RESUSCITATION PLUS 20 (2024) 100754

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Review

Optimising telecommunicator recognition of out-of-hospital cardiac arrest: A scoping review

Anne Juul Grabmayr[a,j,*], *Bridget Dicker*[b,c], *Vihara Dassanayake*[d], *Janet Bray*[e], *Christian Vaillancourt*[f], *Katie N. Dainty*[g,h], *Theresa Olasveengen*[i], *Carolina Malta Hansen*[a,j,k,l], *on behalf of the International Liaison Committee on Resuscitation Basic Life Support Task Force*[1]

Abstract

Aim: To summarize existing literature and identify knowledge gaps regarding barriers and enablers of telecommunicators' recognition of 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 Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR). Studies were eligible for inclusion if they were peer-reviewed and explored barriers and enablers of telecommunicator recognition of OHCA. We searched Ovid MEDLINE® and Embase and included articles from database inception till June 18th, 2024.

Results: We screened 9,244 studies and included 62 eligible studies on telecommunicator recognition of OHCA. The studies ranged in methodology. The majority were observational studies of emergency calls. The barriers most frequently described to OHCA recognition were breathing status and agonal breathing. The most frequently tested enabler for recognition was a variety of dispatch protocols focusing on breathing assessment. Only one randomized controlled trial (RCT) was identified, which found no difference in OHCA recognition with the addition of machine learning alerting telecommunicators in suspected OHCA cases.

Conclusion: Most studies were observational, assessed barriers to recognition of OHCA and compared different dispatch protocols. Only one RCT was identified. Randomized trials should be conducted to inform how to improve telecommunicator recognition of OHCA, including recognition of pediatric OHCAs and assessment of dispatch protocols.

Keywords: Out-of-Hospital Cardiac Arrest, Emergency Medical Services, Telecommunicator, Dispatch, Symptoms, Scoping Review

Introduction

As illustrated in the first link in the chain of survival, prompt recognition of out-of-hospital cardiac (OHCA) is pivotal to increasing the chance of survival with good neurologic outcomes. Particularly, recognition facilitates timely cardiopulmonary resuscitation (CPR), defibrillation, and the dispatch of advanced emergency care.[1,2] Telecommunicators are often the first point of contact during emergencies, and in many cases, they are the first to recognize OHCA and initiate telecommunicator-assisted CPR (TA-CPR) instructions.[3]

While recognition has been highlighted as one of the most important steps within the OHCA chain of survival, the topic has received relatively little attention within resuscitation science.[2] Efforts have mostly revolved around the development of dispatch protocols. In recent years, many communities have implemented dispatch protocols to enhance telecommunicators' timely OHCA recognition. A systematic review from 2021 found telecommunicators could recognize 79% of OHCAs, but this sensitivity ranged between 46% and 98%.[4]

* Corresponding author at: Telegrafvej 5, 2750 Ballerup, Denmark.
E-mail address: anne.juul.grabmayr@regionh.dk (A. Juul Grabmayr).

[1] The members of the International Liaison Committee on Resuscitation Basic Life Support Task Force are listed in Acknowledgement at the end of the article.

https://doi.org/10.1016/j.resplu.2024.100754
Received 15 July 2024; Received in revised form 14 August 2024; Accepted 15 August 2024

While many studies have reported the proportion of recognized OHCAs, an overview and deeper understanding of barriers and enablers of telecommunicator recognition are lacking. Such knowledge is necessary to identify potential targets for improvements and to design and test interventions, including randomized controlled trials (RCTs).

This scoping review examined the barriers and enablers described for telecommunicator recognition of OHCA, and methods to improve recognition. Such information is critical to future research to improve telecommunicator OHCA recognition.

Methods

Protocol

This scoping review followed the International Liaison Committee on Resuscitation (ILCOR) review processes and the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) check list.[5,6] Authors of this scoping review that authored included papers were excluded from the data extraction of their papers. An overview of the population, intervention, control, outcomes, study design, and timeframe (PICOST) that formed the foundation of this scoping review can be found in Table 1.

Inclusion and exclusion criteria

Included studies described factors associated with telecommunicator recognition of OHCAs. During the review, we identified a substantial number of studies that described barriers to telecommunicators' OHCA recognition, which were not defined in the original PICOST. Since we believe these were important, we included those studies in this review. RCTs and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, and qualitative studies) were eligible for inclusion.

Studies that did not describe factors associated with telecommunicator recognition of real OHCAs, such as simulation studies, were excluded. Case series, case studies, letters, and studies published in languages other than English were also excluded.

Information sources and search

A previous search strategy for the latest ILCOR systematic review on telecommunicator recognition of OHCA was expanded to include a wider variety of studies regarding study design and aim to match the purpose of this scoping review.[4] AJG, CMH, and an experienced information specialist from the Copenhagen University Library edited the search strategy. Ovid MEDLINE® was systematically searched for relevant literature from 1946 to February 22nd, 2023. After review from the ILCOR Basic Life Support Task Force, the search strategy was edited accordingly. The last search included Ovid MEDLINE® and Embase from database inception until June 18th, 2024. A grey literature search was not performed. The search strategy can be found in the Supplemental Material.

Selection of sources of evidence

Four reviewers (AJG, BD, VD, and CMH) screened the articles independently. The titles and abstracts of all studies were divided among reviewers. Two reviewers screened each paper, and those in coherence with the PICOST were selected for full-text analysis (see Table 1). The selected papers were then divided among reviewers, and two reviewers evaluated the full text of each paper to affirm its inclusion in the scoping review. In cases where reviewers did not reach a consensus, these were resolved by discussions with a third member of the reviewer team. The included studies were then divided among the researchers, and one reviewer assessed each study in detail. Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia (available at https://www.covidence.org) was used to aid the screening and data extraction.

