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Structured Plus/Delta Debriefing with Graphical Feedback Versus Conversational Debriefing and Chest Compression Quality in Simulated Cardiopulmonary Resuscitation Among Nursing Students: A Quasi-Experimental Study

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Abstract

Background/Objectives: Chest compression quality is a key determinant of survival after cardiac arrest. Debriefing is an essential educational tool in cardiopulmonary resuscitation training; however, limited evidence exists regarding the comparative effectiveness of specific debriefing approaches incorporating objective feedback. The objective of this study was to evaluate whether a structured Plus/Delta debriefing approach incorporating graphical performance feedback was associated with greater improvements in chest compression quality parameters than unstructured conversational debriefing in nursing students. **Methods**: A pre–post quasi-experimental study with a control group was conducted in nursing students. Participants were assigned to experimental or control groups at the academic subgroup level. The experimental group received a structured Plus/Delta debriefing approach incorporating graphical performance feedback, whereas the control group received conversational debriefing. Performance outcomes were assessed before and after the intervention. The primary outcome was the time spent with compression rate, compression depth, and residual leaning simultaneously within their recommended ranges, expressed in seconds. Data were primarily analyzed using linear mixed-effects models to account for repeated measures and clustering. Sensitivity analyses using ANCOVA models adjusted for baseline values and age were performed to assess the robustness of the findings. **Results**: A total of 112 participants were included ($n = 56$ per group), with no baseline differences between groups. Improvements were observed in both groups, although they were larger in the experimental group. Mixed-effects models showed significant group × time interactions, with the experimental group showing greater improvements in the primary outcome ($\beta = 91.40$ s, 95% CI 82.51–100.28; $p < 0.001$). Significant group × time interactions were also observed for the secondary compression-quality outcomes. The percentage of total test duration during which all three parameters were simultaneously within the recommended ranges increased in both groups and showed a greater improvement in the experimental group. A complementary analysis using a fixed 120 s observation period showed a greater proportion of time with all three parameters simultaneously within the recommended ranges in the experimental group (50.7% ± 24.8% vs. 42.8% ± 11.0%; $p = 0.042$). ANCOVA sensitivity analyses adjusted for baseline values and age yielded

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results consistent with the primary analysis. **Conclusions**: A structured Plus/Delta debriefing approach incorporating graphical performance feedback was associated with greater improvements in the consistency of guideline-compliant chest compression performance than unstructured conversational debriefing in undergraduate nursing students during simulated CPR training. However, given the quasi-experimental design, group-level allocation, potential practice effects, residual confounding, and the inability to isolate the independent contributions of structured debriefing and graphical feedback, causal inference should be made with caution. Randomized controlled studies are needed to confirm these findings, evaluate their long-term effects, and determine whether similar findings are observed in other populations and settings.

Keywords: cardiopulmonary resuscitation; chest compressions; simulation-based education; structured debriefing; nursing students

1. Introduction

Chest compression quality is a key determinant of cardiopulmonary resuscitation (CPR) performance and survival after cardiac arrest. Its main elements include compression fraction, compression rate, depth, chest recoil, residual leaning, and the minimization of interruptions [1–3].

Compression rate and depth are key rescuer-dependent factors, and deviations in either can compromise overall CPR quality [1,3–5]. These variables also influence chest recoil and residual leaning, as values outside the recommended range may hinder full recoil and increase residual leaning [1,6]. Therefore, time spent within guideline-recommended ranges may provide a complementary measure of CPR quality, as it captures not only whether adequate performance is achieved but also how consistently it is maintained throughout the assessment. Unlike mean compression values, which may remain within the recommended range despite intermittent periods of inadequate or excessive performance, time within the recommended range provides additional information on the temporal stability of chest compressions [7,8]. International guidelines recommend a compression rate of 100–120 compressions per minute and a depth of at least 50 mm while avoiding excessive depths greater than 60 mm in adults [7,8], which are associated with adequate perfusion of vital organs and better clinical outcomes [5,7–11].

Maintaining an optimal compression rate and depth over time is challenging, as both decline with rescuer fatigue [12–14]. For this reason, current guidelines [7,8] recommend switching rescuers approximately every minute [12–14] or, at least, every two minutes [15].

When a single rescuer must perform chest compressions for prolonged periods, maintaining adequate compression quality can be particularly challenging. In these situations, rescuer fatigue may lead to progressive deterioration in compression depth and overall CPR performance, emphasizing the need for training strategies that support the maintenance of high-quality chest compressions over time [12–15].

To enhance chest compression quality from the outset and sustain it over time, periodic training with appropriate educational strategies is recommended, with clinical simulation followed by debriefing being among the most widely used approaches [16–20]. However, acquiring CPR skills does not necessarily guarantee long-term competence, as psychomotor performance tends to decline over time after training. Previous studies have reported a deterioration in CPR performance when skills are not reinforced through repeated practice or ongoing training [16,21]. Therefore, identifying educational strategies that not only

enhance initial learning but also support sustained performance remains a key challenge in CPR education.

Debriefing following a simulated scenario is widely recognized as a key component of simulation-based learning, as it has been associated with reflective learning processes, reinforcement of correct actions, and identification of potential areas for improvement [22–26]. In addition, it contributes to a supportive learning environment [27].

Systematic reviews and meta-analyses in simulation-based education consistently highlight the central role of debriefing in the learning process and suggest that more structured approaches may enhance knowledge acquisition, reflective processes, and clinical performance compared with less structured formats [28]. However, the available evidence remains heterogeneous, reflecting differences in debriefing frameworks, facilitator experience, simulation contexts, and outcome measures across studies [25]. In addition, direct comparisons between specific debriefing models are still relatively scarce—particularly in the context of CPR training and when combined with objective feedback strategies—making it difficult to determine which approaches are most effective under controlled conditions [29–31].

Debriefing can be conducted in either an unstructured or structured manner. Unstructured debriefing is based on open and flexible feedback that encourages reflection and self-assessment, and is commonly used to analyze psychomotor skills such as chest compressions. In its conversational form, it promotes free dialogue following the simulated activity [29,30,32]. In contrast, structured debriefing follows defined phases (reaction, analysis, and summary), which may facilitate more organized reflection and potentially deeper learning [28,33].

In this context, how feedback is delivered plays a key role in learning outcomes. Evidence shows that feedback devices during CPR training improve skill acquisition, retention, and overall performance [21,34]. In particular, audiovisual and graphical feedback help learners interpret performance data more effectively, supporting self-assessment and reflection. When combined with debriefing, these strategies have been associated with improvements in CPR quality, especially in compression depth and rate [34]. Current evidence also supports integrating real-time and post-event feedback into simulation-based training to enhance adherence to CPR quality standards [35]. Therefore, incorporating graphical feedback into debriefing may further support understanding of performance and reflective learning [22]. However, it remains unclear to what extent the observed improvement in performance can be attributed to structured analysis, graphical performance feedback, or their combined effect, compared with unstructured conversational debriefing.

Within this approach, the Plus/Delta model identifies positive aspects and areas for improvement and is particularly suitable for time-constrained contexts, as well as for the use of visual aids such as a whiteboard [22,36,37].

