RESUSCITATION PLUS 19 (2024) 100715

Available online at www.sciencedirect.com

Resuscitation Plus

journal homepage: www.elsevier.com/locate/resuscitation-plus

Review

# Interventions to optimize dispatcher-assisted CPR instructions: A scoping review

K.N. Dainty[a,b,*], G. Debaty[c,d], J. Waddick[a], C. Vaillancourt[e], C. Malta Hansen[f,g,h,i], T. Olasveengen[j], J. Bray[k], on behalf of the International Liaison Committee on Resuscitation Basic Life Support Task Force

## Abstract

**Aim**: To review and summarize existing literature and knowledge gaps regarding interventions that have been tested to optimize dispatcher-assisted CPR (DA-CPR) instruction protocols for out-of-hospital cardiac arrest (OHCA).

**Methods**: This scoping review was undertaken by an International Liaison Committee on Resuscitation (ILCOR) Basic Life Support scoping review team and guided by the ILCOR methodological framework and the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR). Studies were eligible for inclusion if they were published in peer-reviewed journals and evaluated interventions used to improve DA-CPR. The search was carried out in MEDLINE, EMBASE, Education Resources Information Center (ERIC), PsycINFO, the Cochrane Library, Evidence Based Medicine (EBM) Reviews, and the Campbell Library from 2000 to December 18, 2023.

**Results**: After full text review, 31 studies were included in the final review. The interventions reviewed were use of video at the scene ($n$ = 9), changes in terminology about compressions ($n$ = 6), implementation of novel DA-CPR protocols ($n$ = 4), advanced dispatcher training ($n$ = 3), centralization of the dispatch center ($n$ = 2), use of metronome or varied metronome rates ($n$ = 2), change in CPR sequence and compression ratio ($n$ = 1), animated audio-visual recording ($n$ = 1), pre-recorded instructions vs. conversational live instructions ($n$ = 1), inclusion of “undress patient” instructions ($n$ = 1), and specific verbal encouragement ($n$ = 1). Studies ranged in methodology from registry studies to randomized clinical trials with the majority being observational studies of simulated EMS calls for OHCA. Outcomes were highly variable but included rates of bystander CPR, confidence & willingness to perform CPR, time to initiation of bystander CPR, bystander CPR quality (including CPR metrics: chest compression depth and rate; chest compression fraction; full chest recoil, ventilation rate, overall CPR competency), rates of automated external defibrillator (AED) use, return of spontaneous circulation (ROSC) and survival. Overall, all interventions seem to be associated with potential improvement in bystander CPR and CPR metrics.

**Conclusion**: There appears to be trends towards improvement on key outcomes however more research is needed. This scoping review highlights the lack of high-quality clinical research on any of the tested interventions to improve DA-CPR. There is insufficient evidence to explore the effectiveness of any of these interventions via systematic review.

**Keywords**: Out-of-hospital cardiac arrest, Dispatcher-assisted CPR, DA-CPR, Optimization, Metronome, Video, DA-CPR protocols, Terminology, Compression ratio, CPR metrics, bystander CPR

## Introduction

Rapid initiation of cardiopulmonary resuscitation (CPR) has been shown to double the chance of survival from out-of-hospital cardiac arrest (OHCA).[1] Nevertheless, in most of the world, only 35–50% of cardiac arrest victims receive bystander CPR before emergency medical services (EMS) arrive.[2] Several reasons for this disparity have been postulated, but one of the most commonly implemented interventions to raise bystander CPR rates in recent years has been CPR instructions provided over the telephone by the emergency call taker, called dispatcher-assisted CPR (DA-CPR) or telephone CPR (TCPR). In a systematic review by Nikolau et al in 2019, dispatcher-assisted CPR was shown to be associated with a beneficial effect on patient outcomes following OHCA.[3] When comparing DA-CPR to no CPR, both the unadjusted and adjusted analyses

* Corresponding author at: North York General Hospital, Toronto Canada.
E-mail address: katie.dainty@utoronto.ca (K.N. Dainty).

https://doi.org/10.1016/j.resplu.2024.100715
Received 30 May 2024; Received in revised form 26 June 2024; Accepted 28 June 2024

show DA-CPR provides better results in terms of survival with return of spontaneous circulation, survival to hospital discharge and favorable neurologic outcome.

The 2020 treatment recommendations by the International Liaison Committee on Resuscitation (ILCOR) recommends systems of care provide CPR instructions via dispatchers/call-takers in the emergency call.[4,5] Although the certainty of evidence was rated as very low at that time, DA-CPR is now widely implemented[6] and research has moved towards examining specific interventions aiming to optimize DA-CPR. However, to date these interventions appear to be diverse, and with very little literature published on each one individually (i.e., only one or two studies in some cases).

As such, we undertook a narrative scoping review of this literature to review and summarize existing literature and knowledge gaps regarding interventions that have been tested to optimize dispatcher-assisted CPR (DA-CPR) instruction protocols for out-of-hospital cardiac arrest (OHCA). The scoping review question was defined as "*In adult and pediatric out of hospital cardiac arrest situations where dispatcher-assisted CPR (DA-CPR) is implemented, what impact do interventions used in addition to DA-CPR have on patient and process related cardiac arrest outcomes?* The interventions and outcomes of interest are defined in the PICOST presented in Fig. 1.

## Methods

We developed a review protocol guided by the ILCOR approach to systematic review and specifically the scoping review methods outlined by Arksey and O'Malley[7] and further refined by the Joanna Briggs Institute.[8] The PRISMA Extension for Scoping Reviews (PRISMA-ScR) was used to guide our reporting where appropriate (completed checklist included in supplementary material).[9] Survivors and family members were not engaged with the conception or conduct of this review. A protocol has not been previously published.

For the purposes of this review, we have elected to use the term "dispatcher-assisted CPR" or "DA-CPR" for consistency and to reflect the terminology used in the papers reviewed. We acknowledge there are other terms used throughout the world that more accurately reflect the role of the person delivering the CPR instructions (ie. call-taker, telecommunicator, etc).

### *Eligibility criteria*

Our eligibility criteria were defined as studies conducted in adults and children receiving dispatcher-assisted CPR (DA-CPR) following out-of-hospital cardiac arrest. All study designs including randomised controlled trials (RCTs) and non-randomised studies (non-randomised controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) were eligible for inclusion. Simulated studies were only included if there was insufficient clinical studies in humans at the time of the review. We included all studies for which there was an English language abstract available.

Studies including animals were not eligible. We also excluded commentaries, reviews, and studies not published in peer-reviewed journals or only as abstracts.

