Effects of environmental distractors on nurse emergency triage accuracy: a pilot study

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Study Protocol

Keywords: Serious game, triage accuracy, emergency department, distractors, patient safety

Posted Date: February 29th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-15514/v1

Version of Record: A version of this preprint was published on November 7th, 2020. See the published version at https://doi.org/10.1186/s40814-020-00717-8.

Abstract

Background: Patient safety is a top priority of the health professions. In emergency departments, the clinical decision making of triage nurses must be of the highest reliability. However, studies have repeatedly found that nurses over- or undertriage a considerable portion of cases, which can have major consequences for patient management. Among the factors that might explain this inaccuracy, workplace distractors have been pointed to without ever being the focus of specific investigation, owing in particular to the challenge of assessing them in care settings. Consequently, the use of a serious game reproducing a work environment comprising distractors would afford a unique opportunity to explore their impact on the quality of nurse emergency triage.

Methods/Design : A factorial design will be used to test the acceptability and feasibility of a serious game created to explore the primary effects of distractors on emergency nurse triage accuracy. A sample of 80 emergency nurses will be randomised across three experimental groups exposed to different distractor conditions and one control group not exposed to distractors. Specifically, experimental group A will be exposed to noise distractors only; experimental group B to task interruptions only; and experimental group C to both types combined. Each group will engage in the serious game to complete 20 clinical vignettes in two hours. For each clinical vignette, a gold standard will be determined by experts. Pre-tests will be planned with clinicians and specialised emergency nurses to examine their interaction with the first version of the serious game.

Discussion : This study will shed light on the acceptability and feasibility of a serious game in the field of emergency triage. It will also advance knowledge of the possible effects of exposure to common environmental distractors on nurse triage accuracy. Finally, this pilot study will inform planned large-scale studies of emergency nurse practice using serious games.

Background

Care quality has become a growing concern from the perspective of the continuous improvement of the effectiveness and efficiency of health systems (1). The notion of care quality cannot be dissociated from the notion of patient safety, which is defined as the “reduction of risk of unnecessary harm associated with health care to an acceptable minimum” (2). The notion of patient safety has to do with the presence or absence of adverse events and/or medical errors. These allow documenting and comparing the performance of health facilities worldwide (3). In 2000, a report by the US Institute of Medicine indicated that medical error was responsible for 44,000 to 98,000 deaths each year in the United States (4). Following the publication of this landmark report, health policies on different continents were subjected to deep review. In the United Kingdom, the process resulted in the creation in 2004 of a national patient reporting system for adverse events and medical errors.

The nursing profession, which delivers the lion’s share of patient care, is amply confronted with this issue, particularly in the course of making clinical decisions where errors can put patients at risk (5). In the field of nursing care, various error taxonomies have been proposed, such as the one by Woods and Doan-Johnson (6), which emphasises eight causes of error, including inattention, misjudgement of the clinical situation, and medication errors. While medication errors have been the subject of extensive research (6–8), clinical decision making (9), also, is considered within the nursing profession (10, 11) as essential to safe patient care (12–14) and is, according to Hughes (5), the dimension most affected by errors of judgement whose direct consequence

is to put patients at risk. Therefore, it appears to be central in practice settings where the clinical judgment of nurses orients patient care priorities, such as in emergency units.

In emergency departments (ED), triage, which serves to prioritise patient management, requires nurses to evaluate patients and make decisions rapidly (15–18). Some authors (16, 19, 20) have underscored that decision making differs at triage from other care situations because it requires nurses to sustain a high level of concentration in a work environment rich in distractors (for example, noise, task interruptions and random workload) liable to divert their attention and thus affect the quality of their judgment. Moreover, decisions must be made in very short order (< 5 minutes) and often alone with limited access to peer clinical supervision (16, 19, 20).