Different debriefing models, used alone or in combination with other resources such as videos or checklists, have been shown to influence chest compression performance parameters during CPR [18,31,38,39]. For instance, structured Plus/Delta debriefing has been linked to improved guideline-compliant chest compressions in simulated settings [38]. Although this study was conducted by the same research group, it involved a different sample and study design. However, direct comparisons between debriefing approaches remain limited, as most simulation studies have evaluated single strategies in isolation, often in combination with additional educational resources [28]. Moreover, variability in study designs, outcome measures, and simulation protocols makes comparisons across studies challenging [21,28].

We hypothesized that participants receiving a combined structured Plus/Delta debriefing and graphical performance feedback intervention would show greater improvements

in chest compression quality compared with participants receiving unstructured conversational debriefing without graphical feedback. The objective of this study was to evaluate whether a structured Plus/Delta debriefing approach incorporating graphical performance feedback, compared with unstructured conversational debriefing, was associated with greater improvements in chest compression quality parameters in nursing students.

2. Materials and Methods

2.1. Ethics Statement

The study was conducted in accordance with the principles of the Declaration of Helsinki [40] and was approved by the Ethics Committee of the Catholic University of Murcia (UCAM). Students were informed about the study procedures, were told that participation was voluntary, and that they could withdraw at any time, and that non-participation would not affect their course grades. Written informed consent was obtained from all participants, and confidentiality was ensured by not collecting identifiable data.

2.2. Study Design

This study used a quantitative pre–post quasi-experimental design with a control group. It followed a non-equivalent-groups design, as participants were allocated at the academic subgroup level rather than individually randomized. The intervention was implemented in a natural educational setting using a predefined administrative allocation rule that was independent of the research team.

Allocation to study conditions was performed at the academic subgroup level using a predefined administrative rule based on subgroup numbering (with odd-numbered groups assigned to the experimental condition and even-numbered groups to the control condition). The allocation rule was established and implemented independently of the research team and was applied before the study data were analyzed. Because students were already organized into pre-existing academic subgroups, individual randomization was not feasible. Baseline characteristics and pre-intervention CPR performance were therefore compared between the experimental and control groups, and potential clustering at the academic subgroup level was accounted for in the statistical analyses.

The study adhered to the Transparent Reporting of Evaluations with Non-Randomized Designs (TREND) statement checklist for non-randomized intervention studies [41].

2.3. Participants and Setting

Participants were fourth-year nursing students at UCAM with prior CPR training as part of the nursing curriculum. However, detailed information regarding the content and timing of previous CPR training, certification status, and the time elapsed since the last CPR training session was not systematically collected. Students were organized into pre-existing academic subgroups, reflecting the institutional structure.

The study was conducted at the UCAM clinical simulation facilities between September and December 2025.

2.4. Sample Selection

The sample was selected using non-probability convenience sampling from pre-existing academic practice groups assigned by the UCAM Clinical Placement Unit.

A total of 375 fourth-year nursing students participating in clinical simulation training during the study period were invited to participate. Of these, 128 agreed to participate and were distributed across 14 pre-existing academic subgroups, with 7 subgroups assigned to the experimental condition and 7 to the control condition according to the predefined administrative allocation rule described above. At this stage, the academic subgroups

comprised 8–10 participating students per subgroup. As participants were pre-assigned to these groups, individual randomization was not feasible.

After excluding 16 participants who did not complete both CPR assessments, the final sample consisted of 112 participants. Eleven participants were excluded for not attending on the day of data collection, and five participants were excluded because they did not complete the CPR assessments due to physical discomfort, such as pain or exhaustion. Of the 16 excluded participants, 7 were from the experimental group and 9 from the control group. Therefore, the final sample comprised 112 participants, with 56 participants in each study group. Within each study group, participants were distributed across seven subgroups, each comprising 6 to 10 participants.

No a priori sample size or power calculation was performed. The final sample was determined by the number of eligible students who voluntarily agreed to participate during the study period. All participating academic subgroups were included, resulting in a final sample of 112 participants that reflected the available sample within the institutional simulation schedule.

The participant flow through enrollment, allocation, follow-up, and analysis is presented in Figure 1.

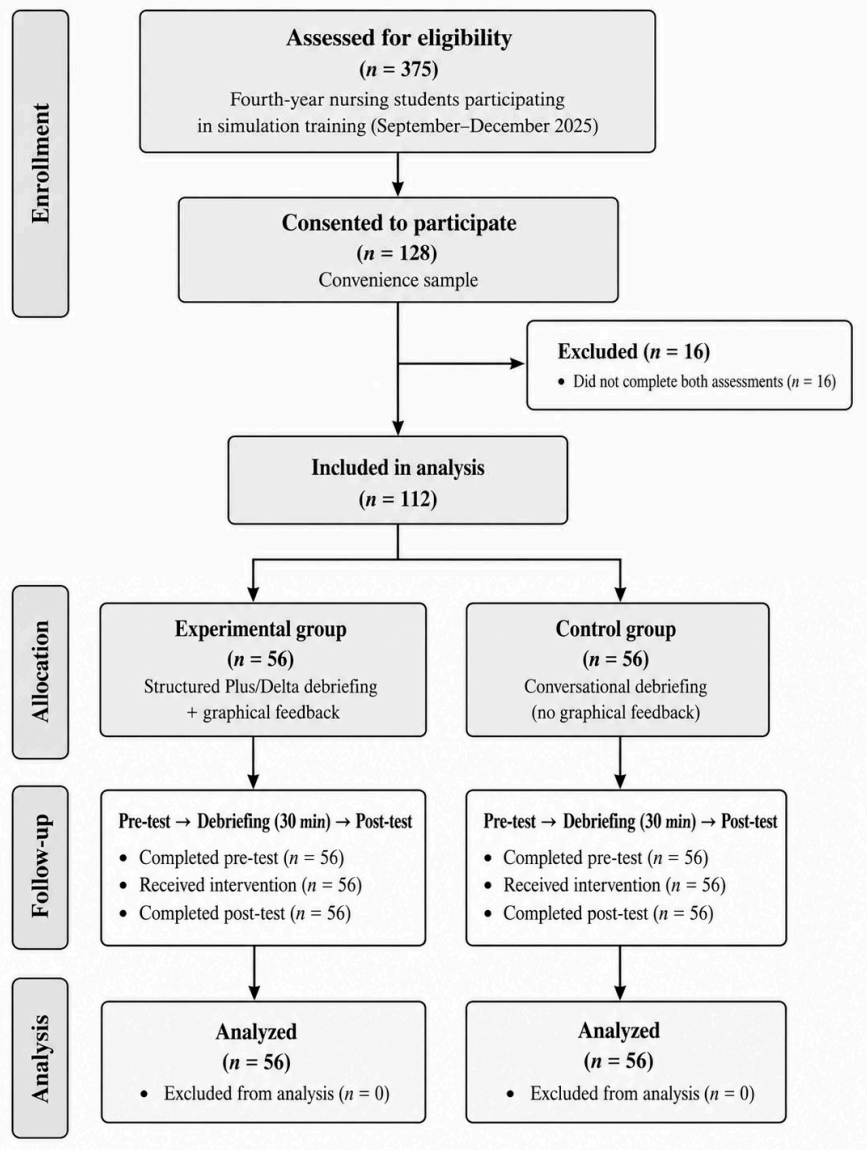

Figure 1. Flow diagram of participant enrollment, allocation, follow-up, and analysis.