Data charting process and synthesis of results

Data was extracted by the four reviewers (AJG, BD, VD, and CMH), with each data extract being generated by one reviewer and checked by a second reviewer. Data extraction included the PICOST, study characteristics, and other key findings. After review, key findings were categorized into four themes: (1) patient characteristics and symptoms, (2) communication, (3) dispatch protocols, and (4) new technology.

Results

The database search yielded 11,224 studies. After duplicate removal, a total of 9,244 studies were included for abstract and title screening. Following a full-text review, 62 studies were considered eligible for inclusion (Fig. 1).

The studies included in this review originate from Europe ($n = 34$), North America ($n = 18$), Australia ($n = 2$), Japan ($n = 2$), Taiwan ($n = 3$), Singapore ($n = 1$), Thailand ($n = 1$), Iran ($n = 1$), and South Korea ($n = 1$).

Table 1 – Population, intervention, control, outcomes, study design, and timeframe.

PICOST	Description
Population	Adult or pediatric OHCA patients with calls to the EMS
Intervention	Factors to improve or hinder OHCA recognition
Outcomes	Telecommunicator recognition of OHCA which leads to specific initiation of cardiac arrest-specific actions such as initiation of instructions.
Study design	Randomized controlled trials, observational studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies), and qualitative studies are eligible for inclusion.
Timeframe	Database inception – June 18th, 2024

This table entails the population, intervention, control, outcomes, study design, and timeframe that was the foundation of this scoping review. OHCA indicates out-of-hospital cardiac arrest and EMS, emergency medical services.

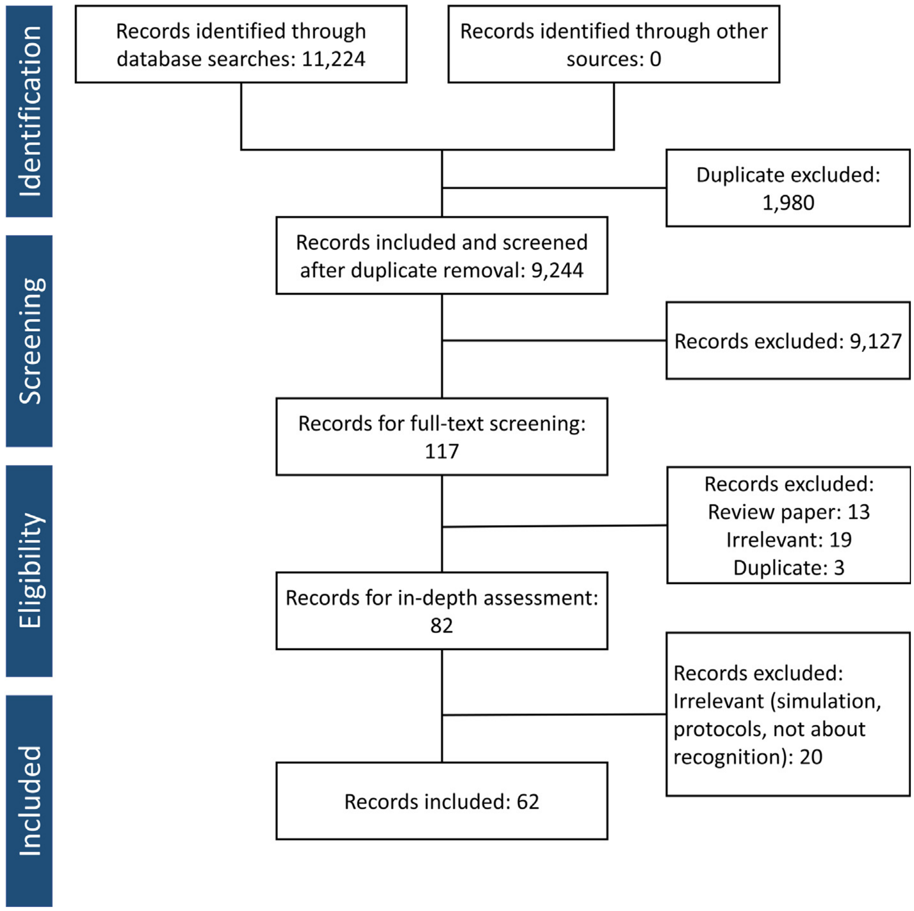

Fig. 1 – Study Selection Chart. Overview of the inclusion of studies in the scoping review.

Patient characteristics and symptoms

Twenty-one studies investigated how patient characteristics and symptoms affected OHCA recognition (see Table 2 and Supplemental Table 2).[7–27] No study investigated the characteristics and demographics of callers.

Two studies investigated patient characteristics and their association with recognition. One study that included pediatric OHCAs found that younger patient age was negatively associated with recognition.[7] Another study found low area-level socioeconomic status to be negatively associated with recognition.[8] Telecommunicators were less likely to recognize witnessed OHCAs compared with unwitnessed OHCAs.[9]

In addition to loss of consciousness, the most frequently reported symptom was agonal breathing, with a prevalence between 30% and 60%. Overall, agonal breathing was negatively associated with recognition and positively associated with patient survival.[7,10–15] Agonal breathing is the most frequently mentioned barrier of recognition in multiple studies from 2002 to 2021.[12,14–20] Callers described agonal breathing using various wordings, including gasping, snoring, and weak breathing.[11,21] Agonal breathing was often misinterpreted as normal breathing by callers and telecommunicators.[11,16,22] Lack of or challenging communication regarding the patient's breathing status led to unrecognized OHCAs.[10,13,16,17,23,24]

Three studies investigated whether the description of seizures was a barrier to telecommunicator recognition. Seizure-like symptoms have been reported in 4–12% of OHCA emergency calls, and 2% of calls describing seizures were OHCA.[25–27] The caller's description of seizure was a barrier for telecommunicator recognition and was positively associated with patient survival.[25]

Communication

Sixteen studies investigated how factors related to the caller, the telecommunicator, or the interplay between the two affected communication in emergency calls (See Table 3 and Supplemental Table 3).[10,15,28–41]

