


BMJ Open Impact of family presence during cardiopulmonary resuscitation on team performance and perceived task load: a prospective randomised simulator-based trial

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ABSTRACT

Objectives Guidelines recommend family presence to be offered during cardiopulmonary resuscitation (CPR). Data on the effects of family presence on the quality of CPR and rescuers' workload and stress levels are sparse and conflicting. This randomised trial investigated the effects of family presence on quality of CPR, and rescuers' perceived stress.

Design Prospective randomised single-blind trial.

Setting Voluntary workshops of educational courses.

Participants 1085 physicians (565 men) randomised to 325 teams entered the trial. 318 teams completed the trial without protocol violation.

Interventions Teams were randomised to a family presence group (n=160) or a control group (n=158) and to three versions of leadership: (a) designated at random, (b) designated by the team or (c) left open. Thereafter, teams were confronted with a simulated cardiac arrest which was video-recorded. Trained actors played a family member according to a scripted role.

Main outcome measures The primary endpoint was hands-on time. Secondary outcomes included interaction time, rescuers' perceived task load and adherence to CPR algorithms.

Results Teams interacted with the family member during 24 (17–36) % of the time spent for resuscitation. Family presence had no effect on hands-on time (88% (84%–91%) vs 89% (85%–91%); p=0.18). Family presence increased frustration (60 (30–75) vs 45 (30–70); p<0.001) and perceived temporal (75 (55–85) vs 70 (50–80); p=0.001) and mental demands (75 (60–85) vs 70 (55–80); p=0.009), but had no relevant effect on CPR performance markers. Leadership condition had no effects.

Conclusions Interacting with a family member occupied about a quarter of the time spent for CPR. While this additional task was associated with an increase in frustration and perceived temporal and mental demands, family presence had no relevant negative effect on the quality of CPR.

Trial registration number DRKS00024759.

INTRODUCTION

Ever since its first implementation in the 1980s¹ family presence during cardiopulmonary resuscitation (CPR) remained a

Strengths and limitations of this study

- Strengths of this trial include the prospective and randomised design, the large sample size and identical conditions for all teams.
- A particular strength of this trial is the in-depth analysis of all relevant cardiopulmonary resuscitation tasks and subtasks right from the start of the cardiac arrest.
- Limitations of simulator-based studies include the absence of real patients and, in the present trial, of real relatives.
- Our teams consisted of physicians only, so findings might not necessarily generalise to other team compositions.

controversial issue.^{2–4} Current guidelines recommend that family members should be offered the option to be present during resuscitation in situations where it is safe, and when the family can be adequately supported.^{5–7} Data on the effects of family presence on the quality of CPR, the additional workload and the psychological burden for rescuers are sparse. However, awareness of the impact of family presence on patients undergoing and healthcare workers providing CPR may prove helpful in a long-lasting controversy.

Family presence during CPR aims at improving family member psychological outcomes.

In the largest randomised trial conducted so far family members witnessing the resuscitation efforts had significantly less post-traumatic stress disorder (PTSD)-related symptoms.^{8,9} However, a prospective comparison group study reported no impact of witnessing CPR on bereavement-related depression and PTSD symptoms¹⁰ while observational studies showed no meaningful

effects of family presence¹¹ or even an increase in PTSD-related symptoms.^{12 13}

CPR is a demanding and often stressful task^{14 15} and the presence of a family member may add cognitive and emotional demands. Data available are conflicting and cover the range from no perceived additional stress to perceived significant hampering one's own activity due to family presence.^{1 4 8 16} So far, there are no apparent negative effects on patients' outcomes in hospitals that allow families to be present during CPR.^{17 18} However, the most desirable outcome of CPR, survival with good neurological function, unfortunately occurs comparatively rarely. Thus, detrimental effects of policies may go statistically undetected. Studies in real cases and simulated scenarios have repeatedly shown a high variance in executing CPR and a less than optimal adherence to treatment algorithms.^{14 19–22} Moreover, teams under stress tend to focus on various subtasks differently and may even neglect certain subtasks.^{22–24} Thus, family presence during CPR may, by leading to distraction or stress of rescuers, further impact execution of CPR and/or affect specific subtasks. Indeed, in a small simulator-based study, the presence of a family member showing overt reactions was associated with both delayed and fewer defibrillation attempts.¹⁶ Though leadership is important in CPR teams,²⁵ there are no data on whether leadership is able to mitigate potential effects of additional stress.

