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In-hospital cardiac arrest call procedures and delays of the cardiac arrest team: A nationwide study

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Abstract

Aim: Fast arrival of the cardiac arrest team (CAT) is associated with improved survival after in-hospital cardiac arrest however little is known about how we can minimize delays in CAT arrival. This study aimed to investigate differences in the cardiac arrest call procedures in Danish hospitals and identify causes for adverse events delaying the CAT arrival.

Methods: This nationwide study surveyed all public somatic hospitals in Denmark with a CAT. We searched for all patient safety incidences related to the cardiac arrest call procedure during a two-year period. Two researchers reviewed all incidents and categorized the cause as either human, technical, or not possible to classify, and whether the incident caused a delay of the CAT arrival.

Results: In total, 36 hospitals (78%) responded and all hospitals used a telephone number, a CAT activation button or both for activation of the CAT. We found 131 reports describing an event related to activation of the CAT of which 87 incidents (66%) caused a definite delay in CAT arrival. The most common were human errors (43%) followed by technical errors (32%) and errors not possible to classify (25%). Almost half of the incidents (47%) could have been avoided if the hospitals used a CAT activation button with direct activation of the CAT.

Conclusion: There are major differences on the in-hospital cardiac arrest call procedure in Danish hospitals. Human errors are the most frequent cause of safety incidents and may be avoided by simplifying the cardiac arrest call procedure with CAT activation buttons.

Keywords: In-hospital cardiac arrest, Patient safety, Medical errors, Communication systems, Resuscitation teams

Introduction

In-hospital cardiac arrest (IHCA) is a common event with an incidence of 1–10 per 1000 hospital admissions and a poor survival rate ranging from 15 to 30%.^{1–6} Early recognition of cardiac arrest with early activation of the emergency response is important to increase survival.⁷ In some countries, approximately 90% of in-hospital cardiac arrests occur outside of the intensive care unit making it even more important.⁸ Moreover, studies found a significantly higher survival rate when the arrival time of the cardiac arrest team (CAT) was shorter than 3 min.^{9,10}

There have been numerous advances in the activation of the emergency response in the prehospital setting contributing to improved outcomes including a standardized pan-European emergency telephone number,¹¹ training of the medical dispatchers receiving the emergency calls, providing of telephone assisted cardiopulmonary resuscitation (CPR)¹² including directing rescuers to the nearest automated external defibrillator (AED)¹³ and use of mobile digital technology to determine the location of the emergency callers.¹⁴

In contrast, the in-hospital cardiac arrest call procedure has overall remained unchanged. So far, only the cardiac arrest telephone numbers have been of interest in studies.^{15–17} However, the

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telephone number is just one of many steps from recognition of cardiac arrest to arrival of the CAT where several human- and technical errors may occur causing delay in CAT arrival. Currently, little is known about differences in the cardiac arrest call procedures and errors causing delays of the CAT. Accordingly, this nationwide study aimed to investigate differences in the cardiac arrest call procedures in Danish hospitals and identify causes for adverse events delaying the CAT arrival.

Methods

Study design

This is a nationwide study. We included all public somatic hospitals in Denmark with a CAT. Denmark is divided into five regional councils administering all public hospitals. We used the official webpage of the regions to identify the hospitals and contacted each hospital by telephone to confirm they had a CAT.^{18–22} Psychiatric hospitals and hospitals serving outpatients only were excluded.

Questionnaires on the cardiac arrest call procedure were sent by email to members of the hospitals' resuscitation committees or resuscitation officers. Participants representing more than one hospital unit having different cardiac arrest call procedures were asked to complete a separate questionnaire for each hospital. Participation was voluntary and participants were guaranteed confidentiality i.e. no answers were revealed to employers or other parties. A reminder email was sent one week, three weeks, and four weeks after the first contact. According to The Danish National Committee on Biomedical Research Ethics, no approval from an ethical review committee was required.

Study questionnaire

The questionnaire collected information on 1) Name of hospital. 2) Respondent's role in the resuscitation committee. 3) Detailed information on the procedure for activating the CAT including how the CAT receives information about location of cardiac arrest. 4) Healthcare staff training for activating the CAT. 5) Background and training of person receiving cardiac arrest calls. 6) Guidelines for activating the CAT.