Telecommunicators communication skills

A study found that telecommunicators remaining calm and using short, distinct questions resulted in quick decision-making, whereas telecommunicators who demonstrated stressful behavior omitted to ask essential questions.[28] Telecommunicators with an open-minded approach who listened carefully and actively to the caller's descriptions were more likely to interpret the case correctly.[15] Callers also affected the telecommunicators' communication; callers providing convincing answers made telecommunicators feel secure, whereas when callers lacked knowledge or were insecure about their answers, it negatively affected the telecommunicator's efforts.[15]

Three studies found the following reasons for OHCAs remaining unrecognized by the telecommunicator: (1) insufficient questioning when inquiring about respiration or consciousness, (2) inaccurate use of medical language, (3) asking non-essential questions, and (4) using certain words.[10,28,29] Two studies found an association

Table 2 – Summary of studies in the theme: patients characteristics and symptoms.

Author, year, country	Design, study population, sample size	Barriers/enablers for OHCA recognition
Kim et al. 2022[7], South Korea	Observational study, OHCA patients < 19 years, $N = 2754$	**Barrier:** Young age of child
Tzeng et al. 2021[8], Taiwan	Observational study, OHCA patients > 18 years transported by EMS, $N = 2928$	**Barrier:** Low area-level socioeconomic status
Lewis et al. 2013[9], USA	Observational study, non-traumatic OHCA patients, $N = 476$	**Barrier:** Caller giving contradictory or uncertain information, agonal breathing, and bystander witnessed OHCA.
Berdowski et al. 2009[10*], The Netherlands	Observational study, suspected OHCA where on-site laypersons call EMS, $N = 14800$	**Barrier:** Telecommunicator not inquiring about breathing. **Enabler:** Caller using trigger words
Riou et al. 2018[11], Australia	Observational study, OHCA patients (>14 years), $N = 176$	**Barrier**: Agonal breathing
Fukushima et al. 2015[12*], Japan	Observational study, unresponsive patients > 18 years transported to hospital, $N = 570$	**Barriers**: Recognition of breathing.
Vaillancourt et al. 2007[13*], Canada	Observational, OHCA patients, $N = 529$	**Barrier:** Agonal breathing. Insufficient information e.g., third-party callers.
Bang et al. 2003[14], Sweden	Observational study, hospital admitted OHCAs, $N = 100$	**Barriers:** Agonal breathing. Telecommunicator no following protocol.
Bang A et al. 2002[15*], Sweden	Qualitative study, telecommunicators, $N = 10$	**Enabler**: The telecommunicator is open-minded and connected with the caller.
Hardeland et al. 2016[16*], Norway	Mixed methods study, OHCA Patients, $N = 579$	**Barrier:** Non-systematic use of dispatch protocol. No clear definition of "normal breathing". The emotional state of the caller. **Enabler:** Good caller/telecommunicator collaboration
Travers et al. 2014[17*], France	Observational study, OHCA patients, $N = 144$	**Barrier:** Agonal breathing. Breathing assessment. **Enabler:** Dispatch protocol.
Watkins et al. 2021[18*], England	Observational study, Hospital transferred OHCAs, $N = 184$	**Enabler:** Adherence to dispatch protocol
Fukushima et al. 2015[19], Japan	Observational study, OHCA patients, $N = 283$	**Barrier:** Agonal breathing
Eisenberg et al. 1986[20], USA	Observational study, emergency calls with/without OHCA, $N = 662$	**Barrier:** Agonal breathing. Seizure-like activities.
Fukushima et al. 2017[21], USA	Observational study, OHCA patients, $N = 2411$	**Barrier:** Agonal breathing
Bohm et al. 2007[22], Sweden	Observational study, bystander-witnessed OHCAs, $N = 313$	**Barrier:** Agonal breathing.
Dami et al. 2015[23], Switzerland	Observational study, OHCA patients, $N = 1256$	**Barrier:** Agonal breathing
Crabb et al. 2022[24], USA	Qualitative study, non-recongized OHCAs, $N = 12$	**Barrier:** Breathing assessment.
Schwarzkoph et al. 2020[25], USA	Observational study, adult OHCA patients, $N = 3502$	**Barrier:** Caller describing seizures
Dami et al. 2012[26*], Switzerland	Observational study, patients > 18, suspected seizures, $N = 561$	**Barrier:** Interpreting OHCA as seizures
Tangpaisarn et al. 2021[27], Thailand	Observational study, hospital transferred OHCAs, $N = 58$	**Barrier:** Description of seizures

The table summarizes study design, barriers, and enablers of the included evidence for patient characteristics and symptoms. Please see Supplemental Table 2 for a more comprehensive overview. OHCA indicates out-of-hospital cardiac arrest and EMS, emergency medical services.

[*] The study was included in more than one theme.

between recognition and the number of OHCA calls taken by a telecommunicator,[41] with more than four OHCAs within the study period of six years improving recognition.[30]

Callers' influence on communication

It was more difficult for telecommunicators to recognize OHCA when callers were emotionally affected.[31] A study assessing callers' emotional status using Emotional Content and Cooperation Score (ECCS) levels concluded that most callers' emotions were manageable with only 8.4% of callers rated as ECCS levels 4–5 (unable to cooperate, crying, or yelling) resulting in lower initiation of CPR.[32] Reassuring these callers caused delays, but if reassured, the callers commenced chest compressions quickly with a shorter median time to recognition and chest compressions (29 s and 122 s respectively).[32] Two other studies revealed similar results whereby callers' emotional status delayed the time to recognition of OHCA and hampered clear communication between the telecommunicator and the caller.[33,34]

Studies described four types of callers: first-party callers (the patient before OHCA onset), second-party callers (bystanders), third-party callers (callers in a different location than the patient), and fourth-party callers (emergency responder or police). Second-

Table 3 – Summary of studies in the theme: communication.