### *Information sources and search strategy*

The protocol for comprehensive literature searches were developed and conducted by an experienced information specialist (JW) in consultation with the subject experts and ILCOR Basic Life Support Task Force members. First, we searched MEDLINE, EMBASE, Education Resources Information Center (ERIC), PsycINFO, the Cochrane Library, Evidence Based Medicine (EBM) Reviews, and the

| PICOST | Description (with recommended text) |
|---|---|
| Population | Adult and pediatric in out-of-hospital cardiac arrest where dispatcher-assisted CPR (DA-CPR) is implemented |
| Intervention | Interventions used in addition to DA-CPR |
| Comparison | Non-modified DA-CPR |
| Outcomes | • Good neurological outcome at hospital discharge/30-days; Survival at hospital discharge/30-days; Return of spontaneous circulation (ROSC)<br>• Time to initiation of bystander CPR; Rates of bystander CPR;<br>• Rates of automated external defibrillator (AED) use;<br>• Bystander CPR quality (any available CPR metrics: chest compression depth and rate; chest compression fraction; full chest recoil, ventilation rate, overall CPR competency);<br>• Bystander fatigue;<br>• Confidence & willingness to perform CPR. |
| Study Design | Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies) are eligible for inclusion. Unpublished studies (e.g., conference abstracts, trial protocols), editorials, commentaries, animal studies and systematic reviews are excluded.<br>If there will be insufficient studies from which to draw a conclusion, case series may be included in the initial search. |
| Timeframe and Language | 2000 to December 18, 2023, and all languages are included if there is an English abstract |

**Fig. 1 – PICOST Table.**

Campbell Library from 2000 to December 18, 2023. The final search strategy used in each database is available from the corresponding author upon request.

### Study selection

Search results were imported into the COVIDENCE software for screening citations (i.e., titles and abstracts) and full-text articles. The inclusion criteria were also imported into this online software and used for screening citations during the screening of titles and abstracts (i.e., level 1 screening) and full-text articles (i.e., level 2 screening).

Initial screening for articles that were deemed to be irrelevant (i.e., not about cardiac arrest, excluded article types, etc.) was done by the lead author (KND). Following this, the remaining articles were entered into COVIDENCE for multi-reviewer title and abstract screening. Two reviewers completed the second stage of title and abstract screening and full text screening (GD and KND) For full-text screening, we achieved 87% agreement. All discrepancies between reviewers at each stage were resolved by discussion with and decision by a third reviewer (CV).

### Data abstraction

We abstracted data on study characteristics (e.g., year of study conduct, country, setting, type of publication, focus of the study), population characteristics (e.g., percent female, percent new investigators), and quantitative (e.g., percent successful applicants) outcomes. Due to the small number of included studies identified, a pilot-test was not conducted for data abstraction. The data abstraction form was developed and modified as required based on feedback from the team. Data was abstracted and entered into an Excel database. Five studies were double abstracted, and discrepancies were discussed. The remaining studies were abstracted by a single team member (KND).

### Methodological quality appraisal

We did not appraise quality or risk of bias of the included articles, consistent with accepted scoping review methods and scoping reviews on health-related topics.[7,8]

### Synthesis and data charting

We charted the data quantitatively to identify the number of relevant publications according to types of participants, interventions, comparators, and outcomes, and summarized these findings using descriptive frequencies.

## Results

### Study selection

The PRISMA flow diagram of study selection is shown in Fig. 2. After the initial search strategy was conducted, a total of 6,031 articles were retrieved. After removing duplicates and excluding study types and articles that were irrelevant, 109 articles were uploaded to the Covidence software and screened by two reviewers using title and abstract data. At this level 1 screening, we found 43 to be potentially relevant articles. After full text review of these studies, 31 studies were included in this scoping review. The additional study was added after a reference list review identified it as relevant but not captured by the in initial search. The main reasons for exclusion included papers that were about the effectiveness of dispatcher-assisted CPR, full articles not available in English, and publication types that did not meet the inclusion criteria, such as reviews, editorials, and commentaries. Given the scoping review approach and variation in study designs, interventions, and types of data presentations in the included studies, statistical *meta*-analysis was not performed.

### Characteristics of included studies

The characteristics and outcomes of studies included are shown in Table 1. Among 31 studies included, 16 were simulation studies (15 RCTs, one non-randomized comparison) and 13 were clinical studies (one was a non-randomized implementation trial, and 12 were observational studies reviewing real-world OHCAs from registries or collected data or emergency call review). Two included studies used qualitative and mixed methods. Only one study focused on pediatric cardiac arrest.[18]

The included studies were from a range of countries including Korea (n = 10), USA (n = 5), Singapore (n = 3), Belgium (n = 2), Australia (n = 2), Denmark (n = 2), Norway (n = 2), Japan (n = 1), Taiwan (n = 1), Russia (n = 1), United Kingdom (n = 1) and Czech (n = 1). The years of publication of included studies ranged from 2008 to 2023.

### Results of included studies

We grouped the interventions of studies included into 11 groups by description of the intervention. A summary of specific interventions and results for each study is included in Appendix A and Table 2 respectively.

a) ***Use of Video vs. Audio-only in call (n = 9; 1 = pediatrics).***

The use of video in the emergency call was examined in 9 studies, including 2 cohort studies,[10,11], 5 simulation RCTs,[12–15,17] and single qualitative[16] and mixed method study.[18]

Only one study examined patient outcomes and compared adult OHCA patients with video-instructed dispatcher CPR to those with audio-only CPR instructions.[10] This study found no difference in survival to discharge of favorable neurological outcome in an adjusted or matched analysis. Another study conducted a subjective assessment of CPR quality in calls using video and found high rates of incorrect hand positioning (42%) before video assessment, which significantly improved following further instructions.[11] This study also reported lower proportions of correct compression rates and depth, which also improved with video-assisted instructions.

