Training and education

Assessment of a quality improvement programme to improve telephone dispatchers' accuracy in identifying out-of-hospital cardiac arrest

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Abstract

Introduction: Early recognition of out-of-hospital cardiac arrest (OHCA) by the medical dispatcher is a prerequisite for an effective chain of survival, leading to rapid dispatch of emergency medical services.

Aim: To analyse and compare the accuracy of the Emergency Medical Dispatch Centre in identifying OHCA before and after an educational intervention.

Methods: A quality-assessment study collecting data from prehospital medical voice logs in Southern Denmark during two periods. Baseline data and post-interventional data were obtained during December, January, and February 2017/2018 and 2019/2020, respectively. We imposed an intervention consisting of a specifically targeted education in quick assessment of OHCA and instructions regarding telephone-assisted-CPR.

The primary outcome measure was the dispatcher's ability to recognise OHCA. Secondary outcome measures were time from contact with the caller to the dispatcher formulated essential questions related to the NO-NO-GO algorithm. These questions included an assessment of the patients' consciousness and respiratory efforts and if both negative, would ideally lead to the dispatcher initiating telephone-assisted-CPR. All data was analysed in accordance with the recommendations and performance goals made by Resuscitation Academy.

Results: Baseline data included 209 calls. Post-interventional data was based on 208 calls.

The sensitivity for recognition of OHCA was 82.3% (95% CI: 76.4−87.2%) before and 92.7% (95% CI: 88.2−95.8%) after the intervention ($p=0.0014$).

The median duration of calls before recognition of OHCA was 68 and 56 s before and after the intervention ($p=0.097$).

Conclusion: After the period of intervention, the accuracy of OHCA recognition by dispatchers improved. The median time to identify OHCA or recognise the first compression did not differ significantly. This indicates that continuing education and quality assessment may be beneficial and necessary.

Keywords: Dispatch centre, Out-of-hospital cardiac arrest, Education

Introduction

Early initiation of bystander cardiopulmonary resuscitation (CPR) and the use of an automated external defibrillator (AED) is strongly associated with survival from out-of-hospital cardiac arrest.[1–4] Emergency medical dispatchers play an essential role in this process by recognising OHCA and initiating telephone-assisted-CPR (T-CPR) instructions if necessary.[5,6] This makes the dispatcher a critical link in the cardiac arrest chain-of-survival.[7,8]

In 2018, the Resuscitation Academy, Seattle, published "10 Steps For Improving Survival from sudden cardiac arrest".[9] These recommendations include T-CPR performance standards published in 2017 from the *American Heart Association*.[10] The five regional prehospital organisations in Denmark have joined the organisation the Resuscitation Academy and the *Danish Resuscitation Council* in order to implement the recommendations in Denmark.[11] The Emergency Medical Dispatch Centre[12] in The Region of Southern Denmark has adopted the recommendations of the Resuscitation Academy seeking to optimise the effectiveness of diagnosing OHCA and delivering T-CPR. The minimum acceptable performance standards recommended by the Resuscitation Academy and the American Heart Association includes a median time between contact with a caller and recognition of OHCA by the dispatcher of under 120s. The maximum acceptable time that may elapse from contact with the caller and until the first compression is administered, is set to 180s.[10] There are studies aiming to measure the accuracy of the medical dispatchers in recognising OHCA but only a few intervention studies have been made to improve the dispatchers overall performance.[13–15]

This study thus aimed to evaluate and compare the accuracy in recognising OHCA by medical dispatchers in Southern Denmark before and after implementing the T-CPR recommendations and performance measures as outlined by the Resuscitation Academy.[10]

Material and methods

System setting

In Denmark, the emergency medical service is regulated by law.[16] The nationally implemented system is a publicly funded, three-tiered system in which the basic resource is an ambulance staffed by two emergency medical technicians. The prehospital resource is dispatched by an emergency medical dispatch centre staffed by health care workers; nurses or paramedics.[12,17]

The dispatch centre services 1.2 million inhabitants and covers an area of 12,200 km^2. The caller can contact the dispatch centre via the national emergency call number, 1-1-2.