The study questionnaire was developed by the study group preceded by a thorough literature search on cardiac arrest call procedures. The questionnaire was subsequently reviewed by an experienced resuscitation officer to identify any obscurities before distribution of the questionnaire. Data from the questionnaires were collected and managed using REDCap.²³

Data collection

In Denmark, healthcare professionals are obliged to report all adverse events to the Danish Patient Safety Database, defined as "*any event that results from treatment at or stay in a hospital and which is not caused by the patient's illness and which is either harmful or could have been harmful*".²⁴ Healthcare professionals reporting adverse events are protected by law against disciplinary investigations and sanctions based on information contained in the reports. Accordingly, the system is well-accepted amongst clinicians and a high number of incidents are reported to the database.

The Danish Patient Safety Database was searched for reports received between November 14, 2015 and November 15, 2017 using the Danish keywords for 'alerting', 'cardiopulmonary resuscitation' and 'cardiac arrest call' or 'emergency call'. Moreover, we searched reports including a combination of 'cardiac arrest' + one of the following 'call', 'alarm', 'resuscitate', 'phone', 'report', or 'cardiac arrest team'.

We critically reviewed all reports and included incidents where the CAT had been activated, attempted to be activated, or if technical issues affecting a potential activation of the CAT were described. We excluded reports describing incidents related to anything else than the cardiac arrest call procedure (e.g. not following the resuscitation guidelines or missing equipment). In Denmark, medical emergency teams (MET) are generally summoned using a different calling procedure compared to CAT activations, and all events related to MET activations were excluded.

Data analysis

Two researchers independently reviewed all incidents and used deductive coding to categorize incidents as either technical- or human errors, whether the incident caused a definite delay of the CAT arrival and whether it could have been prevented by using a CAT activation button with direct notification to the CAT. If incidents could not be classified as either technical- or human errors, they were categorized as not possible to classify. The categorization was performed independently on the questionnaire responses. In case of disagreement between reviewers, the incident was discussed to a joined agreement.

Inductive thematic analysis was subsequently performed to categorize the type of technical- and human errors. Data were analyzed using Stata version 13.0 (StatsCorp LP, College Station, TX, USA). Binary data are presented as number (%). Continuous data were assessed for normality using histograms and quantile-quantile plots. Data were not normally distributed and presented as median (quartile 1; quartile 3) and compared using Wilcoxon Ranksum testing. Tests were two-sided and a p-value of <0.05 was considered as statistically significant.

Results

Data on the cardiac arrest call procedures were collected from October 27, 2017 to December 1, 2017. In total, 46 hospitals were eligible for inclusion, of which 36 (78%) responded.

In total, 18 hospitals (50%) used telephones only to activate the CAT, whereas 5 hospitals (14%) used a CAT activation button only. Both telephones and CAT activation buttons were used in 13 hospitals (36%). Most of the hospitals (83%) did not have a speed dial button on the telephone. When using the telephone to summon the CAT, all calls went through a switchboard operator. In total, overflow, i.e. summoning the CAT from multiple locations in the hospital at the same time, was not available in 6 hospitals (17%). Further details on the cardiac arrest call procedure are shown in [Table 1](#). Multiple methods were used for the CAT to get information about location for cardiac arrest ([Table 2](#)). No hospitals reported use of any global positioning system to help the CAT find the location of the cardiac arrest (94% did not, 6% unknown) and one third of the hospitals used an object, such as a traffic cone or a person, to help visualizing the location of cardiac arrest for the CAT.

Table 1 – Different cardiac arrest call procedures.

	CAT activation button, n (%)	Telephone number, n (%)
<i>Activating the CAT^a</i>		
Direct contact to the CAT	8 (44)	0 (0)
Contact to CAT via switchboard	10 (56)	31 (100)
<i>Telephone network</i>		
External	17 (94)	24 (80)
Internal	0 (0)	4 (13)
Unknown	1 (6)	2 (7)
<i>Overflow available^b</i>		
Yes	8 (44)	20 (65)
No	3 (16)	3 (10)
Unknown	7 (38)	8 (25)
<i>One telephone number within the hospital for calling the CAT</i>		
Yes		31 (100)
Using 2222		9 (29)
No		0 (0)
<i>Speed dial button on the telephone for calling the CAT</i>		
Yes		5 (17)
No		26 (83)

^a Some hospitals used both a cardiac arrest call button and a telephone number.

^b Overflow = more telephone lines available in case of multiple cardiac arrests.