In the simulation RCTs, most reported the video-instructed method resulted in a greater correct compression rate and positioning of the hands.[12,13,15,17] However, another study reported the video group had more “hands-off” time, longer time to first chest compressions and total instruction time.[14]

A qualitative study was conducted to understand the dispatcher’s experience with adding video to calls following a simulation study.[16] In this study dispatchers reported that: video-calls were useful for obtaining information and to support CPR assistance; their CPR assistance became easier; that the CPR might be of better quality; but that there is a risk of distraction (“noise”). The mixed methods simulation study reported better CPR quality with video, and that participants liked the ability to correct CPR.[18]

b) ***Changes in terminology (n = 7)***

Seven studies looked at the impact of changing the DA-CPR terminology, including one before-and-after observational study,[18] three

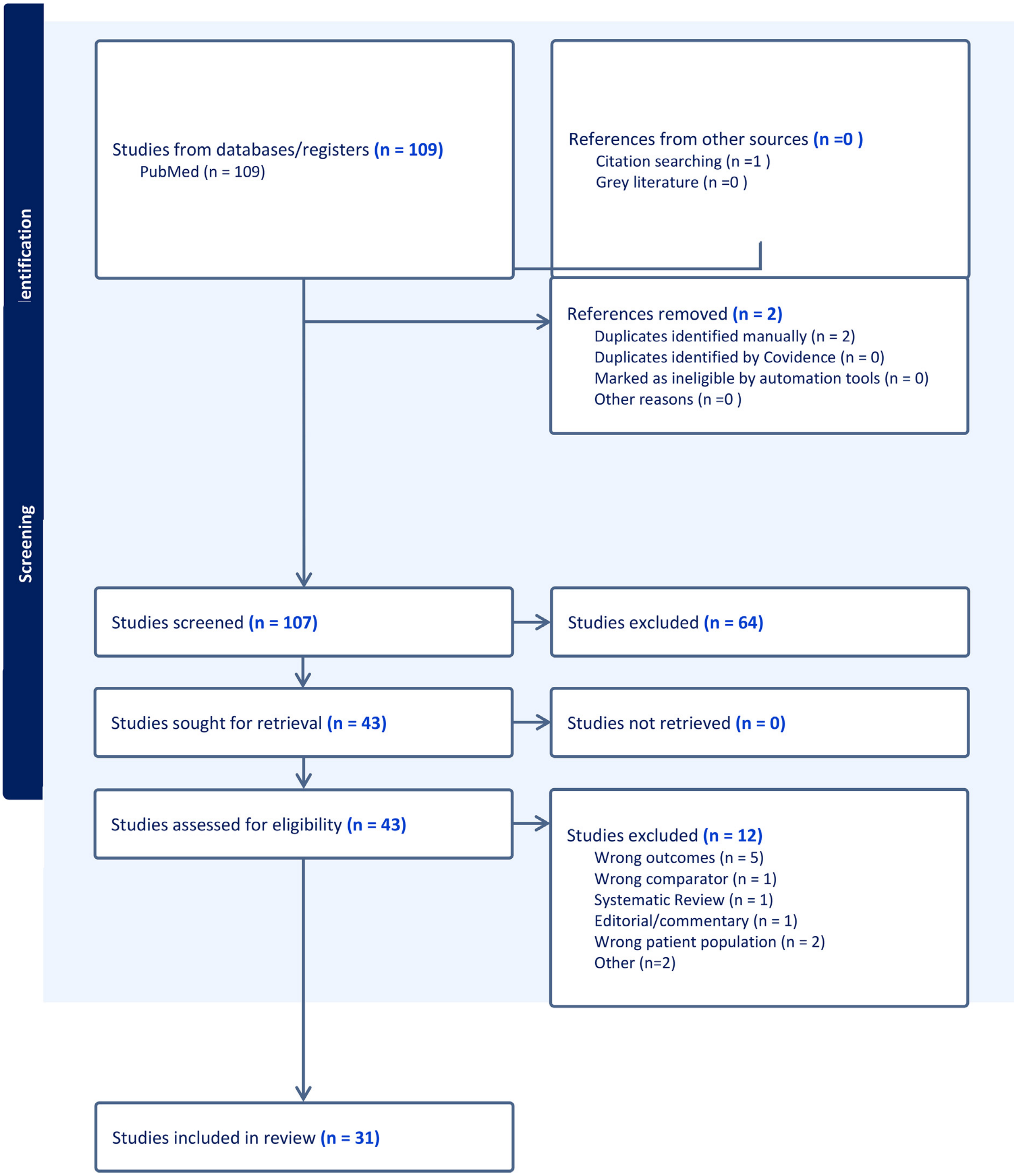


**Fig. 2 – PRISMA Diagram.**

simulation RCTs [20–22], use of secondary data from two simulation RCTs[23] and two reviews of emergency calls.[19,24]

The before-and-after observational study compared a standard protocol for DA-CPR including the instruction 'push 100 times a minute 5 cm deep' versus a quality improvement initiative where the instruction was simplified to 'push hard and fast'.[18] The period with the simplified instruction was associated with a shorter time to first compression. Three other studies examined simplifying the language in CPR instructions in simulations.[20–22] In general, these simulation studies found simplified language (e.g., "press hard and fast", "push as hard as you can") improved time to first compression and compression rate and depth.[21,22] One simulation RCT looked at including the instruction to "put the phone down" during CPR and found no difference in the quality of CPR.[20]

A linguistic study of the words used by dispatchers to initiate CPR found increased agreement to perform CPR by callers when dispatchers used words of futurity ("we are going to do CPR") or obligation ("we need to do CPR") over seeking willingness ("do you want to do CPR").[19].

c) ***Implementation of novel or standardized DA-CPR protocols*** vs. ***control (n = 4)***

