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Clinical paper

Reporting standard for describing first responder systems, smartphone alerting systems, and AED networks

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Abstract

Standardized reporting of data is crucial for out-of-hospital cardiac arrest (OHCA) research. While the implementation of first responder systems dispatching volunteers to OHCA is encouraged, there is currently no uniform reporting standard for describing these systems.

A steering committee established a literature search to identify experts in smartphone alerting systems. These international experts were invited to a conference held in Hinterzarten, Germany, with 40 researchers from 13 countries in attendance. Prior to the conference, participants submitted proposals for parameters to be included in the reporting standard. The conference comprised five workshops covering different aspects of smartphone alerting systems. Proposed parameters were discussed, clarified, and consensus was achieved using the Nominal Group Technique. Participants voted in a modified Delphi approach on including each category as a core or supplementary element in the reporting standard. Results were presented, and a writing group developed definitions for all categories and items, which were sent to participants for revision and final voting using LimeSurvey web-based software.

The resulting reporting standard consists of 68 core items and 21 supplementary items grouped into five topics (first responder system, first responder network, technology/algorithm/strategies, reporting data, and automated external defibrillators (AED)).

This proposed reporting standard generated by an expert opinion group fills the gap in describing first responder systems. Its adoption in future research will facilitate comparison of systems and research outcomes, enhancing the transfer of scientific findings to clinical practice.

Keywords: Community First Responder, Smartphone Alerting System, Basic Life Support, AED

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Introduction

More than 30 years ago the first international conference on cardiac resuscitation was held in the Utstein Abbey in Norway at which a set of minimum standards was defined for research associated with out-of-hospital cardiac arrest (OHCA).[1] This "Utstein Style" reporting template was subsequently updated[2] and templates for specific situations, including in-hospital resuscitation[3] and drowning[4] have also been developed. Currently, 30 Utstein publications have been published with reporting guidelines for a wide range of resuscitation-related fields.[5]

Systems dispatching local volunteer first responders to OHCA have been established worldwide.[6–12] Dispatch of first responders is associated with higher bystander resuscitation rates, higher use of AEDs before ambulance arrival, and increased survival.[13,14] Regions that implemented such systems have substantially higher OHCA survival rates.[15] Therefore, implementation of first responder systems is strongly encouraged by the 2020 American Heart Association resuscitation guidelines and the 2021 European Resuscitation Council (ERC) Guidelines.[16,17]

The authors intended to develop a reporting standard applicable for dispatched first responders with a duty to respond and for volunteer community responders. This seems important as it is not uncommon that a mixture between professional first responders and volunteer community responders are established.[15] First responder systems differ significantly between regions, e.g. regarding responder's qualifications, modes of activation, numbers of first responders dispatched per mission, technology, and integration of AED use.[18,19] This variation makes comparisons of systems, research results and outcomes difficult. Therefore, the 2021 ERC guidelines call for a uniform reporting of these first responder systems.[17] Reporting standards might increase transparency and transferability of research findings and strengthen systematic reviews.[20–22] Standardized reporting may also help to identify research fields and foster new studies.[21] However, the internationally recognized Utstein reporting standard for OHCA[2] does not address the new development of first responder systems.[23] To close this gap, we initiated an international consensus process, which is not formally linked to Utstein. The objective of this initiative was to develop a reporting standard for smartphone-based dispatch of first responders and AED networks in the spirit of Utstein Style format. This paper summarizes the results of the consensus process and proposes such standards for describing first responder systems.

Methods

Experts from the German Resuscitation Council (GRC) and other member organizations from the European Resuscitation Council (ERC) agreed to develop reporting standards on first responder systems and formed a steering committee in July 2021. This steering committee performed a comprehensive literature search to identify researchers publishing in English about smartphone alerting systems. The following terms were used in PubMed: "first responder OHCA", "first responder cardiac arrest", "community first responder", "citizen first responder", "cardiac arrest smartphone". Using the snowballing approach[24] further studies in the field of smartphone alerting systems were identified. The corresponding authors of original articles were contacted via email and invited to participate in the consensus process.

Participants of the consensus conference

Invitations to a consensus conference on unified reporting of first responder system research were sent by email to the previously identified scientists. Furthermore, the organizations that funded and organized the event (German Resuscitation Council, ADAC Foundation, German Heart Foundation) each provided experts to participate in the meeting. The *chair*, *vice-chair* and the *director guidelines and ILCOR* of the European Resuscitation Council were also invited. Out of 66 persons invited, 36 attended the consensus conference in Hinterzarten near Freiburg May 2–3, 2022, in person. Four researchers attended online. The conference participants came from 13 countries in Europe, North America, and Asia. All attendees stated their individual conflicts of interests, consented to participate in the consensus process and agreed to the publication of the results. Prior to the conference a SharePoint folder was created, and access was granted to all participants. The conflict-of-interest declarations of all participants were saved in this folder.

Prior to the consensus conference, attendees were given online access to current literature and were invited to share additional relevant publications. The attendees also received a short description of the proposed research methodology, and the proposed topics of the plenary sessions and the workshops.