To improve emergency triage, various countries have developed triage scales comprising four or five emergency levels (21, 22, 23), such as the Swiss Emergency Triage Scale® (SETS®) implemented in most of the ED in French Switzerland (24, 25). Within this framework, triage quality assessment consists essentially of determining the accuracy of nurse triage decisions, which corresponds to the degree of agreement between emergency levels assigned by nurses and the gold standard that is the response provided by experts (26). Thus, any difference between the two can be considered overtriage or undertriage, either of which can potentially have an effect on patient health and patient flow management (27). On the one hand, overtriage does not have a direct impact on patients themselves so much as on patient flow management (15, 28). Indeed, the inappropriate deployment of care resources can potentially delay the management of patients who require more urgent care (26, 29, 30). On the other hand, undertriage, that is, attributing a lower emergency level than is actually required, may put the patient's health at risk. Such patients are likely to see their clinical condition deteriorate in the waiting room, which can contribute to delayed patient management and even patient death in the most extreme cases (31, 32). Bergs, Verelst, Gillet, et al. (33) found that the undertriage rate could be as high as 80% for level-2 or "urgent" cases. Finally, in their systematic review, Farrohknia et al. (27) showed that the accuracy of nurse emergency-level assessments was widely inconsistent, that this inconsistency was a recurring problem in emergency units, and that research into the causes of this inconsistency remained scant.

Some authors have sought to understand this phenomenon through factors intrinsic and extrinsic to nurses (30, 34, 35). Intrinsic factors include characteristics specific to nurses, such as personality (flexibility, decision-making autonomy), cognitive processes (critical thinking, prompt decision making) and behavioural processes (working under pressure, being organised), not to mention experience (confidence in one's decision making). Cone and Murray (36) demonstrated that a good level of expertise was a key characteristic for guaranteeing an acceptable level of triage accuracy. This finding was corroborated by Considine, Ung, and Thomas (30) and by Goransson, Ehrenberg, Marklund, et al. (42), who showed that nurses with little work experience were the ones primarily responsible for overtriage. Regarding extrinsic factors, some researchers have focused on the numerous distractors in the ED work environment (37–41). They have identified factors such as frequent task interruptions, noise and variable workload as major distractors. Task interruptions may result in the delayed performance of care activities, information loss, and a drop in concentration conducive to altering the decision-making process, particularly when performing complex activities (42–47).

While some researchers who have examined the clinical decision making of emergency nurses have observed their triage performances directly, most, instead, have used written clinical vignettes administered in a closed room devoid of the distractors normally present in the clinical reality and of any organisational and time

constraints (48–51). In these cases, triage nurses determined the emergency level of patients presented in clinical vignettes and their evaluations were then compared against a gold standard established beforehand by experts. Authors have pointed out that this sheltered approach departed considerably from the clinical reality of triage situations and could be at the root of the biased findings of these studies. In order to limit these various biases, some authors (52) have underscored the importance of reproducing real-world conditions as much as possible and immersing nurses completely in these situations. In this context, the use of serious games (SG) simulating the real-life conditions observed in emergency triage provides a unique opportunity to immerse nurses in such situations (52, 53). SG are defined as games of which fun or entertainment are not the primary purpose. These are frequently used in the context of professional development and training, education, and scientific research (54, 55) to develop competencies in fields where poor decisions are associated with a high adverse-event risk, such as in air traffic control (56) and the military (57). More recently, SG have been used in the medical field to examine, for example, the impact of task interruptions on the medical evaluation of patients. Results have shown not only that these interruptions lengthened the duration of medical evaluations but also that subsequent decisions were more disorganised and deviated from prescribed standards (57).

In ED and especially in triage, the clinical decisions made by nurses must be of the highest accuracy to guarantee patient safety. As it turns out, research results have tended to demonstrate the limited accuracy of nurse emergency-level evaluations. It has been suggested that environmental distractors were responsible for this, but the claim has never been proven. The use of an SG reproducing a real-life work environment would make it possible to assess the impact of distractors on triage accuracy. Against this background, we have planned a research project to develop a triage SG and test it with triage nurses to examine the preliminary effects of distractors on triage accuracy.

The creation of an SG reproducing the ED work environment with distractors is innovative in the field of triage. Consequently, we feel it is necessary to carry out a pilot study. Its three main objectives are those identified by Feeley and colleagues (58), namely: 1) assess the feasibility and acceptability of the SG; 2) test the methodology and measures used; and 3) estimate the effect size in order to determine the appropriate sample size for a future experimental study on a larger scale.