Investigating the impact of family presence on the quality of CPR in a randomised controlled trial is challenging in real cases, as circumstances of arrests may vary substantially. Moreover, important deviations and delays can occur in the very beginning of resuscitation efforts, which can only be captured if recording equipment is functional or trained observers are present at the scene. Simulation allows the investigating of team performance both globally and in specific subtasks in a realistic and standardised manner²⁶ and performance markers in simulator-based studies show a high agreement with findings in CPR. A particular advantage of simulation is the possibility of recording data right from the start which is almost impossible in real arrests.

Accordingly, the aim of the present prospective randomised trial was to investigate the effects of family presence on the quality of CPR, the perceived task load of rescuers and the effects of designated leadership in simulated cardiac arrests.

METHODOLOGY

Participants

The Working Group on Intensive Care Medicine, Arnsberg, Germany (<http://www.aim-arnsberg.de>), organises educational courses for physicians, mainly residents in their second to third year of postgraduate medical education in internal medicine, anaesthesia or surgery, from Germany and German-speaking countries working in intensive and emergency care. In the German health system, intensive care medicine is a mandatory rotation

within the 'common trunk residency' of surgery, internal medicine and anaesthesia. During this rotation, these residents are designated first responders for within-hospital emergencies including cardiac arrests. Participants of educational courses were offered to participate in voluntary simulator-based workshops and informed that simulations were video-taped for scientific reasons. Identical workshops were offered to physicians wishing to participate but without being filmed. No formal training in family witnessed CPR was provided. The study is registered at the German Clinical Trial Registry (www.drks.de) and reported herein according to the extensions to the Consolidated Standards of Reporting Trials (CONSORT) statements of the Reporting Guidelines for Healthcare Simulation Research.²⁷

Patient and public involvement

No patient involved.

Study design

This is a prospective randomised single-blind trial. Randomisations were carried out using computer-generated numbers and overseen by a study physician. Participants were randomly assigned to teams of three to four physicians. Teams were then randomly allocated to perform CPR under two different conditions: (1) no family member present (control group) or, (2) family member present (family presence group). Furthermore, teams were randomly allocated to no designated leadership (no intervention); designated leadership by team itself (team was given the task to designate a leader prior to the start of the scenario); or designated leadership by tutor (leader was assigned to a randomly chosen team member by the tutor prior to the start of the scenario). Designated leaders wore a coloured vest and could thus be identified on video-recordings.

Apart from the presence of a family member and the assigned leadership, conditions and circumstances for all teams were identical.

Simulator and scenario

The manikin Ambu Man Wireless (Ambu GmbH, Bad Nauheim Germany) was used. All participants received a standardised introduction to the workshop, the manikin and the resuscitation equipment available. Subsequently, all team members were informed that their role during the following scenario was that of an in-hospital resuscitation team summoned to an unwitnessed cardiac arrest in their hospital's cafeteria. The victim of the arrest (manikin) was pulseless, apnoeic and did not react to verbal commands or painful stimuli. Ventricular fibrillation could be diagnosed on the display of a manual defibrillator. The study period started with the first touch of the patient by one of the participants and ended after the third defibrillation. Trained tutors, instructed to refrain from any intervention until the end of the study period, operated the resuscitation manikin.

Box 1 Role of the actor

Who you are

- ▶ You are the oldest child of the patient.
- ▶ You have no medical knowledge.
- ▶ The patient collapsed in your presence.
- ▶ You called for help.
- ▶ You are distraught over the incident.

What you do and do not do

- ▶ You tell the rescuers immediately after their arrival that your father suddenly collapsed and no longer reacts.
- ▶ You ask the rescuers during the event.
 - What happened to my father?
 - Why does he not react?
 - Could he be dead?
 - What will happen next?
- ▶ If asked about information about your father, you reveal that he suffers from diabetes and hypertension and smokes one package of cigarettes each day.
- ▶ You walk around nervously while staying close to the scene.
- ▶ You observe the rescuers attentively.
- ▶ You follow the commands of the rescuers and especially so if being asked to step aside.
- ▶ You do however not agree to leave the room if asked to do so.
- ▶ You do not stay in the way of the rescuers and do not hinder them in any physical way to do their work.
- ▶ You do not scream or shout.
- ▶ You do not behave aggressively in any way.
- ▶ After the second defibrillation you pretend to speak by mobile phone with your brother for approximately 30 s and update him, audible for the rescuers, about the event.

Family presence

Four actors were trained to play a family member of the patient according to a scripted role (box 1). To ensure consistency across the study video-recordings were repeatedly reviewed in the presence of an investigator with all actors.