Before the conference, all participants were asked to submit proposals for parameters to be included in the reporting standard. These ideas were transferred into an online available spreadsheet to ensure that proposals of the persons not attending the corresponding workshop could be included into the discussion.

Consensus conference in Hinterzarten, Germany (2nd and 3rd May 2022): Plenary sessions and workshops

The consensus conference aimed to discuss and to decide on core and supplemental reporting categories and items to be included in a minimum reporting standard set for describing research on first responder systems. To achieve this, the conference consisted of plenary sessions and workshops with small group discussions and anonymous voting to determine priorities of selected categories (Fig. 1). During the first plenary session every participant presented his or her potential conflicts of interest to ensure that this information was received by every single participant, even by those, who had not read the conflict-of-interest declarations on beforehand. The plenary sessions included five presentations about the new chapter in the guidelines: systems saving lives, community first responder concepts, the evolution of smartphone alerting systems, the results of the Greifswald International Consensus Conference (2019)[25] and reporting standards for OHCA. These presentations were followed by an introduction to the methodological approach used for consensus finding. Five workshops facilitating small group discussions (Fig. 1) covered the following themes: "the system", "first responders", "technology, algorithms, strategies", "reporting data" and "AED". Three rounds of two parallel workshops were held and each was followed by a plenary session for anonymous voting. The number of participants per workshop was limited to 25 to facilitate discussion. Participants decided which of the workshops they wanted to attend. E-Supplement 1 shows the program of the consensus conference.

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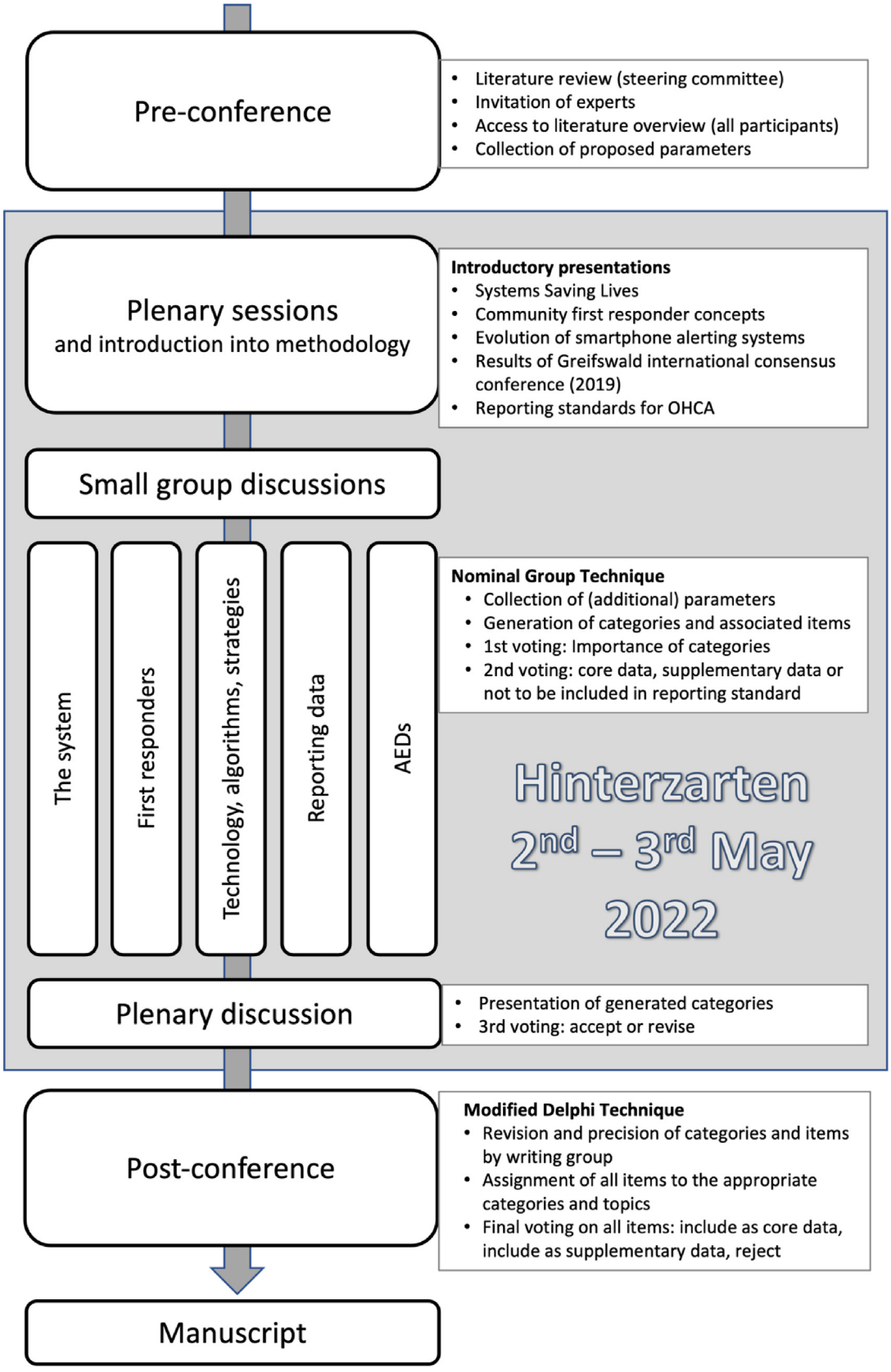

Fig. 1 – Process of generating the reporting standard.

