

RESEARCH PROTOCOL

Part 1

Project summary

This is a prospective, parallel-group, randomized controlled trial with a 2×2 factorial design (hand size: small <170mm vs. non-small ≥170mm; technique: C-E vs. LASOO). The study compares two BVM mask-holding techniques in 208 female nurses. The primary outcome is mean tidal volume. Secondary outcomes include tidal volume threshold attainment (400mL and 150mL), technique correctness rate, and Borg CR-10 fatigue score. Participants are stratified by hand length and randomized 1:1 to C-E or LASOO. Analysis uses two-way ANOVA for interaction effect and TOST equivalence testing (±20mL margin). The study has obtained authorization from the original LASOO developer and is registered with ISRCTN.

General information

Protocol title: A Comparative Study of LASOO Technique and C-E Technique for Bag-Valve-Mask Ventilation in Female Nurses

Sponsor/funder: Self-funded

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Rationale & background information

Bag-valve-mask (BVM) ventilation is a core resuscitation skill. The widely taught C-E technique—thumb and index finger forming a "C" to seal the mask, remaining fingers forming an "E" to lift the jaw—was developed for Western populations and requires sufficient hand length to simultaneously seal the mask and lift the jaw. When hand length is insufficient, these two actions conflict, causing leakage.

According to GB/T 16252-2023 (Hand sizing of adults), the mean hand length of adult Chinese females is 170 mm, shorter than Western populations for whom the C-E technique was originally designed. Over 95% of Chinese nurses are female, meaning hand size limitations affect the majority of the nursing workforce.

The LASOO technique (Strzelecki et al., 2020) modifies the mechanics of force application to reduce hand length dependence. The original UK study found LASOO non-inferior to C-E but did not examine hand size × technique interaction, nor validate in Asian populations. Our team obtained formal authorization from Dr. Clifford L Shelton (corresponding author of the original LASOO study) in 2023 to independently validate LASOO in a Chinese population.

References

1. Strzelecki C, Shelton CL, Cunningham J, et al. A randomised controlled trial of bag-valve-mask teaching techniques. *Clin Teach*. 2020;17(1):41-46.
2. GB/T 16252-2023. Hand sizing of adults. Standards Press of China, 2023.
3. NCD Risk Factor Collaboration (NCD-RisC). Height and body-mass index trajectories of school-aged children and adolescents from 1985 to 2019 in 200 countries and territories: a pooled analysis of 2181 population-based studies with 65 million participants. *Lancet*. 2020 Nov 7;396(10261):1511-1524.doi: 10.1016/S0140-6736(20)31859-6.
4. A modified standardized nine hole peg test for valid and reliable kinematic assessment of dexterity post-stroke ·www.ncbi.nlm.nih.gov·2023-02-14.
5. Study goals and objectivesMadhav A, Parate LH, Govindswamy S. Comparison of effectiveness of CE technique and jaw thrust technique for mask ventilation on apneic anesthetized adults: a randomized controlled trial. *Anesth Essays Res* 2022;16:386–91. https://doi.org/10.4103/aer.aer_110_22.
6. Joffe AM, Hetzel S, Liew EC. A two-handed jaw-thrust technique is superior to the one-handed "EC-clamp" technique for mask ventilation in the apneic unconscious person. *Anesthesiology* 2010;113:873–9. <https://doi.org/10.1097/ALN.0b013e3181ec6414>.
7. Umesh G, Krishna R, Chaudhuri S. et al. E-O technique is superior to E-C technique in manikins during single person bag mask ventilation performed by novices. *J Clin Monit Comput* 2014;28: 269–73. <https://doi.org/10.1007/s10877-013-9531-9>.

Primary objective:

To compare the effectiveness of LASOO and C-E techniques for BVM ventilation in female nurses with different hand sizes, and to test the "hand size × technique" interaction effect.

Secondary objectives:

To compare tidal volume threshold attainment (400mL and 150mL) across four groups;

To compare technique correctness rates across four groups;

To compare perceived fatigue (Borg CR-10) across four groups.

Study design

Type of study: Prospective, parallel-group, randomized controlled trial with 2×2 factorial design.

Research population: Female registered nurses and refresher nurses at Shanxi Bethune Hospital.

Inclusion criteria:

1. Female registered nurses or refresher nurses
2. Voluntarily provide written informed consent

Exclusion criteria:

1. Hand diseases or injuries affecting hand function
2. History of hand or wrist surgery
3. Hand deformities
4. Neurological disorders affecting fine motor skills
5. Hand sensory disorders
6. Hand length <150mm or >190mm

Withdrawal criteria: Participants may withdraw at any time without reason.