Theoretical Framework

The theoretical framework chosen for the study is an adapted version of the Systems Engineering Initiative for Patient Safety (SEIPS) model (59), which allows exploring both the intrinsic and extrinsic factors mentioned above. The model belongs to the group of models used to explain care quality and patient safety commonly referred to as sociotechnical work system models, which place an emphasis on the work environment. It is composed of three dimensions: work system, processes and outcomes. The main strengths of the SEIPS model are that it: 1) describes and operationalises the components of the work environment; 2) explains the interactions between the multiple components of the work system and the care processes; and 3) demonstrates how the interactions between the work system and the care process impact care outcomes. This model explicates the relationship between the work environment and the decision-making process. It distinguishes five components of the work system: person, tasks, tools and technology, environment, and organisation.

More specifically, the tools and technology components refer to the elements that the person uses to perform their tasks, such as a computerized care file, an electronic blood pressure monitor, and a telephone. ED studies have shown that technological breakdowns (computer downtime, blood pressure monitor out of order) can cause task interruptions (38, 60). As this component is commonly explored when new technologies are introduced in the field of care, it will not be studied here, given that the nurses that will participate in the study are proficient in the use of the tools and technologies associated with the triage station.

The person component represents the core variable of the work system and refers not only to all the members of a team that may include physicians, nurses and other care providers, but also to the patients themselves and their families. In our study, the focus will be on nurses performing the task of emergency triage. For this component, Carayon et al. (59) recommended examining various elements, including personal, physical and psychological characteristics, such as knowledge, motivation, and needs (59). Triage studies have shown, in particular, that nurse education level, triage training and work experience can influence triage accuracy (35, 49, 61–63), as can their aptitude to work fast and their confidence in their decision making (35, 53, 61, 64).

The tasks component refers to the tasks to be performed by the person. This in our study corresponds to triage. Carayon et al. (59) proposed exploring elements of this component such as the variety of tasks, job demands, and skills required to complete the task. ED studies (38, 65) have identified one key element that disrupts triage: task interruptions. A task interruption has been defined as “an unexpected temporary or definitive halt to a human activity” (free translation; p. 5) (66). The presence of task interruptions diminishes the operator’s attention by causing it to be redirected towards other tasks (38, 65). This can lead to a loss of information and to decision-making delays and errors (39, 65, 67, 68). Within the framework of our study, the task interruptions considered (telephone call, face-to-face communication, patient request) were chosen after consulting with the experts of the Swiss Triage Group and will be incorporated in the SG scenarios.

The environment component refers to the physical environment. It is characterised by various elements, including noise, lighting, air quality, and work station design. Among these elements, ED studies have identified noise as a factor that limits interaction between care provider and patient and as a potential distractor and stressor (37, 40, 69). It can have a direct impact on productivity and safety in the workplace (70). Noise is defined as an assortment of sounds perceived as annoying (70). It is characterised by intensity (decibels), type (continuous, intermittent, variable), duration of exposure (time), and frequency (70). Nurses in emergency clinical units have been shown to be exposed to continuous ambient noise of more than 65 dB, which exceeds the maximum noise levels (35) recommended by the WHO for hospitals (71, 72). In our study, noise will be considered as a distractor and inserted in the proposed SG. In order to examine the different noises present at an emergency triage station, the researchers will, in conjunction with the experts of the Swiss Triage Group, document these noises through on-site recordings and then select the ones to which triage nurses are most commonly exposed.

The organisation component refers to management style and time management, available resources, social relationships, and rules and procedures in place (59). Nurse triage guidelines mention constraints that bear upon the task, especially limited time (18, 73). Two studies (60, 74) carried out in European ED have demonstrated that the mean duration of nurse triage was four minutes. In our study, the time required by the nurses to determine the triage score for each clinical vignette will be measured and the variable will be taken into account in the analyses.