The basic education in recognition of OHCA consisted of participation in a basic CPR-training course at Odense University Hospital along with the hospital staff. This 30-min course includes a presentation of the chain-of-survival, education in identifying cardiac arrest and how to alert the rescuers, how to perform sufficient CPR with rescue breaths, and instructions in the use of an AED. Further, to aid the recognition of OHCA, an algorithm is presented to the dispatcher.[6,18] This algorithm includes questions regarding consciousness and respiratory efforts. Thus, to determine the likely presence of an OHCA, two critical screening questions are asked by the dispatcher: "Is the patient conscious (awake)?" and "Is the patient breathing normally?" These questions are posed in Danish or, should

the caller speak another language, in English. If the answer to both is "no", the dispatcher immediately begins instructions in T-CPR. This algorithm is often referred to as the NO-NO-GO algorithm.[9] The algorithm was, however, not used systematically by the dispatchers before the intervention as it was not emphasised to the dispatchers that recognition of cardiac arrest might benefit from a systematic approach.

All incoming calls are recorded in a voice log system, enabling auditing and quality control of the recorded voice logs. Following the dispatcher's assessment of the required level of care, the dispatcher forwards the prehospital resource. These resources are managed by the 'SimaOffice' fleet management system (Simatech, Ballerup, Denmark), recording essential system variables pertaining to each emergency run. Following contact with the patient, all observations, treatments, and immediate outcome parameters are registered in a national electronic medical record database.[12]

Quality improvement measures

When the QI programme was initiated all dispatchers were subjected to supplemental education concerning OHCA. Thus, the Resuscitation Academy and the American Heart Association programme recommendations for training of the dispatchers (see Table 1) were applied with slight modifications:

- Each Emergency Medical Dispatcher was subjected to one full day of training every third month. The main content of the education was the conduction of T-CPR.
- Simultaneously, we initiated an auditing process of all dispatchers. Four times a year we assessed two to four randomly chosen OHCA calls from each dispatcher. The assessment was carried out using a form suggested by the Resuscitation Academy in a slightly modified version adapted to the local dispatch centre (Supplemental file 1).[6]

Table 1 – Performance goals and recommendations from Resuscitation Academy and the American Heart Association programme for training of emergency medical dispatchers.

Performance goals
- Time between emergency call and OHCA recognition < 120 s
- Time between emergency call and delivery of T-CPR < 180 s

Train and provide continuing education in telephone-assisted cardiopulmonary resuscitation (T-CPR) for all dispatchers.
- Initial training for 100% of call takers and dispatchers requiring an estimated 3–4 h.
- On-going continuing education requiring 2–3 h annually.

On-going quality improvement for all calls in which a cardiac arrest is confirmed by the Emergency Medical Dispatch Centre personnel in which resuscitation is attempted to improve positive outcomes and quality of T-CPR.
- 100% of calls in which resuscitation is attempted must have the dispatch call audited for quality improvement purposes.
- The quality improvement must collect key time intervals and reasons for non-recognition of cardiac arrest and reasons for delays.
- Individual quality improvement review of every cardiac arrest call provided by the supervisor or designated quality improvement person) including helpful feedback.
- Quality improvement reports must be summarised annually and secular trends reported.
- Quality improvement reports should be used to identify training needs.

On-going education and quality improvement as part of the QI programme

As a permanent QI intervention, over a three-month period in the fall of 2019, the NO-NO-GO algorithm was made an essential part of the dispatchers' decision making process in Southern Denmark. Upon answering every incoming call to the dispatch centre, a pop-up visitation tool consisting of the NO-NO-GO-algorithm was visible on each dispatcher's computer screen. The intention was to force the dispatcher to consider the possibility of OHCA in all calls. If both unconsciousness and abnormal breathing were confirmed, the algorithm would then require the EMD to dispatch an ambulance immediately.

Furthermore, apart from implementing the NO-NO-GO-algorithm as a compulsory tool, the dispatchers received the basic level 1 e-learning CPR-course and additionally, four hours of specific T-CPR education. In addition, the dispatchers received a two-hour OHCA-oriented review of voice logs concerning OHCA in small focus groups. The voice log reviews were based on random OHCA calls extracted from the dispatchers' list of OHCAs.

Every third month the dispatchers received two hours of dedicated T-CPR education and two hours of CPR-training. Furthermore, two random cardiac arrest calls per dispatcher were extracted and evaluated for quality purposes every third month (Fig. 1).

Evaluation of the quality improvement process

In order to evaluate the quality improvement measures, assessment of the voice logs was performed according to the recommendations made by the Resuscitation Academy and the American Heart Association.[9,10]

Thus, the following indicators were applied as measures of quality[10]:

The percentage of OHCA cases correctly identified by should be above 95%.

