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Simulation and education

In-situ simulation of CPR in the emergency department – A tool for continuous improvement of the initial resuscitation

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Abstract

Background: Simulating CPR scenarios in a clinical environment has been described as a method for mitigating latent safety threats. Therefore, we implemented regular inter-professional, multidisciplinary in-situ simulations in the emergency department (ED).

Aim: To iterate a line-up and action cards for initial CPR management. To examine the experiences among participants regarding attitudes towards simulation and if they perceived any benefits for their patients after the participation.

Method: In 2021 we performed 7 in-situ simulations (15-minute simulation, 15-minute hot debrief) in the ED with the CPR team including doctors and nurses from the ED and anaesthesiology department. A questionnaire was sent to the 48 participants the same day and after 3 and 18 months. Answers were given as yes/no or on a Likert scale 0–5 and are presented as median values with interquartile range (IQR) or frequencies.

Results: A line-up and 9 action cards were created. The response rate of the three questionnaires were 52, 23, and 43%, respectively. In total, 100% would recommend the in-situ simulation to a co-worker. Participants perceived that real patients (5 [3–5]) as well as themselves, (5 [3.5–5]), had benefited from the simulation up to 18 months after.

Conclusion: Thirty-minute in-situ simulations are feasible to implement in the ED and simulation observations were useful for development of standardised role descriptions for resuscitation in the ED. Participants self-report benefit for themselves as well as their patients.

Keywords: In-situ, Simulation, Inter-professional education, Cardiopulmonary resuscitation, Emergency department, Anaesthesia department

Background

The use of cardiac arrest simulation and spaced learning[1] in cardiopulmonary resuscitation (CPR) is recommended in the 2021 guidelines[2] from the European Resuscitation Council (ERC). Little is known regarding the feasibility to continuously perform such simulations in the emergency department (ED) as well as the longer-term experience among participants.

In-situ simulation is a simulation occurring in the clinical environment where patient care usually takes place. It involves the team responsible for patient care and preferably with the regular line-up and equipment. These simulations have been described as a method for identification and mitigating of latent safety threats while they might decrease morbidity and mortality in patients.[3,4] In-situ simulations have been described as a useful training tool when opening new hospital facilities.[3] Our institution, Karolinska University Hospital in Solna, Stockholm, Sweden, both moved into a new building as well as received a new clinical assignment in 2018. At the same time the organisational structure was changed. Before the move and this change, multiple different simulations in all departments were performed, gathering important knowledge about for example resources needed in routine patient scenarios. The need to continue with simulations was obvious after the move.

The purpose of this project was to improve the initial resuscitation structure. Before this project there were no fixed positions or described roles for every routine task during the first minutes of resuscitation in the emergency room. We also examined the

Abbreviations: CPR, Cardiopulmonary resuscitation, ED, Emergency Department, ERC, European Resuscitation Council, ECMO, Extracorporeal membrane oxygenation, ER, Emergency Room, IO, Intraosseous, ICU, Intensive care unit, ROSC, Return of spontaneous circulation, IQR, Interquartile range, EtCO2, End-tidal carbon dioxide

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experiences among participants regarding attitudes towards CPR education and simulation, and if they perceived any benefits for their patients after the participation.

Settings

Aim of the in-situ simulation

The purpose of the simulation was to improve the participants' CPR skills, and the collaboration between the ED and the anaesthesia department, to improve the care of patients with out-of-hospital cardiac arrest. The clinical outcomes of these simulations were a continuous evaluation of roles and tasks in the emergency room (ER) and generation of a standard of line-up as well as action cards (see Appendix). For example the positioning of the defibrillator, the ultrasound, and the anaesthesia nurse were tested and optimized.

