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YOU SHOULD TRY THIS!

Augmented reality telementoring for procedural skills in remote medical education

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Implication Statement

Augmented reality (AR) telementoring offers a novel approach to delivering real-time procedural instruction to learners in remote and austere environments. By enabling faculty to annotate a learner's field of view, overlay visual guides, and provide live audio coaching, AR can extend the reach of procedural training without requiring in-person presence. In this pilot, we demonstrate the feasibility of AR telementoring for visually guided, tactile procedures such as escharotomy, while highlighting important challenges for complex, image-dependent tasks such as ultrasound-guided central venous access. With intentional alignment between procedure type and technological capabilities, AR telementoring may help reduce instructional inequities across geographically dispersed medical education sites.

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Le télémentorat en réalité augmentée pour l'acquisition de compétences procédurales dans la formation médicale à distance

Énoncé des implications de la recherche

Le télémentorat en réalité augmentée (RA) offre une approche novatrice pour dispenser une formation procédurale en temps réel aux apprenants dans des environnements isolés et difficiles d'accès. En permettant aux formateurs de visualiser le champ de vision de l'apprenant, de superposer des guides visuels et de fournir un accompagnement audio en direct, la RA peut étendre la portée de la formation procédurale sans nécessiter de présence physique. Dans ce projet pilote, nous démontrons la faisabilité du télémentorat en RA pour les procédures tactiles guidées visuellement, telles que l'escarotomie, tout en soulignant les difficultés importantes rencontrées pour les tâches complexes dépendant de l'imagerie, comme la pose d'un cathéter veineux central sous échographie. Grâce à une adéquation entre le type de procédure et les capacités technologiques, le télémentorat en RA peut contribuer à réduire les inégalités d'accès à l'enseignement au delà des frontières des établissements de formation médicale.

Introduction

Procedural instruction in geographically remote training sites is often constrained by limited faculty availability, high travel costs, and connectivity challenges.[1] These barriers are particularly salient in military and prehospital training environments, where learners must acquire procedural competence despite austere conditions and limited on-site expertise.

Augmented reality (AR) refers to technologies that overlay digital content, such as visual markers, annotations, or guides, onto a user's real-world field of view. Telementoring involves real-time remote guidance from an expert to a learner performing a task, typically through audio, video, or shared visual platforms. When combined, AR and telementoring allow remote faculty to provide visual-spatial guidance directly within the learner's line of sight, potentially approximating in-person coaching.

Although AR has shown promise in well-resourced simulation centers and controlled educational settings,[2,3] far less is known about its feasibility in field-based or austere environments where bandwidth, hardware reliability, and setup time are constrained. To address this gap, we piloted AR telementoring during a high-fidelity prehospital simulation exercise to explore its feasibility, instructional fit across procedural types, and perceived educational value.

Description of the innovation

We implemented this pilot during an annual field-based medical simulation at Fort Indiantown Gap, Pennsylvania. Six third-year medical students participated while performing two procedures: escharotomy and ultrasound-guided central venous catheter placement. Students wore the Magic Leap 2 AR headset, which provides a transparent display with spatial computing and real-time annotation capability[4] (See Figure 1).

Ethics approval was obtained from the University of Toronto Research Ethics Board. Informed consent was obtained from all participants, with accessibility supports provided.



Figure 1. A third-year medical student performs a simulated escharotomy while wearing an augmented reality headset, guided remotely by faculty during a field exercise at Fort Indiantown Gap, PA. The augmented reality display allows the remote faculty member to overlay visual annotations (e.g., incision lines and anatomical landmarks) and provide real-time verbal coaching within the learner's field of view.

Four remote faculty members provided telementoring support. Faculty participants were board-certified physicians with clinical and teaching expertise in emergency medicine, critical care, and procedural instruction, including experience supervising escharotomy and central line placement in both clinical and simulation settings. Faculty guided the learners by annotating the student's field of view, overlaying anatomical landmarks, and providing live coaching (See Figure 2).