Teams randomised to the family presence group encountered the distraught family member at the scene next to the patient. The family member volunteered that his/her father had collapsed in his/her presence and did no longer react.

NASA Task Load Index

Immediately after the completion of their simulation, participants were asked to fill in the NASA Task Load Index (NASA-TLX) questionnaire. The NASA-TLX was developed to assess operators' workload during or immediately after a task and assesses six domains that are rated on Visual Analogue Scales (range from 0 to 100): mental demand, physical demand, temporal demand, own performance, effort and frustration.²⁸ The NASA-TLX has been extensively validated, is easy to administer and widely used in different domains like flying, driving, teamwork and medicine.^{29 30}

Data analysis

Data analysis was performed using video recordings obtained during simulations by MW, TS and SM. The first

touch of the patient by one of the participants was defined to be the starting point for the timing of all events.

Statistical analysis

The primary endpoint was percentage of hands-on time, defined as time of actual chest compressions expressed as percentage of the total time available for chest compressions. A power analysis, based on data of pilot experiments, revealed that approximately 50 teams had to be studied in each study arm to detect a between-group difference of 10% in the primary outcome with significance levels of 0.05 (two-tailed) and 80% power. Accordingly, we decided to terminate the study as soon as at least 50 videotapes of sufficient quality for each study arm were available. For organisational reasons, the number of available videotapes of sufficient quality could be assessed only after completion of each educational course.

Secondary outcomes included the amount of interaction with the family member, NASA task load data and adherence to various aspects of the international CPR guidelines. In addition, the effect of designated leadership was assessed as secondary outcome.

All data were analysed on an intention-to-treat basis. Data are expressed as medians (IQR) unless otherwise stated. Statistical analysis was performed using SPSS (V.25). Numerical data were analysed by non-parametric analysis of variance, followed by Mann-Whitney test, if appropriate. Estimates for differences between medians and their CIs were obtained by the Hodges-Lehmann estimation. Categorical data were analysed using the χ^2 test. A $p < 0.05$ (two-tailed) was considered to represent statistical significance.

RESULTS

Participants

Data of 318 teams with 1058 participants (158 control group; 160 family presence group) were analysed (CONSORT flow chart, figure 1). In the family presence group verbal interactions with the family member occurred during cumulatively 97 (65–134) s representing 24 (17–36) % of the study time. Two (2–3) team members contributed to this interaction on 5 (4–6) different occasions. Team leadership had no effect on the number of interactions ($p = 0.39$) and number of team members interacting ($p = 0.06$). However, teams without a designated leader had significantly longer interactions with the family member: 110 (73–156) versus 88 (57–116) s (difference 21, 95% CI 4 to 40; $p = 0.017$) corresponding to 30 (19–41) versus 23 (15–33) % (difference 7, 95% CI 2 to 11; $p = 0.004$) of the study time.

Primary outcomes

Hands-on time was 89% (85%–91%) in the control group and 88% (84%–91%) in the family presence group (difference 1, 95% CI 0 to 2; $p = 0.18$; figure 2). Leadership assignments ($p = 0.60$) had no effect on hands-on time and there was no significant correlation between hands-on