Description of the in-situ simulation

The in-situ simulation took place in the ED at Karolinska University Hospital in Solna during spring of 2021. Before initiation and repeatedly during the spring of the simulations, all participating staff received verbal and written information about the purpose and goals as well as their expected respective roles in the simulation. Information was e-mailed, informed during recurrent staff meetings and posted on bulletin-boards throughout the departments. A document prepared by the team of instructors regarded local instructions of the simulation and the tasks assigned each role. They also received the European guidelines on resuscitation.[5] Since the information was provided on several occasions it is hard to determine how long before each simulation the information was given. All staff were encouraged to read the material and engage in spontaneous discussions about CPR management, especially before and after the simulations. Every Tuesday morning at 10.00 a.m., we activated a code blue on emergency beepers. The text on the beepers included short information about the incoming out-of-hospital cardiac arrest, (for details see Appendix). All staff who would participate in a real-life CPR situation got activated, usually including 2 assistant nurses, 2 emergency nurses, 2 emergency doctors, 1 anaesthesia nurse, and 2 anaesthesiologists. A nurse from the ED, locally named "the clock nurse", initiated sign-in including presentation of names and roles for all team-members, also including a brief comment from the instructors (less than 30 seconds) about the exercise's goals. A manikin (ResusciAnne® Advanced SkillTrainer™ with SkillReporter™ for PC [Laerdal Medical, Stavanger, Norway]) entered the ER together with two instructors. Participants were encouraged to use available resources as needed and follow standard medical procedure. Disposable materials such as laryngeal masks, endotracheal tubes and introducers, arterial pressure kits, and intravenous catheters were placed where the participants would normally find them in the ED. They were all saved and used in subsequent simulations. Ultrasound was also used. After the machine and correct probe were in place and turned on the participants were shown a video on a tablet, held at the screen of the ultrasound machine. Depending on the participants' actions these simulations could be regarded as both high and low fidelity, (using real defibrillators with Shock-link, ultrasound, airway management including video laryngoscope, a digital simulation monitor with vital signs, arterial pressure monitoring etc.). The in-situ simulation of a cardiac arrest case ran for 15 minutes followed by a semi-structured 15-minute hot debriefing. The two instructors spent about 60 minutes for each simulation, including preparation, simulating and cleaning. All participants were invited to share insights, including the instructors. The scenarios

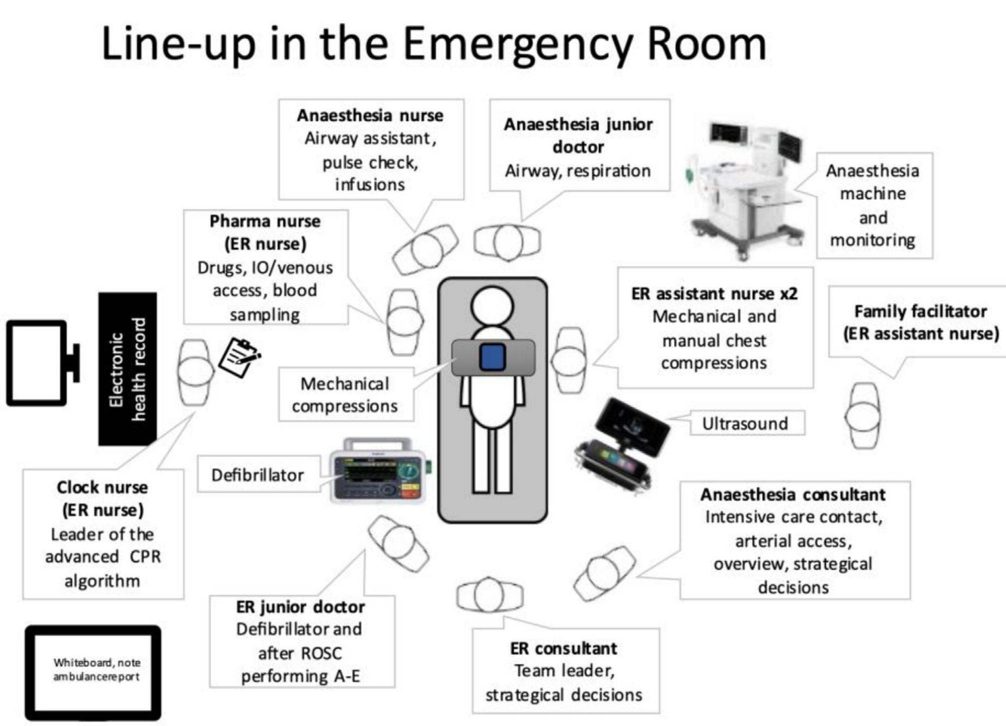


Fig. 1 – Line-up including roles and positioning at the beginning of each CPR simulation.

were developed by the instructors, (see Appendix), and chosen by the instructors for each simulation.