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Table 1 – Recommended items associated with the first responder system. C – item is included as a core element; S – item is included as a supplementary element.

Category	Item	C/S	Description
1A: Geospatial	1: Name of the region	C	Specify the country, city, county, district where the system is established. Describe, whether the study includes data from the whole system or only parts of the region.
	2: Square km covered	C	Square km covered by the system
	3: Inhabitants	C	Number of inhabitants of the area covered by the system in the study time
	4: OHCA incidence	C	Number of OHCA cases per 100,000 inhabitants per year
1B: System description	1: Name of the app	C	What is the name of the software (app, backend system)?
	2: Who runs the system? Profit/Non-profit?	C	Which organisation is responsible for the operation of the system?
	3: Relevant authorities	C	Which authorities are responsible/supervise the system?
	4: AED network/database	C	Is the alerting system linked to an AED database? If yes, give the name (reference) of the AED database.
	5: Number of FR	C	Give the total number of first responders who were active during the study period
1C: Role of dispatch centre	1: Number of emergency dispatch centres	C	Is more than one dispatch centre involved? Are there differences in the relevant procedures? (e.g., different indications for dispatch).
	2: Systems in use	C	Is more than one alerting system in use? Overlapping areas? Compatibility?
	3: Activation through emergency dispatch centre or without dispatch centre	C	How is the system triggered? Integrated into dispatch centre control system? Can the system be triggered without dispatch centre involvement?
	4: Activation of system triggered manually/automatically	C	Is the system triggered automatically (if activation criteria are fulfilled)? Or is the system triggered manually by the dispatcher?
	5: Mission cancellation (dispatch centre)	S	Can the dispatch centre notify FR via the app if they cancel a mission?
	6: Mission abort (FR)	S	Can FR notify the dispatch centre via the app if they decide to abort a mission?
1D: Maturity of responder system	1: Maturity	S	Give some details about the maturity of the system. Is it in a pilot phase or well established?How old is the system (years)?
1E: Daytime	1: Times for system activation	C	At which times is the system active (day/night; weekday/weekend)?
1F: Role allocation	1: Number of first responders (FR) alerted in a single mission	C	How many responders get alerted? (This does not represent the number of FR who accepted and arrived).
	2: Roles in the system	C	Describe the roles assigned to each FR by the system and the number of FR assigned to the respective role (e.g., 2 FR go to patient, 1 FR goes to AED).
1G: Activation criteria	1: Trigger for activation of the system	C	Which indications trigger the activation of the system?
	2: Exclusion criteria	C	Describe any exclusion criteria for the activation of the system, e.g., crime scene, trauma, road traffic accidents, children
1H: Delay time to system activation	1: Delay time	C	The delay time is the time from activation of the system (usually running on a server) until the first responders are being alerted through app or text message. Please describe the usual delay in your system.
1J: Places alerted to (private, public)	1: Sites FR are dispatched to	C	Sites where a suspected cardiac arrest leads to an activation of the system (public places, private places)
	2: Sites FR are not dispatched to	C	Sites where a suspected cardiac arrest does not lead to an activation of the system (e.g. care homes)
1K: Characteristics of FRs	1: FR groups	C	Which groups are serving as FR? If possible, give the number/percentage of firemen, policemen, nurses or other groups involved into the program.
	2: On duty/off duty	S	Are the FR usually available when they are on duty or off duty?
	3: FR duties	S	Describe the functions of the FR.
1L: Additional features of first responder system	1: Feedback form/report	S	Are the FR requested to file feedback reports? If yes, please explain.
1M: Data reporting	1: How are data reported (dispatch centre, system backend, app)	C	Describe how the data are reported, extracted and processed.
1N: Psychological protection of FRs	1: Psychological support	S	Explain measures to support FR such as debriefing offer or similar

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Table 2 – Recommended items associated with the first responder network. C – item is included as a core element; S – item is included as a supplementary element.