**Table 1 – Included Studies.**

| Study | Pub Year | Location | Category | Study Design | Sample | Primary Outcome |
|---|---|---|---|---|---|---|
| Lee 2021[10] | 2021 | Korea | Video vs. Audio | Randomized Mannikin Simulation | 131 | Mean proportion of adequate hand positioning |
| Linderoth 2021[11] | 2021 | Denmark | Video vs. Audio | Cohort Study | 838 | Change in dispatchers' emergency response |
| Lee 2020[12] | 2020 | Korea | Video vs. Audio | Retrospective Cohort Registry study | 1,720 | Survival to hospital discharge |
| Lee 2011[13] | 2011 | Korea | Video vs. Audio | Randomized Mannikin Simulation | 138 | Not defined; Compression quality*** |
| Yang 2009[14] | 2009 | Taiwan | Video vs. Audio | Randomized Mannikin Simulation | 96 | Compression quality*** |
| Bolle 2009[15] | 2009 | Norway | Video vs. Audio | Randomized Mannikin Simulation | 180 | Not defined; "time to" and compression quality |
| Johnsen 2008[16] | 2008 | Norway | Video vs. Audio | Qualitative after simulated calls | 6 | N/A (Qualitative) |
| Peters 2022[17] | 2022 | Belgium | Video vs. Audio (Paediatrics) | Randomized Mannikin Simulation | 120 | Overall CPR Performance Score |
| Kim 2021[18] | 2021 | Korea | Video vs. Audio + drones | Exploratory sequential MMR | 24 | Not defined: Overall CPR Performance |
| Bray 2011[19] | 2011 | Australia | Terminology – compression rate | Before/after registry study | 3,122 | Not defined; Bystander CPR Initiation, survival to hospital and hospital discharge |
| Riou 2018[20] | 2018 | Australia | Terminology – language | Telephone record review | 424 | Caller agreement to perform CPR |
| Brown 2008[21] | 2008 | USA | Terminology – put phone down | Randomized Mannikin Simulation | 215 | Compression quality*** |
| Trethewey 2019[22] | 2019 | UK | Terminology – simplified | Randomized Mannikin Simulation | 330 | Compression depth |
| Rodriguez 2014[23] | 2014 | USA | Terminology – simplified | Randomized Mannikin Simulation (Paeds) | 128 | Compression depth |
| Mirza 2008[24] | 2008 | USA | Terminology – simplified | Secondary data analysis from RCTs | 332 | Compression quality*** |
| Leong 2021[25] | 2021 | Singapore | Terminology – simplified | Telephone record review | 1,296 | Time from call to first compression |
| Ong MEH 2022[26] | 2022 | Singapore | DA-CPR Implementation | Randomized Clinical Trial | 170,687 | Survival to hospital discharge/30th day survival post-arrest |
| Plodr 2016[27] | 2016 | Czech | Novel Protocol | Before/After | 326 | Not defined; "Time from call to..." measurements** |
| Stipulante 2014[28] | 2014 | Denmark | Novel Protocol (ALERT) | Before/After | 223 | Time from call to first compression |
| Rasmussen 2017[29] | 2017 | Belgium | Novel Protocol | Randomized Mannikin Simulation | 125 | Composite score* |
| Tsunoyama 2017[30] | 2017 | Japan | Advanced Dispatcher Training | Before/After | 532 | Bystander CPR Initiation |
| Park 2022[31] | 2022 | Korea | Advanced Dispatcher Training | Before/after registry study | 10,127 | Survival to hospital discharge |
| Harjanto 2016[32] | 2016 | Singapore | Advanced Dispatcher Training | Before/After; intervention | 2,968 | Survival to hospital admission, survival neurologically intact at 30 days |
| Lerner 2019[33] | 2019 | USA | Centralized Dispatch | Before/After | 169 | Not defined |
| Ro 2018[34] | 2018 | Korea | Centralized Dispatch | Before/After; natural experiment | 11,616 | Bystander CPR Initiation |
| Lee 2014[35] | 2014 | Korea | Metronome rates | Randomized Mannikin Simulation | 78 | Compression depth & rate |
| Park 2013[36] | 2013 | Korea | Metronome sound | Randomized Mannikin Simulation | 64 | Compression depth & rate |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Choa 2008[37] | 2008 | Korea | Animation vs. human Dispatcher | Randomized Mannikin Simulation | 85 | CPR Performance Checklist |
| Birkun 2018[38] | 2018 | Russia | Pre-recorded vs Live Instructions | Randomized Mannikin Simulation | 109 | Overall CPR Performance Score |
| Eisenberg-Chavez 2013[39] | 2013 | USA | Undress instructions | Randomized Mannikin Simulation | 99 | Time from call to first compression |
| Hwang 2020[40] | 2020 | Korea | Verbal Encouragement | Randomized Mannikin Simulation | 69 | Not defined; Compression quality*** |

* Composite outcome score based on time to first compression, hand position, chest compression depth and rate and hands-off time.
** Times to identification of cardiac arrest, time to the first compression, time to patient's address verification and the time to initiate instructions to the caller.
*** Chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release.

Four studies examined the introduction of a novel or standardized DA-CPR protocol designed to improve the effectiveness of the DA-CPR programs in systems not using the Medical Priority Dispatch System.[25–28]

In a non-randomised three-armed implementation trial, sites opted for 1) a comprehensive (with quality improvement tool), 2) a basic DA-CPR package, or 3) served as controls.[25] In a before-and-after analysis, the primary outcome of survival to discharge/at 30-days improved in all arms but was greater in the comprehensive arm. Similar trends were reported for bystander CPR and survival with favorable neurological outcome.

Two observational before-and-after studies listened to emergency calls and examined patient outcomes.[26,27] Stipulante et al reported increased rates of bystander CPR and a faster median time to recognition, but no difference in time to first compression, rate of shockable rhythm or unadjusted patient outcomes following the introduction of a standardised protocol.[27] Plodr et al noted shorter time to patient's address verification and identification of cardiac arrest, which allowed faster dispatching of the nearest EMS response team. They also demonstrated a trend to shorter time to initiation of instructions and to the first compression.[26]

A simulated RCT reported a novel protocol improved an overall composite CPR quality score compared with the standard protocol.[28] The novel protocol also resulted in deeper chest compressions, improved rates of correct hand position and participants felt more motivated by the dispatcher.

d) ***Advanced dispatcher training (n = 3)***

Three before-and-after studies examined the impact of advanced dispatcher training on patient outcomes[29–31]. Two of the three studies showed a statistically significant increase in rates of bystander CPR in the period of time following dispatcher training,[29,31] but only one study examined survival and reported an increase in adjusted survival at 30 days. The third study reported lower rates of bystander CPR after training was introduced, and no difference in survival or good neurological outcomes following advanced training.[30]

e) ***Centralized Dispatch Centre referral (n = 2)***

Two before-and-after studies examined the impact of centralizing dispatch centres on OHCA patient outcomes.[32,33] Both studies showed increased rates of bystander CPR after centralization of dispatch centers. Only one study reported survival and found an increase in adjusted survival to hospital discharge[33].

f) ***Use of Metronome or Varied Metronome Rates*** vs. ***control (n = 2)***

Two simulation RCTs studies examined the impact of using a metronome during DA-CPR instructions on CPR quality.[34,35] One simulation RCT[35] compared metronome sound-guided instruction to control without a metronome. This study reported the group with the metronome provided a higher mean compression rate, and a higher proportion with a rate between 100–120/min. There was no difference in mean compression depth, but the metronome group had a higher proportion of shallower compressions compared to the control group. The other simulation RCT found no significant differences in compression rates using three metronome rates (120/min, 110/min, and 100/min). In all groups, the mean depth of chest compression was less than 5 cm.[34]

g) ***Change in CPR sequence and ratio (n = 1)***

One before-and-after registry study examined the impact of changing dispatcher CPR instructions from 2 breaths and conventional CPR (15:2) to a compression-focused strategy (400 compressions: 2 breaths, followed by 100:2 ratio) in adult OHCA patients.[19] The change to a compression-focused strategy was associated with a significant increase in rates of bystander CPR, and an increase in adjusted survival to hospital (shockable and non-shockable patients) and survival to discharge (shockable only).