Clinical goals for the in-situ simulation

A priori we decided to specifically evaluate adherence to the European Resuscitation Council Guidelines 2021[5], quality of chest compressions, timing of and causes for pauses in chest compression, defibrillation techniques and timing, adequate airway management, use of peri-arrest ultrasound, and consideration of extracorporeal CPR when appropriate. We also aimed for adherence to the Swedish CPR guidelines[6].

Evaluation of participants' experiences and attitudes

An anonymous evaluation form was sent at three time-points; immediately after the simulation, after 3 months, and after 18 months (see Appendix). Questions about attitude towards CPR education were answered with no or yes. Questions about the benefits of the in-situ simulation were measured on a six-point Likert scale (0–5). Questions about increased skills were also answered on a six-point Likert scale (0–5). In each questionnaire the respondents had the opportunity to insert free text comments. For each questionnaire, all participants were asked to approve the use of their anonymous answers for research purposes. When consent was not given, the questionnaire was excluded. The questionnaires were developed by the authors of this article, based on knowledge from previous questionnaires used by the authors and from discussions with researchers at Karolinska Institute with knowledge of questionnaire-based research.

Line-up in the emergency room

There was no standard line-up before the in-situ simulations were implemented. Therefore, we created a draft which was continuously evaluated and revised after each simulation (Fig. 1). Detailed descriptions of each role and associated tasks were specified on 'action cards' (see Appendix). The action cards and the ER settings were also continuously evaluated and revised.

Statistics, data presentation and management

Normality in the data was examined using the Shapiro-Wilk test. Results are presented as medians with interquartile range (IQR) or frequencies (%). Trends over time were examined at three time-points – immediately after the simulation, at three months and at 18 months. Differences between groups were tested using Chi square. A P-value of <0.05 was considered statistically significant. Graphs and tables were produced in Microsoft Excel. Statistic calculations were performed using Python version 3.9.5, Python Software Foundation.

Ethical approval

The Ethical Review Authority issued an advisory opinion in which they stated that they had no ethical objections to this research project . Informed consent was given for each anonymous questionnaire. All data is presented on group level.

Results

During spring of 2021 we performed 7 simulations inviting 48 participants, of whom all were able to participate. In all, 25 (52%) participants answered the first evaluation immediately after the simulation, while 11 (23%) answered the follow-up after 3 months and 20 out of 46 eligible (43%) answered the follow-up after 18 months. Two were unreachable due to no longer working at the hospital.

Line-up in the ER at initial resuscitation

During the project we optimized the positioning of both the healthcare workers and the equipment in the room. In Table 2 we describe some of the results from our work with the line-up. In Fig. 1 we show a schematic of our final line-up during the first minutes of CPR management in the ER.

Spaced learning

The staff were subject to repeated opportunities to prepare for the simulation. During the spring of the recurrent simulations the instructors perceived a high awareness of the CPR management routines in the staff.

Managing cardiac arrest

At 3 months 82% reported that they had managed a real patient with cardiac arrest. At 18 months the result was 75%.

Attitudes to CPR education and simulations

Among participants, 100% of respondents answered, both immediately and at both follow-ups, that they would recommend participation in the in-situ simulation to a colleague. Even participants that rated the benefits or achieved skill as low, still recommended the simulation. Further, 100% also thought we should continue with both in-situ simulations and formal CPR courses.

Table 1 – Questions on perceived benefit for the participants and real patients at 3- and 18-month follow-up.