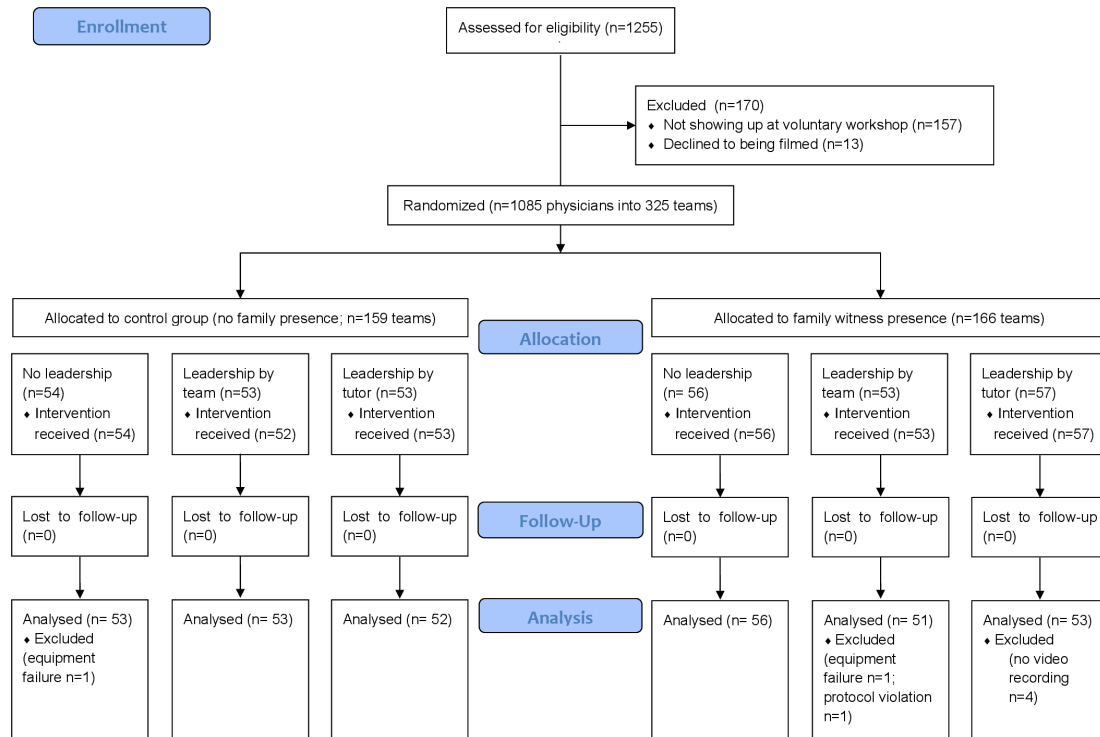


Figure 1 Consolidated Standards of Reporting Trials flow chart.

time and the absolute time ($p=0.69$) or percentage of time ($p=0.55$) of verbal interaction with the family member.

Secondary outcomes

NASA-TLX findings are summarised in **figure 3**: Family presence was associated with significantly higher ratings for the domains frustration (45 (30–70) vs 60 (30–75) difference 10, 95% CI 5 to 15; $p<0.001$), temporal demand (70 (50–80) vs 75 (55–85) difference 5, 95% CI 5 to 10; $p=0.001$) and mental demand (70 (55–80) vs 75 (60–85) difference 5, 95% CI 0 to 5; $p=0.009$), but no significant differences for the domains physical demand (60 (40–80) vs 65 (40–80) difference 0, 95% CI 0 to 5;

$p=0.20$), effort (65 (50–75) vs 70 (45–80) difference 0, 95% CI 0 to 5; $p=0.09$) and performance (70 (50–80) vs 70 (45–80) difference 0, 95% CI 0 to 5; $p=0.55$). Leadership was associated with decreased mental demand by 5% (95% CI 0% to 5%); $p=0.014$) but had no effect on other NASA task load ratings.

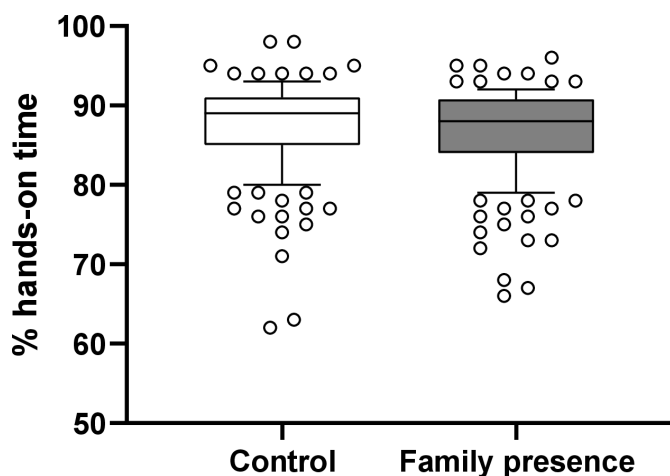


Figure 2 Hands-on time. Box and whisker plot of the percentage hands-on time. Boxes represent medians and IQR; whiskers delineate the 10th and 90th percentile, respectively.