Though the SEIPS model focuses on the work system dimension, it also allows examining the dimensions of process and outcomes. The processes dimension informs on the reasoning used by nurses to arrive at clinical decisions (75). Within the framework of our study, the decision-making process itself will not be examined in depth, only the final outcome of the process will, that is, the nurses' SETS® scores corresponding to patient emergency level. Finally, the outcomes dimension will be analysed in terms of the accuracy of the emergency levels assigned (accurate triage, undertriage and overtriage). Under- and overtriage outcomes have a direct impact on patient safety and on the occurrence of adverse events. The outcomes dimension in connection with employees and the organisation will not be examined in this pilot study.

Purpose Of The Study

The purpose of this pilot randomised study is to evaluate the acceptability and feasibility of a study design and of an SG reproducing a work environment comprising distractors, and to assess the preliminary effects of distractors (noise and task interruptions) on the triage accuracy of emergency nurses in French Switzerland.

Research Questions

The questions asked in connection with the evaluation of preliminary effects are the following:

Primary question:

1.
What are the individual and combined effects of distractors on ED nurse triage accuracy?

Secondary questions:

2.
What is the relationship between the sociodemographic variables and personal characteristics of nurses and triage accuracy?
3.
What is the relationship between nurse perceived confidence and triage accuracy?

Proposed Hypotheses

We propose the following hypotheses informed by the SEIPS theoretical model (59): 1) Following exposure to a distractor, the triage accuracy and inter-rater reliability of the nurses in the exposed group will be lower than that of the nurses in the non-exposed group. 2) Following exposure to two distractors, the triage accuracy and inter-rater reliability of the nurses in the exposed group will be lower than that of the nurses in the group exposed to only one distractor and of those in the non-exposed group. 3) Nurse work experience is positively related to triage accuracy. 4) Nurse perceived confidence is positively related to triage accuracy.

Method

Study design

In order to evidence the effects of noise and task interruptions on nurse triage accuracy, we will carry out a 2x2 factorial randomised controlled trial (78). The use of a factorial design is justified by the fact that two independent variables will be manipulated (noise and task interruptions) and that we wish to examine not only the effect of each one on the dependent variable (nurse triage accuracy), but also their combined effect (78-80). The factorial design will follow the CONSORT guidelines (81) and will lay out the structure of the trial and the choice of control, an analysis of study benefits and harms, the quality and reliability of the intervention, a description of the population, the randomisation procedure, and the statistical analysis plan.

This factorial design will allow us to create four groups: one control group and three experimental groups. While triaging the clinical vignettes, nurses in the control group will be exposed to no distractors, those in experimental group A will be exposed to a noise distractor, those in experimental group B will be exposed to a task interruption distractor, and those in experimental group C will be exposed to both types of distractor . The nurses will be block-randomised across the four groups by a computer program. The groups will be of equal size or as similar as possible in this regard.

The study design comprises longitudinal measures. We will collect sociodemographic and personal data from the nurse participants before they begin evaluating the clinical vignettes. Then, during the evaluation of each clinical vignette, the following data will be systematically gathered: 1) emergency level assigned; 2) level of perceived confidence in emergency level assignment; and 3) duration of each clinical vignette evaluation. Upon completing the evaluation of the 20 clinical vignettes, the nurse participants will be asked to complete a questionnaire on the acceptability of the SG (Table 1

Table 1 Data collection for ED nurses

TIME POINT		Enrollement	Allocation	Intervention (SG)						Close out
				20 clinical vignettes (CV) in 2 hours 1er CV 2 emeCV 3emeCV 4emeCV 5emeCV 6emeCV…..						
ENROLMENT	Project presentation	x								
	to Swiss Triage Group									
	ED units recruited	x								
	Informed consent obtained for	x								
	ED Nurses									
ALLOCATION	Randomization of nurses		x							
INTERVENTION	Control group (CG)				x	x	x	x	x	x	
	Experimental groups ABC (EG)				x	x	x	x	x	x	
ASSESSMENT										
ED NURSE (CG and EG)	QUANTITATIVE DATA									
	Sociodemographic questionnaire			x						
	Level of urgency				x	x	x	x	x	x	
	Chief complaint SETS				x	x	x	x	x	x	
	Level of confidence				x	x	x	x	x	x	