Author, year, country	Design, study population, sample size	Barriers/enablers for OHCA recognition
Berdowski et al. 2009[10*], The Netherlands	Observational study, suspected OHCA where on-site laypersons call EMS, $N = 14800$	**Barrier:** Telecommunicator not inquiring about breathing. **Enabler:** Caller using trigger words
Bang A et al. 2002[15*], Sweden	Qualitative study, telecommunicators, $N = 10$	**Enabler:** The telecommunicator is open-minded and connected with the caller.
Bang et al. 2000[28], Sweden	Observational study, hospital-admitted OHCAs, $N = 99$	**Barrier:** Stressful telecommunicator asking irrelevant questions instead of relevant questions.
Tamminen et al. 2020[29], Finland	Observational study, witnessed OHCA, $N = 80$	**Enabler:** Use of trigger words
Kuisma et al. 2005[30], Finland	Observational study, witnessed OHCAs, $N = 373$	**Enabler:** Increased frequency of telecommunicator exposure to OHCA calls
Alfsen et al. 2015[31], Denmark	A qualitative study, OHCA patients, $N = 21$	**Barrier:** Third-party and emotionally unstable callers. **Enabler:** Caller remaining calm
Chien et al. 2019[32], Taiwan	Observational study, adult OHCAs, $N = 367$	The callers emotional state was not a barrier to OHCA recognition.
Missel et al. 2023[33], USA	Qualitative study, OHCA patients, $N = 65$	**Barrier:** Emotional unstable caller and telecommunicator asking non-essential questions
Richards et al. 2022[34], USA	Observational mixed methods study, Adult OHCA patients, $N = 46$	**Barrier:** Inaccurate medical terms, emotional status **Enabler:** Telecommunicator using directive language
Garza et al. 2003[35], USA	Observational study, OHCA patients, $N = 506$	**Barriers:** Third-party caller **Enablers:** First-, second-, or fourth-party caller.
Castren et al. 2001[36], Finland	Observational study, witnessed OHCAs, $N = 328$	Callers professional background were not associated with OHCA recognition
Bradley et al. 2011[37], USA	Observational study, EMS-treated OHCAs, $N = 2812$	**Barriers:** Limited proficiency in English.
Perera et al. 2021[38], Australia	Observational study, OHCA patients, $N = 353$	**Barriers:** Language barriers
Stangenes et al. 2020[39], USA	Observational study, OHCA patients, $N = 433$	**Barriers:** Caller mentioning incorrect diagnosis
Riou et al. 2021[40], Australia	Observational study, OHCA patients, $N = 422$	**Enabler:** Caller using the word "death".
Saberian et al. 2019[41], Iran	Observational study, OHCA patients, $N = 4732$	**Enabler:** Telecommunicator experience

The table summarizes study design, barriers, and enablers of the included evidence for communication. Please see Supplemental Table 3 for a more comprehensive overview. OHCA indicates out-of-hospital cardiac arrest and EMS, emergency medical services.
[*] The study was included in more than one theme.

party callers enabled better communication and assessment of the patient, so telecommunicators were able to react fast and initiate an appropriate emergency medical services (EMS) response with little or minimal interruptions.[31] In contrast, third-party callers delayed or hindered telecommunicator recognition.[3,13,35] Accuracy in recognition was higher if telecommunicators were talking with second-party or fourth-party callers compared to third-party callers.[35] Sixteen studies published between 2014 and 2024 excluded patients with third-party callers, and no study investigated third-party callers specifically.[11,16,17,19,23,32–34,38,39,41–46]

Calls with healthcare professional callers differed from other calls by telecommunicators assuming a more passive and counseling role, leaving the caller with an active role.[31] Compared to non-healthcare callers, the telecommunicator asked fewer questions since they believed healthcare professionals could handle the situation without further help.[36] No differences in recognition based on the caller's background were reported.[36]

Language barriers led to poorer communication between callers and telecommunicators and a lower likelihood of recognition.[37] A study comparing cases with or without language barriers found that in calls with language barriers, recognition, acquisition of address, and CPR were delayed.[38]

The callers' description the patients' situation also affected OHCA recognition. When the caller presented a diagnostic condition rather than signs or symptoms, recognition was delayed, particularly if the diagnostic condition which was presented was incorrect.[39] Similarly, recognition was delayed when telecommunicators pursued a diagnostic condition before the state of consciousness.[39] Recognition was improved in cases where the caller described the patient as dead. However, these patients were less likely to survive, and bystanders more frequently refused to provide CPR.[40]

Dispatch protocols

Twenty-six studies evaluated the accuracy of OHCA recognition in relation to the use of dispatch protocols and quality improvement initiatives (See Table 4 and Supplemental Table 4).[12,13,16–18,26,30,42–60] All studies were observational, and no randomized trials tested different protocol types. The majority of these studies ($n = 20$) reported only the accuracy of OHCA detection in terms of the proportion of OHCAs recognized of those confirmed to be OHCA on-scene by EMS and did not report both sensitivity and specificity. The majority of dispatch protocols can be divided into Medical Priority Dispatch (MDPS), structured questions to collect symptoms and determine EMS response, and Criteria Based Dispatch (CBD), using prompts

Table 4 – Summary of Studies in the Theme: Dispatch Protocols.

