Project title:

Effects of in situ simulation-based team training on clinical performance during pediatric cardiac arrest: An intervention study comparing two Danish Regions.

2024/06/18

BACKGROUND AND AIMS

Treating critically ill newborns and children is a challenge in pediatric departments [1]. The rare encounter with critically ill pediatric patients results in limited experience and a lack of routine for each healthcare professional (HP)[2]. Numerous studies document that emergency treatment of pediatric and neonatal patients often fails to meet standard guidelines for treatment [3][4][5][6]. A sentinel event alert from 2004 showed that ineffective communication played a role in nearly three-quarters of neonatal deaths or permanent disabilities [7]. Furthermore, a recent study identified a lack of training in pediatric resuscitation skills in Danish hospitals [8]. Accordingly, these factors are major issues challenging the treatment provided for pediatric in-hospital cardiac arrest (pIHCA).

Outcome and survival in critical situations depend on how HPs use technical skills and teamwork competencies [9][10][11]. Simulation-based team training (SBTT) is a well-known and effective method to improve team performance in high-stake and time-sensitive situations, without putting actual patients at risk [12][13]. SBTT develops leadership, teamwork, and communication, and mastering such teamwork competencies is shown to improve outcomes and survival in critical situations [14][15][16]. However, retention of achieved competencies is a major challenge, but recent observational studies demonstrated improved technical pediatric basic life support skills after short simulation sessions with a high frequency of repeat [17][18]. The HPs in these studies are however limited to selected groups and tests are performed exclusively on skill stations. Further, a recent review of optimal simulation training methods concludes that more high-quality research comparing training effectiveness is needed [19].

We therefore aim to investigate the effects of a novel high-frequency training program on teamwork, team effectiveness, and treatment quality during in-situ simulated pediatric in-hospital cardiac arrest. In the intervention group, healthcare professionals will conduct high-frequency simulation-based team training (four training sessions in one year, approx. three months apart). The control group will conduct simulation-based team training ‘as usual’ at a two to three times lower frequency (based on unpublished data).

We hypothesize that high-frequency training will affect primary outcomes as specified: 1) Improve teamwork competences, 2) Reduce time (seconds) to recognition of cardiac arrest, 3) Reduce time (seconds) to initiation of cardiopulmonary resuscitation, 4) Reduce longest chest compression pause duration.

MATERIALS AND METHODS

DESIGN. We will conduct a non-randomized controlled intervention study in two comparable Danish Regions. Both regions include a university hospital and three regional hospitals and each region serves approximately 1.200.000 inhabitants. We aim to include all HPs handling acute patients from the pediatric departments in both regions (approx. 600 employees in each region).

INTERVENTION. Participants in the intervention Region will from April 1st, 2023 to April 1st, 2024, be exposed to a high-frequency training program, in which each HP will attend four SBTT sessions in one year, approx. three months apart. Three-month intervals were chosen based on knowledge of retention of technical skills [17][18]. Sessions are estimated to last 30 to 120 minutes. A local investigator in each pediatric department will be responsible for planning the SBTT sessions. The sessions consist of cases from the abovementioned "scenario bank" including debriefing and will be facilitated by a local certified simulation facilitator.

Pediatric departments in the control Region will conduct SBTT "as usual" with no implemented simulation program and with a 2.5 times lower frequency (based on unpublished data). The simulation activity in both groups will be meticulously registered in a secure electronic database. Each HP has an individual "log" that is registered immediately after each training by a local investigator. Registration began on January 1st, 2023, and terminated on March 31st, 2024.

The intervention is supported by four preliminary initiatives:

1) 15 extra pediatric simulation facilitators were educated, bringing the total number up to 40.
2) A two-day pre-intervention workshop for all pediatric simulation facilitators.
3) A "scenario bank" containing standardized scenarios on common pediatric and neonatal emergencies was created and made accessible for simulation facilitators to support consistency in the intervention.
4) Purchase of equipment. Eight Leardal manikins. Four SimPads. Four monitors. During the intervention year, these will rotate between the pediatric departments.

DATA COLLECTION. To get the most realistic clinical performance assessment**,** we will conduct unannounced in-situ simulations of pIHCA before and after the intervention in all hospitals. These simulations will be video-recorded and are distinctly different from the high-frequency training program described in the intervention. The dates of the simulations are unknown to everyone except the head nurse who will assign a patient room for the simulation and the researchers enter the room unseen. An advanced manikin (Laerdal Little Baby Q-CPR) is placed in a hospital bed. A nurse is called to the room and presented with a case story whereafter the simulation session begins. Before

the study period, all staff members received information informing them to act exactly as they would in a real emergency with a true patient (call routines, equipment, medicine, etc.). Four GoPro cameras are placed for recording audio and footage to enable assessment. Two assessors will independently evaluate each video in a random order (blinded to pre/post and intervention/control) to score and extract data. At least one assessor of each video recording will be recruited from outside the participating regions to ensure blinding related to recognizability. Discrepancy between observers will be settled by discussion and by including a third rater if needed.