2.5. Measurement Instrument and Data Collection

Chest compressions were performed using a life support simulation manikin (SimMan 3G, Laerdal, Stavanger, Norway) placed on the floor that was capable of continuously recording compression rate, depth, and residual leaning. The manikin records compression performance continuously over time, allowing the duration spent within predefined quality ranges to be identified from the recorded data.

Each participant performed chest compressions for a minimum of 120 s. After this minimum period, testing was terminated if the predefined stopping criterion was reached, defined as four consecutive compressions falling outside the predefined range for any of the three parameters (rate, depth, or residual leaning), indicating sustained deterioration in compression quality. All participants completed at least 120 s of chest compressions; therefore, the fixed 120 s sensitivity analysis could be performed for the entire sample. Total test duration was recorded. Because test termination was partly dependent on compression performance, participants who maintained adequate performance for longer could accumulate more time within the recommended ranges, potentially influencing the primary outcome. To assess the potential influence of unequal test duration, a sensitivity analysis was performed using a fixed 120 s observation period for all participants, with time within each recommended range calculated from the first 120 s of performance. In addition, the percentage of total test duration during which all three parameters were simultaneously within the recommended ranges was calculated as the time spent within all three ranges divided by total test duration and multiplied by 100. Chest compressions were considered adequate when the compression rate ranged between 100 and 120 compressions per minute and the depth between 50 and 60 mm [7,8].

Although simulation manikins can detect small deviations in chest recoil, these measurements have technical limitations due to biomechanical differences between manikins and real patients. The literature typically describes chest recoil as complete or incomplete, without defining thresholds in millimeters, while current guidelines recommend full chest decompression as the standard [7,8]. For analytical purposes, complete chest recoil was operationally defined as residual leaning $\leq$5 mm, consistent with previously described manikin-based CPR assessment approaches [42].

A pre-intervention chest compression test was conducted using the simulation manikin, followed by a 30 min debriefing session. A post-intervention chest compression test was subsequently performed under the same conditions.

The experimental group received a structured Plus/Delta debriefing session incorporating graphical performance feedback from the simulation manikin. The session was organized into reaction, analysis, and summary phases. During the analysis phase, participants first identified aspects of their performance that were effective (Plus) and then areas requiring improvement (Delta), which were recorded on a digital whiteboard to support structured reflection. Graphical performance data from the manikin, including the recorded CPR parameters, were then presented, allowing participants to compare their self-assessment with their recorded CPR performance over time and identify periods of compliance and deviation from the recommended ranges. The facilitator used these data to prompt participants to interpret their own performance, relate deviations to specific aspects of their compression technique, identify potential technical errors, and develop concrete strategies for improvement, without directly providing corrective explanations or solutions.

The control group participated in an open, conversational debriefing without graphical performance feedback. The session was guided by the instructor through an open discussion of participants' perceptions and experiences during the CPR performance. Participants were encouraged to reflect on their performance, describe aspects they considered

effective or requiring improvement, and discuss possible strategies for improving their technique. The instructor facilitated the discussion by asking open-ended questions and providing opportunities for participants to exchange observations, but did not use graphical performance data or a predefined Plus/Delta structure to guide the analysis.

The variables collected included gender, age, total test duration, time spent within the recommended compression rate range, mean compression rate, time spent within the recommended compression depth range, mean compression depth, time spent within the recommended residual leaning range, mean residual leaning, and time spent with all three compression parameters simultaneously within the recommended ranges. Compression data were recorded continuously by the manikin throughout each simulation. Data were processed from the complete continuous recording for each participant and were not divided into independent one-minute segments. Time spent within each recommended range was derived from these continuous recordings, while mean compression rate, depth, and residual leaning were calculated across the full duration of each simulation. The percentage of total test duration during which all three compression parameters were simultaneously within the recommended ranges was also calculated as a normalized measure of performance. Thus, all CPR performance variables were derived directly from the continuous manikin recordings obtained during each test.

2.6. Data Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA).

Descriptive statistics were calculated for all variables. Categorical variables are reported as frequencies and percentages, and continuous variables as means and standard deviations.

Baseline between-group differences were assessed using standardized mean differences (SMDs). SMDs were calculated as Hedges' g to account for small-sample bias, with values closer to zero indicating greater baseline balance between groups. An absolute SMD < 0.10 was considered indicative of minimal between-group imbalance at baseline.

The primary outcome was time spent with all three chest compression parameters—compression rate, compression depth, and residual leaning—simultaneously within the recommended ranges, expressed in seconds. This outcome was selected as an integrated indicator of overall chest compression quality. Time spent within the recommended range for each individual compression parameter and the corresponding overall mean values for compression rate, compression depth, and residual leaning were considered secondary outcomes and were not part of the primary outcome. The percentage of total test duration during which all three compression parameters were simultaneously within the recommended ranges was analyzed as an additional normalized outcome to account for potential differences in total test duration and was not considered the primary outcome. Primary analyses were conducted using linear mixed-effects models to account for repeated measures and the hierarchical structure of the data. The primary and secondary outcomes were analyzed using the same modeling approach. The additional normalized outcome was analyzed using the same modeling framework as a supplementary analysis. For each outcome, time (pre- vs. post-intervention) was included as a within-subject fixed effect, group (experimental vs. control) as a between-subject fixed effect, and the group $\times$ time interaction was included to estimate differential changes between the groups. Random intercepts were specified for academic subgroup and for participants nested within academic subgroup, accounting for clustering at the academic subgroup level and repeated observations within participants. Model assumptions were assessed using residual diagnostics. The β coefficient for the group $\times$ time interaction represents the difference in change from pre- to post-intervention between the experimental and control

groups (experimental change minus control change). The β coefficient is expressed in the same units as the corresponding outcome variable: seconds for time-based outcomes, compressions per minute for compression rate, millimeters for compression depth and residual leaning, and percentage points for the percentage of total test duration during which all three compression parameters were simultaneously within the recommended ranges. Positive β values indicate a greater increase from pre- to post-intervention in the experimental group, whereas negative β values indicate a greater decrease. For outcomes in which performance was interpreted according to proximity to the recommended range, the direction and magnitude of β coefficients were interpreted in relation to movement toward or away from the guideline-recommended range rather than simply as increases or decreases. Mixed-effects model estimates, 95% confidence intervals, *p*-values, and variance components for the random effects and residual error are reported.

Sensitivity analyses were conducted to assess the robustness of the primary findings. Separate ANCOVA models were performed for the primary outcome and each secondary outcome, with the corresponding baseline value and age included as covariates and group as the between-subject factor. Because academic subgroup was not included as a random effect in these models, the ANCOVA analyses were considered complementary rather than alternative specifications of the primary mixed-effects models. In addition, cluster-robust standard errors were applied to the linear mixed-effects models, with academic subgroup specified as the clustering unit, to assess the robustness of the estimates while accounting for the hierarchical structure of the data. The additional normalized outcome was analyzed using the same mixed-effects modeling framework but was considered supportive rather than confirmatory. Statistical significance was set at $p < 0.05$. Secondary outcomes and the additional normalized outcome were considered supportive rather than independently confirmatory. No adjustment for multiple comparisons was applied because the outcomes represented related dimensions of chest compression performance rather than independent hypotheses. Nevertheless, the use of multiple secondary outcomes and a complementary normalized outcome increases the possibility of type I error; therefore, these findings should be interpreted cautiously.