Category	Item	C/S	Description
2A: Training	1: Qualification	C	Describe minimum qualification for FR: no qualification; BLS/AED course; first aid course or similar; emergency medical technician or any emergency medical training more than BLS/AED or first aid course; health care professionals (nurses, doctors, paramedics etc); other requirements (such as regular BLS training).
	2: Revalidation	S	Is there a revalidation process for FR? If yes, please describe.
2B: Type of FR	1: In-/exclusion criteria for FR	C	Are there any inclusive or exclusive criteria for FR (e.g., age, member of any specific organisation).
	2: Volunteer or professional	C	Explain whether the system includes professional responders on regular duty/units (such as police cars, fire service and others) or volunteers (including professional responders during off-duty times) or both. If there is any payment/compensation for FR activities?
	3: Training required for FR	C	Describe any mandatory training for FR prior to or during registration; type of training (theory, skill training, online tutorial) and content (introduction into the system, resuscitation). If a refresher course is offered, please specify.
2C: Availability	1: Location of FR	S	If stationary units are integrated (such as police stations or fire stations), please indicate the number of units and their distribution within the covered area.Not applicable, if only mobile units are integrated (police officers, police cars, fire engines) or in case of georeferenced alarm (via an app) or text message alerting of FR based on home or working address.
	2: Communities/groups	S	If groups of FR are activated for emergencies in a respective area (e.g., village), please describe.
2D: Equipment	1: Equipment provided	S	Describe the equipment provided to all FR: [vest]; [pocket mask or similar]; [bag/mask]; [emergency bag or similar]; [AED]. Regarding AED: If FR are (partially) equipped with AEDs through the system, please explain. If the number of AEDs distributed to FR is known, please indicate.

Nominal group technique

The Nominal Group Technique was used to identify items and categories to be included during the workshops.[26] Nominal Group Technique conjoins quantitative and qualitative data collection in group settings, while limiting the influence of researcher bias and group dynamic to allow active participation of all group members.[26,27]

One medical and one methodological facilitator moderated each workshop. Additionally, two persons recorded all discussion points and the ensuing consensus. This real-time documentation was stored on a web platform, accessible by participants at any time. After a short introduction into the topic by the medical facilitator, all participants were asked to write down further parameters for possible inclusion into the reporting standard. Written and verbally expressed inputs from participants were clarified by discussion. Every single proposal was identified either as a subconcept of a topic, which was defined as a category, or as an item, which was assigned to a corresponding category. In a first round of voting, the categories were ordered according to priority by anonymous voting. This was followed by a second anonymous vote using Pingo web app (University of Paderborn, Germany). The participants voted whether the proposed categories should be included into a reporting standard as core data, as supplementary data, or not at all. In concordance with the Utstein style, core data are defined as elements, which research articles in this field should aim to report, while supplementary data are desirable but not essential.[2] If 50% of the participants or more voted to reject a category, it was not included in the reporting standard. Otherwise, it was included as core or supplementary element, depending on the single majority of the approving votes.

Plenary discussion

After each workshop, all participants of the conference participated in a plenary discussion where the workshop facilitators presented the workshops' results. In a third vote all conference participants were asked anonymously whether the proposed categories should be accepted as it was or whether they should be revised. Acceptance needed 80% and more for approval in the voting, less meant the need for revision. All voting results were recorded online.

After the conference

Following the conference, the writing group elaborated the definition for each item and revised categories and items where necessary. The nature of the workshop topics, the structure of the meeting and repeated iterations resulted in (i) redundancy of some data points and (ii) identification of data points better suited in another topic. Hence, the writing group analysed all proposed data points, checked for duplicates and the need for transfer any into another topic. Based on this, the writing group proposed definitions of categories and their incorporated items and presented a first version of the minimal reporting standard by email to all attendees for possible revisions. In a modified Delphi approach an invitation for the final anonymous online voting was sent to all attendees using LimeSurvey web-based software. Consensus was *a priori* defined as agreement of at least 80% of respondents to include each category during the conference. If an item was approved by 80% of the participants or more, it was included into the reporting standard. If more than 50% of the positive votes were ´core´, it was defined as a core item. Otherwise (50% or less) it was defined as a supplementary item.

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Table 3 – Recommended items associated with the technology, algorithms, and strategies. C – item is included as a core element; S – item is included as a supplementary element.