Median time between emergency call connected and OHCA recognition: <120 s.

Median time between emergency call connected and first T-CPR directed compression: <180 s.

Three months of consecutive OHCA calls were audited before the intervention period (December 2017, January 2018 and February 2018) and after the intervention period (December 2019, January 2020 and February 2020). We measured the following elements:

1. When was consciousness confirmed?
2. When was respiration status confirmed?
3. When did the dispatcher recognise OHCA?
4. When was the first compression confirmed?

To derive all OHCA calls, we searched the Danish Cardiac Arrest Registry[19] for OHCA in the relevant periods. To ensure completeness of data, the following variables from the Danish Prehospital Medical record system[12] were used to validate the number of OHCA:

"CPR Treatment before ambulance arrival", "Cardiac arrest with CPR performed by ambulance personnel", "ROSC at any time".

Finally, we searched the voice logs of the dispatch centre for all calls in which the dispatcher had suspected OHCA.

During contact with a caller, the dispatcher assigns an assignment code describing the major problem of the caller according to a nationally implemented Danish decision support tool to prioritise prehospital resources.[17] These assigned codes were used to identify potential cardiac arrests. The following assignment codes were scrutinised[20]:

(1) A0101: Unconscious adult
(2) A0201: Unconscious child < 1 year old
(3) A0202: Unconscious child > 1−8 years old
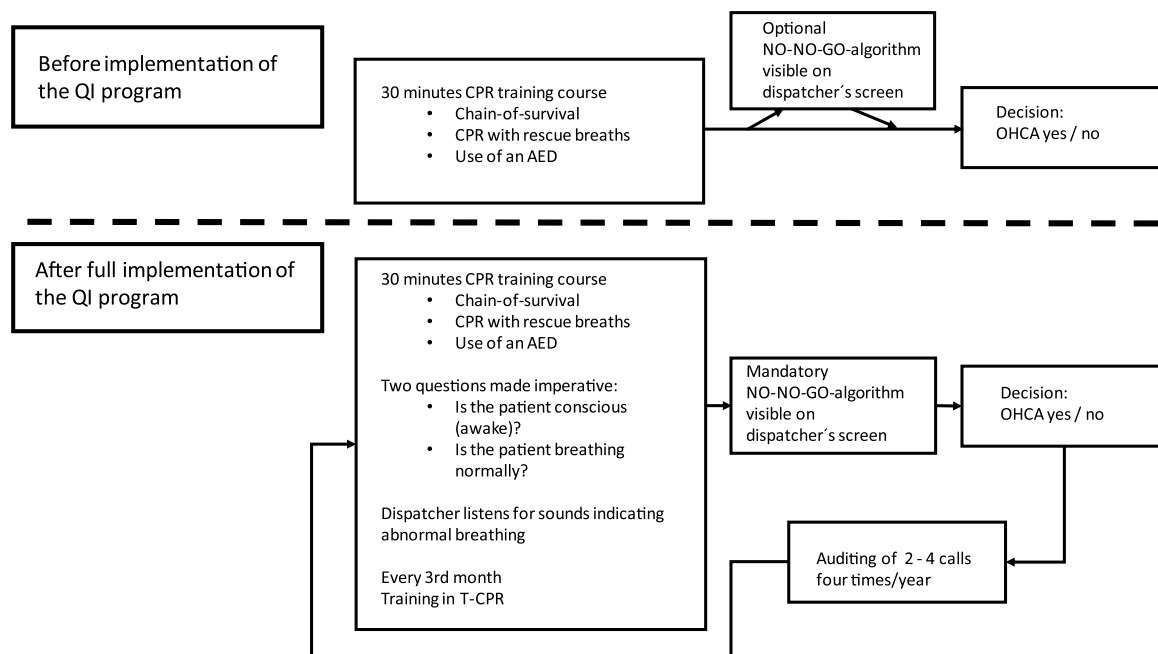(4) A0203: Unconscious child − older children

Fig. 1 – Diagrammatic presentation of the quality improvement programme. Boxes above the dotted line represents actions made by the dispatchers before the QI programme was implemented. Boxes below the dotted line represents actions made by the dispatchers after the implementation of the QI programme. The NO-NO-GO-algorithm consists of two questions: Is the patient conscious (awake)? and Is the patient breathing normally?. If NO is the answer to both questions, an ambulance should be dispatched immediately.

