Impact of Simulated Field Stressors on Manual Blood Pressure Accuracy

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Abstract

Responder training in collegiate EMS is often conducted under idealized conditions that do not reflect field settings. This study evaluated the impact of common operational stressors on manual blood pressure (BP) accuracy using a within-subjects design. Responders obtained manual BP measurements across five standardized conditions: ideal, noise, time constraint, recovery positioning, and a combined condition incorporating all stressors. Manual readings were compared to an automated oscillometric reference, with seated and recovery position measurements used to account for postural BP effects. Technique was assessed using a standardized checklist, and responder confidence was measured using an adapted Clinical Skills Self-Efficacy Scale.

Accuracy differed significantly by condition ($p < .001$). Recovery and combined conditions showed the greatest degradation, with only 50% and 40% of systolic readings within ±10 mmHg of the reference. Accuracy was higher and comparable across ideal, noise, and time conditions (76–81% within ±10 mmHg). Recovery and combined conditions were associated with increased technique errors, particularly stethoscope placement and deflation rate ($p < .05$). Responders consistently overestimated BP and failed to detect true orthostatic changes. Confidence remained high and was not associated with accuracy. **These findings demonstrate that environmental stressors impair manual BP accuracy, highlighting the need for operationally realistic training.**

Methods

Design

- Participants (**n = 44**) were Gator Emergency Medical Response Unit responders (EMRs and EMT-Bs)
- **Within-subjects** design with randomized condition order
- **5 conditions** with 5-minute rest periods between trials
- Manual BP obtained on a standardized patient
- Manual readings compared to a validated automated oscillometric reference

Conditions

- Manual BP obtained in five standardized conditions:
  - **Ideal**: Quiet environment, no time pressure
  - **Noise**: Scripted patient interaction with background noise (~85 dB)
  - **Time**: One-minute time limit with 15-second verbal prompts
  - **Recovery**: Patient in recovery position
  - **Combined**: Noise, Time, and Recovery conditions
- **Seated and recovery-position reference BPs used to account for postural effects**

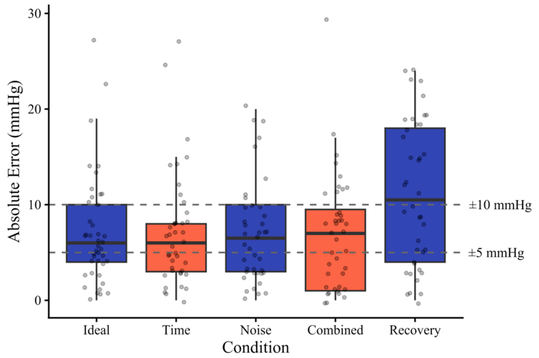
Technique & Confidence Assessment

- Technique independently evaluated by two trained raters using a checklist to evaluate:
  - No clothing interference
  - Correct stethoscope placement
  - Correct cuff placement
  - Correct deflation rate
  - Reattempts
- Post-session confidence assessed using 6-item scale (0–100), adapted from the Clinical Skills Self-Efficacy Scale
- Confidence domains included positioning, auscultation, speed, noise, and recovery positioning

Results

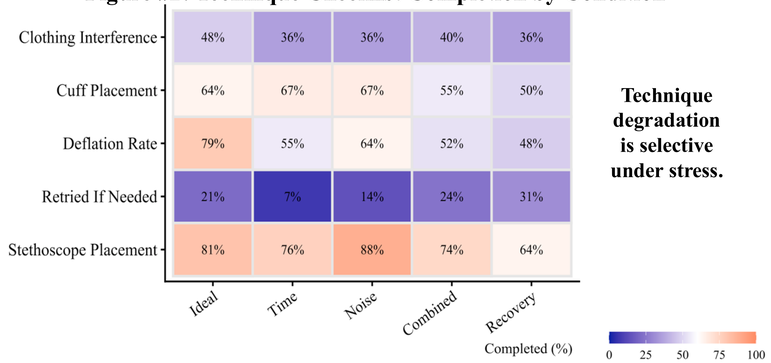
Figure #1: Absolute Blood Pressure Measurement Error by Condition

Absolute error calculated as absolute difference between manual and oscillometric reference blood pressure values. Dashed lines indicate ±5 mmHg and ±10 mmHg thresholds.



