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ORIGINAL RESEARCH

Smart Glasses to Facilitate Ultrasound Guided Peripheral Intravenous Access in the Simulation Setting for Thai Emergency Medical Service Providers

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Purpose: The ultrasound-guided peripheral venous access (USGPIV) was reported as difficult for novices to perform. Smart glasses equipped with teleconference systems can display real-time ultrasound images to sonographers and consultants which can increase the success rate of this procedure. The purpose of this study was to assess the effectiveness of employing smart glasses for USGPIV.

Patients and Methods: A randomized, simulation study was conducted in emergency medical service (EMS) providers at Srinagarind Hospital, Thailand, from January to April 2023. We randomized participants into two groups which included participants who wore smart glasses during procedures requiring USGPIV (the smart glasses group) and participants who performed USGPIV with no smart glasses (the non-smart glasses group). After participating in USGPIV cannulation training, the simulations were carried out. The primary outcome was the first-attempt success rate, with secondary outcomes including the procedure time and subjective difficulty.

Results: Fifty participants were recruited for the study. The smart glasses group was superior to the non-smart glasses group both in terms of first-attempt success rate with no statistically significant (64% vs 60%; P = 0.460) and also demonstrated a shorter procedure time than the non-smart glasses group (25.5 sec vs 42.3 sec; P = 0.003). The participants reported the subjective difficulty score was higher in the smart glasses group (the visual analog scale, VAS = 8).

Conclusion: In simulation scenarios, the smart glasses-assisted USGPIV could shorten the procedure time. However, our study did not find significant differences in the first pass success rate of USGPIV between the two groups.

Keywords: smart glasses, ultrasonography, emergency medical services

Introduction

Peripheral intravenous cannulation (PIVC) is one of the procedures frequently performed by emergency medical service (EMS) providers in prehospital situations. According to the conventional procedures, PIVC is difficult to accomplish for certain individuals resulting in treatment being delayed.[1–3] In advanced venous scenarios, multiple puncture attempts which are time-consuming, uncomfortable for the patients, and not always successful are frequently required. The development of Ultrasound-Guided Peripheral Intravenous (USGPIV) cannulation has improved the procedure's overall success rate in a host of different situations.[3–8] However, effective ultrasound-guided venous cannulation might also be challenged by the type of ultrasound equipment available, procedure field, knowledge of anatomy, and hand-eye coordination skills which are necessitated by training.[8]

Smart glasses are a type of wearable computer that includes a small camera for live streaming. Smart glasses innovation has been deployed and examined across various clinical settings and healthcare facilities over the past ten years including PIVC and EMS settings.[9–16] This technology enables real-time teleconsultation utilizing a videoconferencing platform, data presentation on the see-through optical display, and recording of photos or videos with a front-facing camera, among many other features. The development of smart glasses allows the procedure to be

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live-streamed to a display monitor (tablet computer or specific display monitor) with the medical staff with greater levels of expertise in Point of Care Ultrasound (POCUS). This allows the practitioner to perform USGPIV in the field with remote medical staff who could suggest the anatomy and ultrasound techniques to insert the intravenous catheter in real-time. This is a cutting-edge technology in Thailand for EMS healthcare professionals. Studies in this particular sector are still lacking. In this study, we employed the smart glasses used by EMS providers to determine first pass success rate of the USGPIV in the simulation setting.

Materials and Methods

This was a randomized simulation study in the EMS unit at Srinagarind hospital, Faculty of Medicine, Khon Kaen University conducted from January to April 2023. This hospital, which has the most sophisticated tertiary care facilities and professionals in northeastern Thailand, serves as the region's principal medical teaching facility and handles an average of two thousand EMS operations each year.

Data Collection

The study recruited EMS members including emergency medicine residents, nurses, and emergency medical technicians. All participants had experience in intravenous access without ultrasound for at least 1 year. In terms of the emergency medicine residency training, emergency medicine residents in this study were the third-year residents which had experience more than ten times in this procedure in the simulation training. All participants have finished at least 1 hour of ultrasound-guided procedure education. However, the participants had no experience with USGPIV. The principal investigator provided a detailed explanation of the study's objectives and the overall procedure to all participants, who subsequently provided their signed written informed consent to proceed with enrolment. After that, the study defined two study groups: those with smart glasses and those without smart glasses, using simple randomization by sealed envelopes for blind allocation implemented by the investigator. Prior to enrolment, there were no financial incentives to participate.