Question	3 months Median (IQR)	18 months Median (IQR)	p-value
Do you perceive that YOU have benefited from something you learned at the team practice? (CPR)	4 (4–5)	5 (3.5–5)	0.013*
Do you perceive that YOU have benefited from something you learned at the team practice? (other situation)	5 (4–5)	4.5 (4–5)	0.6
Do you perceive that A REAL PATIENT has benefited from something you learned at the team practice? (CPR)	4.5 (4–5)	5 (3–5)	0.3
Do you perceive that A REAL PATIENT has benefited from something you learned at the team practice? (other situation)	4.5 (4–5)	4 (3–5)	0.6

* Perceived benefit for the participants in CPR situations was statistically significant higher, $p = 0.013$ between the two timepoints.

Table 2 – Some challenges identified (first three columns) during the simulations, and result (last column).

Challenge	Before	Findings	After
Position of the defibrillator	At different locations in the emergency rooms	1. The defibrillator cannot be in the optimal CPR position all the time because there is no space or charging possibility 2. The defibrillator must be moved for CPR	To the right, by the wall, close to the door. Moved to CPR position by Assistant Nurse 2.
Position of the anaesthesia nurse	Between the junior anaesthesia doctor and the ventilator (left side of patient)	The airway equipment, drugs and other important equipment is not reachable from that position. It is difficult for the anaesthesia nurse to move to the other side of the junior anaesthesia doctor because of equipment blocking the passage.	Between the junior anaesthesia doctor and the pharma nurse (right side of patient)
Performing ultrasound	No structure to discuss or decide who performs it	The competency varies between doctors. The most competent might have other important tasks. There are other doctors possible to contact to perform ultrasound.	All doctors are able to perform ultrasound depending on competency. The decision of who and timing of the ultrasound is ultimately made by the team leader, who is encouraged to discuss it with the team. A structure for performing ultrasound without too long pause in compressions is now also described in the local guidelines.
Timing of ambulance report	Sometimes report first, sometimes handover of the CPR tasks, compressions and ventilation, first. No structure.	Ambulance staff are sometimes tired and need quick handover of manual tasks. Ambulance report is difficult to deliver and at the same time deliver high quality CPR. Ambulance report is difficult to receive and at the same time deliver high quality CPR.	1. Assistant nurse 1 takes over compressions on the patient's left side already at the ambulance bay. 2. When entering the ER the junior anaesthesia doctor takes over ventilation and counts to three – everybody available bedside transfers the patient to the ER bed. 3. Assistant nurse 2 takes over compressions on the patient's right side. 4. The ambulance bed is quickly removed. 5. Everybody except assistant nurse 2 – hands off and listen to the ambulance report for 30 seconds, while compressions are maintained, (no ventilation). 6. After 30 seconds the CPR team continues advanced high quality CPR. The senior doctors continue to shortly interview the ambulance staff if applicable.