h) ***Animated audiovisual instructions (n = 1)***

A simulated mannikin cluster RCT compared an animated audiovisual video on a cell phone to verbal DA-CPR instructions.[36] Overall CPR performance, hand positioning and compression rate were better in the animated group.

i) ***Pre-recorded instructions*** vs. ***conversational live instructions (n = 1)***

In a single simulated mannikin RCT there were no significant differences in CPR quality between the recorded-assisted and dispatcher-assisted groups.[37] The recorded-assisted group demonstrated significantly shorter times to first compressions, higher compression rate and more compressions provided.

j) ***Inclusion of "undress patient" instructions*** vs. ***control (n = 1)***

**Table 2 – Summary of Study Results.**

**Table 2a: Video vs. Audio-only calls. ***chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release“**

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Johnsen 2008 | Qualitative after simulated calls | 6 | N/A (Qualitative) | Video-calls influenced the information basis and understanding of the dispatchers. The dispatchers experienced that (1) video-calls are useful for obtaining information and provides adequate functionality to support CPR assistance; (2) their CPR assistance becomes easier; (3) the CPR might be of better quality; but (4) there is a risk of “noise”. |
| Bolle 2009 | Randomized Mannikin Simulation (HS Students) | 180 | Not defined; “time to” and compression quality | The median CPR time without chest compression (‘hands-off time’) was shorter in the video-call group vs. the audio-call group (303 vs. 331 s; P = 0.048), but the median time to first compression was not shorter (104 vs. 102 s; P50.29). The median time to first ventilation was insignificantly shorter in the video-call group (176 vs. 205 s; P50.16). This group also had a slightly higher proportion of ventilations without error (0.11 vs. 0.06; P50.30). |
| Yang 2009 | Randomized Mannikin Simulation | 96 | Compression quality*** | Chest compressions among the video group were faster (median rate 95.5 vs. 63.0 min1, p < 0.01), deeper (median depth 36.0 vs. 25.0 mm, p < 0.01), and of more appropriate depth (20.0% vs. 0%, p < 0.01). The video group had more “hands-off” time (5.0 vs. 0 s, p < 0.01), longer time to first chest compression (145.0 vs. 116.0 s, p < 0.01) and total instruction time (150.0 vs. 121.0 s, p < 0.01). |
| Lee 2011 | Randomized Mannikin Simulation | 138 | Not defined; Compression quality*** | For the video group, the chest compression rate was more optimal (99.5 $min^{-1}$ vs. 77.4 $min^{-1}$, P < 0.01) and the time from the initial phone call to the first compressions was shorter (184 s vs. 211 s,P < 0.01). The depth of compressions was deeper in the audio group (31.3 mm vs. 27.5 mm, P = 0.21), but neither group performed the recommended depth of compression. The hand positions for compression were more appropriate in the video group (71.8% vs. 43.6%, P = 0.01). As many as 71.8% of the video group had no ‘hands-off’ events when performing compression (vs. 46.2% for the audio group, P = 0.02). |
| Lee 2020 | Retrospective Cohort Registry study | 1720 | Survival to hospital discharge | A total of 1720 eligible OHCA patients (1489 and 231 in the audio and video groups, respectively) were evaluated. The median ITI was 136 s in the audio group and 122 s in the video group (p = 0.12). The survival to discharge rates were 8.9% in the audio group and 14.3% in the video groups (p < 0.01). Good neurological outcome occurred in 5.8% and 10.4% in the audio and video groups, respectively (p < 0.01). Compared to the audio group, the AORs (95% CIs) for survival to discharge, good neurological outcome and early ITI of the video group were 1.20 (0.74–1.94), 1.28 (0.73–2.26) and 1.00 (0.70–1.43), respectively. |
| Kim 2021 | Exploratory sequential MMR | 24 | Not defined: Overall CPR Performance | Video-based instruction was found to be more effective in the number of chest compressions (p < 0.01), chest compression rate (p < 0.01), and chest compression interruptions (p < 0.01). The accuracy of the video group for the chest compression region was high (p = 0:05). Participants’ qualitative experiences were divided into three categories: ‘‘unfamiliar but beneficial experience,’’ ‘‘met helper during a desperate and embarrassing situation,’’ and ‘‘diverse views on drone use.’’ |
| Lee 2021 | Randomized Mannikin Simulation | 131 | Mean proportion of adequate hand positioning | The mean proportion of adequate hand positioning was highest in V-DACPR with rapid transition (V- DACPR with rapid transition vs. C-DACPR: 92.7% vs. 82.4%, p = 0.03). The mean chest compression depth was deeper in both V-DACPR groups than in the C- DACPR group (V-DACPR with rapid transition vs. C- DACPR: 40.7 mm vs. 35.9 mm, p = 0.01, V-DACPR with delayed transition vs. C- DACPR: 40.9 mm vs. |

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**Table 2 (continued)**

**Table 2a: Video vs. Audio-only calls. ***chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release“**

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| | | | | 35.9 mm, p = 0.01). Improvement in the proportion of adequate hand positioning was observed in the V-DACPR groups (r = 0.25, p < 0.01 for rapid transition and r = 0.19, p < 0.01 for delayed transition). |
| Linderoth 2021 | Retrospective Cohort study | 52 | CPR quality | Improvements following video-assisted instruction to correct hand position (55.6% to 72.2%, p < 0.001), compression rate (50% to 74.4%, p < 0.001), and compression depth (21.1% to 30.0%, p < 0.001). No difference in chest recoil (63.3% to 61.1%). |
| Peters 2022 | Randomized Mannikin Simulation | 120 | Overall CPR Performance Score | Of 255 candidates assessed for eligibility, 120 subjects were randomly assigned to 1 of the 4 following groups: untrained telephone-guided (U-T; n = 30) or video-guided (U-V; n = 30) groups and trained telephone-guided (T-T; n = 30) or video-guided (T-V; n = 30) groups. Cardiac arrest was appropriately identified in 86.7% of the U-T group and in 100% in the other groups (P = 0.0061). Hand positioning was adequate in 76.7% of T-T, 80% of T- V, and 60% of U-V, as compared with 23.4% of the U- T group (P = 0.0001). Fewer volunteers managed to deliver 2 rescue breaths/cycle (P = 0.0001) in the U-T (16.7%) compared with the U-V (43.3%), the T-T (56.7%), and the T-V groups (60%). Subjects in the video groups had a lower fraction of minute to ventilate as compared with the telephone groups (P = 0.0005). |

Table 2b: Terminology Changes. ***chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release“