3. Results

Baseline demographic characteristics were generally well balanced between the experimental and control groups (Table 1).

Table 1. Baseline characteristics of participants by study group.

Variable	Experimental Group	Control Group	SMD	*p*-Value
Age, years, mean (SD)	22.61 (2.77)	22.48 (2.71)	0.046	0.810
Female, *n* (%)	37 (66.10)	34 (60.70)	0.111	0.695
Male, *n* (%)	19 (33.90)	22 (39.30)	—	—

Note: Values are presented as mean (standard deviation) for continuous variables and number (percentage) for categorical variables. SMD, standardized mean difference.

Pre-intervention chest compression performance is presented in Table 2 and was comparable between groups. Following the intervention, both groups showed an increase in the time spent within the recommended ranges for compression rate, compression depth, and residual leaning. For the primary outcome, time spent with all three compression parameters simultaneously within the recommended ranges increased from 113 ± 49.08 s to 250 ± 72.70 s in the experimental group and from 113.0 ± 48.64 s to 158 ± 57.50 s in the control group. Time spent within the recommended range for each individual compression parameter also increased in both groups; these measures were considered secondary outcomes. Total test duration was similar between groups at baseline but

was longer at post-intervention assessment, with a longer duration in the experimental group than in the control group. The percentage of total test duration during which all three compression parameters simultaneously remained within the recommended ranges increased from 51.2% to 78.5% in the experimental group and from 51.5% to 69.3% in the control group. A reduction in standard deviation was observed across most variables in both groups, suggesting greater consistency in performance after the intervention, although changes in variability were not formally tested. Baseline standardized mean differences were below 0.10 for all variables, indicating minimal between-group differences before the intervention (Table 2).

Table 2. Chest compression performance by group and time point.

Variable	Experimental Group Pre Mean (SD)	Control Group Pre Mean (SD)	SMD	*p* Value (Baseline)	Experimental Group Post Mean (SD)	Control Group Post Mean (SD)
Primary outcome: Time with all three compression parameters within the recommended ranges	113 (49.08)	113 (48.64)	0.000	0.94	250 (72.70)	158 (57.50)
Time within recommended compression rate range	214 (74.73)	213 (73.88)	0.013	0.96	266 (67.77)	242 (57.18)
Overall mean compression rate	114 (3.93)	114 (3.74)	0.000	0.78	111 (3.81)	114 (3.49)
Time within recommended depth range	213 (74.05)	213 (74.09)	0.000	0.99	313 (65.16)	249 (56.03)
Overall mean depth	53 (1.43)	53 (1.54)	0.000	0.65	51 (1.05)	53 (1.45)
Time within recommended residual leaning range	187 (71.70)	189 (71.77)	−0.028	0.88	238 (68.55)	221 (59.98)
Overall mean residual leaning	4 (1.19)	4 (1.23)	0.000	0.91	3 (1.13)	4 (1.01)
Total test duration	216 (75.46)	214 (73.90)	0.027	0.85	314 (65.80)	250 (60.14)
Percentage of total test duration within the recommended ranges for all three compression parameters	51.2 (5.23)	51.5 (5.28)	−0.057	0.77	78.5 (8.01)	69.3 (8.00)

Note: Values are presented as mean (standard deviation). Time is expressed in seconds. Compression rate is expressed in compressions per minute. Depth and residual leaning are expressed in millimeters. SMD, standardized mean difference, calculated using Hedges' g.

As a sensitivity analysis, the primary outcome was recalculated using a fixed 120 s observation period to address the potential influence of unequal test duration. The experimental group spent a greater proportion of this fixed observation period with all three compression parameters simultaneously within the recommended ranges compared with the control group (50.7% ± 24.8% vs. 42.8% ± 11.0%, respectively; $p = 0.042$). This difference was also observed in the absolute time spent within the recommended ranges (60.8 ± 29.8 s vs. 51.3 ± 13.2 s). These findings indicate that the between-group difference in simultaneous guideline-compliant performance was maintained when both groups were evaluated over an identical observation period.

Table 3 presents the results of the primary analyses. Significant group × time interactions were also observed for overall mean compression rate, compression depth, and residual leaning (Table 3). The negative β coefficients indicated greater decreases in adjusted mean values in the experimental group compared with the control group. Nevertheless, post-intervention mean values remained within the target ranges, suggesting that these differences primarily reflected changes within the guideline-recommended range rather than a clear improvement or deterioration in mean compression performance.

These findings indicate a greater improvement in the consistency and sustained maintenance of guideline-compliant CPR performance over time among participants in the experimental group than among those in the control group. This pattern was observed

among participants receiving the structured Plus/Delta debriefing approach incorporating graphical performance feedback compared with those receiving conversational debriefing.

Table 3. Linear mixed-effects models for chest compression performance outcomes.

Variable	β (95% CI)	*p*-Value	Academic Subgroup Variance	Participant Variance	Residual Variance
Primary outcome: Group × Time with all three compression parameters within the recommended ranges	91.40 (82.51 to 100.28)	<0.001	3286.08	185.53	287.74
Group × Time within recommended compression rate range	22.59 (16.66 to 28.92)	<0.001	5083.17	187.70	145.92
Group × Time—overall mean compression rate	−3.49 (−3.94 to −3.04)	<0.001	14.34	1.13	0.75
Group × Time within recommended depth range	64.11 (54.16 to 74.05)	<0.001	4740.50	91.69	360.55
Group × Time—overall mean compression depth	−2.11 (−2.35 to −1.86)	<0.001	2.09	0.08	0.22
Group × Time within recommended residual leaning range	19.00 (14.50 to 23.50)	<0.001	5086.29	239.55	73.70
Group × Time—overall mean residual leaning	−1.21 (−1.44 to −0.97)	<0.001	0.93	0.11	0.20
Group × Time—total test duration	62.39 (52.59 to 72.19)	<0.001	4945.98	127.97	330.79
Group × Time—percentage of total test duration within the recommended ranges for all three parameters	9.42 (8.19 to 10.65)	<0.001	21.13	21.94	5.51

Note: β represents the model-estimated between-group difference in pre–post change (experimental minus control), expressed in the same units as the outcome. Positive values indicate a greater increase in the experimental group; interpretation of continuous CPR measures should consider the recommended range. Linear mixed-effects models included random intercepts for academic subgroup and participants nested within academic subgroup; variance components are reported.

The mixed-effects models also showed substantial variance at the academic-subgroup level for several time-based outcomes, with variance estimates ranging from 3286.08 to 5086.29, compared with lower participant-level and residual variance components. This finding indicates substantial between-subgroup variability and supports accounting for the hierarchical structure of the data in the statistical analysis.

Sensitivity analyses using cluster-robust standard errors yielded similar estimates and did not alter the direction or statistical significance of the observed effects.

As a complementary sensitivity analysis, ANCOVA models were fitted using post-intervention values as the dependent variables and adjusting for baseline values of each outcome and age (Table 4). The results were consistent with the direction of the primary analysis, showing higher adjusted post-intervention values in the experimental group for total test duration, time spent within the recommended ranges for compression rate, compression depth, and residual leaning, as well as time and percentage of total test duration during which all three compression parameters were simultaneously within the recommended ranges. The experimental group also showed lower adjusted post-intervention values for overall mean compression rate, compression depth, and residual leaning, with group differences remaining within the recommended guideline ranges. Overall, these findings indicate that the observed between-group differences persisted after adjustment for baseline performance and age.