Figure 2 Student's view of the augmented reality interface showing remote faculty annotations overlaid onto the learner's field of view, including visual markers and guidance used during procedural instruction.

Each student received a brief five-minute orientation to the AR system prior to task initiation. Task trainers included a moulaged foam escharotomy model[5] and a CentraLineMan® central venous access trainer.

Connectivity and technical infrastructure

The AR system relied on a wireless internet connection available within the field training site, with variable bandwidth typical of austere environments. Connectivity supported live audio communication and visual annotation but was intermittently unstable, contributing to lag, occasional signal loss, and delayed calibration. No dedicated high-bandwidth network was available in our remote location.

This innovation was grounded in experiential learning theory, emphasizing situated practice, immediate feedback, and visual-spatial scaffolding. The Uniformed Services University Institutional Review Board approved the study, and all participants provided informed consent.

Outcomes

Evaluation and data analysis

We collected data from verbal and written post-session debriefs and structured observational notes. Two investigators independently reviewed transcripts and notes using conventional content analysis, appropriate for brief, focused qualitative datasets. We coded recurring observations related to procedural fit, technical feasibility, and instructional value, resolving discrepancies through discussion and consensus.

Reflexivity

Our research team consisted of clinician-educators with experience in simulation-based education, military medical training, and procedural instruction. We recognize that our familiarity with both the educational context and the technology may have shaped data interpretation. We addressed this potential bias by independently coding data and explicitly attending to negative cases and technical limitations.

Theme 1. Procedural fit

AR telementoring aligned best with visually intuitive, tactile procedures such as escharotomy. Learners reported that visual overlays and real-time annotations enhanced incision placement and approximated in-person guidance. One participant noted, *"Visual markers in my field of view guided my incisions accurately."*

In contrast, ultrasound-guided central venous catheter placement posed challenges. These image-dependent tasks required faculty to interpret real-time ultrasound images and probe positioning, details that could not be consistently visualized through the AR display. Limited resolution and difficulty transmitting fine-detail imaging artifacts constrained faculty feedback.

Theme 2. Technical feasibility

Technical challenges included intermittent connectivity, repeated device reboots, and calibration delays. These issues extended setup time to approximately 20–30 minutes per session. Visual artifacts and resolution limitations further reduced clarity for fine-detail tasks, particularly those dependent on imaging rather than gross spatial orientation.

Theme 3. Instructional value

Despite technical constraints, both learners and faculty valued the immediacy of interaction and the ability to receive or provide guidance without physical co-location. Participants emphasized that AR telementoring should be selectively applied to procedures that match the technology's current strengths, rather than broadly replacing in-person instruction.

Suggestions for next steps

Because this brief report relied on short debrief transcripts rather than in-depth interviews, our analytic goal was to capture key recurring observations rather than to achieve thematic saturation. We did not seek data saturation, but we will pursue a more rigorous research design in a follow on study.

Future implementations should:

- Select procedures with strong visual-spatial components and minimal imaging dependence[3]
- Provide asynchronous onboarding modules to reduce live setup time.
- Develop offline overlays for environments with unreliable connectivity.
- Incorporate standardized performance metrics (checklists, completion times) to complement qualitative feedback.

Limitations

This pilot was limited by variable connectivity, hardware constraints, and the brief nature of the evaluation. Findings may not generalize to procedures that depend heavily on high-resolution imaging or to settings with different technological infrastructure. As a brief innovation report, this

work prioritizes feasibility and descriptive insights rather than outcomes-based effectiveness.

Conclusion

This pilot demonstrates that AR telementoring is feasible for selected procedural skills in remote and austere medical education settings. While technical and procedural limitations remain, particularly for image-dependent tasks, AR telementoring shows potential to extend faculty expertise where in-person instruction is not feasible.

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Conflict of Interest:

The authors declare no conflicts of interest. The opinions and assertions expressed herein are those of the authors and do not reflect the official policy or position of the Uniformed Services University of the Health Sciences, the United States Navy, the United States Air Force, or the Department of Defense.

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