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Brown 2008 | Randomized Mannikin Simulation | 215 | Compression quality*** | Instructions to "put the phone down" had no effect on the quality of bystander-initiated dispatcher-assisted CPR. |
| Mirza 2008 | Secondary data analysis from RCTs | 332 | Compression quality*** | Subjects were randomized to either modified Medical Priority Dispatch System (MPDS) v11.2 protocol or a new simplified protocol. Instructions to "push as hard as you can", compared to "push down firmly 2 in. (5 cm)", resulted in improved chest compression depth (36.4mm vs. 29.7mm, p < 0.0001), and improved median proportion of chest compressions done to the correct depth (32% vs. <1%, p < 0.0001). No significant difference in median proportion of compressions with total release (100% for both) and average compression rate (99.7 min vs. 97.5 min, p < 0.56) found. |
| Rodriguez 2014 | Randomized Mannikin Simulation (Paediatrics) | 128 | Compression depth | Randomized to: (1) "Push as hard as you can" (PUSHHARD) or (2) "Push approximately 2 in." (TWOINCHES) and do CPR on a simulated, 6-year- old pediatric manikin. The average CC depth (mean (SEM)) was greater in PUSH HARD compared to TWO INCHES (43 (1) vs. 36 (1) mm, *p* < 0.01) and met AHA targets more often (39% (25/64) vs. 20% (13/64), *p* = 0.02). CC rates trended higher in the PUSH HARD group (93 (4) vs. 82 (4) CC/min, p = 0.06). More providers did not achieve full chest recoil with PUSH HARD compared to TWO INCHES (53% (34/64) vs. 75% (48/64), p = 0.01). |
| Riou 2018 | Telephone record review | 424 | Caller agreement to perform CPR | Caller agreement was low (43%) when dispatchers used terms of willingness ("do you want to do CPR?"). Caller agreement was high (97% and 84% respectively) when dispatchers talked about CPR in terms of futurity ("we are going to do CPR") or obligation ("we need to do CPR"). In 38% (25/66) of calls where the caller initially declined CPR, the dispatcher eventually secured their agreement by making several attempts at initiating CPR. |

**Table 2 (continued)**

Table 2b: Terminology Changes. ***chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release“

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Trethewey 2019 | Randomized Mannikin Simulation | 330 | Compression depth | Participants were randomized to ‘at least 5 cm’ (n = 109), ‘approximately 5 cm’ (n = 110) and ‘hard and fast’ (n = 111), in which mean chest compression depth was 40.9 mm (SD 13.8), 35.4 mm (SD 14.1), and 46.8 mm (SD 15.0) respectively. Mean difference in chest compression depth between ‘at least 5 cm’ and ‘approximately 5 cm’ was 5.45 (95% confidence interval (95% CI) 0.78– 10.12), between ‘hard and fast’ and ‘approximately 5 cm’ was 11.32 (95% CI 6.65–15.99), and between ‘hard and fast’ and ‘at least 5 cm’ was 5.87 (95% CI 1.21– 10.53). Chest compression rate and count were both highest in the ‘hard and fast’ group. |
| Leong 2021 | Telephone record review | 1296 | Time from call to first compression | Standard protocol involves the instruction ‘push 100 times a minute 5 cm deep’ versus initiative where the instruction was simplified to ‘push hard and fast’. Time to first compression was 238.62 seconds and 218.83 s in the ‘before’ and ‘after’ groups, respectively (p = 0.016). In the per- protocol analysis, the interval between instruction and compression was 37.19 s, 28.31 s and 32.40 s in the standard protocol, simplified protocol and ‘own words’ groups, respectively (p = 0.005). |

Table 2b: Terminology Changes. ***chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release“

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Stipulante 2014 | Before/After | 223 | Time from call to first compression | Before and after the ALERT protocol implementation (2009 and 2011). In 2009, only 9.9% victims benefited from bystander CPR, this increased to 22.5% in 2011 (p < 0.0002). The main reasons for protocol underutilization were: assistance not offered by the dispatcher (42.3%) and caller physically remote from the victim (20.6%). Median time from call to first compression, defined as no flow time, was 253 s in 2009 and 168 s in 2011 (NS). Ten victims were admitted to hospital after ROSC in 2009 and 13 in 2011 (p = 0.09) which was not statistically significant. |
| Plodr 2016 | Before/After | 326 | Not defined; “Time from call to. . .“ measurements** | Median times to cardiac arrest recognition were 46 s before the new protocol (PER 1) and 37 s after the new protocol (PER2) (p = 0.002), to first compression 2 min 35 s in PER1 and 2 min 25 s in PER2 (p = 0.549). Admission to hospital with return of spontaneous circulation (ROSC) was achieved in 39 patients (31.9%) in PER1 and 57 (45.6%) in PER2 (p < 0.05), discharge from hospital (CPC 1–2) in 9.0% and 14.4% patients in PER1 and PER2, respectively. If ventricular fibrillation was the initial rhythm, survival rate (CPC 1–2) was not statistically different at 32.3% in PER1 and 38.7% in PER2 (p = 0.523). |
| Rasmussen 2017 | Randomized Mannikin Simulation | 125 | Composite score* | The novel protocol (n = 61) improved CPR quality score (a composite endpoint of time to first compression, hand position, compression depth and rate and hands-off time; maximum score of 22 points) compared with the standard protocol (n = 64) (mean (SD): 18.6 (1.4)) points vs. 17.5 (1.7) points, p < 0.001. The novel protocol resulted in deeper chest compressions (mean (SD): 58 (12) mm vs. 52 (13) mm, p = 0.02) and improved rate of correct hand position (61% vs. 36%, p = 0.01) compared with the standard protocol. In both protocols hands-off time was short. The novel protocol improved motivation among rescuers (p = 0.002). |

(*continued on next page*)

**Table 2 (continued)**

Table 2b: Terminology Changes. ***chest compression rate, depth, and the proportion of compressions without error, with correct hand position, adequate depth, and total release“

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Ong 2022 | Non-randomised Implementation Trial | 170,687 | Survival to hospital discharge/30- days | Comparing between groups, the comprehensive group had significantly higher change in BCPR (comprehensive vs control ratio of OR 1.86, 95% CI [1.66–2.09]; basic vs control ratio of OR 0.94, 95% CI [0.85–1.05]; and comprehensive vs basic ratio of OR 1.97, 95% CI [1.87–2.08]); survival with favorable neurological outcome (comprehensive vs basic ratio of OR 1.2, 95% CI [1.04–1.39]) |