The study protocol started with the investigator reviewing the details of the simulation protocol with all participants. Then, the smart glasses group had a 30-minute training session on how to operate the devices before participating in the simulation.

In our study, we used CAE BLUE PHANTOM (Sarasota, Florida, USA) as the 2-vessel ultrasound phantom. For this investigation, the Butterfly IQ portable ultrasound equipment (Guilford, Connecticut, USA) was utilized, acquiring B-mode images without employing color Doppler. The transducer was set to the vascular image setting.

The smart glasses utilized in this investigation were provided by the Real Wear Company (Vancouver, Washington, USA), specifically the HMT-1 model (Figure 1). Real-time ultrasound images were transmitted via Wi-Fi to a computer (Lenovo 520–22IKU, Jiangsu, China) running Windows 10 (Redmond, Washington, USA). During the simulation, the

Figure 1 The smart-glasses system.

participants used A 20-gauge needle attached to a 10-mL syringe for venous access. The advancement of the needle could be performed using either an "out-of-plane" or an "in-plane" technique. The confirmation of successful venous access was determined as confirmed air aspiration in the syringe.

For the smart glasses group, the participants performed the procedure in the same manner as the non-smart glasses group, even though the participants got the ultrasound image via the smart glasses and an investigator supervised how to perform the procedure via the teleconference system.

The information was recorded, including the procedure time required to complete the process and the number of attempts needed to achieve USGPIV access. The procedure time was measured from the initial application of the ultrasonic probe to the phantom until successful venous access was achieved. The difficulty level of the procedure was assessed using a visual analogue scale (VAS) ranging from 0 to 10, with 0 indicating the easiest and 10 indicating the hardest. Following the completion of the simulation scene, participants provided their subjective judgments regarding the level of challenge they experienced. Data were gathered and assessed by two independent, highly qualified investigators accompanied by a second round of data input.

Sample Size

The formula beneath[17] was used to obtain the sample size. P was calculated using data from previous research[11] that had been published, and a sample size of 25 was thought to be required in each group.

Statistical Analysis

Outcome variables were characterized using interquartile ranges (IQRs) and medians. The two arms were compared using Mann–Whitney *U*-tests for statistical analysis, considering P-values <0.05 as statistically significant. The data was input into Microsoft Excel and analyzed using IBM SPSS for Windows version 28.0, which is licensed to Khon Kaen University (SPSS Inc., Chicago, IL, USA).

Results

The current study consisted of 50 EMS providers, the characteristics of which are shown in Table 1, indicating there were no significant differences between the individuals to account for fairness. In terms of accuracy, there were no significant differences in the first attempt success rate in USGPIV between the smart glasses users (64%) and non-smart glasses groups (60%) ($p = 0.460$). However, participants in the smart glasses group outperformed the non-smart glasses group in the procedure time, 25.5 sec VS 42.3 sec, respectively ($p = 0.003$; Table 2). Additionally, the smart glasses participants reported more subjective difficulty than non-smart glasses individuals (smart glasses group: median VAS, 8; non-glasses group: median VAS, 6).

Table 1 An Overview of the Study Population's Demographics

Categorized	Smart Glass Group (N =25)	Non-Smart Glass Group (N =25)	*P*-value
Gender, Male (%)	10 (40)	12 (48)	0.630
Age, mean (SD), years	33.1 (6.5)	32.2 (7.03)	0.960
Type of healthcare providers (frequency, %)			0.920
Emergency medicine residents	10 (40)	8 (32)	
Emergency nurse practitioners	9 (36)	10 (40)	
Emergency medical technicians	6 (24)	7 (28)	

Abbreviation: SD, standard deviation.

Table 2 The Outcome of This Study

	Smart Glass Group (N =25)	Non-Smart Glass Group (N =25)	*P*-value
Procedure time (sec) (IQR)	25.5 (9.8–32.3)	42.3 (18.2–57.1)	0.003
The number of attempts to complete the procedure (frequency, %)			
1	16 (64)	15 (60)	0.460
2	9 (36)	5 (20)	0.025
3	0	3 (12)	<0.001
4	0	2 (8)	<0.001

Abbreviations: sec, seconds; IQR, interquartile range.