Category	Item	C/S	Description
3A: Technical availability	1: Operating system	C	If smartphone apps are used, which operating system is employed? [android]; [iOS]; [others]
	2: Critical alert	S	Does the app offer a feature to play an alarm sound if the phone is on 'do not disturb' or 'silent' mode?If yes, is this feature offered for all operating systems?
3B: Location technology	1: How are first responders located	C	Which technology is used to locate first responders? [Mobile Phone Positioning System]; [GPS]; [Other: please describe]. If no technology is used to locate first responders nearby the scene, please explain who receives the alarm. (Registered home or working address? All first responders in system?)
	2: First responder tracking	C	Are first responders tracked during a mission? Is their position displayed in the dispatch centre? Is their position displayed in the app of other first responders on the same mission?
	3: Position updates	C	How often are positions of first responders updated? (1) Before an alarm (2) During a mission
	4: Navigation	C	Is a map/navigation feature included in the app-system?
	5: AEDs visible in app	C	Are the AED positions visible in the app?
3C: Algorithm	1: Distance calculation	C	When first responders are located during an alarm, is the distance to the emergency site calculated? If yes, how is this done? [distance by air] [travel distance]
	2: Alerting radius	C	What is the alerting radius (radius of a circle, within which first responders receive an alarm). Is it a static or dynamic radius? Please explain (e.g., different radius for city/rural area; radius depending on estimated ambulance arrival; radius depending on individual means of transportation of the respective first responder). Is the radius based on air distance (circle) or are isochrones (e.g., for travel time or travel distance) used?
	3: Mode of transportation	C	Is the mode of transportation recognized by the system (e.g., by the velocity of the first responder) or does the first responder report his/her mode of transportation? If so, is the mode of transportation used in the algorithm for selecting first responders?
	4: Alarm procedure	C	Describe the alarm procedure: How many FR get alerted? If more than the maximum number of FR confirm the alarm, which responders are selected? Does the system allocate specific tasks? If yes, describe.
	5: Responding alarms	C	Can first responders who receive an alarm accept or reject? If so, is the respective information visible in the dispatch centre? Are the data about acceptance/rejection available in the system for research/quality management?
	6: New technology algorithm	S	If any new technology, such as artificial intelligence, is included in the algorithm please specify.
	7: AED task	C	Does the system task FR to bring an AED? If so, is the AED selected by the system/app or by the FR?
3D: Legal	1: Privacy restrictions	C	Are there any legal regulations, which limit the (technological) feature of the alerting system? (Example: legal regulations prohibit location of FR)

Role of the funding source

The funding sources were not involved in study design, the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

Results

The final reporting standard included 5 topics (first responder system; first responders; technology, algorithms, strategies; reporting data; AED) containing 68 core items (System: 23, First Responders: 4, Technology: 13, Reporting Data: 17, AED: 11) and 21 supplementary items (System: 7, First Responders: 4, Technology: 2, Reporting Data: 2, AED: 6) (Tables 1–5).

- Topic 1 comprises categories and items, which are related to the first responder system. This includes data regarding the region covered (which is not necessarily the same region as the respective ambulance system), the system in use (alerting system, connection to AED database/AED network), and configuration of the system (Table 1).
- Topic 2 includes parameters, which describe the first responder network: Who serves as first responders? Which qualifications are needed? How are first responders trained? Is any revalidation necessary? Is any equipment provided? (Table 2).
- Topic 3 includes Items, which are associated with the technology used to locate and alert first responders. It also includes some details about tracking of the first responders and the alerting algorithms including distance calculations and alerting radii. (Table 3).

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Table 4 – Recommended items associated with data collection. C – item is included as a core element; S – item is included as a supplementary element.

Category	Item	C/S	Description
4A: System data	1: Activation rate	C	Number of activations per year (or within respective time period)
	2: Response rate	C	Number of cases with at least one first responder accepting the alarm divided by the number of system activations
	3: Number of first responders per case	C	Number of first responders arriving at the emergency site per case.
	4: First responder at the scene rate	C	Number of cases with at least one first responder arriving at scene divided by the number of system activations
	5: Acceptance rate	C	Number of first responders accepting an alarm divided by the number of first responders receiving an alarm
	6: Arrival before EMS rate	C	Number of cases with at least one first responder arriving before the first professional response vehicle divided by the total number of system activations
	7: AED arrival before EMS rate	C	Number of cases in which an AED arrives at the patient´s site before the first professional vehicle arrives, divided by the total number of system activations
	8: Distance FR - Emergency location	C	Distance for the first responder who accepts an alarm and moves to the scene. Explain whether [airline distance] or [traveling distance] are used.
4B: Time	1: Call-alarm interval	C	Time from receipt of call at the dispatch centre until the FR receive the alarm.
	2: FR response time	C	Time from emergency call to FR arriving at scene. If the system does not allow to extract the respective data, please indicate. If estimated response times are calculated by the system, these should not be given in the research manuscript (please indicate). Specify the method of measuring arrival time: [manual confirmation of arrival time]; [GPS based measurement of arrival time]; [other method to determine arrival time].
	3: Call-response interval AED	C	Time from emergency call to FR arrives at scene with an AED. If the system does not allow extraction of respective data, please indicate. If estimated response times are calculated by the system, these should not be given in the research manuscript (please indicate). Specify the method: [manual confirmation of arrival time]; [GPS based measurement of arrival time]; [other method to determine arrival time]. Describe whether FR arrival at scene is logged at the moment at which the first responder is with the patient (e.g., when manual confirmation is used) or whether any other method is used.
	4: Call-shock interval	C	Time from receipt of call at the dispatch centre until the FR delivers the first shock (if indicated).
4C: CPR cases	1: CPR rate	C	Number of cases where chest compressions were delivered by FR arriving prior to the ambulance, divided by the total number of OHCA cases in the region.
	2: AED rate	C	Number of cases where chest compressions (cc) were delivered and an AED was attached by FR, prior to arrival of professional help, divided by the number of all cases where cc were delivered by FR.
	3: AED shock rate	C	Number of cases where chest compressions were delivered and a shock was delivered by a FR, prior to arrival of professional help, divided by the total number of cases in which cc are delivered by FR.
4D: Outcome	1: Emergency location	C	Number of system activations with an emergency in [private places] and [public places]
	2: Means of transport	S	Means of transport used by the first responders to reach the emergency site. Explain how these data are established (e.g. in questionnaire after the alarm)
	3: Adverse safety event rate	C	Number of FR experiencing safety issues, divided by the total number of FR jobs (not the total number of cases). Please specify the adverse events such as accidents, infections, harassment, relatives, bystanders or other witnesses which are reported. Specify how the adverse events are investigated ([alarm report], [questionnaire], [e-mail], [other]
	4: Need for debriefing rate	S	Number of first responders, who request a debriefing after an alarm/job divided by the total number of first responders' jobs.