Author, year, country	Design, study population, sample size	Barriers/enablers for OHCA recognition
Fukushima et al. 2015[12*], Japan	Observational study of a modified dispatch protocol, OHCA patients > 18, $N = 570$	**Barriers**: Recognition of breathing. **Enablers**: detailed assessment of breathing status
Vaillancourt et al. 2007[13*], Canada	Observational study of a TA-CPR protocol, OHCA patients > 16, $N = 529$	**Barrier:** Agonal breathing. Insufficient information e.g., third-party callers.
Hardeland et al. 2016[16*], Norway	Mixed methods study, OHCA Patients, $N = 579$	**Barrier:** Non-systematic use of dispatch protocol. No clear definition of "normal breathing". The emotional state of the caller. **Enabler:** Good caller/telecommunicator collaboration
Travers et al. 2014[17*], France	Observational study, OHCA patients, $N = 144$	**Barriers:** Incomplete breathing assessment. **Enabler:** Adherence to dispatch protocol incl. hand-on-abdomen communication.
Watkins et al. 2021[18*], England	Observational study of advanced MDPS protocol, hospital-transferred OHCA patients, $N = 184$	**Enabler:** Adherence to dispatch protocol
Dami et al. 2012[26*], Switzerland	Observational study, patients > 18, suspected seizures, $N = 561$	**Barrier:** Interpreting OHCA as seizures
Kuisma et al. 2005[30], Finland	Observational study, witnessed OHCAs, $N = 373$	**Enabler:** Increased frequency of telecommunicator exposure to OHCA calls
Derkenne et al. 2020[42], France	Observational study, "recognizable" OHCAs, $N = 321$	**Enabler:** Hand-on-abdomen method for checking breathing.
Gram et al. 2021[43], Denmark	Observational study of a modified dispatch protocol, OHCA patients, $N = 417$	**Barriers:** Non-systematic protocol use **Enablers:** Visual pop-up reminders, additional training/ education, and systematic protocol use
Hardeland et al. 2014[44], USA and Norway	Observational study of CBD and MDPS protocols, OHCA patients, $N = 240$	**Barriers:** Recognition of agonal breathing No difference between protocols
Huang al. 2017[45], Taiwan	Observational study of a CBD protocol, OHCA patients > 18, $N = 1426$	**Barrier:** **U**se of descriptive text. **Enabler:** Use of CBD protocol, quality improvement, and telecommunicator training.
Mao et al. 2020[46], Singapore	Observational study of a modified dispatch protocol, unconscious patients > 21, $N = 1557$	**Enablers:** Use of hand-on-abdomen protocol
Besnier et al. 2015[47], France	Observational study of a TA-CPR protocol, OHCA patients, $N = 245$	**Barriers:** No protocol for OHCA recognition **Enabler:** Protocol for TA-CPR
Deakin et al. 2017[48], United Kingdom	Observational study, pediatric emergency calls, $N = 53213$	**Barriers:** Patients reported unconscious with breathing difficulties.
Heward et al. 2004[49], United Kingdom	Observational study of a MDPS protocol, OHCA Patients, $N = 700$	**Barrier:** Non-systematic protocol use **Enabler:** **S**ystematic use of Advanced MPDS protocol
Michiels et al. 2021[50], Belgium	Observational study, OHCA patients > 18, $N = 244$	**Barrier:** Moving patient to floor and irrelevant questions
Moller et al. 2016[51], Sweden and Denmark	Observational study, OHCA patients, $N = 930$	**Enabler**: Use of CBD protocols.
Nurmi et al. 2006[52], Finland	Observational study, OHCA patients, $N = 776$	**Barrier:** Use of CBD protocol.
Orpet et al. 2015[53], USA	Observational study comparing a one- vs. a two-question protocol, unconcious patients, $N = 679$	**Enablers:** A one-question protocol increased OHCA recognition, though tripled false positives
Plodr et al. 2016[54], Czech Republic	Observational study comparing no protocol to CBD, OHCA patients, $N = 323$	No difference in recognition between CBD and no protocol
Sanko et al. 2020[55], USA	Observational study of LATDS protocol, OHCA patients, $N = 597$	**Enabler:** Use of Los Angeles Tiered Dispatch System compared to MDPS
Sanko et al. 2021[56], USA	Observational study comparing MDPS and LATDS protocol, OHCA patients, $N = 597$	**Enabler:** LATDS improved recognition in case with language barriers compared to MPDS
Stipulante et al. 2014[57], Belgium	Observational study of a CBD protocol, OHCA patients, $N = 600$	No changes in recognition after CBD protocol implementation
Viereck et al. 2017[58], Denmark	Observational study, OHCA patients, $N = 779$	**Barrier:** Third-party caller, bystander-witnessed, older patients, and healthcare professional callers. Older patients. **Enabler:** Breathing assessed
Roppolo et al. 2007[59], USA	Observational study of new protocol for breathing assessment, OHCA patients > 18**,** $N = 962$	**Enabler:** Modified dispatch protocol to assess breathing status.
Vaillancourt et al. 2015[60], Canada	Observational study of CBD protocol at different sites, unconscious patients, $N = 2260$	**Barrier:** Recognition varied across sites

The table summarizes study design, barriers, and enablers of the included evidence for dispatch protocols. Please see Supplemental Table 4 for a more comprehensive overview. OHCA indicates out-of-hospital cardiac arrest; CBD, criteria-based dispatch; MPDS, medical priority dispatch system; LATDS, Los Angeles Tier Dispatch System; and TA-CPR, telecommunicator-assisted cardiopulmonary resuscitation.

[*] The study was included in more than one theme.

to promote caller descriptions of symptoms and using callers spontaneous descriptions to determine the EMS response.[44] MDPS and CBD use a similar initial assessment of the patient. Consciousness is assessed first, followed by breathing status.