The calls were monitored in 'RecordIt' (Recordit.nu, Vejle, Denmark) and each incoming call was subsequently evaluated in the emergency medical record system[12] to verify correct diagnosis of OHCA, or to investigate whether the OHCA occurred after the ambulance arrived.

To determine when consciousness and respiratory status were confirmed, we measured the time from the dispatcher picking up the telephone until either the dispatcher began to ask the questions from the NO-NO-GO algorithm or to when the information was provided spontaneously by the caller.

The dispatcher was considered to have recognised the OHCA if CPR-instructions were given or if the dispatcher commented: "He/she is in cardiac arrest" or "You need to start CPR". Furthermore, the time until the first compression was initiated was determined as the point in time when the auditor was able to acknowledge someone at the scene counting the compressions or when the caller confirmed that someone was giving CPR.

Inclusion and exclusion criteria:

We used the inclusion criteria applied by the Resuscitation Academy and the American Heart Association[9,10]: All OHCA reported to the dispatch centre. The overall exclusion criteria were: Third-party calls; calls that were terminated by the caller immediately after the caller had delivered the message; and calls concerning OHCA where CPR was already in progress. Furthermore, calls in which communication was impeded by for instance language barriers; calls concerning OHCA occurring after EMS arrival; and calls in which other circumstances made the supervisor assess the calls as being "unidentifiable" were excluded.

In relation to the assessment of the instructions regarding T-CPR the following calls were excluded: Calls in which the caller was unable to physically perform CPR (i.e. caller not besides patient); and calls in which the caller was unable to position the patient appropriately for CPR due to physical limitations. Furthermore, calls in which the caller refused to perform CPR and calls in which the CPR could not be performed for fear of the caller's safety (trauma, disasters) were excluded. Finally, calls concerning cases where the supervisor deemed that T-CPR could not be performed were excluded.

Sample size

The study was planned as a master's thesis for a medical student. This imposed a limited time to gather baseline data and establish the effects of the ensuing QI programme. Thus, a three-month period was chosen as the baseline period and, correspondingly, a three-month period was used gathering post-interventional data. No formal sample size calculations were made.

Ethical issues, data management, data storage and statistical analyses

According to the Danish Legislation, quality control follow-up studies do not require any legislative authorisations except approval from the local board of directors at the treating facility.[21]

This study was approved as a quality control study by the prehospital director in the region of Southern Denmark. All patient information was extracted by authorised health care personnel according to the approval. All data were anonymised.

Data were entered into Excel-files (Microsoft Corporation, Redmond, Washington, USA). Statistical analyses were performed using STATA 16.0 (StataCorp, College Station, Texas, USA). Non-parametric analyses (Chi-square, Wilcoxon rank-sum test) were applied, as normal distribution could not be assured.
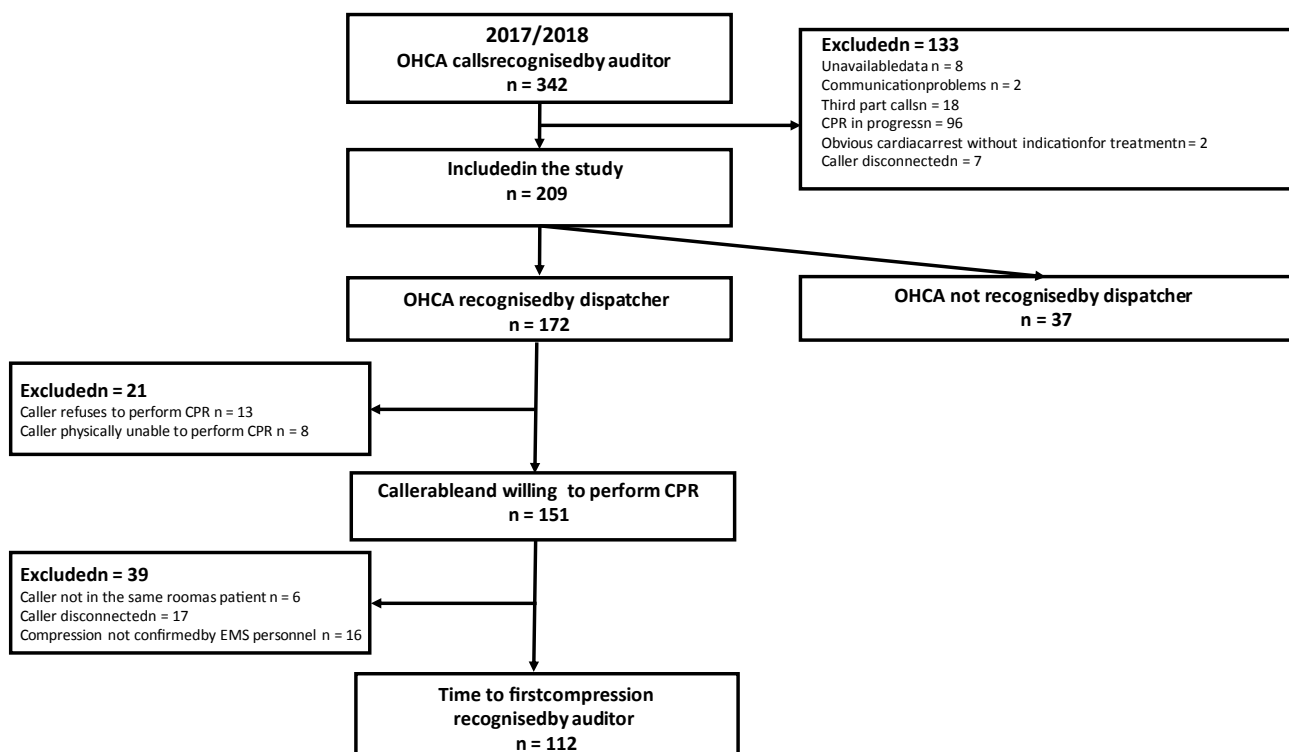