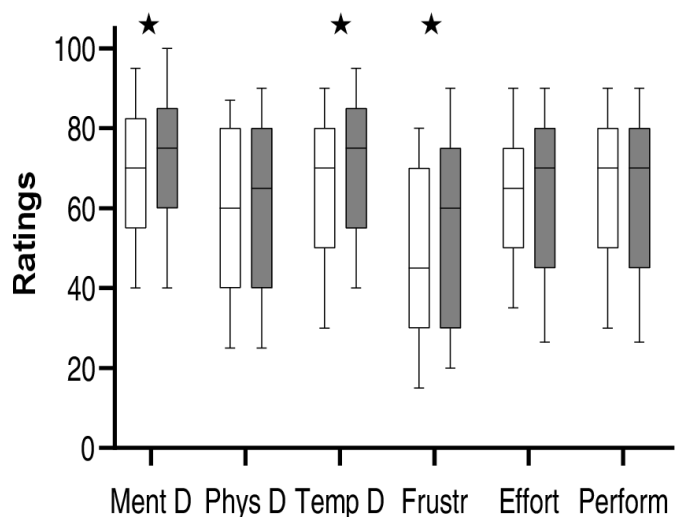


Figure 3 NASA task load index. Box and whisker plot of the ratings of the NASA task load index. Boxes represent medians and interquartile range; whiskers delineate the 10th and 90th percentile respectively. White bars = control group; grey bars = family presence group. MenD = mental demand; PhyD = physical demand; TemD = temporal demand; Frustr = frustration; Perform = own performance. * = $P<0.05$ for difference between teams with and without family presence.

Table 1 Secondary outcomes

	Control group (n=158)	Family presence group (n=160)	Effect of family presence, p value	Effect of leadership, p value
Chest compression				
Time interval to start of CPR (s)	14 (10–16)	15 (11–20)	0.001	0.56
Start of CPR with massage (teams)	149/158	146/160	0.39	0.71
Start of CPR with defibrillation (teams)	8/158	13/160	0.37	0.84
Any pause in CPR >10 s (teams)	29/158	30/160	0.93	0.20
Any pause in CPR >10 s (episodes)	33	32	0.79	0.57
For rhythm analysis/defibrillation	11/33	14/32	0.27	0.59
For airway management	22/33	18/32	0.51	0.53
Chest compression rates (strokes/min)	120 (115–125)	119 (111–127)	0.23	0.54
Compression rates <100/min (teams)	6/158	11/160	0.32	0.95
Within-team variance in four cycles (%)	10 (7–14)	11 (7–15)	0.19	0.07
Change overs (n)	2 (2–3)	2 (2–3)	0.89	0.65
Defibrillation				
Time of first defibrillation (s)	62 (47–102)	72 (52–99)	0.49	0.15
VF not recognised ≥once (teams)	10/158	3/160	0.14	0.08
Single shock defibrillation only (teams)	157/158	159/160	0.99	0.99
Shock with adequate energy (teams)	158/158	158/160	0.99	0.99
Restart CPR ≥4 s ≥once (teams)	50/158	53/160	0.78	0.45
Restart CPR ≥4 s (episodes)	64	68	0.79	0.24
Airway management				
Advanced airway management (teams)	153/158	156/160	0.47	0.59
Endotracheal tube: supraglottic airway	52:101	67:89	0.21	0.83
Timing of AAM (in cycle 1:2:3:4)	40:97:14:2	41:95:18:2	0.90	0.18
Ventilation rate before AAM (b/min)	6 (4–10)	4 (4–8)	0.09	0.42
Ventilation rate after AAM (b/min)	17 (11–24)	17 (11–25)	0.97	0.59
Medication				
Epinephrine administered (teams)	108/158	114/160	0.56	0.42
Correct dose administered (teams)	108/108	114/114	0.99	0.99
Second dose after 3–5 min (teams)	3/15	4/15	0.67	0.97
Amiodarone administered (teams)	132/158	133/160	0.64	0.32
Correct dose administered (teams)	132/132	133/133	0.99	0.99
Administered after epinephrine AND third shock (teams)	50/132	50/133	0.90	0.89
Administered before epinephrine (teams)	80/132	82/133	0.91	0.43
Incorrect ACLS drug administered (teams)	0/158	0/160	0.99	0.99

Data are medians (IQR). AAM, advanced airway management. ACLS, Advanced Cardiovascular Life Support; CPR, cardiopulmonary resuscitation; VF, Ventricular fibrillation.

Secondary outcomes are presented in [table 1](#). The family presence group did not differ from the control group in the CPR quality measures assessed except for a later start of resuscitation (14 (10–16) vs 15 (11–20) s; difference 2, 95% CI 1 to 3; p=0.001). Leadership assignments had no significant effect on any CPR quality measure.

DISCUSSION

In this prospective randomised simulator-based trial involving 318 resuscitation teams, interaction with family

members occurred during approximately one-quarter of the time available for CPR. While family presence was associated with an increase in frustration and perceived temporal and mental demands, no relevant effects on the quality of CPR were observed. Designated leadership was associated with shorter interactions with the family member and decreased mental demand.