Table 2d: Advanced Dispatcher Training

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Harjanto 2016 | Before/After; intervention | 2968 | Survival to hospital admission, survival neurologically intact at 30 days | Bystander CPR rates increased from 22.4% to 42.1% (p < 0.001) with odds ratio of 2.52 (95% confidence interval [CI]: 2.09–3.04) and ROSC increased significantly from 26.5% to 31.2% (p = 0.02) with OR of 1.26 (95%CI: 1.04–1.53) after the comprehensive DACPR training program intervention. Significantly higher survival at 30 days was observed for patients who received bystander CPR from a trained person as compared to no BCPR (p = 0.001, OR = 2.07 [95%CI: 1.41–3.02]) and DACPR (p = 0.04, OR = 0.30 [95%CI: 0.04–2.18]). |
| Park 2022 | Before/ after registry study | 10,127 | Survival to hospital discharge | OHCA patients in the intervention group were less likely to receive bystander cardiopulmonary resuscitation (57.8% vs 61.1%; P = 0.02) and showed lower survival outcomes (5.7% vs 6.4% for survival up to hospital discharge; P = 0.34 and 2.8% vs 3.7% for good neurological recovery; P = 0.11), but this was not statistically significant. Compared to 2014, good neurological recovery in 2017 was significantly improved in the intervention group (Difference-in- difference (DID) for good neurological recovery = 3.2%; 0.6–5.8). There were no statistically significant differences in return of spontaneous circulation and survival up to hospital discharge between the 2 groups (DID for survival to discharge was 1.8% [1.7 to 5.3] and DID for return of spontaneous circulation was 2.5% [9.8 to 4.8]). |
| Tsunoyama 2017 | Before/After | 532 | Bystander CPR Initiation | After the program, provision of oral guidance to callers slightly increased from 63% of cases to 69% (P = 0.13) and implementation of chest compression on patients by bystanders significantly increased from 40% to 52% (P = 0.01). Appropriate chest compression also increased from 34% to 47% (P = 0.01). In analysis stratified by the provision of oral guidance, increased chest compressions were observed only under oral guidance. |

Table 2e: Centralized Dispatch

| Study | Category / Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Lerner 2019 | Centralized Dispatch/ Before/After | 169 | Not defined | Centralizing dispatcher CPR program to serve seven public safety answering points also increased bystander CPR (53%) over previously documented bystander CPR rate (20% the prior year). |
| Ro 2018 | Centralized Dispatch/ Before/After; natural experiment | 11,616 | Bystander CPR Initiation | OHCAs that occurred after the centralization period were more likely to receive BCPR (62.6%, 50.6% BCPR- with-DA and 12.0% BCPR-without-DA) than were those that occurred before-centralization period (44.6%, 16.6% BCPR-with-DA and 28.1% BCPR- without-DA) (p < 0.01, adjusted OR: 1.59 (1.38–1.83), adjusted rate difference: 9.1% (5.0–13.2)). |

Table 2f: Use of Metronome with DA-CPR

| Study | Category / Study design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Lee 2014 | Metronome Rates<br><br>Randomized Mannikin Simulation | 78 | Compression depth & rate | No significant differences among three different metronome rates (at least 100/min: the metronome rates were 120/min, 110/min, and 100/min in groups 1, 2, and 3, respectively). In all groups, the mean depth of chest compression was less than 5 cm. The mean rates of chest compression were 113.44 ± 12.35/min in group 1, 109.37±2.73/min ingroup 2, and 128.11±16.22/min in group 3. There was a significant difference among groups (P < 0.001). The mean rate of chest compression of group 1 (120/min) and group 3 (100/min) was higher than that of group 2 (110/min). However, the proportions of compressions between 100 and 120/min were 100.00% (24/24) in group 2, 70.00% (19/24) in group 1, and 25.93% (7/27) in group 3. |
| Park 2013 | Metronome Sound/<br><br>Randomized Mannikin Simulation | 64 | Compression depth & rate | The metronome group showed a faster compression rate than the control group (111.9 vs 96.7/min; p=0.018). A significantly higher proportion of subjects in the MG performed the DA-CPR with an accurate chest compression rate (100–120/min) compared with the subjects in the CG (32/33 (97.0%) vs 5/34 (14.7%); p<0.0001). The mean compression depth was not different between groups (45.9 vs 46.8 mm; p=0.692). However, a higher proportion of subjects in the MG performed shallow compressions (compression depth <38 mm) compared with subjects in the CG (median % was 69.2 vs 15.7; p=0.035). |

Table 2g. Change in CPR sequence and ratio.

| Study | Category / Study design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Bray 2011 | Before/after registry study | 3122 | Not defined; Bystander CPR Initiation, survival to hospital and hospital discharge | Removal of two initial breaths and introduction of a new compression ratio (from 15:2 to 400 compressions, then 100:2) was associated with rates of bystander CPR increased overall (45–55%, p < 0.001) and by initial rhythm (shockable 55– 70%, p < 0.001 and non-shockable 40–46%, p = 0.01). In VF/VT OHCA, there were improvements in the number of patients arriving at hospital with a return of spontaneous circulation (ROSC) (48–56%, p = 0.02) and in survival to hospital discharge (21– 29%, p = 0.002), for patients receiving bystander CPR. After adjusting for factors associated with survival, the period of time following the change in CPR instructions was a significant predictor of survival to hospital discharge in VF/VT patients (OR 1.57, 95% CI: 1.15–2.20, p = 0.005). |

Table 2h: Audiovisual animated instructions

| Study | Category / Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Choa 2008 | Audio-visual animated video (AA) vs. human Dispatcher (DA)<br>Cluster Randomized Mannikin Simulation | 85 | CPR Performance Checklist | The AA-CPR group had a significantly better checklist score (p < 0.001) and time to completion of 1 CPR cycle (p < 0.001) than the DA-CPR group. In an objective assessment of psychomotor skill, the AA-CPR group demonstrated more accurate hand positioning (68.8 ±3.6%, p = 0.033) and compression rate (72.4±3.7%, p = 0.015) than DA-CPR group. However, the accuracy of compression depth (p = 0.400), ventilation volume (p = 0.977) and flow rate (p = 0.627) were below 30% in both groups. |

Table 2i. Pre-recorded instruction audio

| Study | Category / Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Birkun 2018 | Randomized Mannikin Simulation | 109 | Overall CPR performance (checklist) | No significant differences between groups for the overall performance score (5.6±2.2 vs. 5.1±1.9, *P*>0.05) or individual criteria of the CPR performance checklist. The recording-assisted group demonstrated significantly shorter time interval from call receipt to the first compression (86.0±14.3 vs. 91.2 ±14.2 s, *P*<0.05), higher compression rate (94.9±26.4 vs. 89.1±32.8 min-1) and number of compressions provided (170.2±48.0 vs. 156.2±60.7). |