Self-reported skills

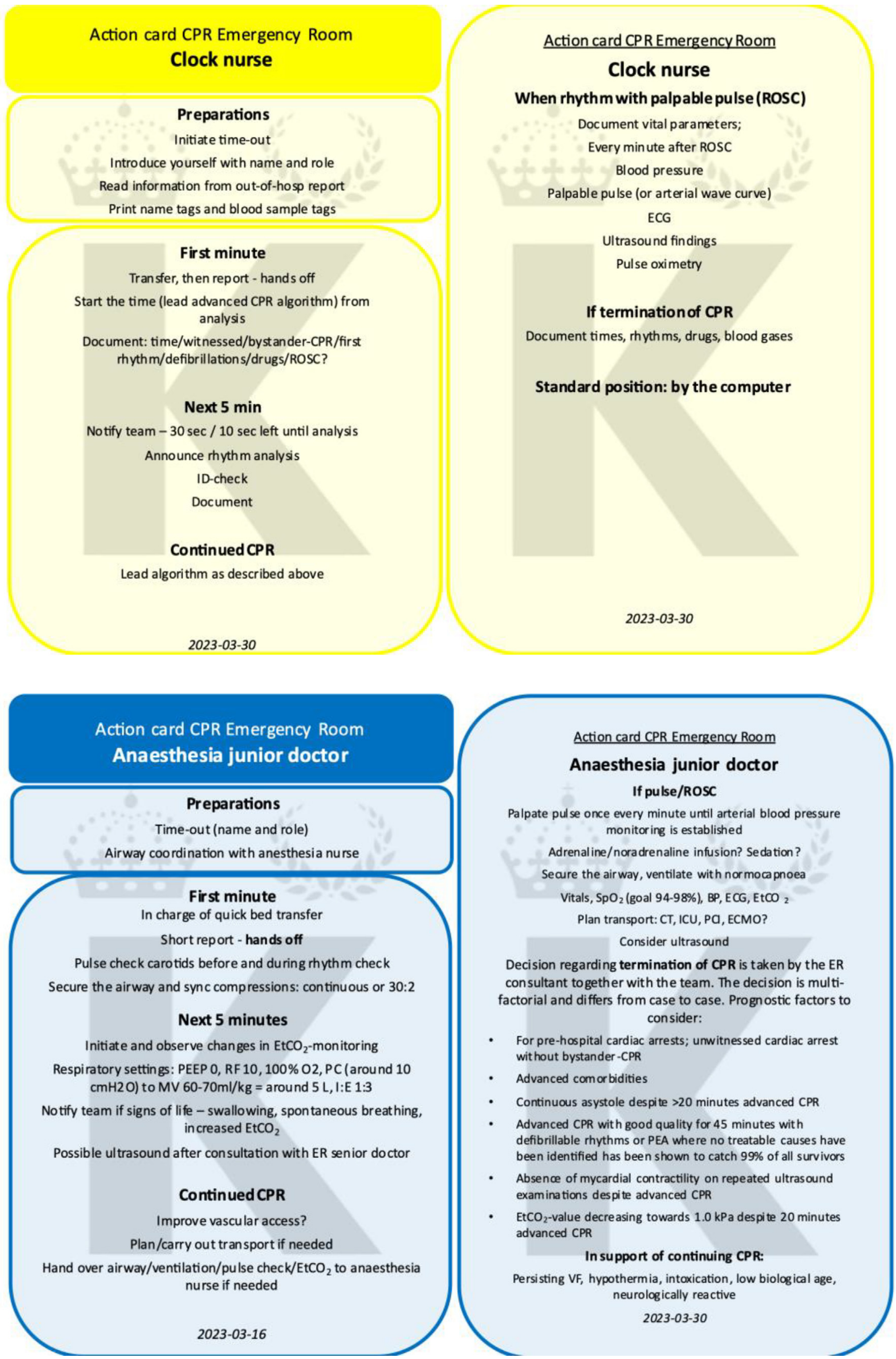
The self-reported achieved competencies after the in-situ simulations were high and statistically significantly higher between simulation and 18 months after, (4 [3–4] immediately after, 4.5 [3.75–5] 18 months after, p-value <0.008) (Fig. 2).

Perceived personal and patient benefits

Participants self-reported benefits for themselves and for real patients, at 3- and 18-month follow-up (Table 1). Even participants who had not managed cardiac arrests after the simulations reported benefits for real patients in other situations.

Action cards

In Appendix figure, we show an example of the action cards used in initial CPR management at the ED, iterated during this project. Clock nurse is a locally coined term based on the CPR algorithm leadership. The clock nurse is responsible for timing of rhythm analysis every two minutes and when applicable adrenaline every four minutes. To aid in keeping time the clock nurse uses two separate alarm clocks. The junior anaesthesia doctor has several specified tasks, including airway, pulse check, endtidal carbondioxide-monitoring ($EtCO_2$) and ventilation. After return of spontaneous circulation, (ROSC), the junior anaesthesia doctor is responsible for monitoring vital signs and optimizing haemodynamics, oxygenation, ventilation, and, if needed, sedation. The ER consultant is the team leader, standing initially by the foot of the bed and avoiding hands-on work, stepping back and having overview. Thinking ahead, reevaluating, considering reversible causes, partnering in difficult discussions with the anaesthesia consultant. Nurse assistant 2 is responsible for putting important equipment in the right spot before patient arrival and to maintain high quality compressions when the rest of the team engages in the ambulance report.