Medical Priority Dispatch System (MPDS)

Eight studies evaluated the MPDS or similar protocols, such as the Ontario Dispatch Priority Card Index (DPCI).[13,18,44,48,49,55,56,60] Of these MPDS protocol studies, two evaluated the Los Angeles Tiered dispatch protocol compared to MPDS, with the Los Angeles Tiered dispatch protocol having a similar OHCA recognition to MPDS.[55,56] In particular, the Los Angeles Tiered dispatch protocol evaluated differences in recognition in relation to callers having English as a second language and noted no difference in recognition but a higher proportion of telephone CPR in callers with English as a second using the Los Angeles Tiered dispatch protocol.[56] Two studies evaluated the Ontario DPCI, one comparing different dispatch centers and the second undertaking a sub-analysis for reasons for non-recognition, noting agonal respirations as the primary reason for non-detection of OHCA.[13,60] Three studies compared MPDS to 'no protocol', National Health Services pathways for children under 16, and criterion-based dispatch (CBD). Compared to no-protocol, MPDS had a higher likelihood of recognition.[49] Furthermore, compliance with MPDS was also associated with a higher likelihood of recognition.[49] Unrecognized OHCAs were associated with breathing symptoms, fluctuating consciousness, and patient being female in emergency medical systems using MDPS.[18] Using the United Kingdom dispatch protocol (NHS Pathways) for OHCA recognition in children under 16 years demonstrated similar sensitivity and specificity to that of MPDS, with those not recognized as OHCA commonly coded as an unconscious patient with breathing difficulties.[48]

Criterion Based Dispatch (CBD)

CBD was the second most used protocol. The likelihood of recognition using CBD ranged from 70% to 83%.[26,44,47,52,58] In an observational study, Hardeland et al. investigated MPDS (Richmond, USA) versus CBD (Oslo, Norway) performance on recognition.[44] This study showed both systems had similar performance on recognition, with the most frequent reason for unrecognized OHCAs being misinterpretations of agonal breathing. The EMS in Sweden and Denmark used CBD.[51] In Sweden, 53% of the telecommunicators did not have a medical professional background, whereas in Denmark, all had a medical professional background. These systems had similar probabilities of recognition.[51] One study evaluated themes around unrecognized OHCAs when using the CBD protocol and noted: (1) whether telecommunicators considered CBD a good tool for decision support varied widely; (2) collaboration between caller and telecommunicator was essential for recognition, affected by the emotional state of the caller; and (3) telecommunicators used varying definitions of normal breathing and found it challenging to assess breathing status.[16] One study described quality improvement of an existing but infrequently used CBD protocol. Telecommunicators were trained to use the CBD strictly for every incoming call. The likelihood of recognition rose significantly after training, from 82% to 93%.[43] One study went from no protocol to using a CBD-like protocol and included an extensive training and quality improvement program; this improved recognition from 55% to 69%.[45]

Modified protocols

Some studies investigated the performance of an altered version of CBD where breathing assessment was changed or bypassed.[12,17,42,46,50,53,54,57] Recognizing the difficulty of assessing breathing status, a theoretical study investigated the potential of bypassing breathing assessments by comparing recognition performance using a one-question protocol (assessment of consciousness) to a two-question protocol (assessment of consciousness and breathing). The two-question protocol recognized 90% of OHCAs, whereas the one-question protocol recognized all OHCAs but tripled the number of non-OHCAS who would receive an OHCA response.[53] Protocols from Belgium and the Czech Republic follow three steps: (1) assess consciousness, (2) place the patient on the floor, and (3) assess breathing; these protocols had a likelihood of recognition at 75–90%.[50,54,57] Similarly, studies from France and Singapore used hand-on-abdomen to assess breathing by asking bystanders to place their hand on the patient's abdomen and feel for breathing with further elaboration by counting between breaths or asking if they can feel breathing.[17,42,46] The hand-on-abdomen studies reported a likelihood of recognition between 61% and 93%.[17,42,46] A modified protocol where absent or abnormal breathing was categorized as 'no breathing', 'weak breathing', 'not sure if the person is breathing', 'weak snoring', and 'not breathing normally' demonstrated a sensitivity of 93% and a specificity of 50%.[12] A before-and-after study investigated the impact of a new protocol designed to identify agonal breathing through counting respiratory rate aloud and placing the phone by the patient's mouth in cases where callers answered yes to breathing or were unsure. This led to improved recognition from 72% to 81%.[59]

New technology

Eight studies reported on new technology to improve OHCA recognition (see Table 5 and Supplemental Table 5).[61–68]

Video transmission from OHCA scene

Two studies used closed-circuit television (CCTV) of OHCA scenes to investigate how telecommunicators' understanding of the OHCA scene and the visual view of the scene overlapped or diverted.[61,62] In a qualitative analysis of CCTV recordings of OHCAs, Linderoth et al. identified the lack of situation awareness as a barrier to recognition and suggested providing the telecommunicators with live-stream video from the scene as a way to improve the situation awareness.[61] Another study supported the implementation of video streaming from the scene. It assessed how ten telecommunicators perceived CCTV recordings and found significant discrepancies in the telecommunicators' perceptions of the OHCA scene and the CCTV recordings.[62] The authors concluded that providing telecommunicators with visual information from the location of OHCA might improve their understanding of the OHCA scene, which might enhance communication, their ability to guide bystanders, and improve the quality of CPR.[62]

Machine learning algorithm using language models

Two studies assessed whether a machine learning model could recognize OHCA from audio recordings of calls to the EMS.[63–65] The Danish study examined all (n = 108,607) emergency calls during 2014, of which 918 (0.8%) were OHCAs.[63] Compared with medical

Table 5 – Summary of studies in the theme: new technology.

Author, year, country	Design, study population, sample size	Barriers/enablers for OHCA recognition
Linderoth et al. 2015[61], Denmark	Qualitative study, OHCA patients caught on CCTV, $N = 21$	**Barrier:** Lack of situation awareness, non-adherence to dispatch protocol, and misleading information.
Linderoth et al. 2019[62], Denmark	Qualitative study, telecommunicators, $N = 10$	**Barriers:** Telecommunicators' perception of OHCA scene did not match CCTV recording **Enabler:** Visual information from OHCA scene
Blomberg et al. 2019[63], Denmark	Observational study of ML model, all patients with EMS calls, $N = 108607$	**Enabler:** ML models can potentially aid OHCA recognition
Byrsell et al. 2021[64], Sweden	Observational study of ML model, OHCA patients, $N = 851$	**Enabler:** ML models can potentially aid OHCA recognition
Blomberg et al. 2021[65], Denmark	Randomized controlled trial allocating EMS OHCA calls to machine learning model or standard care, AI-suspected OHCAs, $N = 5242$	No improvement in recognition using ML model
Blomberg et al. 2023[66], Denmark	Observational study of ML model, all patients with EMS calls, $N = 169049$	**Barrier:** Caller describing normal breathing or condition other than OHCA and language barriers.
Rafi et al. 2022[67], France	Observational study of ML model, OHCA and non-OHCA patients, $N = 820$	**Enabler:** ML model based on phonetics to aid telecommunicators' decision-making
Chan et al. 2019[68], USA	Observational study of ML model to identify agonal breathing, OHCA patients with agonal breathing, $N = 729$, People sleeping in a lab, $N = 12$	**Enabler:** ML model to recognize agonal breathing