SERIOUS GAME	Visual analogic scale	x
	Attradkiff scale	x

Population and sampling

This multi-site study will be carried out in ED where the SETS® is used. This is the case in 20 private and public care facilities in the five cantons of French Switzerland (Geneva, Vaud, Fribourg, Jura, Neuchâtel). The pilot study population will consist of all nurses who perform the function of triage nurse in these facilities. As at this day, this corresponds to an accessible population of 454 nurses. The eligibility criteria will be based on those used in previous studies of triage accuracy (25, 34, 83). More specifically, to participate in our study, nurses must: 1) perform triage in one of the ED where the SETS® is used and 2) consent to participate. There will be no exclusion criteria in order to obtain a broad panel of nurses. All that matters for the study is that a nurse performs ED triage. The list of nurses will be drawn up by the head nurses in each of the participating units and this list will be block-randomised across the four groups. Assuming an accurate triage rate of 0.85 for the control group, a decline of 0.1 in the experimental groups, and an intraclass correlation (that is, between vignettes triaged by a same nurse) of no more than 0.03, we estimated through simulations that each group would need to comprise at least 20 participants to obtain a power of at least 0.80 in order to answer the primary research question. Consequently, we will aim to form a convenience sample of at least 80 nurses and we will cease recruitment once this target is reached.

Procedure

The study will follow a four-step procedure. First, the SG will be constructed and the clinical vignettes developed in conjunction with the various experts involved in the study. Pre-tests have been planned in order to regularly assess the game's scalability, the relevance of the clinical vignettes selected, and the continuous analysis of the time required to evaluate the 20 vignettes. Once the vignettes thus created are stabilised, the clinical experts will, in concert with the research team, assign to each a gold standard. Second, all of the care facilities with an emergency unit in the five cantons of French Switzerland (Geneva, Vaud, Fribourg, Jura, Neuchâtel) will be contacted to validate their interest in participating in the study. To date, five facilities have confirmed their intention to participate, which represent an accessible population of 65 nurses. Third, each nurse who consents to participate in the study will receive an information and consent form. The definitive list of participants will be drawn up after consent forms are signed and each nurse participant will then be assigned an identification

number. These numbers will be used to randomise the nurses across the four groups. Fourth, the study data will be collected. To this end, the head nurses of each participating unit will, together with the research team, establish a plan to deliver the SG in their unit over a period of three months. SG delivery will follow the procedure laid out below in the section titled “SG: construction and delivery”. After their two-hour SG session, the nurse participants will return to their workplace.

SG: construction and delivery

The SG comprises three components: graphic interface, clinical vignettes, and distractors.

- **Graphic interface**: The purpose of the SG is to simulate the conditions of an ED triage station as authentically as possible. The “ED triage” SG will be developed on and operated from an open-source platform called Wegas (http://www.albasim.ch). To develop the SG and allow it to evolve, the research team will use a logical graphic interface that may include audio-visual elements adaptable to needs and scenarios. This graphic interface will consist of a virtual waiting room capable of containing different animated sequences, such as the arrival of patients and care staff. A triage station will be recreated, equipped with all the devises used by nurses under the circumstances (e.g. triage form, clock).
- **Clinical vignettes**: A series of 20 interactive clinical vignettes will be developed by the research team based on real cases, revised by a group of four experts (two staff physicians and two nursing experts), and incorporated in the SG. The clinical vignettes will be constructed following the three quality guidelines proposed by Evans et al. (84): 1) each vignette must simulate situations faced by participants, which is the case in this study; 2) each vignette must be different and entail a specific decision to be made, which in our case is to assign an emergency level to each vignette; and 3) the results obtained from using the vignette must be transferable to real-life triage situations, which makes for a better generalisation of the results. For our study, all the clinical vignettes will involve the medico-surgical issues most commonly encountered in ED and will be generalisable to other French-speaking emergency units. Finally, for each clinical vignette, the emergency level will be validated by expert consensus in strict compliance with the criteria and definitions of the SETS® (90). This will constitute the gold standard.
- **Distractors**: Noise and task interruptions will be selected in connection with the scientific literature, using, for example, the instrument developed by Johnson and colleagues (2014) for classifying the different task interruptions into categories (38). Interruptions will be introduced in the 20 clinical vignettes for the experimental groups. The distribution of task interruptions (type, number and duration) will follow a predetermined sequence and will therefore be perfectly reproducible from one vignette session to another. The SG will allow nurse participants to choose to respond or not to some task interruptions (e.g. an incoming telephone call) but will require them to respond to others (e.g. a patient inquiring about the wait time). The noise will correspond to the soundscape (observed value) of triage stations. Given that no previous study has ever proposed a categorisation, audio recordings will be made at several stations and the different types of noise obtained will be analysed. The research team will modulate the noise exposure condition by varying the form, length of exposure, and intensity of the ambient noise (e.g. conversation, telephone ringtone). The intensity of the noise exposure will range from 35 dB (A) to 85 dB (A), the