Action card CPR Emergency Room
Clock nurse

Preparations
Initiate time-out
Introduce yourself with name and role
Read information from out-of-hosp report
Print name tags and blood sample tags

First minute
Transfer, then report - hands off
Start the time (lead advanced CPR algorithm) from analysis
Document: time/witnessed/bystander-CPR/first rhythm/defibrillations/drugs/ROSC?

Next 5 min
Notify team – 30 sec / 10 sec left until analysis
Announce rhythm analysis
ID-check
Document

Continued CPR
Lead algorithm as described above

2023-03-30

Action card CPR Emergency Room
Clock nurse
When rhythm with palpable pulse (ROSC)
Document vital parameters;
Every minute after ROSC
Blood pressure
Palpable pulse (or arterial wave curve)
ECG
Ultrasound findings
Pulse oximetry

If termination of CPR
Document times, rhythms, drugs, blood gases

Standard position: by the computer

2023-03-30

Action card CPR Emergency Room
Anaesthesia junior doctor

Preparations
Time-out (name and role)
Airway coordination with anesthesia nurse

First minute
In charge of quick bed transfer
Short report - **hands off**
Pulse check carotids before and during rhythm check
Secure the airway and sync compressions: continuous or 30:2

Next 5 minutes
Initiate and observe changes in $EtCO_2$-monitoring
Respiratory settings: PEEP 0, RF 10, 100% O2, PC (around 10 cmH2O) to MV 60-70ml/kg = around 5 L, I:E 1:3
Notify team if signs of life – swallowing, spontaneous breathing, increased $EtCO_2$
Possible ultrasound after consultation with ER senior doctor

Continued CPR
Improve vascular access?
Plan/carry out transport if needed
Hand over airway/ventilation/pulse check/$EtCO_2$ to anaesthesia nurse if needed

2023-03-16

Action card CPR Emergency Room
Anaesthesia junior doctor
If pulse/ROSC
Palpate pulse once every minute until arterial blood pressure monitoring is established
Adrenaline/noradrenaline infusion? Sedation?
Secure the airway, ventilate with normocapnoea
Vitals, SpO_2 (goal 94-98%), BP, ECG, $EtCO_2$
Plan transport: CT, ICU, PCI, ECMO?
Consider ultrasound

Decision regarding **termination of CPR** is taken by the ER consultant together with the team. The decision is multi-factorial and differs from case to case. Prognostic factors to consider:

- For pre-hospital cardiac arrests; unwitnessed cardiac arrest without bystander-CPR
- Advanced comorbidities
- Continuous asystole despite >20 minutes advanced CPR
- Advanced CPR with good quality for 45 minutes with defibrillable rhythms or PEA where no treatable causes have been identified has been shown to catch 99% of all survivors
- Absence of mycardial contractility on repeated ultrasound examinations despite advanced CPR
- $EtCO_2$-value decreasing towards 1.0 kPa despite 20 minutes advanced CPR

In support of continuing CPR:
Persisting VF, hypothermia, intoxication, low biological age, neurologically reactive

2023-03-30

Figure 2 – Nine action cards were iterated during this project. An ER nurse has the role of clock nurse, (locally coined term). The anaesthesia junior doctor is responsible for airway and ventilation at the start of ER resuscitation. The ER consultant is the team leader and avoids hands-on work. The nurse assistant 2 maintains high quality compressions when the rest of the team listens to the ambulance report. All action cards are found in the Appendix.

Action card CPR Emergency Room
ER consultant
Team leader

Preparations

Time-out (name and role)

Health records - background, DNR-decisions – understanding the patient

Initiate treatments?

Need for other competencies? Accessible ultrasound competence?

First minute

Transfer, then report - hands off

Overview - avoid hands-on

Advanced CPR with good quality (short overview)

Next 5 minutes

Detailed ambulance report

Most probable reversible cause?

Interpret blood gas. Consider ultrasound.

$EtCO_2$ available?

Get feedback ABCDE from examining doctor

Continued CPR

Reversible causes ruled out?