Overall, descriptive analyses, mixed-effects models, and sensitivity analyses consistently indicated greater improvements in guideline-compliant chest compression performance in the experimental group compared with the control group.

Table 4. Adjusted post-intervention differences between groups (ANCOVA).

Variable	Adjusted Mean Difference (β)	95% CI	*p*-Value
Primary outcome: Time with all three compression parameters within the recommended ranges	91.23	83.77 to 98.68	<0.001
Time within recommended compression rate range	22.78	18.26 to 27.30	<0.001
Overall mean compression rate	−2.86	(−3.27 to −2.45)	<0.001
Time within recommended depth range	64.16	56.29 to 72.02	<0.001
Overall mean depth	−2.16	(−2.38 to −1.95)	<0.001
Time within recommended residual leaning range	18.82	14.95 to 22.68	<0.001
Overall mean residual leaning	−1.35	(−1.56 to −1.15)	<0.001
Total test duration	62.95	56.08 to 69.82	<0.001
Percentage of total test duration within the recommended ranges for all three parameters	9.56	8.20 to 10.92	<0.001

Note: ANCOVA, analysis of covariance. β represents the adjusted mean difference between groups at post-intervention (experimental − control).

4. Discussion

The results of this study suggest that a structured Plus/Delta debriefing approach incorporating graphical feedback was associated with greater improvements in CPR compression quality compared with conversational debriefing. Participants in the structured debriefing with graphical feedback group showed larger improvements across performance metrics. However, part of the observed effect may reflect the pre–post design and repeated exposure, as previously described in simulation-based educational research [43]. Additionally, improvements may partly reflect a practice or retesting effect, whereby participants perform better due to repeated exposure to the assessment task itself, independent of the quality or structure of the debriefing. Overall, a consistent pattern favoring structured debriefing was observed. Because the analyzed outcomes reflect related aspects of chest compression performance, they should not be interpreted as independent confirmatory measures [44].

These observations agree with previous research on structured debriefing in simulation-based education, including studies showing improvements in CPR performance during simulated cardiopulmonary resuscitation [29–31]. Compared with our previous study [38], in which structured debriefing alone was associated with improvements in CPR performance, the present findings extend those observations by suggesting that combining the structured Plus/Delta debriefing approach with graphical performance feedback may be associated with greater performance consistency. While the earlier study primarily reported changes in mean values, the current results suggest that the proportion of time spent within guideline-compliant ranges provides additional information on temporal consistency that is not captured by mean values alone.

This is consistent with prior research showing that feedback effectiveness depends not only on its presence but also on how it is structured and delivered [32,33,36,37,45]. A plausible explanation for the greater improvements observed in the experimental group is that the combination of structured Plus/Delta reflection and graphical performance feedback may have enhanced feedback processing and performance awareness. These findings are also consistent with previous evidence suggesting that visual performance feedback, including graphical and audiovisual modalities, may improve CPR quality by facilitating immediate recognition of performance deviations and supporting more accurate self-assessment during training [34,39,46]. Because a structured Plus/Delta debriefing and graphical performance feedback were delivered simultaneously, the present design does not allow their individual contributions to be disentangled. Therefore, the observed between-group differences should be interpreted as an effect associated with the combined intervention rather than as evidence that either structured debriefing or graphical feedback

alone was responsible for the observed improvements [31]. Accordingly, this study should be interpreted within a quasi-experimental, non-equivalent groups design conducted in a natural educational setting.

Both groups showed increases in time within the recommended range for compression rate, depth, and residual leaning, although the improvements were more pronounced in the experimental group. These differences may partly reflect learning effects from the pre–post design. Analyses adjusting for baseline performance and sensitivity analyses yielded consistent results; nevertheless, residual confounding cannot be excluded.

The experimental group demonstrated larger improvements in the proportion of time spent within guideline-recommended ranges following a structured Plus/Delta debriefing approach with graphical performance feedback, consistent with the significant group × time interactions observed in the mixed-effects models. Because baseline performance was already within guideline-recommended ranges for most participants, ceiling effects may have limited the detectable changes in mean compression values. Thus, the negative coefficients should not be interpreted as indicating poorer performance, but rather as reflecting movement in mean values that remained within the guideline-recommended ranges. Rather than reflecting substantial changes in average performance, the findings suggest greater consistency in maintaining guideline-compliant chest compressions throughout the simulation. Accordingly, time within the recommended range may provide a more informative measure of sustained CPR performance than mean values alone, as it captures both the achievement and maintenance of guideline-compliant compressions over time. This distinction is relevant because an acceptable mean value may mask intermittent periods of inadequate or excessive compression depth. Descriptively, standard deviations were lower for several outcomes after the intervention; however, variability was not formally compared between groups.

The magnitude of the observed differences also deserves consideration. The experimental group showed a greater proportion of the assessment period during which all three compression parameters were simultaneously maintained within the recommended ranges, and this difference was also observed in the fixed 120 s sensitivity analysis. Although no established minimal clinically important difference is available for these specific time-within-range measures, the observed differences may have educational relevance because they indicate a greater ability to maintain guideline-compliant chest compression performance over time.

In the control group, unstructured conversational debriefing was also associated with increases in time within the recommended range, although to a lesser extent than in the experimental group, indicating that even less-structured approaches may produce measurable changes [28,30,45].

From a clinical training perspective, increases in time within guideline-recommended ranges may reflect improved ability to sustain high-quality chest compressions during a standardized simulation. In simulation-based CPR education, improvements in the proportion of time spent within guideline-compliant ranges are generally considered educationally relevant outcomes, as they reflect the learner's ability to maintain consistent performance rather than achieving only brief periods of correct technique [23,26,28]. Taken together, these findings suggest a potentially relevant educational improvement in the consistency and sustained maintenance of guideline-compliant chest compression performance during simulation [16,47,48]. This type of improvement is particularly relevant in training settings, where consistency and error reduction are key learning objectives [16,18,19,28]. Although valuable for simulation-based education, translation to real-world clinical outcomes cannot be assumed. Therefore, the findings should be interpreted as evidence of performance changes within a standardized simulation context rather than as evidence of improved CPR

performance or patient outcomes in actual clinical cardiac arrest situations. No conclusions regarding patient outcomes, survival, or long-term skill retention can be drawn, as these were not assessed. High-quality chest compressions are strongly associated with improved survival in cardiac arrest, underscoring the importance of effective training strategies to optimize CPR performance [5,49,50].

From an educational perspective, the findings suggest that a structured Plus/Delta debriefing approach with graphical performance feedback may warrant further evaluation in more advanced training contexts, whereas less structured approaches may remain useful in large-scale basic training settings [28,32,36,37].