maximum level at which no auditory protection is required (85). To create a sound immersion and eliminate extraneous noise, nurses will be required to wear headphones during the SG session.

SG delivery will comprise several stages. First, the nurse participants will receive a 15-minute information session led by a member of the research team to familiarise themselves with the SG. During this session, the nurse participants will be able to ask all the questions they want to familiarise themselves as best possible. Second, the nurse participants will have the chance to test the SG on two clinical vignettes that will not be included in the analyses. During this practice run where the nurses will be equipped with headphones, the members of the research team will be on hand to answer questions, if any, and to provide help with how to use the SG, if needed. Once the practice run is completed, each nurse will be able to begin evaluating the vignettes when ready. The 20 vignettes will be presented in a pre-established order. The nurses will have two hours within which to complete the 20 evaluations, which corresponds to the average number of patients triaged at an emergency department over this lapse of time. The SG will be delivered in the computer room of each participating site following a schedule established by the head nurses in each participating unit. In all, at each game session, a maximum number of four nurses will be able to participate, based on the number of computers available at each site. All the data collected during the actual game phase will be automatically recorded and saved by the SG in a swiss located computer server. Members of the research team will be on site to provide technical support, if needed, and to document any anomaly that might occur during the SG. Finally, once the allotted two hours have elapsed, each nurse participant will stop the game session. If all 20 vignettes have not been evaluated by then, the nurse participant will complete the vignette presently being evaluated before stopping the game. All of the actions taken by the nurse participants will be timed systematically by the SG and saved to log files for later analysis.

Instruments of measurement: Outcome measures

Sociodemographic data, both personal (gender, age, family situation) and professional (employment status, total number of years of experience, number of years in current department), will be collected through a questionnaire developed on the basis of elements gathered in the course of previous studies on the subject (29, 34, 53).

The clinical decision making of the nurse participants will be judged on the emergency level that they assign based on the SETS® criteria. This scale was initially developed in Geneva and called the Geneva Triage Scale. Presently, the SETS® has four levels: acute = 1, urgent = 2, semi-urgent = 3, non-urgent = 4. Following their clinical reasoning, nurses assign patients an emergency level from 1 to 4. The scale has been the focus of various independent studies (25, 87, 88) where computerized clinical vignettes were used with ED nurses and paramedics. It is currently recommended by the Swiss Society of Emergency and Rescue Medicine (24) for ED patient triage and widely used in Switzerland, France and Belgium.

Nurse level of confidence in their clinical decision making will be measured using a visual analogue scale from 0 to 100 (89). This scale will be used by nurses after each emergency level assignment immediately after validating it. The question asked will be: “Now that you have completed this clinical vignette, in your opinion,

what is your degree of confidence in the emergency level that you have assigned?" Nurses will rate their confidence from 0 to 100, with 0 corresponding to "I have no confidence at all in my decision" and 100 to "I have full confidence in my decision". Visual analogue scales allow measuring the intensity of a subjective experience and are widely used in clinical settings (79). The researchers in a study where this scale was used by 69 nurses in a triage situation reported no problems with its utilisation (53).

The feasibility of the SG will be assessed on the basis of criteria drawn from Sidani and Braden (76) and Feeley et al. (58), including accessibility of target population, appropriateness of inclusion and exclusion criteria, nurse participation rate, nurse withdrawal rate after starting SG, presence and frequency of problems during the SG (understanding, utilisation, clarity), presence and frequency of missing data and outliers, and nurse participant satisfaction with the SG.

