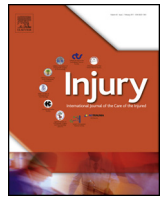




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Serious game training improves performance in combat life-saving interventions

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ABSTRACT

Aim: In modern warfare, almost 25% of combat-related deaths are considered preventable if life-saving interventions are performed. Therefore, Tactical Combat Casualty Care (TCCC) training for soldiers is a major challenge. In 2014, the French Military Medical Service supported the development of 3D-SC1[®], a serious game designed for the French TCCC program, entitled *Sauvetage au Combat de niveau 1* (SC1). Our study aimed to evaluate the impact on performance of additional training with 3D-SC1[®].

Material and methods: The study assessed the performance of soldiers randomly assigned to one of two groups, before (measure 1) and after (measure 2) receiving additional training. This training involved either 3D-SC1[®] (Intervention group), or a DVD (Control group). The principal measure was the individual performance (on a 16-point scale), assessed by two investigators during a hands-on simulation. First, the mean performance score was compared between the two measures for Intervention and Control groups using a two-tailed paired *t*-test. Second, a multivariable linear regression was used to determine the difference in the impacts of 3D-SC1[®] and DVD training, and the order of presentation of the two scenarios, on the mean change from baseline in performance scores.

Results and discussion: A total of 96 subjects were evaluated: seven could not be followed-up, while 50 were randomly allocated to the Intervention group, and 39 to the Control group. Between measure 1 and measure 2, the mean (SD) performance score increased from 9.9 (3.13) to 14.1 (1.23), and from 9.4 (2.97) to 12.5 (1.83), for the Intervention group and Control group, respectively ($p < 0.0001$). The adjusted mean difference in performance scores between 3D-SC1[®] and DVD training was 1.1 (95% confidence interval $-0.3, 2.5$) ($p = 0.14$). Overall, the study found that supplementing SC1 training with either 3D-SC1[®] or DVD improved performance, assessed by a hands-on simulation. However, our analysis did not find a statistically significant difference between the effects of these two training tools. 3D-SC1[®] could be an efficient and pedagogical tool to train soldiers in life-saving interventions. In the current context of terrorist threat, a specifically-adapted version of 3D-SC1[®] may be a cost-effective and engaging way to train a large civilian public.

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Introduction

In modern warfare, almost 90% of combat casualties die before reaching the first medical treatment facility. Almost 25% of combat-related deaths are considered preventable, concerning haemorrhages that could have been treated efficiently on the battlefield, by performing crucial life-saving interventions [1]. Therefore, Tactical Combat Casualty Care (TCCC) training for soldiers is a major challenge for armed forces [2]. The French

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Military Medical Service has formalized its military, pre-hospital care policy into a *Sauvetage au Combat* (SC) program (Forward Combat Casualty Care) [3,4]. The program includes one day of initial training and an ongoing series of half-day courses that are repeated at least annually, for groups of up to 10 military personnel. Hands-on simulations are a major part of the program. This is an expensive challenge, given that there are more than 80,000 soldiers to train for life-saving interventions that include survival positioning, the application of haemostatic gauze, or a tactical tourniquet. To address this problem, in 2014, the French Military Medical Service decided to develop and deploy 3D-SC1[®] (Fig. 1). This serious game (SG) is intended to train and assess soldiers involved in the care-under-fire initial stages of the SC program, also known as SC1 [5].

SGs are similar to video games in that they are engaging, rewarding, and fun. However, at the same time, they can also be used to educate or train [6–12]. They have emerged as a popular way to enhance instructional outcomes in many professional contexts [13]. Other countries have developed virtual simulations in the context of their TCCC programs and military medical settings, while specific guidelines are set at national level [14,15]. SGs, like other virtual environments, are not a substitute for hands-on training; they cannot simulate the physical elements of tactical response, nor can they provide comprehensive training in performing procedures on combat casualties. Nonetheless, the benefits include the ability to create a wide variety of scenarios, while the learner can repeatedly try and fail in a consequence-free environment, anytime and anywhere. However, the actual extent to which SGs may improve the performance of soldiers in the management of combat casualties remains unknown. In this context, we conducted a prospective, randomized study designed to evaluate the pedagogical impact of 3D-SC1[®], as a supplement to SC1 training. The first hypothesis is that additional 3D-SC1[®] training improves performance for combat life-saving interventions. Our second hypothesis is that additional SC1 training with 3D-SC1[®] improves performance to a greater extent than the current tool used for additional training, namely a pedagogical DVD provided by the French Military Medical Service Academy.

Materials and methods

Design, setting and participants

Participants were divided into two groups: an Intervention group (A), and a Control group (B). Throughout the evaluation, the investigators were unaware which group the participant had been allocated to. Fig. 2 summarizes the study design. The Ethics Committee of the French Medical and Health Research Institute (INSERM) approved the study (approval number: IRB 00003888). All participants provided written, informed consent.

Participants were healthy, voluntary military personnel from the 121[°] Régiment du Train (Montlhéry, France). They were recruited and enrolled in the study by one of the investigators at the end of each initial SC1 training session organized during a pre-deployment period that ran from 1 January 2016 to 30 June 2016. Inclusion criteria were being certified for active duty, being aged 18 or over and being available 15 days after inclusion. Exclusion criteria were military personnel with the status of caregiver, and those aged under 18.

Procedure, data collection and outcome variables

The scenarios and their evaluation were adapted from those in French guidelines for tactical combat casualty care. They were validated by five French experts in the domain (three doctors and two SC instructors). A pilot feasibility study involving eight volunteers was conducted in December 2015, which tested the scenarios and scoring system. Based on the data that was collected, it was estimated that a sample size of 120 participants (60 per group) would have 90% power to detect, at $\alpha=0.05$, an expected change of 1 point between the mean score of the two groups. A difference of 1 point (on a 16-point scale) was considered important, as the failure to complete any of the actions is sufficient to jeopardize the survival of the casualty. Just after their enrolment, all participants completed a questionnaire concerning their sociodemographic characteristics (i.e., age, gender, rank, job tenure) and characteristics that may influence SC1 performance



Fig. 1. Pick and run in 3D-SC1.

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