Expected duration: August to November 2026.

Methodology**Interventions:**

Participants receive standardized 2-hour training in either C-E or LASOO (modified Peyton four-step approach). After passing a theory test ($\geq 80\%$), each participant performs 10 BVM ventilations with each hand on a Laerdal QCPR manikin.

C-E technique (5 steps): (1) Place mask; (2) Thumb and index finger form "C"; (3) Little finger behind mandibular angle, middle and ring fingers on mandible form "E"; (4) Apply downward pressure with thumb/index finger while lifting with remaining fingers; (5) Observe chest movement.

LASOO technique (5 steps, confirmed by Dr. Shelton): (1) Lift: middle/ring/little fingers lift chin; (2) Apply: place mask; (3) Slide: slide thumb to first web space; (4) Oppose: thumb and index finger squeeze to seal; (5) Observe: chest movement.

Randomization method:

Stratified block randomization. Hand length measured according to GB/T 16252-2023. Participants stratified by hand size (<170mm vs. ≥170mm). Computer-generated random sequence (Excel RAND function). Fixed block size of 4. 1:1 allocation to C-E or LASOO. Sequentially numbered, opaque, sealed envelopes for allocation concealment.

Blinding:

Assessor-blinded trial with dual-assessor independent design. Assessor A (technique supervisor) observes hand movements without access to tidal volume data. Assessor B (outcome assessor) reads tidal volume data behind opaque screen without seeing hand operation. Data analyst blinded until all analyses completed.

Flow diagram: (Insert flow diagram here: Enrollment → Hand length measurement → Stratification → Randomization → Training → Theory test → Manikin assessment → Data analysis)

Safety considerations

This study uses a manikin, involves no patients, and carries minimal risk. The only potential adverse event is mild hand muscle fatigue, which resolves with rest. If a participant reports pain or significant discomfort, the procedure will be stopped immediately and the event recorded.

Follow-up

No follow-up is planned. Data collection is completed immediately after the practical assessment session.

Data management and statistical analysis

Data management:

Paper-based CRFs are double-entered and cross-verified. Tidal volume data are automatically recorded by the Laerdal QCPR manikin and iPad QCPR App, exported as CSV files, and saved with blinded study IDs (S-001 to S-101 for small hand stratum; L-001 to L-107 for non-small hand stratum). A third research assistant merges data and codes as T1–T4 before submitting to the statistician. Paper records are stored in a locked filing cabinet; electronic data are encrypted.

Statistical analysis:

SPSS version 25.0. Baseline comparisons use ANOVA or chi-square tests. Primary analysis uses

two-way ANOVA with hand size and technique as fixed factors and mean tidal volume as the dependent variable; the interaction term is the primary focus. Equivalence testing for LASOO small vs. LASOO non-small uses TOST procedure with equivalence margin of ± 20 mL. $P < 0.05$ is considered statistically significant.

Quality assurance

All research assistants are trained and calibrated before data collection. Double data entry with cross-verification. Assessor A and Assessor B work independently. Regular data audits are conducted.

Expected outcomes of the study

This study will determine whether LASOO eliminates the hand-size disadvantage in BVM ventilation. If confirmed, the findings will provide evidence for hand-length screening in nursing skills training and support LASOO as the recommended technique for smaller-handed nurses.

Dissemination of results and publication policy

Results will be submitted to a peer-reviewed journal (e.g., Nurse Education Today), presented at conferences, and shared with participants as a summary. All authors have approved the final manuscript. No conflicts of interest.

Duration of the project

Phase	Timeline
Ethics approval	August 2026
Recruitment and enrollment	September–October 2026
Training and assessment	September–October 2026
Data analysis	November 2026
Manuscript preparation	November 2026 onward

Problems anticipated

1. Recruitment challenges — addressed by multi-department promotion
2. Instructor consistency — addressed by uniform training and standardized scripts
3. Participant fatigue — rest periods scheduled between hands

Project management

Name	Responsibility
Li Wen	Protocol design, ethics submission, data integration, manuscript writing
Cui Jinli	Training quality supervision, manuscript review
Hao Pengqian	Technique standardization, instructor training Assessor A/B, QCPR operation
Wang Hongxiong	Equipment maintenance, technical support
Ma Jinyu	Participant recruitment, baseline data collection

Ethics

This study follows the Declaration of Helsinki. The protocol has been submitted to the Ethics Committee of Shanxi Bethune Hospital . Written informed consent is obtained from all participants. Data are de-identified. Participants may withdraw at any time without affecting their employment status.