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Table 5 – Recommended items associated with AEDs. C – item is included as a core element; S – item is included as a supplementary element.

Category	Item	C/S	Description
5A: AED registry	1: Number of AEDs	C	Number of AEDs registered
	2: AED network	C	Describe the AED network (where appropriate in the respective study): Which devices are included? Semi-automatic or fully automatic? AEDs with chest compression feedback? Which parameters are included in the database? Is the battery status included? Electrode expiry date? Times of unrestricted accessibility?
	3: AED drones	S	Number of AED drones in the system
	4: Mobile AEDs	S	Number of mobile AEDs in the system. A mobile AED is a FR with a personal AED
	5: Maintenance	S	Describe how the maintenance is organised (if there is any local/regional strategy in the system)
	6: Legal obligations	S	Are there any legal obligations to register private AEDs (with a registry) and to make them available for first responders?
	7: Strategic placements	C	Is there any strategic placement of AEDs?
	8: Data retrieval	C	Describe how the data are read out from AEDs.
5B: Mode of delivery	1: Delivery: FR	C	Number of cases in which a stationary AED was fetched by first responder
	2: Delivery: Drone	S	Number of cases in which the AED was delivered by drone
	3: Delivery: Mobile	S	Number of cases in which a mobile AED was delivered
5C: Accessibility and availability	1: Accessibility of AEDs	C	Number of AEDs available 24/7
	2: AED visibility	C	Are the AEDs visible in the alerting app?
5D: Post incidence report	1: First rhythm AED	C	First rhythm at arrival of first FR before arrival of the first professional response vehicle.
	2: AED data	C	Ensure the data are read out from the AED. Report any data which are of interest.
	3: Number of shocks	C	Number of shocks delivered prior to ambulance arrival
	4: Distance AED	C	Distance from AED (if stationary device) to emergency site. Explain whether [airline distance] or [traveling distance] are used.

- Topic 4 comprises methodological details about which data should be reported and how they are measured (Table 4).
- Topic 5 comprises all categories and items associated with AEDs. They are only applicable if the system is connected to an AED network. In this case the respective items help to describe the AED network/registry, the integration into the first responder network and technology/app, and AED data in the respective cases (Table 5).

Discussion

The Hinterzarten Community First Responder Consensus Conference developed a reporting standard in the spirit of the Utstein-style. The proposed reporting standard was based on expert input from 40 researchers in the field of smartphone alerting systems. This reporting standard offers researchers in the field of smartphone-based dispatch of first responders and AED networks an opportunity to describe key elements of their system in a comparable way. The authors encourage its use, when reporting and publishing research findings in this growing field. However, it is not intended as a tool to measure the "quality" of a first responder system.

Furthermore, we strongly encourage combining this reporting standard for describing first responder systems with the well-established OHCA-Utstein-elements.[2] We decided *a priori* not to include items which are part of the Utstein style, and which have been described as part of these previous reporting standards.

The original Utstein template has been updated in 2015,[28] but this was years before the chapter systems saving lives became part of the guidelines and thus, this update does not yet include items associated with volunteer first responder systems. The need to include first responder systems in the Utstein template has been discussed,[23] and a further update will be published soon.[29]

To allow for a transparent and inclusive consensus process the organizing committee did not set any limits on the parameters to be included. This led to intense discussions amongst the groups during all sessions of the consensus process on the parameters to be included. During the conference it became clear, all systems shared one common goal: Reducing the time to first chest compression. This helped to sharpen the focus for parameter selection. However, the dissimilarities (technical, organizational, training, etc.) between the systems led to a large number of parameters proposed. The consensus group therefore had to condense the proposals down to a reasonable number to achieve a balance between including too many items (which would result in nearly perfect description of the

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systems) on one hand and too few items (making it difficult to compare systems and research findings) on the other hand. Reporting of all relevant parameters may not fit into a manuscript. In this case, a supplementary table may be provided by the respective authors.

To compare the different evolving technologies, strategies, and systems in-depth knowledge about the configuration, alerting algorithms, and technology in use is needed. Furthermore, all relevant parameters need to be defined. Some systems retrieve estimated response times,[29] others use automatic logging of global positioning system (GPS) data to determine the arrival times of first responders at the emergency site.[12] Some papers do not describe how the response times are being determined.[30] Different methods for determining arrival times lead to significantly different results.[31]

The contribution of smartphone alerting systems has been recognized in the international resuscitation guidelines and is resulting in increasing research focus with ensuing publications. A reporting standard may not only facilitate precise study planning and encourage researchers to describe the methods used in detail, but it may also evolve ideas for new studies among the international community of researchers in the field of prehospital resuscitation. Moreover, adopting a uniform reporting standard may facilitate comparing different systems and conducting systematic reviews and meta-analysis.