Guidelines and training of staff

Local hospital guidelines describing what information the staff should provide when activating the CAT by telephone, existed in 26 hospitals (72%). All guidelines included specific location of cardiac arrest, 4 guidelines (15%) included reading back, i.e. repeating the message that was given, and 2 guidelines (8%) included telling the switchboard operator a telephone number to call back if further information was needed. Overall, 3 hospitals (8%) did not have any training at all in how to activate the CAT by telephone. Training of hospital staff on how to activate the CAT by telephone included instruction on the telephone number only in 5 hospitals (15%), instruction on what to say only in 12 hospitals (36%), whereas 16 hospitals (49%) reported training on both.

The switchboard operators most often had a non-medical background, received informal training by a colleague and were unable to provide telephone assisted CPR or guide the staff towards the nearest AED or defibrillator (Table 3).

Adverse events related to the cardiac arrest call procedure

We identified 809 reports of which 131 reports (16%) described an event related to activation of the CAT (Fig. 1). 86 reports (66%)

included information on the specific hospital unit. The remaining 45 reports (34%) did not include information on specific hospital unit (n = 17) or were from hospitals that did not complete our questionnaire, i.e. their cardiac arrest call procedure was unknown (n = 28). Median (quartile 1; quartile 3) number of reports from hospitals using telephones or a combination of telephones and CAT activation buttons was 2 (1; 4) compared to a median of 0 (0; 2) for hospitals using a CAT activation button only (p = 0.22).

Overall, the most common adverse event was human errors (43%), followed by technical errors (32%) and errors not possible to classify (25%) (Table 4). Human errors were the cause for 37% of adverse events for hospitals using telephones only and 62% for hospitals with both telephones and CAT activation buttons to activate the CAT, whereas technical errors were the most frequent cause for adverse events for hospitals using a CAT activation button (67%) only to activate the CAT. No human errors were identified from using the CAT activation button only.

Adverse events causing delayed arrival of at least one CAT member or delayed activation of the CAT was described in 87 reports (67%). Human errors were most common (43%), followed by indefinable errors (33%) and technical errors (24%). 46 reports (35%) described adverse events that could have been avoided if the

Table 2 – Information about location for cardiac arrest.

	CAT activation button n (%)	Telephone number n (%)
Text on beeper	17 (94)	19 (61)
Verbally by telephone	1 (6)	12 (39)
<i>The CAT gets a text on beeper, each member must call the switchboard to get information about location</i>		
One phone line	1 (100)	4 (33)
Multiple phone lines	0 (0)	1 (9)
<i>The CAT is called by switchboard operator to get information about location</i>		
Members of CAT are called one by one	0 (0)	4 (33)
Members of CAT are called at the same time	0 (0)	3 (25)

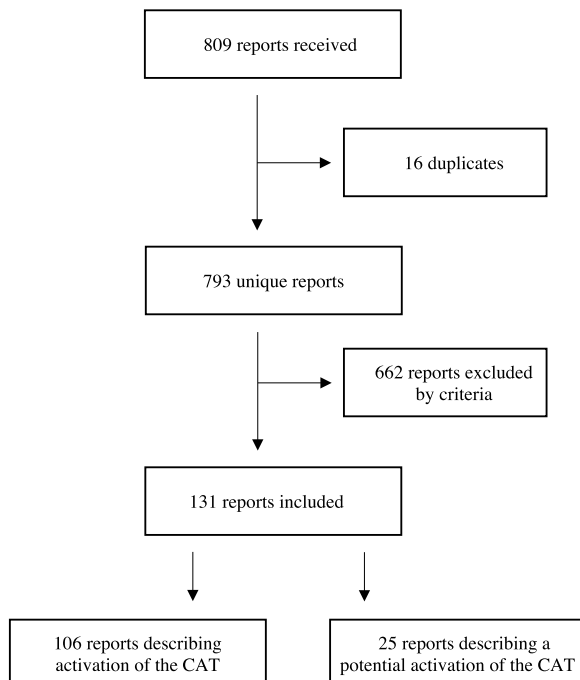
Table 3 – Calling the CAT via switchboard.