Fig. 2 – Data collection flowchart 2017/2018 – before implementation of the Resuscitation Academy's Guidelines.

Results

A total of 673 OHCA calls from the two study-periods were eligible for analyses. Of those, 256 (38%) were excluded (see Figs. 2 and 3). Of 209 included OHCA calls in the pre-intervention period, in 37 (17.7%) of them OHCA were unrecognised by the dispatcher, giving a sensitivity for identifying OHCA at 82.3% (95% CI: 76.4−87.2%). Of 208 included OHCA calls in the post-intervention period, in 15 (7.3%) of them OHCA went unrecognised, giving a sensitivity for identifying OHCA calls at 92.7% (95% CI: 88.2−95.8%). This difference was significant ($p=0.0014$).

Table 2 presents data from the review of audio recordings from both observational periods.

Consciousness and breathing were addressed in general and no significant difference between median time in the two groups was found ($p=0.679$ and 0.688). The median call duration to recognise OHCA was 68 and 56 seconds before and after the intervention. This difference was not significant ($p=0.097$). Furthermore, the median time to the first compression did not differ between the two periods ($p=0.918$).

Discussion

This study aimed to evaluate the medical dispatchers' ability to recognise OHCA before and after implementation of a quality improvement protocol. Our main finding was that the dispatchers had an improved sensitivity for recognising OHCA after the intervention period. Despite the significant improvement in recognition of OHCA, the performance recommendations from the Resuscitation Academy, aiming at 95% correctly identified OHCA cases, were not met.

Another performance goal from the Resuscitation Academy is to reduce the time spent from contact with the caller to the dispatcher formulates essential questions and recognises the OHCA. In our study, these parameters did not improve significantly. However, the median time to identify OHCA was insignificantly reduced from 68 (43−114.5) seconds before the intervention to 56 (40−95) seconds after the intervention. This indicates some improvement, but our study may have been underpowered to make any significant conclusions. Despite no significant improvement, the time intervals met the minimum standard recommendation from the Resuscitation Academy. The Resuscitation Academy recommends a median time between 112-call connected and OHCA recognition < 120s. This, however, includes the time from when the 112-call is connected to the primary public safety answering point and the call is redirected to the dispatch centre. In our study, we have only been able to analyse the voice logs from the dispatch centre and therefore only include the time from when a medical dispatcher is connected with the call. No studies have been made to determine the call duration and time before the redirection of the 112-calls to the dispatch centre in case of an OHCA in Denmark. If, stipulatively, 30s are added to the study findings, the estimated time to recognition of OHCA would amount to 98 and 86s before and after the quality improvement programme (QI programme). These estimated time intervals are within the performance goals of the Resuscitation Academy but are subject to much uncertainty and an investigation into the primary public safety answering point (in Denmark, the police) and their efficacy would be required to make any conclusions.

