no medical kits and first aid training. Setting same as intervention group. Participants: number of people trained NA; number of people treated: NA | Percentage of emergency health cases managed at wilderness hunt camps with kit: 60% versus 36% without kit (frequencies: NR) | Weak |

CI: confidence interval; CrI: credible interval; NA: not applicable; NR: not reported; OR: odds ratio.

1. We used the Effective Public Health Practice Project quality tool to assess internal and external validity, selection and measurement biases, and confounding factors.
2. We retrieved multiple papers regarding the same study. See the authors’ data repository.
3. We computed Fisher exact test using the reported data.
4. Haematocrit ≤ 24%.