Criteria for termination of CPR fulfilled?

Contact with PCI, intensive cardiac unit, poison information centre, patient responsible doctor etc

Reevaluating with anesthesia consultant and the team - - think ahead – plan out loud

Checking in, summary

Action card CPR Emergency Room

ER consultant

If rhythm with palpable pulse (ROSC)

Ensure vital signs (every minute), ABCDE, arterial access

Consider ultrasound

Responsible for differential diagnostics and stabilization

Transport where: CT, ICU, PCI, ECMO?

Decision regarding **termination of CPR** is taken by the ER consultant together with the team. The decision is multi-factorial and differs from case to case. Prognostic factors to consider:

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- $EtCO_2$-value decreasing towards 1.0 kPa despite 20 minutes advanced CPR

In support of continuing CPR:

Persisting VF, hypothermia, intoxication, low biological age, neurologically reactive

2023-03-30

Action card CPR Emergency Room
Nurse assistant 2

Preparations

Time-out (name and role)

Put defibrillator at designated spot

Put ultrasound machine at designated spot

First minute

Transfer

Take over compressions from patient's right side after transfer – don't focus on the report

Next 5 minutes

Apply mechanical compressions device if needed

Sync 30:2 or continuous with the anesthesia

Continue compressions, switch regularly

Be available

Attach monitoring equipment (ECG 4 leads, pulse ox, bp cuff)

Continued CPR

Monitor mechanical compressions, especially chest positioning

Compressions

Be available

2023-03-16

Action card CPR Emergency Room

Nurse assistant 2

If pulse /ROSC

12-lead-ECG

Temperature-urine catheter

Standard position (red ring) after the 1st minute:

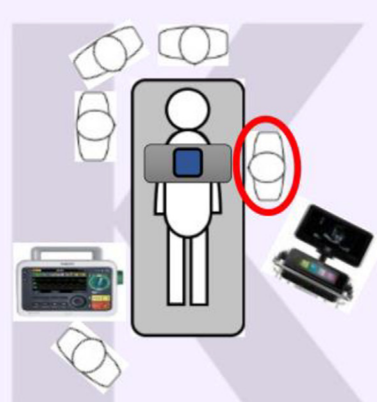

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Fig 2. ***(continued)***

Discussion

This implementation of regular in-situ simulations in an ED demonstrates that it is possible to accomplish them in a limited amount of time (30 minutes) and that participating personnel self-report long-term positive impact on actual patients.

To our knowledge, perceived benefit for actual patients have not been described previously from in-situ simulations on resuscitation performed in parallel with the regular clinical work. We lack patient data but speculate that acquired communication skills, increased understanding of team members and their competencies, and knowledge about resources in the ED could all have contributed to this experience. Future studies should deepen the knowledge of this claim.

A positive change in behaviour regarding communication, roles and team cooperation has been reported in the questionnaires free text comments and in the hot debriefs. Further, even if we have a small sample size and missing data, we did not expect that 100% of the participants would think we should continue with simulations and would recommend them to a colleague. Even those who had not seen the benefits personally or in real patients would recommend it.

The improvement in achieved skills supports theories of spaced learning.[1] Spaced learning has been shown to improve both performance on tests as well as long-term retention of knowledge[1,7]. We understand that the perceptions of achieved new skills in the immediate follow-up have not faced reality, however and more interestingly, at the 18-month follow-up, we know that a majority had been in situations where the knowledge from the simulation had been tested and used. Further, it seems that participants remember and relate to the in-situ simulation 18 months after its performance. However, the CPR simulation was not the first time the participants practiced cardiac arrest management and continuous information about the project as well as continuous exposure before and after the simulation might have triggered learning every time. This is somewhat supported by Benjamin and Tullis[9] in their description of the reminding theory. Kramàr et al.[10] has showed the increase in long-term potentiation in spines of rats exposed to spaced learning. Further, the European Resuscitation Council educational approach[2] recommends a variety of teaching methods. Of those, we have used briefing/debriefing, reducing cognitive load (in assigning tasks to roles), interprofessional education, small group teaching and deliberate practice and more within this project and it is impossible to understand the causal relationship. Finally, at the hot debrief, participants were informed by the instructors on how they had performed in regard to current guidelines and such interventions might in themselves improve teamwork performance.[8]

The lack of statistical significance between the questionnaires relates to small sample sizes as well as a roofing effect with little room for improvement. Future similar studies therefore might need to use scales ranging from 0 to 100 instead of 0–5.