The visitation algorithm contained the two essential questions; "Is the patient conscious (awake)?" and "Is the patient breathing normally?". This NO-NO-GO pop-up tool was constructed as a pop-up menu on the dispatcher's computer screen but could be disabled by the medical dispatcher. Although the personnel were advised to use it, the NO-NO-GO pop-up tool allowed the dispatcher to deviate from the algorithm if the dispatcher concluded that the
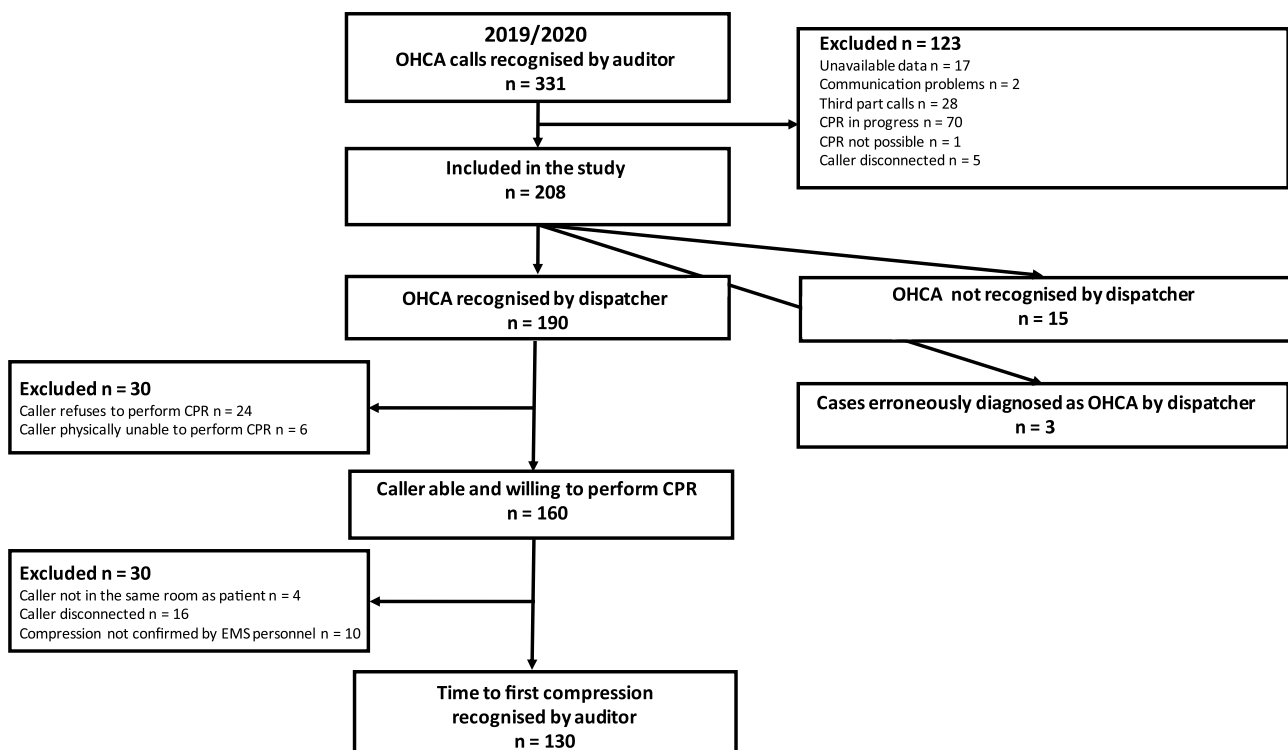

Fig. 3 – Data collection flowchart 2019/2020.

questions were not appropriate or not clinically relevant. However, this could lead to failure or delay in acknowledgement of OHCA.[22] Before the QI programme, the medical dispatchers were trained to ask about "normal breathing", but this was not further specified. The definition of "normal" breathing can differ from health professional to layman, thus making it difficult to identify agonal breathing.[6,23,24] As agonal breathing is often occurring in patients with ventricular fibrillation (VF) cardiac arrests, respiratory insufficiency is crucial to identify.[18,22−24] Following the QI programme, evaluation of a patient's respiratory effort was addressed by training the dispatchers to recognise agonal breathing by listening to the patient over the telephone and attempting to visualise the agonal breathing efforts by interpretation of the messages relayed by the caller.