Finally, the companies and organizations developing the alerting systems are encouraged to ensure that the parameters included in the reporting standard can be measured, collected, and evaluated.

Limitations

Foremost, this reporting standard on first responders was developed by consensus and represents the opinion and experience of the participating experts in the field. However, the composition of the consensus conference participants has an impact on this recommendation. A consensus also has the weakness of not reflecting the broad discussions, opposing opinions, and opinions by minorities.[32] Thus, by identifying and inviting key scientists involved in first responder systems to participate in the development of this reporting consensus, broadest agreement and acceptance was sought. However, some research groups may not have been identified, e.g., due to language and publication bias. Additionally, as the conference was hosted in Europe, most conference participants were from Europe, which reflects current existing systems and research published and might be amplified in the future. Some scientists declined participation, e.g., because of other obligations. That also might contribute to underrepresentation of missing specific aspects of reporting on first responder systems. The authors encourage other research groups in the field of first responder systems to approach them and to participate in future joint research.

The authors acknowledge that this reporting standard does not cover all aspects of first responder systems and researchers are encouraged to provide further information when they are describing their systems in future publications.

Conclusions

This article presents a reporting standard for describing first responder systems, smartphone alerting systems, and AED networks. It was generated in an international consensus process by an expert opinion group with participants from 13 countries representing and reflecting the high diversity among first responder schemes contributed. The authors encourage the resuscitation community to use this reporting standard on first responders, when describing and publishing future research findings in order to facilitate comparison and transferability of the found results.

CRediT authorship contribution statement

M.P. Müller: Conceptualization, Funding acquisition, Investigation, Project administration, Writing – original draft. **C. Metelmann:** Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **K.C. Thies:** Conceptualization, Investigation, Project administration, Supervision, Writing – review & editing. **R. Greif:** Writing – review & editing, Methodology, Investigation, Conceptualization. **T. Scquizzato:** Writing – review & editing, Validation, Resources, Data curation. **C.D. Deakin:** Data curation, Supervision, Validation, Writing – review & editing. **A. Auricchio:** Writing – review & editing, Validation, Data curation. **T. Barry:** Writing – review & editing, Validation, Data curation. **E. Berglund:** Writing – review & editing, Validation, Data curation. **B.W. Böttiger:** Conceptualization, Data curation, Funding acquisition, Supervision, Writing – review & editing. **R. Burkart:** Writing – review & editing, Validation, Data curation. **H.J. Busch:** Data curation, Funding acquisition, Validation, Writing – review & editing. **M.L. Caputo:** Data curation, Validation, Writing – review & editing. **S. Cheskes:** Writing – review & editing, Validation, Data curation. **R. Cresta:** Writing – review & editing, Validation, Data curation. **D. Damjanovic:** Writing – review & editing, Validation, Investigation, Data curation. **E. Degraeuwe:** Writing – review & editing, Validation, Data curation. **M.M. Ekkel:** Data curation, Investigation, Validation, Writing – review & editing. **D. Elschenbroich:** Writing – review & editing, Validation, Data curation. **D. Fredman:** Writing – review & editing, Validation, Data curation. **J. Ganter:** Writing – review & editing, Validation, Project administration, Investigation, Data curation, Conceptualization. **M.C.T. Gregers:** Data curation, Validation, Writing – review & editing. **J. Gronewald:** Writing – review & editing, Validation, Project administration, Data curation. **M. Hänsel:** Writing – review & editing, Validation, Supervision, Software, Methodology, Conceptualization. **F.L. Henriksen:** Data curation, Validation, Writing – review & editing. **L. Herzberg:** Writing – review & editing, Validation, Data curation. **M. Jonsson:** Writing – review & editing, Validation, Data curation. **J. Joos:** Writing – review & editing, Validation, Resources, Project administration, Funding acquisition, Conceptualization. **T.A. Kooy:** Data curation, Validation, Writing – review & editing. **M. Krammel:** Writing – review & editing, Validation, Data curation. **T. Marks:** Writing – review & editing, Validation, Investigation, Data curation. **K. Monsieurs:** Writing – review & editing, Validation, Supervision, Conceptualization. **W.M. Ng:** Data curation, Validation, Writing – review & editing. **S. Osche:** Writing – review & editing, Validation, Funding acquisition, Data curation. **D. D. Salcido:** Data curation, Validation, Writing – review & editing. **A. Scapigliati:** Writing – review & editing, Validation, Data curation. **J. Schwietring:** Writing – review & editing, Validation, Data curation. **F. Semeraro:** Writing – review & editing, Validation, Supervision, Resources, Data curation. **P. Snobelen:** Writing – review & editing, Validation, Data curation. **J. Sowa:** Writing – review & editing, Resources, Project administration. **R. Stieglis:** Writing – review & editing, Validation, Data curation. **H.L. Tan:** Data curation, Validation, Supervision, Writing – review & editing. **G. Trummer:** Writing – review & editing, Validation, Resources, Funding acquisition, Data