The table summarizes study design, barriers, and enablers of the included evidence for new technology. Please see Supplemental Table 5 for a more comprehensive overview. OHCA indicates out-of-hospital cardiac arrest; EMS, emergency medical services; ML, machine learning and CPR, cardiopulmonary resuscitation

telecommunicators, the machine learning framework had a significantly higher sensitivity (72.5% vs. 84.1%, $p < 0.001$) with lower specificity (98.8% vs. 97.3%, $p < 0.001$). The machine learning framework had a lower positive predictive value than telecommunicators (20.9% vs. 33.0%, $p < 0.001$). Time-to-recognition was significantly shorter for the machine learning framework compared to the telecommunicators (median 44 s vs. 54 s, $p < 0.001$). In 2016, a Swedish study trained a deep neural network model to detect OHCA through speech recognition. They used 3,944 OHCA calls to the EMS and 39,888 calls without OHCA to train the model.[64] The machine learning model was tested on validated OHCA calls ($n = 851$) and calls without OHCA ($n = 85{,}205$) in 2018. The machine learning model recognized 36% ($n = 305$) of the OCHAs within 60 s with median time to recognition of 72 s (IQR, 40–132 s), whereas the telecommunicators recognized 25% ($n = 213$), median time to recognition was 94 s (IQR, 51–174 s). The machine learning model and telecommunicators were equally good at recognizing OHCA at any time during the call. The machine learning model recognized 6% ($n = 52$) of OHCAs not recognized by telecommunicators, and telecommunicators recognized 4% ($n = 38$) of OHCAs, not recognized by the machine learning model.

One randomized study evaluated the effect of a machine learning model (described above) on telecommunicators' recognition of OHCA.[63,65] The study was a double-masked, 2-group, randomized clinical trial, randomizing emergency calls 1:1 to intervention vs. control. Telecommunicators in the intervention group were alerted when the machine learning model suspected OHCA, and those in the control group followed normal protocols without alert. The primary endpoint was the likelihood of telecommunicator recognition of subsequently confirmed OHCAs. A total of 169,049 emergency calls were examined, of which the machine learning model identified 5,242 as suspected OHCA, randomized equally to intervention (alert) or control (no alert). Of the suspected OHCAs, 336 (12.6%) and 318 (12.3%) had confirmed OHCA in the control and intervention group, respectively. Telecommunicators recognized 296 (93.1%) of confirmed OHCA in the intervention group and 304 (90.5%) in the control group (P=0.15). Machine learning alerts alone had a significantly higher sensitivity than telecommunicators without alerts for confirmed OHCA (85.0% vs. 77.5%; P<0.001) but lower specificity (97.4% vs 99.6%; P<0.001) and positive predictive value (17.8% vs. 55.8%; P<0.001). The study did not find a significant increase in telecommunicators' ability to recognize OHCA when using the machine learning algorithm. OHCAs not recognized by the machine learning model were characterized by the caller presenting a different condition (31%), the caller describing normal breathing (28%), and language barriers (23%).[66]

Machine learning model using phonetic characterization of caller's voice

One study reported the development of a machine learning algorithm based on phonetic characterization of a caller's voice (e.g., pace, jitter, and voice breaks), including 820 calls.[67] The authors tested three models: a binary logistic regression, random forest, and neural network, where the random forest model performed best with an area under the curve of 74.9 (67.4–82.4). The machine learning model based on the caller's voice might aid recognition by integrating acoustic parameters in support of decision-making.

Smart Devices to detect agonal breathing

One study reported an observational proof-of-concept study using smartphones to detect agonal breathing.[68] The study introduced a support vector machine using Amazon Echo and Apple iPhone.

The system was trained using emergency calls from Public Health-Seattle & King County, Division of Emergency Medical Services. The agonal breathing dataset included 162 calls (19 h) with clear recordings of agonal breathing (2009–2017). To evaluate how the system performed with real sleep sounds, the system was tested in a sleep lab (n = 12) and on real-world sleep data (n = 35). In the latter, the system had a sensitivity and specificity of 97.17% (95% CI: 96.79–97.55%) and 99.38% (95% CI: 99.20–99.56%), respectively. The false positive rate was 0.22%, corresponding to 515 of the 236,666 audio segments (164 h) used as test data.

Discussion

This scoping review assessed the literature on telecommunicators' recognition of OHCA, including methods used to optimize recognition and barriers and enablers for telecommunicators' recognition of OHCA. The main findings were that most studies were observational and assessed barriers to recognition and different dispatch protocols. Recognition of pediatric OHCAs or disparities in recognition were only reported in one study, respectively.[7,8] Few studies reported new technology, such as machine learning models for OHCA recognition. [63–68] Only one randomized-controlled trial was identified, which tested the implementation of a machine learning model to aid recognition, though telecommunicator recognition was not improved.[65] Taken together, these findings underline the need for more research, particularly randomized studies, to improve telecommunicator recognition of OHCA.