Strengths of this trial include the large sample size, identical conditions for all teams and the in-depth analysis of a variety of CPR tasks and subtasks right from the



start of the event. Limitations of simulator-based studies include the absence of real patients and, in the present trial, of real relatives. Our teams consisted of physicians only, so findings might not necessarily generalise to other team compositions. Moreover, findings may not generalise to teams with more formalised CPR training and more frequent exposure like in emergency medicine. Teams had no prior knowledge of the presence of a family member and did not include an additional person designated for family support. However, this reflects reality in the vast majority of similar real cases. As only a small minority of family witnesses are aggressive or interfere with resuscitation activities,¹⁸ this trial assessed the impact of a non-obstructive family member which may differ from that of obstructive or overtly emotional family witnesses.¹⁶

So far, there are only limited data on the effects of family presence on the quality of CPR.³¹ Observational studies from institutions allowing family presence during CPR reported no apparent differences in patients' outcome after their change in policy.^{8 18 32} In a small simulator-based study the presence of a family witness resulted in delayed defibrillation and fewer defibrillation attempts.¹⁶ The present prospective randomised trial demonstrated that family presence had no negative effect on hands-on time, defibrillation patterns and most other CPR-related subtasks. The observed small delay in starting CPR in the family presence group might be a very subtle signal of an initially more complex process of within-team task allocation in the absence of a pre-designated person to support the family member. However, since this finding is of marginal, if any, medical relevance we conclude that the presence of a family witness has no relevant negative impact on the quality of CPR.

Emergency department staff reported increased stress by family presence during CPR, and 6 of 20 respondents reported being hampered in their activities.¹⁴ In a post-event questionnaire with the possibility of answering 'true' 'false' or 'I don't know' no difference in stress levels relating to family presence was reported in a large clinical trial.⁸ By contrast, the present trial found significant differences in frustration as well as perceived temporal and mental demand. While this may well be due to differences in specific circumstances like advanced knowledge and written guidelines in the prior trial,⁸ the Likert scale of the validated NASA load index²⁸ enables respondents to provide more fine-grained answers. Declaring oneself as 'stressed' as a dichotomous response may be subject to a rather high threshold, not least because admitting being stressed may imply appearing weak or not resilient.^{33 34} To the best of our knowledge, the present study is the first to quantify the interaction of the CPR team with a family member.

Family presence during CPR remains an emotional and controversial issue.^{2-4 35 36} While not resolving this controversy, the present findings indicate that the quality of CPR is not a valid argument against family presence. Our rescuers could cope with the additional task load

imposed by family presence. Thus, offering family presence during CPR does not imply weighing the benefits of relatives against the benefits of patients (high-quality CPR) but rather against the psychological well-being of the healthcare teams involved.^{35 36} However, temporarily dealing with unpleasant or stressful events is inherent in medical practice. Future research is necessary to determine whether training CPR with family presence can reduce or even abolish negative emotions encountered. Moreover, future research should address whether the psychology burden imposed by medical emergencies may have lasting negative effects on healthcare workers and/or their future patients.²⁴ Family presence during CPR imposes a significant additional temporal burden on the team of rescuers. Thus, in keeping with current guidelines,⁵⁻⁷ family presence should only be offered when the family can be adequately supported.

CONCLUSIONS

Family presence during CPR is an additional stressful burden in an already demanding task. However, teams of rescuers were able to cope with this burden and to perform CPR in similar quality as without family presence.

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Contributors Guarantor: SM is responsible for the overall content as guarantor; Conceptualisation, TS, DW, HS and SM; methodology, TS, DW and SM; software, TS; validation, MW, TS, SGR and SM; formal analysis, MW, TS, FT, NS and SM; investigation, MW and TS; resources, DW and HS; data curation, TS, DW and HS; writing—original draft preparation, SM; writing—review and editing, MW, TS, DW, HS, FT, NS and SGR; visualisation, MW, TS and SM; supervision, TS, DW, HS and SM; project administration, TS, DW and HS; funding acquisition, TS, DW and HS. All authors have read and agreed to the published version of the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Participants of educational courses were offered to participate in voluntary simulator-based workshops and informed that simulations were video-taped for scientific reasons. Identical workshops were offered to physicians wishing to participate but without being filmed. The trial was carried out following the rules of the Declaration of Helsinki and was approved by the Ethics Committee of Aerztchammer Westfalen-Lippe (2016–558 f-N) which waived the obligation to obtain written consent.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Video recordings are strictly confidential and cannot be shared. Anonymised data can be shared on reasonable request.

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