The statistically significant differences between the questionnaires should be interpreted with much caution. The response rates are low and the questionnaires are anonymous. There is no knowledge of whether the same participants answered all questionnaires. Responses about managing cardiac arrest suggests that the questionnaires were, in fact, not answered by the same participants, in that the percentage of yes decreased between 3 and 18 months.

The current project highlights a critical part of evaluating implementation and scientific studies in real-life hospital settings (i.e. to get responses to questionnaires). The staff in our in-situ simulations participated while doing clinical work in the ED or anaesthesia department, respectively. Even though the participation only took 30 minutes it might be on the verge of how much extra workload a clinician can take on. Further, it is possible that our hot debriefing results in a feeling of double-work and/or reluctancy to fill out the questionnaire.

Limitations of the study are first the low response rate as well as recall bias, especially for the 3-month follow-up questionnaire. By the high scores, we can assume that positive experiences were more likely to be reported than negative experiences. Further, limitations include difficulties to reach out to staff, since they rarely find the time to read e-mails or attend meetings due to 24/7 work. Gladly, many of the participants that gave low scores were brave enough to mention it early in the hot debriefings and the first questionnaire immediately after which gave us the possibility to improve information early on. In the hot debrief participants often stated that the most valuable lessons learned were communication and the impact of recent preparation – to enter the simulation well-informed of algorithms and roles. Finally, within this study it is difficult to align a certain intervention, i.e. the in-situ simulation, to a certain effect or result.

As mentioned previously, before initiation of this project, no line-up or action cards existed. Concrete examples of double-work, missed care and repetitive conflicts between team-members' tasks were identified and sorted out along the way. Therefore, a major by-product of this in-situ simulation and the hot debriefings is a more standardized approach during the first 15 minutes of resuscitation in the ED. Suggestions from one profession could quickly be assessed and commented on by the other professions as do-able or not. Not only roles, tasks and positioning of the healthcare staff were optimized. As we held the simulations in our actual workplace, we could also improve the setting, e.g. positioning of the defibrillator, ultrasound etc. One concrete example is the standardization of the handover process of the ambulance service to the ED staff. Before the in-situ simulations it was unclear whether the report or bed transfer should take place first as well as who should listen to the report versus take care of the patient. After some iterations, one nurse assistant now takes over the compressions from the patient's left side already in the ambulance bay. When entering the ER, the patient is immediately transferred to an ER bed and another nurse assistant takes over compressions on the patient's right side. After that everybody else listens to the ambulance report (maximum 30 seconds). This setup makes sure that CPR with good quality compressions is continued without interruption.

Our recommendation for others who want to run similar projects is that it is critical to have a team of instructors from all the participating departments and professions in order to motivate the staff to take on this extra workload in the middle of their ordinary work. Further, at times the ED or anaesthesia department were too busy with patients and our solution to these potential 'show-stoppers' was to run the sessions with either one of the instructors acting a role or without complete teams (since that is also a possible real-life scenario).

To summarize, clinical lessons learned from this project are that in-situ simulations are appreciated and wanted in the clinical setting, they might have long term effects and they help develop standardized roles and tasks in the ER.

Conclusion

Recurrent, inter-professional, 30-minute in-situ simulations are possible to implement in the ED and can be useful in the development of more standardised roles and tasks for a team managing cardiac arrest. CPR simulation in a real environment is self-reported having long-term benefits both for healthcare workers and patients.

Lessons learned

- Implementing a 30-minute in-situ simulation once a week is feasible
- Using the simulations to improve routines for standard time-critical scenarios is valuable
- Simulations are appreciated by the healthcare workers and are perceived to benefit actual patients

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.resplu.2023.100413.

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