Improving CPR Quality with Online Booster Training System in Medical Students:

A Randomized Controlled Trial

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1. Objective

To explore the effect of the online booster training system on cardiopulmonary resuscitation (CPR) skill retention among adult CPR learners.

2. Participants

Medical university students, who have received the standardized offline AHA BLS course.

Inclusion Criteria

- Aged ≥ 18 years; no CPR training within the past 3 years.
- Full attendance and completion of the initial offline CPR course.
- Voluntary participation and signed informed consent.
- Availability of smart phones, tablets or computers for online training and follow-up.

Exclusion Criteria

- Physical limitations preventing high-quality chest compression (e.g., severe carpal tunnel syndrome, spinal diseases, etc.).
- Prior CPR learning experience or potential access to additional spontaneous CPR booster training after initial training.
- Unavailability to complete follow-up assessments within the study period for any reason.

3. Randomization

Participants will be randomly allocated (1:1) to either of groups using the online system, with an online random number generator (www.randomizer.org). The numbers were randomly assigned to consented participants by a person, who is not a member of the research team.

Blinding: Outcome assessors, offline training instructors and statistical analysts are blinded. Due to the nature of the intervention, participants are not blinded.

4. Interventions

Intervention group (Online Booster Training Group)

Requirements: Within 3 months after initial training, participants should complete full online training session **at least once per month**.

Platform: Qilu Online Booster Training System for Adult Cardiopulmonary Resuscitation.

Contents: Teaching review (video lectures); practice assessment.

Control group (No Booster Training Group)

No booster training of any form was provided. Participants only returned for outcome assessment at the end of 3rd month.

5. Outcomes

5.1 Primary Outcome

Excellent CPR, which was defined as at least 90% guideline-compliance for depth, rate and recoil of chest compression.

5.2 Secondary Outcome

(i) compression depth (mm), assessed with the certified CPR manikins.

(ii) compression rate (per minute), assessed with the certified CPR manikins.

(iii) Percentage of compression depth > 50 mm.

(iv) Percentage of CC (chest compression) with rate of 100–120/min.

(v) Percentage of CC with complete recoil.

(vi) The pass rate of theoretical test, at 3 months after initial training.

6. Sample Size Calculation

The sample size was estimated based on the primary outcome measure. A previous study showed that the proportion of "excellent CPR" without booster training is 88%. We expected to detect a 10% difference in the proportion of excellent CPR between groups. Based on these assumptions, an alpha of 0.05 and a power of 0.8, assuming a dropout of 5%, we will aim to include 105 participants per group, that is, a total of 210 participants.

7. Statistical Analysis

variables will be assessed for normal distribution and reported as means (SD) or medians (IQR), whichever is appropriate. Continuous data will be compared using a Student's t-test or Mann-Whitney U test, whichever is appropriate. Categorical variables will be reported as

numbers (%) and compared using $\chi 2$ or Fisher's exact tests, whichever is appropriate. All baseline variables and outcome data variables will also be compared between the two study groups using the abovementioned tests. In case of confounding variables, we will correct comparisons on the outcome measures between the study groups for these confounders using analysis of covariance. A p-value of <0.05 will be considered statistically significant. Analyses will be performed using SPSS V.25.