Table 2j: Undress instructions

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Eisenberg-Chavez 2013 | Randomized Mannikin Study | 99 | Time from call to first compression | Time to first compression was 109s among the instruction to remove clothing group and 79s among those randomized to forgo clothing removal, (p < 0.001). Among those randomized to remove clothing instructions, mean compression depth was 41mm, compression rate was 97 per minute, and the percentage with complete compression release was 95%. Among those randomized to forgo clothing removal instruction, mean compression depth was 40mm, compression rate was 99 per minute, and the percentage with complete compression release was 91% (p > 0.05 for each CPR metric comparison). |

Table 2k: Verbal encouragement

| Study | Study Design | Sample | Primary Outcome | Main Findings |
|---|---|---|---|---|
| Hwang 2020 | Randomized Mannikin Simulation | 72 | Compression rate and depth | Compared to standard DA-instructions, ongoing encouragement from dispatchers resulted in improved compression rate but no change in chest compression depth. |

One simulation RCT found longer time to first compressions when instructions to remove clothing were given.[38] No difference was seen in the quality of CPR (rate, depth or recoil) between groups.

k) ***Verbal encouragement (n = 1)***

One simulation RCT found the use of verbal encouragement in a simulation RCT in addition to DA-instructions with a metronome, resulted in improved compression rate but no change in chest compression depth.[39]

## Discussion

This scoping review maps the literature related to several promising interventions to improve or optimize the outcomes of OHCA patients who received dispatcher-assisted CPR. Overall, all interventions seem to show an association with improved bystander CPR metrics in simulated situations. However, there is insufficient evidence on any of them to recommend progression to a formal systematic review at this stage. There is a distinct lack of high-certainty clinical research on any the included interventions and therefore several opportunities for future research. In particular, the implementation of novel DA-CPR protocols, pre-recorded instructions, centralized dispatch, advanced dispatcher training, use of metronomes and varying metronome rates and instructions to undress the patient all have fewer than two papers published at the time of this review and therefore we are unable to make any summary comment on their effectiveness at this point.

The interventions which have five or more studies are showing directional trends. The studies which focus on simplifying the compression instruction language (ie. "Push as hard as you can" vs "Push approximately 2 in./5 cm") suggests an improvement in CPR quality. A linguistic analysis of emergency calls was able to observe differences in the willingness to perform CPR related to the futurity or the necessity to perform CPR.[19] However, terminology changes in instructions may not be generalizable to other languages or cultures and therefore something that would have to be considered in larger, global studies. The studies which look at adding video to the emergency call (vs. audio-only calls) suggest an improvement in CPR quality. Bieski et al. in a *meta*-analysis, compared audio vs video assisted dispatcher CPR instructions based on the analysis of two Korean retrospective cohort studies and 8 randomized simulation trials.[41] They observed a statistically significant improvement in ROSC rates, survival to hospital discharge, as well as survival with good neurological outcome using video assisted dispatcher CPR instructions. The quality of chest compressions was also significantly better in the video guidance group compared to the conventional guidance group.

Lastly, the research methodologies used in the studies we reviewed were largely in simulated environments; almost half of the studies comparing video to audio were in simulated situations and the majority of the interventions have not been tested in real OHCA situations. Although quality review is not part of the scoping review methodology, the studies included exhibited consistently low quality and substantial bias due to their observational and non-randomized designs. This highlights the need for more clinical trial designs with proper comparator groups to be applied to future research in this area.

### *Limitations of this review*

We limited our review to only include publications which had an English language abstract available. As such it is possible that we missed studies which were published in other languages and not translated.

We also used a relatively broad search strategy, including the names of most known interventions, to capture as much relevant research as possible in this area (hence the initial pull of over 6,000 articles). While it is possible that we may have missed interventions with this approach, we feel this limitation had relatively low impact given the expertise and knowledge of the review team on this topic.

## Conclusion

Several interventions have been tested in an effort to improve the effectiveness of DA-CPR and most seem to show trends towards improved performance on DA-CPR and bystander CPR metrics. However, this review also highlights the lack of sufficient high-quality clinical research on any of the tested interventions to make concrete recommendations about their impact. Further research conducted in real-life situations is needed to fully examine their effectiveness in optimizing DA-CPR and bystander CPR.

## Funding

International Liaison Committee on Resuscitation. JB receives a Fellowship by the National Heart Foundation of Australia.

## CRediT authorship contribution statement

**K.N. Dainty:** Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **G. Debaty:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **J. Waddick:** Writing – review & editing, Methodology, Data curation. **C. Vaillancourt:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **C. Malta Hansen:** Writing – review & editing, Supervision, Conceptualization. **T. Olasveengen:** Writing – review & editing, Supervision, Methodology, Conceptualization. **J. Bray:** Writing – review & editing, Supervision, Methodology, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: KND is an Editorial Board member of Resuscitation Plus. TMO is a Board Member of the Laerdal Foundation and an Editorial Board Member of Resuscitation Plus and Resuscitation. JB is an Editor of Resuscitation Plus and an Editorial Board Member of Resuscitation. The remaining authors report no competing interests.

## Acknowledgements

The authors acknowledge the contributions of the ILCOR BLS Task Force Members: Michael Smyth, Julie Considine, Sung Phil Chung, Vihara Dassanayak, Bridget Dicker, Fredrik Folke, George Lucas, Takanari Ikeyama, Nicholas J. Johnson, Siobhán Masterson, Chika Nishiyama, Ziad Nehme, Tatsuya Norii, Giuseppe Ristagno, Tetsuya Sakamoto, Christopher M. Smith, Peter Morley, Gavin Perkins.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2024.100715.

## Author details

on behalf of theInternational Liaison Committee on Resuscitation Basic Life Support Task Force [a]*North York General Hospital, Toronto Canada* [b]*Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto Canada* [c]*Emergency Department and Mobile Intensive Care Unit, University Hospital of Grenoble Alpes, Grenoble, France* [d]*University of Grenoble Alpes, CNRS, UMR 5525, VetAgro Sup, Grenoble INP, TIMC, 38000 Grenoble, France* [e]*Department of Emergency Medicine, Ottawa Hospital Research Institute, University of Ottawa, Canada* [f]*Copenhagen Emergency Medical Services, Copenhagen University, Denmark* [g]*Department of Cardiology, Gentofte and Herlev Hospital, Copenhagen University, Denmark* [h]*Department of Cardiology, Rigshospitalet, Copenhagen University, Denmark* [i]*Department of Clinical Medicine, Copenhagen University, Denmark* [j]*Institute of Clinical Medicine, University of Oslo and Department of Anesthesia and Intensive Care Medicine, Oslo University Hospital, Norway* [k]*School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia*

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