Several limitations should be considered when interpreting these findings. The use of a single instructor who was not blinded to group allocation may have introduced instructor-related bias, particularly because the debriefing approaches differed between groups. Although using the same instructor across conditions reduced variability between facilitators and helped maintain consistency in the delivery of the sessions, the instructor's knowledge of group assignment could have influenced the interaction, emphasis, or feedback provided during the debriefing sessions. Therefore, a facilitator-related effect cannot be completely excluded. The predefined stopping rule linked compression quality to test duration; therefore, the primary outcome, time within the recommended ranges for all three compression parameters, reflects both performance quality and exposure time, which may potentially inflate between-group differences. However, the sensitivity analysis using a fixed 120 s observation period yielded consistent between-group differences, suggesting that the observed differences were not solely attributable to differences in test duration. Non-randomized allocation may have introduced residual confounding, and causal inference should be made with caution. Accordingly, the observed between-group differences should be interpreted as associations rather than definitive evidence of a causal effect of the debriefing strategy.

In addition, participants were allocated at the academic-group level rather than individually, which introduces potential cluster effects. Although mixed-effects models and cluster-robust standard errors were used to account for the hierarchical structure of the data, residual differences between academic subgroups cannot be fully excluded. Additionally, the mixed-effects analysis revealed substantial variability across academic subgroups, particularly for time-based outcomes. For most of these measures, the variance attributable to academic subgroups exceeded both participant-level and residual variance components. This finding suggests that CPR performance may have been influenced not only by individual characteristics but also by the academic subgroup in which training took place, supporting the use of a multilevel analytical approach. From an educational perspective, these findings suggest that CPR training interventions should monitor not only individual progress but also the group-level dynamics that may emerge during practical training sessions. The predefined administrative allocation rule reduced the potential for investigator-driven allocation, but it did not provide the protection against confounding afforded by individual randomization. Potential contamination between academic subgroups should also be considered, as students belonged to the same academic cohort and informal exchange of information between groups may have occurred, potentially attenuating differences between conditions. Furthermore, although allocation followed a predefined administrative rule independent of the research team and baseline comparability was observed, residual confounding cannot be entirely ruled out, as unmeasured group-level or individual-level factors may have influenced the observed outcomes despite statistical adjustment. Although all participants had received prior CPR training as part of the nursing curriculum, detailed information regarding the content and extent of previous training, timing of the last training session, certification status, and time elapsed since the

last CPR exposure was not collected. These factors may have contributed to variability in baseline CPR skills and could not be fully controlled for in the analyses, representing a potential source of residual confounding.

The single-university setting, convenience sampling, and inclusion of only fourth-year nursing students may limit the external validity of the findings. Participants shared a common educational background and prior exposure to CPR training, and the results may therefore not be directly generalizable to other healthcare professionals, students at different stages of training, or clinicians with different levels of clinical experience. In addition, the study was conducted in a simulated environment using a manikin rather than during actual cardiac arrest care. Although simulation provides a standardized setting for evaluating CPR performance, improvements observed in simulated chest compressions cannot be assumed to translate directly into clinical practice or patient outcomes.

Although a sensitivity analysis using a fixed 120 s observation period was conducted to assess the robustness of the findings to differences in test duration, this analysis does not compensate for the absence of an a priori sample size or power calculation. The study may therefore be underpowered to detect small effects, increasing the risk of type II error. However, the sample size was determined by feasibility within a real educational setting, where participants were drawn from pre-existing academic subgroups with a fixed number of eligible students. This pragmatic approach is common in simulation-based educational research, although it may limit the precision and generalizability of the findings. No adjustment for multiple comparisons was applied, which represents an additional limitation. This approach was chosen because the study included one primary outcome and a limited number of secondary and additional outcomes assessing related dimensions of chest compression performance. Nevertheless, analyzing multiple outcomes and conducting complementary sensitivity analyses increases the risk of type I error at the family-wise level. Therefore, the secondary and additional findings should be considered supportive rather than independently confirmatory, and the overall pattern of results should be interpreted cautiously.

Only immediate post-intervention performance was assessed, and no follow-up assessments were conducted. Therefore, the study cannot determine whether the observed improvements were retained over subsequent weeks or months or whether the intervention resulted in lasting learning. The findings should consequently be interpreted as short-term changes in simulated CPR performance rather than evidence of long-term skill retention. Future studies should include follow-up assessments at predefined intervals to determine whether performance gains are maintained over time.

An additional limitation is that the experimental intervention combined the structured Plus/Delta debriefing approach with graphical performance feedback. Because these components were delivered together, the independent contribution of each component cannot be determined. Future studies should use randomized designs and longer-term follow-up to confirm these findings and to disentangle the individual contributions of the Plus/Delta structure and graphical feedback. Overall, the structured Plus/Delta debriefing approach with graphical performance feedback was associated with greater improvements in CPR performance compared with unstructured conversational debriefing. Both approaches led to measurable improvements, although effectiveness may vary depending on the training context. Taken together, these findings should be considered exploratory and require confirmation in randomized controlled trials.

5. Conclusions

The structured Plus/Delta debriefing approach incorporating graphical feedback was associated with a greater improvement in the primary outcome, defined as the time during

which compression rate, compression depth, and residual leaning were simultaneously within guideline-recommended ranges, compared with unstructured conversational debriefing in nursing students. Because the two intervention components were delivered simultaneously, their independent contributions could not be determined. These findings suggest greater consistency in maintaining guideline-compliant chest compression performance during the post-intervention simulation. However, given the quasi-experimental design and group-level allocation, the findings should be interpreted with caution and confirmed in randomized controlled studies.

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References

1. González-Otero, D.M.; Russell, J.K.; Ruiz, J.M.; Ruiz de Gauna, S.; Gutiérrez, J.J.; Leturiondo, L.A.; Daya, M.R. Association of chest compression and recoil velocities with depth and rate in manual cardiopulmonary resuscitation. *Resuscitation* **2019**, *142*, 119–126. [CrossRef] [PubMed]
2. Lee, S.H.; Kim, K.; Lee, J.H.; Kim, T.; Kang, C.; Park, C.; Kim, J.; Jo, Y.H.; Rhee, J.E.; Kim, D.H. Does the quality of chest compressions deteriorate when the chest compression rate is above 120/min? *Emerg. Med. J.* **2014**, *31*, 645–648. [CrossRef] [PubMed]
3. Smereka, J.; Iskrzycki, Ł.; Makomaska-Szaroszyk, E.; Bielski, K.; Frass, M.; Robak, O.; Ruetzler, K.; Czekajło, M.; Rodríguez-Núñez, A.; López-Herce, J.; et al. The effect of chest compression frequency on the quality of resuscitation by lifeguards: A prospective randomized crossover multicenter simulation trial. *Cardiol. J.* **2019**, *26*, 769–776. [CrossRef] [PubMed]
4. Agostinucci, J.M.; Weisslinger, L.; Marzouk, N.; Zouaghi, H.; Ekpe, K.; Genthillomme, A.; Adnet, F.; Guenin, A.; Reuter, P.G.; Lapostolle, F. Relation between chest compression rate and depth: The ENFONCE study. *Eur. J. Emerg. Med.* **2021**, *28*, 352–354. [CrossRef] [PubMed]
5. Duval, S.; Pepe, P.E.; Aufderheide, T.P.; Goodloe, J.M.; Debaty, G.; Labarère, J.; Sugiyama, A.; Yannopoulos, D. Optimal combination of compression rate and depth during cardiopulmonary resuscitation for functionally favorable survival. *JAMA Cardiol.* **2019**, *4*, 900–908. [CrossRef] [PubMed]
6. Chandran, K.; Algaze Gonzalez, I.M.; Wang, S.; Davis, D.P. Chest Decompressions—The driver of CPR efficacy: Exploring the relationship between compression rate, depth, recoil velocity, and end-tidal CO_2. *Prehosp. Emerg. Care* **2025**, *29*, 154–161. [CrossRef] [PubMed]
7. Del Rios, M.; Bartos, J.A.; Panchal, A.R.; Atkins, D.L.; Cabañas, J.G.; Cao, D.; Dainty, K.N.; Dezfulian, C.; Donoghue, A.J.; Drennan, I.R.; et al. Part 1: Executive summary: 2025 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* **2025**, *152*, S284–S312. [CrossRef] [PubMed]
8. Smyth, M.A.; van Goor, S.; Hansen, C.M.; Fijačko, N.; Nakagawa, N.K.; Raffay, V.; Ristagno, G.; Rogers, J.; Scquizzato, T.; Smith, C.M.; et al. European Resuscitation Council Guidelines 2025: Adult basic life support. *Resuscitation* **2025**, *215*, 110771. [CrossRef] [PubMed]
9. Deliliga, A.; Chatzinikolaou, F.; Koutsoukis, D.; Chrysovergis, I.; Voultsos, P. Cardiopulmonary resuscitation (CPR) complications encountered in forensic autopsy cases. *BMC Emerg. Med.* **2019**, *19*, 23. [CrossRef] [PubMed]
10. Lukas, R.P.; Gräsner, J.T.; Seewald, S.; Lefering, R.; Weber, T.P.; Van Aken, H.; Fischer, M.; Bohn, A. Chest compression quality management and return of spontaneous circulation: A matched-pair registry study. *Resuscitation* **2012**, *83*, 1212–1218. [CrossRef] [PubMed]