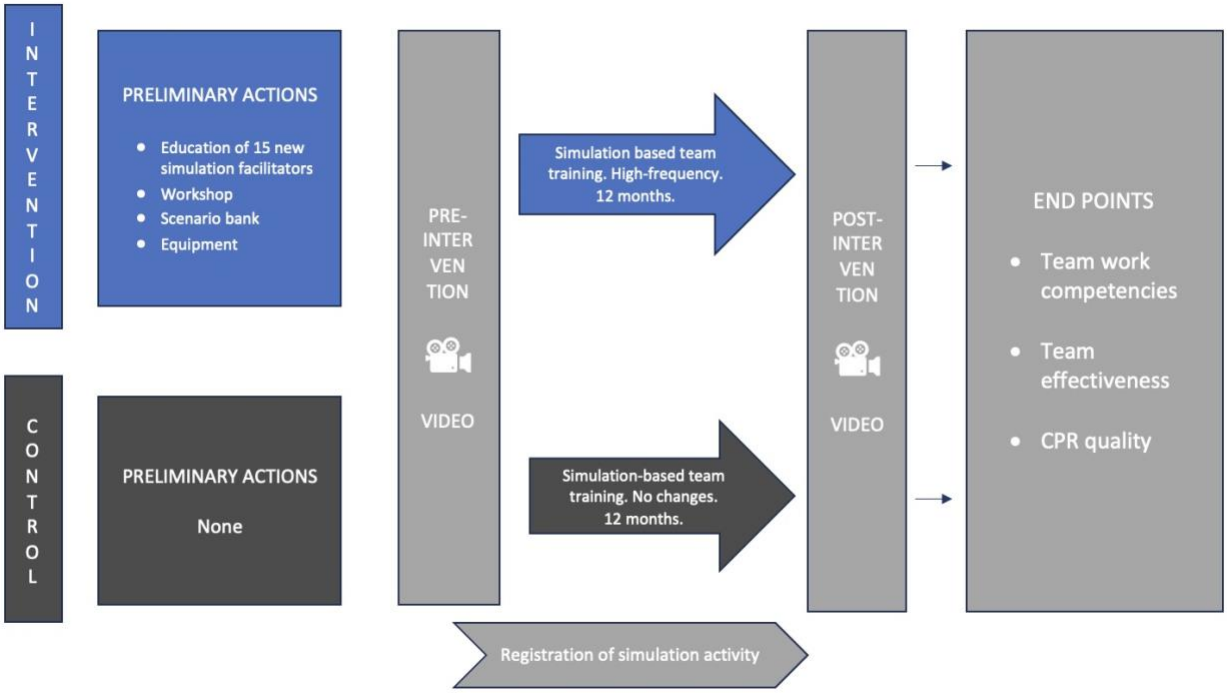

Figure 1. Overview of study design.

A total of 122 unannounced simulations will be conducted for performance assessment. Pre-intervention simulations count 32 in the intervention region and 10 in the control region (a lower number to avoid training and Hawthorne effects)[20]. Post-intervention simulations are expected to be 40 in each region.

PRIMARY OUTCOMES.

1) Teamwork competencies. Global team score, assessed with "Team Emergency Assessment Measure" measuring leadership control, communication, cooperation, coordination, team climate, adaptability, situation awareness, prioritization, and clinical standards [21][22][23][24].
2) Time (seconds) until cardiac arrest is recognized.

3) Time (seconds) to initiation of cardiopulmonary resuscitation within standard guidelines for neonates/children.
4) Longest chest compression pause duration.

SECONDARY OUTCOMES.

1) Time (seconds) to: call for help, arrival of defibrillator and first rhythm check.
2) Proportion of compressions and ventilations within recommendations for depth/rate and tidal volumes, respectively.

STATISTICS. Parametric data will be reported as mean (± standard deviation (SD)) and non-parametric data as median (1st quartile; 3rd quartile). Data will be analyzed using appropriate parametric and non-parametric tests. A two-sided p-value < 0.05 will be considered statistically significant. We will fit Linear regression models to adjust for important covariates. Primary analyses will compare pre- and post-intervention data between intervention and control regions. Secondary analyses will compare post-intervention outcome measures for each sub-study by the team members´ training exposure in the preceding year regardless of intervention/control status; including the number, timing, and topic of training sessions.

Sample size considerations: For sub-study 1, a total of 62 recordings would be needed to show an improvement in the overall TEAM score of 5 points with a power of 80% and a standard deviation of 7 points. For sub-study 2, a total of 62 recordings would be needed to show an improvement in time to detection of cardiac arrest of 10 seconds with a power of 80% and a standard deviation of 14. For sub-study 3, a total of 64 recordings would be needed to show an improvement of 30% in the longest chest compression pause duration with a power of 80%.

RESEARCH PLAN AND FEASIBILITY

The preliminary initiatives and the intervention have been completed as part of a related project (Fellow PhD, Anders L. Schram). Future PhD student, Nadja Lindberg Bonne, has successfully conducted the collection of the pre-intervention video recordings and is currently conducting the post-intervention video recordings, which are proceeding according to plan with an expected total of 120 videos of SBTT from both regions. The project group has the necessary clinical network and academic competencies to analyze these highly interesting data with expectations of at least three academic articles and presentation of these at both national and international conferences. The feasibility of this Ph.D. project is unarguably good, and it will add novel and invaluable clinical data to an existing data collection.

ETHICS

The studies comply with the recommendations from the Danish Central Ethics Committee. All participants will give their written consent. Data will be handled according to The Danish Data Protection Agency and the European Union Act on protecting personal data. The project has been reported to the internal registry of research projects, the Central Denmark Region, and the Danish National Committee on Research Ethics.

PERSPECTIVES

By providing important knowledge on optimizing and implementing large-scale high-frequency training strategies, this project is expected to improve the quality of treatment of pIHCA, with an anticipated improvement in mortality and morbidity among survivors. We believe psychological safety among HPs will increase, hopefully with decreased sick leave and employee turnover as a positive side effect. We expect the results to influence the planning and implementation of future onboarding and refresher training programs to ensure high value-for-money approaches in a challenged healthcare system.

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