	n (%)
<i>Background of switchboard operator</i>	
Medical background	5 (15)
Non-medical background (e.g. student, secretary)	16 (47)
Both (depending on time of the day)	7 (20)
Unknown	6 (18)
<i>Training of switchboard operator</i>	
Formal course	10 (29)
E-learning course	3 (9)
Informal training by colleague	10 (29)
Unknown	11 (33)
<i>Guidelines describing what information to give to the CAT</i>	
Yes	24 (71)
No	7 (21)
Unknown	3 (8)
<i>Can provide telephone assisted CPR</i>	
Yes	1 (3)
No	30 (88)
Unknown	3 (9)
<i>Directs to the nearest AED</i>	
Yes	0 (0)
No	31 (91)
Unknown	3 (9)

cardiac arrest calls did not go through a switchboard operator. Almost half of the reports (47%) could have been avoided if the hospitals used a CAT activation button with direct activation of the CAT.

Discussion

We found major discrepancies in cardiac arrest call procedures in Danish hospitals. The majority of adverse events related to the cardiac

**Fig. 1 – The screening process.**

arrest call procedure caused delay of the CAT arrival. Human errors were the predominant cause, and almost half of the incidents could have been avoided by using a CAT activation button with direct activation of the CAT.

Several of the discrepancies in the cardiac arrest call procedure may affect the time to activation of the CAT. Most of the hospitals called the CAT through a switchboard operator, using a telephone number, which is thought to be the case in 80% of European hospitals.²⁵ A study investigating the quality of in-hospital cardiac arrest calls found that call durations ranged between 6 and 92 s and another 57 s to activate the CAT after completion of the call.²⁶ These findings suggest that valuable time may be lost when activating the CAT through a switchboard operator. Importantly, a study on in-hospital cardiac arrest found that survival mainly depends on the arrival time of the CAT.¹⁰

Less than a third of the hospitals in Denmark used the recommended standardized telephone number 2222 for in-hospital cardiac arrest calls.¹⁶ A standardization of the number may be important as only 50% of the medical staff know the cardiac arrest number. Moreover, physicians in regions with a standardized number (2222) are more likely to know the number compared with physicians from regions without standardized cardiac arrest telephone number.^{15,17} Not knowing the correct number is a potential reason for delayed activation of the CAT.

A number of other factors related to activating the CAT through telephones may contribute to delay. In several cases, the CAT members got notified through a pager after which they had to call the switchboard operator to get information about location. In most cases only one telephone line was available, i.e. the members of the CAT had to wait in a line to get through to the switchboard operator or the switchboard operator had to call the members one by one. In such cases, the delay for activating the CAT after the call from the ward staff may be longer than the previously reported 57 s in Great Britain where the switchboard operator notified all CAT members simultaneously using a voice message.²⁶ Notifying the CAT members one at a time could cause a potential delay of several minutes.

In our study, overflow on the telephone line, i.e. summoning the CAT from multiple locations in the hospital at the same time, was not available in several hospitals (16%). This could be critical in the case of more than one cardiac arrest at the same time. We found 3 adverse events describing that the telephone line was blocked when attempting to make a cardiac arrest call. It is unknown if this was due to simultaneously cardiac arrest calls – either from nurses in the same ward or from a different department also having a patient in cardiac arrest as well. Safety incidents with a blocked telephone line when doing a cardiac arrest call have also been reported previously.²⁷ The same study found that incidents related to alerting the CAT was the major cause of patient safety incidents related to cardiac arrests in hospitals, suggesting that there are important improvements to be made regarding the cardiac arrest call procedure.

We found that nearly half of the hospitals used a switchboard operator with a non-medical background often receiving informal training by colleague as the only training. Moreover, we found several safety incidents related to misinformation of the CAT causing delayed arrival. These findings suggest that formalized training of the switchboard operators should be considered. In contrast, the dispatch operators in the pre-hospital settings are often healthcare providers trained to handle emergency calls and instruct the bystanders in performing CPR and using an AED. In contrast to the pre-hospital

Table 4 – Types and definition of incidents.