Accuracy is preserved under noise and time, but not position change.

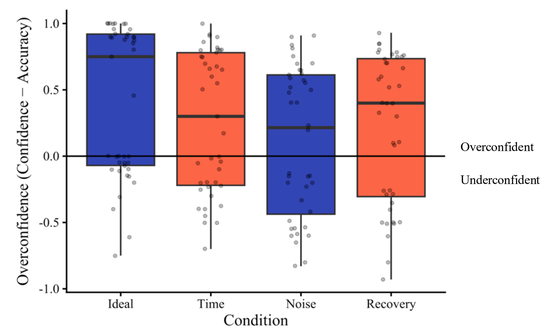
Figure #2: Technique Checklist Completion by Condition



Technique degradation is selective under stress.

Figure #3: Overconfidence by Condition

Accuracy defined as a manual reading within ±5 mmHg of the oscillometric reference. Overconfidence represents difference between self-reported confidence and objective accuracy.



Responders remained confident, even as accuracy declined.

Additional Findings

- Responders systematically overestimated blood pressure, indicating a consistent directional bias rather than random error
- Orthostatic BP changes were poorly detected, with responders underestimating both magnitude and direction of physiologic BP drops during recovery positioning
- Correct stethoscope placement and deflation rate independently reduced systolic error, even after controlling for condition and individual responder variability
- Recovery and combined conditions increased error beyond technique alone, indicating positional and physiologic effects

Discussion/Conclusion

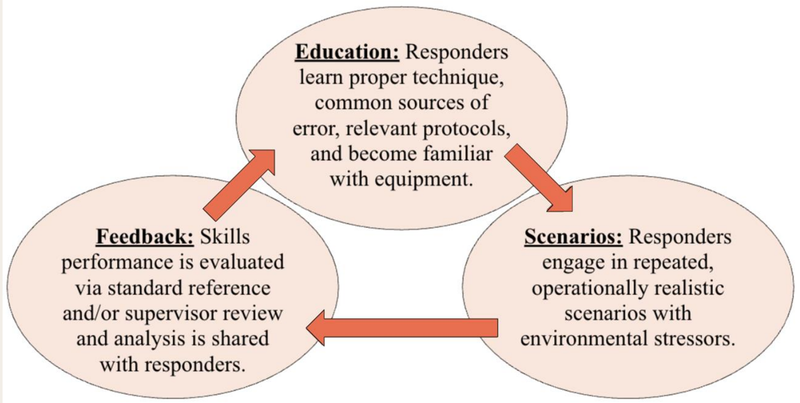
Manual BP accuracy among collegiate EMS responders is significantly compromised under common field stressors, particularly patient positioning and combined stress conditions. Although this study used simulated scenarios and a single-unit sample, limiting generalizability, the findings demonstrate consistent accuracy degradation in realistic operational settings.

Accurate vital sign assessment directly informs clinical decision-making, and measurement errors may contribute to delayed intervention or inappropriate treatment[1]. Despite declining accuracy, responders remained highly confident, revealing a mismatch between perceived competence and objective performance.

Given the dynamic and unpredictable nature of collegiate EMS responses, training that prepares responders to perform essential skills accurately under realistic field conditions is critical to ensuring safe and effective prehospital care.

Future Outlook

Implementing a data-informed training model may better support continuous skill development under realistic field conditions. Training in operationally realistic scenarios reflective of collegiate EMS field settings could enable responders to improve accuracy, technique, and decision-making in challenging conditions. Within this model, responders receive targeted reeducation, additional practice, and reassessment until consistent proficiency is demonstrated. Standardized feedback may better align responders' confidence with actual performance.



References

1. Sapra A, Malik A, Bhandari P. Vital sign assessment. In: StatPearls. StatPearls Publishing; 2023. https://www.ncbi.nlm.nih.gov/books/NBK553213/