We were unable to demonstrate any improvement in the time required for the dispatcher to ask the key questions regarding respiration even after the QI programme that included mandatory use of the NO-NO-GO-algorithm. Consistency in the use of the NO-NO-GO pop-up tool could, therefore, form a direction for further improvement.[6,18,25]

Medical dispatchers have an obvious role in diagnosing OHCA, initiating resuscitation instructions, and allocating prehospital resources such as AEDs and emergency medical services. To further optimise the effectiveness of out-of-hospital resuscitation, new technologies and innovations keep changing the time limitations in the chain-of-survival. Many dispatch centres are now able to locate the nearest AED and some can dispatch volunteer lay rescuers carrying an AED. There is on-going work to provide real-time video at the scene from the caller's smartphone to help the medical dispatcher in recognising OHCA and especially agonal breathing and, furthermore, to help coach high quality resuscitation. Another tool to improve recognition of OHCA is the use of machine learning that could be help to identify some cases of OHCA, which the dispatcher otherwise might miss.[26,27]

Overall, the dispatcher will continue to be a key element in the dispatch centre and continuous quality improvement of the dispatchers' performance should include education and on-going quality assessment of the voice logs. Adjustments could, however, be the key to more effective evaluation. Self-audit could enhance the dispatchers' ability to reflect on their own practice and thereby become aware of irrelevant questioning and self-adjust to more effective diagnostic capabilities. Simulated call scenarios have been shown to be a successful education-form for dispatchers to improve recognition of OHCA.[28] Furthermore, low dose−high frequency simulation training could be implemented to keep practical learning abreast with theoretical education. Low dose−high frequency training has been

shown to be an effective approach to teaching, as repetitive training results in better learning outcomes.[29,30] Additionally, complete adherence to the NO-NO-GO visitation algorithm in every emergency call could enhance consistency and faster acknowledgement of OHCA.[21]

Limitations

There are several limitations in this study. First of all, the study may have been underpowered. It is thus possible that the lack of significance regarding time to recognition of OHCA between the two investigation periods is a reflection of the small sample.

Furthermore, the study represents findings from one single dispatch centre and thus may reflect solely the culture of this particular dispatch centre.

Furthermore, because of the exclusion of some voice log files −according to the pre-specified exclusion criteria, a comprehensive specificity analysis could not be performed. One final limitation was that the study design made it difficult to ascertain whether the true intervention is the use of an algorithm (NO-NO-GO) or the education surrounding the importance of recognition and ongoing quality improvement. We are thus only able to report an association of the QI programme as a whole with improved performances.

Strengths

One of the strengths of the study are that all consecutive voice logs in the study period were assessed and were audited by one person applying the same criteria for analysis. The OHCA were extracted from the Danish Cardiac Arrest Registry, which is being extensively validated. We are thus convinced that all potential OHCA were included. This notion is supported as we scrutinised all prehospital medical records containing variables or phrases that could be connected to cardiac arrest. Finally, a strength of the study is that the guidelines applied in recognition of OHCA corresponded to the guidelines endorsed by the Resuscitation Academy.

Conclusion

The accuracy of OHCA recognition showed significant improvement after implementing a quality improvement programme in line with the recommendations and performance goals of the Resuscitation

Academy and the American Heart Association. Implementation of the quality improvement programme and the mandatory use of the NO-NO-GO-algorithm, however, did not reduce the time needed for the dispatcher to recognise OHCA or to ask essential questions regarding the status of the patient. This indicates that continuing education in recognition of OHCA is both beneficial and necessary.

Authors' contribution

Kristel Hadberg Gram was involved in conception and design of the study, acquisition of data, and analysis and interpretation of data. She drafted the article and participated in revising the draft. Kristel Hadberg Gram has read and approved the final article.

Mikkel Præst was involved in conception and design of the study, acquisition of data, and interpretation of data. Mikkel Præst participated in revising the article critically for important intellectual content. Mikkel Præst has read and approved the final article.

Ole Laulund was involved in conception and design of the study, acquisition of data, and analysis and interpretation of data. Ole Laulund participated in revising the article critically for important intellectual content. Ole Laulund has read and approved the final article.

Søren Mikkelsen was involved in conception and design of the study and analysis and interpretation of data. Søren Mikkelsen participated in drafting the article and participated in revising the draft. Søren Mikkelsen has read and approved the final article.

Conflict of interest

None of the authors have any conflicts of interest to declare.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.resplu.2021.100096.

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