Category	n (%)	Definition
<i>Human errors</i>		
Insufficient, wrong or no information about location	37 (28)	Not possible to identify the location of cardiac arrest
Incorrect call procedure	15 (12)	Not following the guidelines for alerting the CAT and misunderstood messages
Insufficient signing	4 (3)	Not possible to find the location of cardiac arrest
<i>Sub-total</i>	<i>56 (43)</i>	
<i>Technical errors</i>		
CA button out of order	10 (8)	No alarm received when using the CA buttons
Beeper/telephone not working	14 (11)	No cause described
Dispatch or telephone system down	5 (3)	Entire dispatch or telephone system down
No phone signal	8 (6)	No phone signal detected by phone used to alert the CAT or phone used to receive the alarm
Information disappears	5 (3)	Information about location received on phonescreen/beeper disappears
<i>Sub-total</i>	<i>42 (32)</i>	
<i>Not possible to classify as a technical or a human error</i>		
CAT member not receiving alarm	12 (9)	No cause described
Error during telephone call	10 (8)	No answer to call, line blocked, call interrupted
Late or no arrival of CAT member	9 (7)	No cause described
Delayed information about location	2 (1)	Waiting a long time for information about location after receiving alarm
<i>Sub-total</i>	<i>33 (25)</i>	
In total	131 (100)	

setting, the hospital switchboard operators were unable to provide either telephone assisted CPR or guide the staff towards the nearest AED. Healthcare staff on the wards are expected to perform CPR and early defibrillation by themselves. However, cardiac arrest is an infrequent event in some hospital departments and CPR skills of providers in such departments are often poor.²⁸ Accordingly, CPR and defibrillation is often not being initiated before the arrival of the CAT.^{10,28} Implementing telephone assisted CPR in hospitals including guiding the healthcare staff to the nearest AED should be considered even though the effect remains unknown and should be investigated further.

Human errors represented the largest group of adverse events when activating the CAT. Frequent issues were lacking adherence to guidelines for alerting the CAT, misunderstanding messages and miscommunication when calling the switchboard operator, resulting in delayed arrival of the CAT. The large number of adverse events related to the call going through a switchboard operator highlights the importance of formalized training of the clinicians and switchboard operators or a simpler cardiac arrest call procedure with fewer steps – e.g. by using a CAT activation button sending direct message to the CAT. Using a CAT activation button would minimize the risk of human errors although the risk of technical

errors would persist. Moreover, the CAT also had problems finding the location of cardiac arrest because they got insufficient information about location or because they did not know the way around in the hospital. Failure to find the location may not only result in delayed arrival of a team member but also delayed arrival of ALS equipment. In the pre-hospital setting, the caller can be located using apps or automatic geo-localization and the ambulance will get the fastest route to the location using global positioning systems.¹⁴ A similar system in hospitals may minimize the risk of delayed arrival of the CAT due to difficulties finding the location or due to insufficient information about location.

Almost a third of the included reports could not be classified as either human or technical error which included CAT member not receiving alarm, error during telephone call (no answer to call, line blocked or interrupted call), late or no arrival of CAT member and delayed information about location. It is unknown whether some of these incidents may have been caused by human errors, which suggests that the number of human errors involved, when activating the CAT, might be even higher.

Nearly one third of the adverse events related to the cardiac arrest call procedure were caused by technical errors which can be difficult to prevent completely. However, a simple cardiac arrest call procedure

involving fewer technical steps, e.g. skipping the switchboard operator, might minimize the risk of technical errors when activating the CAT and thereby minimizing the risk of delay.

Limitations

Our questionnaire was distributed by email and there was no opportunity to ask clarifying questions. However, respondents were all resuscitation officers or members of the hospitals' resuscitation committees and are therefore believed to have in-depth knowledge on the local hospital level.

Danish health care professionals are obliged to report adverse events to the Danish Patient Safety Database. However, there may be some adverse events that are not reported which suggest that the number of adverse events related to the cardiac arrest call procedure might be even higher.

Based on the reported adverse events we coded whether the CAT was delayed or not. Our estimates for delays of the CAT may be conservative as we only coded events as causing delay if it was stated that the team was delayed or if an error inevitably had caused a delay. However, we do not know how much the CAT was delayed and whether it affected patient morbidity or mortality.

Finally, several adverse events from the Danish Patient Safety Database were not linked to a specific hospital unit and we do not know the exact cardiac arrest incidence per hospital. It is therefore unknown if the absolute number of adverse events happening was due to a higher rate of cardiac arrest.

Conclusion

There are major differences on the in-hospital cardiac arrest call procedure in Danish hospitals. Human errors are the most frequent cause of safety incidents and may be avoided by simplifying the cardiac arrest call procedure with cardiac arrest call button systems with direct activation of the CAT.