Discussion

The primary outcome of this study aimed to compare the first pass success rate of USGPIV with smart glasses users and non-smart glasses users in a simulation setting. The current study demonstrated the use of smart glasses did not significantly increase the first pass success rate of USGPIV. Our study illustrated the success rate of this procedure at 64% in the smart glasses group. This due to the participant used the smart glass were not familiar with the new equipment and used the own experience to perform the intravenous procedure. However, when comparing the first pass success rate of the USGPIV to previous studies[13,18,19] which showed the success rate up to 87%, we found that our results demonstrated a lower rate than the others. This may be caused by the fact that the primary factor associated with first pass success rate of USGPIV is the previous experience with the procedure.[20] In addition, almost half of all participants were residency level which means they may lack the sufficient experience in peripheral intravenous access in real clinical settings as this type of procedure in Thailand is mostly performed by nurse practitioners. Our findings were consistent with a previous study[21] that demonstrated that smart glasses failed to enhance the success rate; however, that study concluded that smart glasses could be used to perform ultrasound-guided procedures in all levels of medical practitioners.

In terms of the secondary outcome, our study demonstrated the shorter procedure time in the smart glasses group (25 sec) in the smart glasses group compared to the non-smart glasses group (42 sec). Our results contrasted with a previous study[11] which found no significant differences in procedural time observed between the smart glasses and non-smart glasses groups. These discrepancies could be attributed to the fact that not all participants had experience to perform USGPIV; thus, participants who wore smart glasses in the simulation scenario received real-time teleconsultation from an expert while performing the procedure, which may have led them to perceive that the use of smart glasses could decrease the time required for this procedure.

In terms of the feasibility of the procedure, our study illustrated the VAS score was higher than in the non-smart glasses group. The USGPIV is a complex procedure that necessitates trust in the equipment and comprehension of complex imaging. Moreover, ultrasound procedures in general have been shown to be highly user dependent.[22] For the novice user with no prior training, this should affect the feasibility of the procedure. The participants reported levels of difficulty in performing this procedure in the smart glasses group. Difficulty ratings were most likely influenced by a lack of familiarity with smart glasses despite participants having received a 30-minute training session on how to use the devices prior to participating in the simulation. Participants commented that smart glasses assisted these individuals in facilitating the procedure time quickly due to the teleconference system made available. Our result was consistent with the previous study which demonstrated the smart glasses group experienced a slightly higher level of subjective difficulty.[11] In addition, the participants reported one of the disadvantages of using the smart glasses was dizziness. However, the participant's dizziness did not prevent them from participating in this study. This disadvantage was similar to that found in the previous study.[12]

In previous studies,[23–25] smart glass was important role in central venous catheterization and regional anesthesia procedure. Our study was the first-time smart glass used in the intravenous access procedure especially in the EMS members in Thailand which support and developed the policy in the Healthcare systems to make the efficiency and safety of the patients.

The study's limitations included its performance bias, in which either the participants or the researcher in charge of the actual simulation had not been blinded. Second, because this research was carried out in a simulated setting, we were therefore unable to investigate the effectiveness of smart glasses in real-world scenarios. Third, our study did not demonstrate the long-term effect of smart glasses used which may cause nasal, ear, neck, and head discomfort due to the weight of the device.

Prehospital care is a high-risk, time-sensitive medical domain in which emergency medical services (EMS) providers treat patients in the field and stabilize patients by addressing severe illnesses or life-threatening injuries as soon as possible. The smart glasses used to perform USGPIV in the prehospital setting may shorten procedure time at the scene and allow for quicker transport of the patient to the nearest hospital or care facility.

Conclusion

In conclusion, our study did not find the statistically significant differences in the first pass success rate of USGPIV between the two groups. However, the results did show that the time required for successful USGPIV was shorter when using smart glasses. This study suggests that smart glasses, combined with a teleconference system, could be beneficial in assisting novices in performing USGPIV. Future prospective controlled trials are needed to gain a comprehensive understanding of the utility of smart glasses not only for USGPIV but also for the interpretation of other US images, especially in real clinical settings.

Abbreviations

USGPIV, ultrasound-guided peripheral venous access; EMS, emergency medical service; VAS, the visual analog scale; PIVC, peripheral intravenous cannulation; POCUS, point of care ultrasound; IQRs, interquartile ranges.

Data Sharing Statement

The corresponding author will disclose the data sets utilized and/or analyzed during the current work upon reasonable request.

Ethics Approval and Informed Consent

This study was conducted in accordance with the Helsinki Declaration's principles and Good Clinical Practice recommendations. The Khon Kaen University Ethics Committee for Human Research approved the study. To ensure confidentiality, all identifiers were removed from the obtained data (HE651354).

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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