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: 'MPM is chair of Region of Lifesavers, shareholder of SmartResQ ApS, and received speaker honoraria from Stryker. RG is Board Director of Guidelines, European Resuscitation Council, and chair of the Task Force Education, Implementation and Teams, International Liaison Committee on Resuscitation. TS is member of the editorial board, Resuscitation and Resuscitation Plus, member of the science and education committee BLS of the ERC, and member of the ILCOR social media working group. CDD is member of the editorial board of the journal Resuscitation, treasurer of the UK Resuscitation Council and ALS working group member of ILCOR. AA is a consultant with Boston Scientific, Backbeat, Biosense Webster, Cairdac, Corvia, Daiichi-Sankyo, Medtronic, Merit, Microport CRM, and Philips; received speaker fees from Daiichi-Sankyo, Boston Scientific, Biosense Webster, Medtronic, Microport CRM, and Philips; participates in clinical trials sponsored by Boston Scientific, Medtronic, Microport CRM, and Zoll Medical; and has intellectual properties assigned to Boston Scientific, Biosense Webster, and Microport CRM. TB has research, clinical and educational roles in resuscitation care, including in first responder systems. He is a member of the Pre-Hospital Emergency Care Council (Ireland). EB is working group member in ESCAPE-NET and PARQ COST action. BB is treasurer of the European Resuscitation Council (ERC), Chairman of the German Resuscitation Council (GRC), Member of the Advanced Life Support (ALS) Task Force of the International Liaison Committee on Resuscitation (ILCOR), Member of the Executive Committee of the German Interdisciplinary Association for Intensive Care and Emergency Medicine (DIVI), Founder of the "Deutsche Stiftung Wiederbelebung", Federal Medical Advisor of the German Red Cross (DRK), Co-Editor of "Resuscitation", Editor of the Journal "Notfall + Rettungsmedizin", Co-Editor of the Brazilian Journal of Anesthesiology. He received fees for lectures from the following companies: Forum für medizinische Fortbildung (FomF), Baxalta Deutschland GmbH, ZOLL Medical Deutschland GmbH, C.R. Bard GmbH, GS Elektromedizinische Geräte G. Stemple GmbH, Novartis Pharma GmbH, Philips GmbH Market DACH, Bioscience Valuation BSV GmbH. HJB is member of the executive committee of the German Resuscitation Council and vice chair of Region of Lifesavers. SC is member of the editorial board of the journal Resuscitation, member of the advisory board drone delivery Canada and received speaker honoraria from Zoll Medical. ED is shareholder of EVapp VZW, Belgium. DF is co-founder and operations manager of the Heartrunner Citizen Responder System, Sweden and member of the tech&ops committee of EENA (European Emergency Number Association). FLH is shareholder of FirstAED ApS, Denmark. MJ is a working group leader in the EU-funded network PARQ-COST, focusing on cardiac arrest research. JJ is CEO of the non-profit organisation Region der Lebensretter e.V. TAK is employed at Stan B.V. running the national citizen responder network HartSlagNu in the Netherlands. MK is chief medical director, Vienna Emergency Medical Service, and executive president PULS – Austrian Cardiac Arrest Association. KM is member of the editorial board of the journal Resuscitation. SO is employed at the German Red Cross and is board member of the GRC. DDS provided unpaid scientific consulting to CPRSave, a company developing a novel SAS system, and his department received a small grant from the PulsePoint Foundation to increase SAS participation in Allegheny County, PA, US. AS is vice president of the Italian Resuscitation Council (IRC). JSchwietring is chief medical director, ADAC (air rescue) LRG gGmbH. FS is chair elect, European Resuscitation Council and chair, ILCOR Social Media Working Group. PS is chair of the medical committee, Ontario Para & Summer Games and board member, Peel Paramedic Association. HLT is co-founder of PacingCure. He has received funding from the European Union's Horizon 2020 research and innovation programme under acronym ESCAPE-NET, registered under grant agreement No 733381, and the COST Action PARQ (grant agreement No CA19137) supported by COST (European Cooperation in Science and Technology). GT is employed at Resuscitec GmbH, shareholder of Resuscitec GmbH, and board member of the GRC and Region der Lebensretter. JGanter is board member of Region of Lifesavers. SV is president of EVapp NGO, and shareholder Prior-IT BV. CM, KCT, RB, MLC, RC, DD, MME, DE, MCTG, JGronewald, MH, LH, TM, KM, WMN, JSowa, RS, JU, WAW have no conflicts of interest.'.

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Data availability

The documents regarding the consensus process are available at the following address: https://osf.io/bsujt/.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.resuscitation.2023.110087.

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