11. Nichol, G.; Daya, M.R.; Morrison, L.J.; Aufderheide, T.P.; Vaillancourt, C.; Vilke, G.M.; Idris, A.; Brown, S. Compression depth measured by accelerometer vs. outcome in patients with out-of-hospital cardiac arrest. *Resuscitation* **2021**, *167*, 95–104. [CrossRef] [PubMed]
12. Heydari, F.; Eghdami, K.; Zamani, M.; Golshani, K.; Masoumi, B. Evaluation of the effect of shift cycle time on chest compression quality during cardiopulmonary resuscitation. *Tzu-Chi Med. J.* **2021**, *33*, 270–274. [CrossRef] [PubMed]
13. Kim, D.H.; Seo, Y.W.; Jang, T.C. CPR quality with rotation of every 1 versus 2 minutes as characteristics of rescuers: A randomized crossover simulation study. *Medicine* **2023**, *102*, e33066. [CrossRef] [PubMed]
14. Mathew, M.J.; Kundra, P.; Vinayagam, S. Chest compression quality comparing 1-min vs 2-min rotation of rescuers wearing N95 masks. *Am. J. Emerg. Med.* **2024**, *76*, 75–81. [CrossRef] [PubMed]
15. Kılıç, D.; Göksu, E.; Kılıç, T.; Buyurgan, C.S. Resuscitation quality of rotating chest compression providers at one-minute vs. two-minute intervals: A mannequin study. *Am. J. Emerg. Med.* **2018**, *36*, 829–833. [CrossRef] [PubMed]
16. Anderson, R.; Sebaldt, A.; Lin, Y.; Cheng, A. Optimal training frequency for acquisition and retention of high-quality CPR skills: A randomized trial. *Resuscitation* **2019**, *135*, 153–161. [CrossRef] [PubMed]
17. Haffner, L.; Mahling, M.; Muench, A.; Castan, C.; Schubert, P.; Naumann, A.; Reddersen, S.; Herrmann-Werner, A.; Reutershan, J.; Riessen, R.; et al. Improved recognition of ineffective chest compressions after a brief Crew Resource Management (CRM) training: A prospective, randomised simulation study. *BMC Emerg. Med.* **2017**, *17*, 7. [CrossRef] [PubMed]
18. Parikh, P.; Samraj, R.; Ogbeifun, H.; Sumbel, L.; Brimager, K.; Alhendy, M.; McElroy, J.; Whitt, D.; Henderson, C.; Bhalala, U. Simulation-based training in high-quality cardiopulmonary resuscitation among neonatal intensive care unit providers. *Front. Pediatr.* **2022**, *10*, 808992. [CrossRef] [PubMed]
19. Rojo, E.; Maestre, J.M.; Piedra, L.; Esteban, J.; Sánchez, B.; Hoz, V.; Del Moral, I. Interprofessional team training with in situ simulation to improve the quality of cardiopulmonary resuscitation. *J. Healthc. Qual. Res.* **2022**, *37*, 92–99. [CrossRef] [PubMed]
20. Del Carmen Pérez-Fuentes, M.; Del Mar Molero Jurado, M.; Romanos-Rodríguez, A.; Martos Martínez, Á.; Gómez-Gómez, F.J.; Aguado-Campos, J. Self-efficacy and Communication in Health Personnel After Simulation Training in Cardiopulmonary Resuscitation: A Quasi-experimental Study. *Inquiry* **2026**, *63*, 469580251411471. [CrossRef] [PubMed]
21. Nicolau, A.; Jorge, I.; Vieira-Marques, P.; Sa-Couto, C. Influence of Training With Corrective Feedback Devices on Cardiopulmonary Resuscitation Skills Acquisition and Retention: A Systematic Review and Meta-Analysis. *JMIR Med. Educ.* **2024**, *10*, e59720. [CrossRef] [PubMed]
22. Escribano, G.; Ruzafa-Martínez, M.; Leal-Costa, C.; Díaz-Agea, J.L.; Ramos-Morcillo, A.J.; García, A. Debriefing and Learning Strategies: A Comparison between Two Reflective Analysis Styles with/without a Graphical Record of Strengths/Weaknesses. *Healthcare* **2021**, *9*, 130. [CrossRef] [PubMed]
23. INACSL Standards Committee; Decker, S.; Sapp, A.; Bibin, L.; Brown, M.R.; Chidume, T.; Crawford, S.B.; Fayyaz, J.J.; Johnson, B.K.; Szydlowski, J. The impact of simulation debriefing process on learning outcomes: An umbrella review. *Clin. Simul. Nurs.* **2025**, *101*, 101715. [CrossRef]
24. Holmes, C.; Mellanby, E. Debriefing strategies for interprofessional simulation: A qualitative study. *Adv. Simul.* **2022**, *7*, 18. [CrossRef] [PubMed]
25. MacKenna, V.; Díaz, D.A.; Chase, S.K.; Boden, C.J.; Loerzel, V. Self-debriefing in healthcare simulation: An integrative literature review. *Nurse Educ. Today* **2021**, *102*, 104907. [CrossRef] [PubMed]
26. Salik, I.; Paige, J.T. Debriefing the interprofessional team in medical simulation. In *StatPearls [Internet]*; StatPearls Publishing: Treasure Island, FL, USA, 2023. Available online: https://www.ncbi.nlm.nih.gov/books/NBK554526/ (accessed on 3 July 2025).
27. Medel, D.; Cemeli, T.; Sanromà-Ortíz, M.; Jimenez-Herrera, M.; Bonet, A.; Torné-Ruiz, A.; Roca, J. Exploring communicative interactions in debriefing sessions with nursing students: A qualitative study. *Nurse Educ. Today* **2024**, *142*, 106334. [CrossRef] [PubMed]
28. Niu, Y.; Liu, T.; Li, K.; Sun, M.; Sun, Y.; Wang, X.; Yang, X. Effectiveness of simulation debriefing methods in nursing education: A systematic review and meta-analysis. *Nurse Educ. Today* **2021**, *107*, 105113. [CrossRef] [PubMed]
29. Dogu, O.; Bozkurt, R.; Ziyai, N.Y.; Elcin, M.; Aygin, D. Use of different debriefing methods after in situ simulation with intensive care unit nurses. *Nurs. Crit. Care* **2024**, *29*, 953–961. [CrossRef] [PubMed]
30. Nur Fariduddin, M.; Wee, L.; Halim, L.; Jaafar, M. Structured vs. unstructured debriefing: Finding the right approach in cabin crews' simulation-based resuscitation training. *ASM Sci. J.* **2020**, *13*, 1–15. [CrossRef]
31. Cheng, A.; Davidson, J.; Wan, B.; St-Onge-St-Hilaire, A.; Lin, Y. Data-informed debriefing for cardiopulmonary arrest: A randomized controlled trial. *Resusc. Plus* **2023**, *14*, 100401. [CrossRef] [PubMed]
32. Almomani, E.; Sullivan, J.; Saadeh, O.; Mustafa, E.; Pattison, N.; Alinier, G. Reflective learning conversations model for simulation debriefing: A co-design process and development innovation. *BMC Med. Educ.* **2023**, *23*, 837. [CrossRef] [PubMed]
33. Jørgensen, T.; Rosenkrantz, O.; Eberhard, K.E.; Jensen, T.W.; Dieckmann, P. Perceptions of medical students on narrow learning objectives and structured debriefing in medical escape rooms: A qualitative study. *BMC Med. Educ.* **2024**, *24*, 403. [CrossRef] [PubMed]