Agonal breathing and challenges with assessing breathing status were the most commonly reported barriers for recognition, whereas assessment of consciousness level was not reported as a barrier.[12,14–20] Several dispatch protocols have attempted to omit or change how breathing status is assessed. Omitting the questions potentially leads to too many false positives. However, this has only been investigated in one theoretical study.[53] Altering the breathing assessment to add more nuances does improve recognition in observational studies.[12,17,42,46,59] However, randomized controlled trials are needed to evaluate the impact of various dispatch protocols on recognition. Whether a healthcare professional telecommunicator is superior to a telecommunicator without a professional background also has to be investigated in a randomized controlled trial.

Other barriers reported were related to callers' emotional status, callers' description of the patient's situation and symptoms, and callers not being with the patient.[3,9,10,13,31,33–35,40,61] Enablers of recognition was caller remaining calm, telecommunicators communication skills, and implementing a dispatch protocol.[12,15,18,28,31,32,34,43,45–47,49,56,59] There is also a need for studies elucidating strategies for maintaining the caller's calm demeanor, including whether the caller's prior CPR training facilitates better communication with telecommunicators. If so, widespread training of the population in CPR might be a strategy to mitigate emotionally unstable callers.

The main source of data used in the included studies was audio recordings of emergency calls. Other sources of data, such as interviewing callers, bystanders, and telecommunicators might provide new information to help us understand the mechanisms of enablers and barriers.

Knowledge gaps

Most studies originated from Europe, followed by North America, limiting the transferability of the results to other regions.

The included studies systematically excluded patients with third-party callers.[11,16,17,19,23,32–34,38,39,41–46] We do not know the mechanisms behind third-party callers, who they are, whether OHCA can be recognized through a third-party caller, and what strategies would reduce the incidence of third-party callers.

Disparities in OHCA recognition were only described in one study concerning area-level socioeconomic status. Understanding disparities in recognition regarding socioeconomic status, ethnicity, gender, patient age, or rurality is crucial to improving recognition for all patients and designing inclusive interventions. Particularly, a recent study reported lower rates of bystander CPR in women, which was partially explained by low OHCA recognition.[69] More research is needed to explore recognition of pediatric OHCAs further.[7]

Video streaming has been suggested to improve OHCA recognition and has been implemented in many communities. However, whether and how video-streaming can improve recognition, particularly in cases where the assessment of breathing status poses challenges, has yet to be investigated.

Limitations

The literature search was conducted using two databases (Medline and Embase). Studies from other databases, languages, or grey literature could have provided further evidence for this scoping review. However, these studies would likely not have been large RCTs and thus would be less likely to offer practice-changing evidence. Lastly, we did not have a measure of agreement between reviewers.

Conclusion

Most studies were observational, assessed barriers to telecommunicator recognition of OHCA, and compared different dispatch protocols. Only one RCT was identified, which tested the implementation of a machine learning model to aid in telecommunicator recognition of OHCA and did not find improved recognition of OHCA. These findings underline the need for more research, including pediatric OHCAs, disparities in recognition and test of dispatch protocols, and particularly randomized studies to improve telecommunicator recognition of OHCA.

CRediT authorship contribution statement

Anne Juul Grabmayr: Writing – review & editing, Writing – original draft, Methodology, Investigation. **Bridget Dicker:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Vihara Dassanayake:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Janet Bray:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Christian Vaillancourt:** Writing – review & editing, Methodology, Conceptualization. **Katie N. Dainty:** Writing – review & editing, Conceptualization. **Theresa Olasveengen:** Writing – review & editing, Methodology, Conceptualization. **Carolina Malta Hansen:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing inter-

ests: “Some of the authors (JB, CV, TO) have published manuscripts which are included in this review. However, none of the authors have any financial conflicts of interest. Authors with identified conflicts of interest as per the guidance of the ILCOR Conflict of Interest Committee were not involved in the data extraction. JB is an Editor of Resuscitation Plus.”.

Acknowledgement

The authors acknowledge the contributions of the non-author members of the **ILCOR BLS Task Force:** Michael Smyth, Julie Considine, Sung Phil Chung, Fredrik Folke, George Lucas, Takanari Ikeyama, Nicholas J. Johnson, Siobhán Masterson, Chika Nishiyama, Ziad Nehme, Tatsuya Norii, Giuseppe Ristagno, Maya Dewan, Tetsuya Sakamoto, Christopher M. Smith, Peter Morley, Gavin Perkins. We will also like to acknowledge the contribution from the information specialist, Annemette Møller Hansen from Copenhagen University Library.

Funding

This Scoping Review was funded by the American Heart Association, on behalf of The International Liaison Committee on Resuscitation (ILCOR). None of the authors received payment from this funding source to complete this scoping review. JB receives a Fellowship from the National Heart Foundation of Australia.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.resplu.2024.100754.

Author details

on behalf ofthe International Liaison Committee on Resuscitation Basic Life Support Task Force[1] [a]*Emergency Medical Services Capital Region of Denmark – University of Copenhagen, Ballerup, Denmark* [b]*Clinical Audit and Research Team, Hato Hone St John, National Headquarters, Ellerslie, Auckland, New Zealand* [c]*Paramedicine Research Unit, Paramedicine Department, Auckland University of Technology, Manukau, Auckland, New Zealand* [d]*Department of Anaesthesiology & Critical Care, Faculty of Medicine, University of Colombo & National Hospital of Sri Lanka, Sri Lanka* [e]*School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia* [f]*Department of Emergency Medicine, Ottawa Hospital Research Institute, University of Ottawa, Canada* [g]*Research and Innovation, North York General Hospital, Toronto, Ontario, Canada* [h]*Institute of Health Policy Management and Evaluation, University of Toronto, Toronto, Ontario, Canada* [i]*Institute of Clinical Medicine, University of Oslo and Department of Anesthesia and Intensive Care Medicine, Oslo University Hospital, Norway* [j]*Department of Clinical Medicine, University of Copenhagen, Denmark* [k]*Department of Cardiology, Herlev and Gentofte Hospital, University of Copenhagen, Denmark* [l]*Department of Cardiology, Rigshospitalet, Copenhagen University, Denmark*

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