Conflicts of interest

None to declare.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.resplu.2021.100087>.

REFERENCES

- Ehlenbach WJ, Barnato AE, Curtis JR, et al. Epidemiologic study of in-hospital cardiopulmonary resuscitation in the elderly. *N Engl J Med* 2009;361:22–31.
- Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS. Trends in survival after in-hospital cardiac arrest. *N Engl J Med* 2013;368:680–1.
- Morrison LJ, Neumar RW, Zimmerman JL, et al. Strategies for improving survival after in-hospital cardiac arrest in the United States: 2013 consensus recommendations: a consensus statement from the American Heart Association. *Circulation* 2013;127:1538–63.
- Merchant RM, Yang L, Becker LB, et al. Incidence of treated cardiac arrest in hospitalized patients in the United States. *Crit Care Med* 2011;39:2401–6.
- Nolan JP, Soar J, Smith GB, et al. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. *Resuscitation* 2014;85:987–92.
- Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. *Intensive Care Med* 2007;33:237–45.
- Deakin CD. The chain of survival: Not all links are equal. *Resuscitation* 2018;126:80–2.
- Andersen LW, Holmberg MJ, Lofgren B, Kirkegaard H, Granfeldt A. Adult in-hospital cardiac arrest in Denmark. *Resuscitation* 2019;140:31–6.
- Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the "chain of survival" concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. *Circulation* 1991;83:1832–47.
- Sandroni C, Ferro G, Santangelo S, et al. In-hospital cardiac arrest: survival depends mainly on the effectiveness of the emergency response. *Resuscitation* 2004;62:291–7.
- Council of the European Union. Access to European Union Law. Europe. (Accessed December 2017 at . <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31991D0396>).
- Rea TD, Eisenberg MS, Culley LL, Becker L. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. *Circulation* 2001;104:2513–6.
- Stiell IG, Wells GA, Field BJ, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS study phase II. Ontario Prehospital Advanced Life Support. *JAMA* 1999;281:1175–81.
- Hovedstadens Beredskab. 112app. Copenhagen. (Accessed December 2017 at . <http://www.112app.dk/>).
- Lofgren B, Rasmussen ML, Henriksen FL, Krarup NH. Limited knowledge of the crash call number among hospital staff—A call for standardisation. *Resuscitation* 2010;81:28.
- European Resuscitation Council. European standardisation of the in-hospital cardiac arrest call number 2222. Belgium. (Accessed December 2017 at . <https://www.erc.edu/projects/2222>).
- Lauridsen KG, Lofgren B. A call for 2222 in European hospitals—A reply to letter by Dr. Whitaker. *Resuscitation* 2016;107:e19.
- Region Syddanmark. (Accessed February 2017 at <https://www.regionsyddanmark.dk/wm205617>).
- Region Sjælland. (Accessed February 2017 at <http://www.regionsjaelland.dk/sundhed/Sider/default.aspx>).
- Region Nordjylland. (Accessed February 2017 at <http://www.rm.dk/sundhed/patient-i-region-nordjylland/hospitaler/find-dit-hospital>).
- Region Midtjylland. (Accessed February 2017 at <https://www.rm.dk/kontakt/hospitaler/>).
- Region Hovedstaden. (Accessed February 2017 at <https://www.regionh.dk/Sundhed/Hospitaler/Sider/default.aspx>).
- Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven

- methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–81.
24. National Board of Health. Danish Patient Safety Database. Denmark. 2007 (Accessed August 2019 at https://stps.dk/en/health-professionals-and-authorities/Laering/danish-patient-safety-database/~/_/media/E5A852E8037D4A20A83CD385243C27CD.ashx).
 25. Whitaker DK, Nolan JP, Castren M, Abela C, Goldik Z. Implementing a standard internal telephone number 2222 for cardiac arrest calls in all hospitals in Europe. *Resuscitation* 2017;115:A14–5.
 26. Akhtar N, Field RA, Greenwood L, et al. Quality of in-hospital cardiac arrest calls: a prospective observational study. *BMJ Qual Saf* 2012;21:184–90.
 27. Andersen Po, Maaloe R, Andersen Hb. Critical incidents related to cardiac arrests reported to the Danish Patient Safety Database. *Resuscitation* 2010;81:312–6.
 28. Weil MH, Fries M. In-hospital cardiac arrest. *Crit Care Med* 2005;33:2825–30.