34. Lin, Y.; Lockey, A.; Donoghue, A.; Greif, R.; Cortegiani, A.; Farquharson, B.; Siddiqui, F.J.; Banerjee, A.; Matsuyama, T.; Cheng, A. Use of CPR feedback devices in resuscitation training: A systematic review and meta-analysis of randomized controlled trials. *Resusc. Plus* **2025**, *23*, 100939. [CrossRef] [PubMed]
35. Finn, J.C.; Bhanji, F.; Lockey, A.; Monsieurs, K.; Frengley, R.; Iwami, T.; Lang, E.; Ma, M.H.-M.; Mancini, M.E.; McNeil, M.A.; et al. Part 8: Education, implementation, and teams. 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* **2015**, *95*, e203–e224. [CrossRef] [PubMed]
36. Cheng, A.; Eppich, W.; Epps, C.; Kolbe, M.; Meguerdichian, M.; Raemer, D.; Rudolph, J.W. Embracing informed learner self-assessment during debriefing: The art of plus-delta. *Adv. Simul.* **2021**, *6*, 22. [CrossRef] [PubMed]
37. Kainth, R. Dynamic plus-delta: An agile debriefing approach centred around variable participant, faculty and contextual factors. *Adv. Simul.* **2021**, *6*, 35. [CrossRef] [PubMed]
38. García-Álvarez, J.M.; García-Sánchez, A. Effect of Plus/Delta Structured Debriefing on the Duration of Guideline-Compliant Chest Compressions During Simulated Cardiopulmonary Resuscitation. *Emerg. Care Med.* **2026**, *3*, 12. [CrossRef]
39. Ghaderi, M.S.; Malekzadeh, J.; Mazloum, S.; Pourghaznein, T. Comparison of real-time feedback and debriefing by video recording on basic life support skill in nursing students. *BMC Med. Educ.* **2023**, *23*, 62. [CrossRef] [PubMed]
40. World Medical Association. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA* **2013**, *310*, 2191–2194. [CrossRef] [PubMed]
41. Des Jarlais, D.C.; Lyles, C.; Crepaz, N.; TREND Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: The TREND statement. *Am. J. Public Health* **2004**, *94*, 361–366. [CrossRef] [PubMed]
42. Stuby, L.; Jampen, L.; Sierro, J.; Bergeron, M.; Paus, E.; Spichiger, T.; Suppan, L.; Thurre, D. Effect of Early Supraglottic Airway Device Insertion on Chest Compression Fraction during Simulated Out-of-Hospital Cardiac Arrest: Randomised Controlled Trial. *J. Clin. Med.* **2022**, *11*, 217. [CrossRef] [PubMed]
43. Mitchell, A.A.; Ivimey-Cook, E.R. Technology-enhanced simulation for healthcare professionals: A meta-analysis. *Front. Med.* **2023**, *10*, 1149048. [CrossRef] [PubMed]
44. Liu, C.; Kudenchuk, P.K.; Rea, T.; Kwok, H. The CPR compression matrix: Relationship among depth, recoil, and rate. *Resuscitation* **2026**, *224*, 111117. [CrossRef] [PubMed]
45. Masterson, S.; Norii, T.; Yabuki, M.; Ikeyama, T.; Nehme, Z.; Bray, J. Real-time feedback for CPR quality: A scoping review. *Resusc. Plus* **2024**, *19*, 100730. [CrossRef] [PubMed]
46. Lee, H.; Kim, J.; Joo, S.; Na, S.H.; Lee, S.; Ko, S.B.; Lee, J.; Oh, S.Y.; Ha, E.J.; Ryu, H.G. The effect of audiovisual feedback of monitor/defibrillators on percentage of appropriate compression depth and rate during cardiopulmonary resuscitation. *BMC Anesthesiol.* **2023**, *23*, 334. [CrossRef] [PubMed]
47. Prakash, P.; Nayak, K.R.; Babu, A.S.; Devi, E.S.; Chaudhuri, S.; Pai, D.R.; Krishnan, S.V. Impact of cardiopulmonary resuscitation health care workers' physical health parameters on cardiopulmonary resuscitation performance quality in simulated manikin-based settings—A systematic review. *JACEP Open* **2026**, *7*, 100395. [CrossRef] [PubMed]
48. Sawee, C.; Churuangsuk, C.; Vattanavanit, V. Effect of Compression Rotation Intervals on Cardiopulmonary Resuscitation Quality: A Systematic Review and Meta-Analysis. *Arch. Acad. Emerg. Med.* **2025**, *13*, e58. [CrossRef] [PubMed]
49. Song, J.; Guo, W.; Lu, X.; Kang, X.; Song, Y.; Gong, D. The effect of bystander cardiopulmonary resuscitation on the survival of out-of-hospital cardiac arrests: A systematic review and meta-analysis. *Scand. J. Trauma Resusc. Emerg. Med.* **2018**, *26*, 86. [CrossRef] [PubMed]
50. Ruiz Azpiazu, J.I.; Fernández Del Valle, P.; Escriche, M.C.; Royo Embid, S.; Fernández Barreras, C.; Azeli, Y.; Juanes García, M.; Batres Gómez, S.; Valenciano Rodríguez, J.; Luque Hernández, M.J.; et al. Incidence, treatment, and factors associated with survival of out-of-hospital cardiac arrest attended by Spanish emergency services: Report from the Out-of-Hospital Spanish Cardiac Arrest Registry for 2022. *Emergencias* **2024**, *36*, 131–139. [CrossRef] [PubMed]

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