The acceptability of the SG will be measured using a French version of the self-administered Attrakdiff 2 (90) developed initially by Hassenzal and colleagues in German (91). This 28-item scale allows evaluating the hedonic and pragmatic qualities of interactive systems such as SGs. Each item takes the form of a seven-point scale (-3 to +3) on which to rate a quality according to semantic differentials, that is, a pair of antonyms. It comprises four subscales: usability, functionality, social impact, and attractiveness. For each item, the respondent must choose between seven answers bookended by the semantic differentials. A mean score and standard deviation are calculated for each dimension taking account of a recoding of certain inverted items (90). The values -1, 0 and 1 are considered neutral. Dimensions are deemed positive if scored +2 or +3 and negative if scored -2 or -3, in which case the SG needs to be improved. The psychometric properties (validity and reliability) of the French-language scale are entirely satisfactory, having obtained a Cronbach's α of 0.75 for each of the dimensions (90). A supplementary question in the form of a visual analogue scale from 0 to 100 will be added to examine the nurse participants' perception of the SG's realism relative to their professional activity.

Data analysis plan

The analysis units will be the nurse participants (expected N = 80) for the descriptive analyses and the triage scale scores assigned (number of nurses x number of vignettes: expected N: 80 x 20 = 1600) for the correlational analyses and some descriptive analyses. To answer the research questions, the following data analysis plan is proposed. First, the collected data will be verified (compliance with inclusion criteria, identification of missing data and outliers). Second, the data on the nurses (sociodemographic and professional) will be analysed via descriptive statistics, both univariate (mean, median, standard deviation, interquartile range, and absolute and relative frequency) and bivariate (contingency table and marginal frequency). Third, triage accuracy will be measured by the level of agreement obtained between the answers given by the nurses and the gold standard established by the experts. For each nurse, the scores assigned to each clinical vignette will be compared against the gold standard. The result will be a three-category multinomial variable: accurate triage (nurse score same as gold standard), overtriage (score higher than gold standard), and undertriage (score lower than gold standard). Over- and undertriage frequencies will be used to describe the triage accuracy of the four groups, that is, the control group and three experimental groups: Noise (A), Task interruption (B), and Noise and task interruption (C). Fourth, to examine the individual and combined

effects of the distractors on the triage accuracy of the nurse participants, the groups will be compared to one another using a random-intercept multinomial regression model. For all the analyses, the statistical significance level will be $p \leq 0.05$. All the data will be analysed using the R statistical software (93).

Ethical considerations

Each nurse from the emergency units selected for the study will receive a written information letter explaining how the study will be conducted, what their participation entails, and what data protection measures will be taken. Only team research will have acces to anonymous data. All data will be canceled after analysis data. Each nurse will then take the time they need to decide whether to participate in the study, without the decision having any consequence whatsoever for their career. To participate in the study, the nurses will have to sign a consent form, which will be stored in accordance with the recommendations of the Swiss Human Research Ethics Board (Canton of Vaud, Switzerland). The time that the nurses spend evaluating the clinical vignettes with the SG will count as work hours.

Discussion

Care quality and patient safety are core concerns of health facilities, particularly in clinical settings. During ED triage, nurse clinical decision making must be extremely accurate in order to guarantee patient safety. However, distractors such as noise and task interruptions may undermine the accuracy of the emergency levels assigned by nurses. In our project, the effects of distractors on triage accuracy will be tested and the findings will inform recommendations that we will provide EDs regarding such distractors.

Today’s technological revolution has made it possible to create tools such as SGs to optimise the learning and evaluation processes in different disciplines (e.g. medicine, aviation). In the clinical sphere, the development of these new technologies is still in its early stages, all the more so regarding the clinical decision making of health professionals. Constructing and implementing these tools in close collaboration with the settings concerned facilitates their use as training and skill assessment tools. This will no doubt be another contribution expected from this research project.

Finally, from a strictly scientific perspective, this pilot study will contribute to advance knowledge in the field of nurse triage practice assessment. Currently, nurse triage accuracy is measured in an environment that does not reproduce the conditions that prevail in clinical practice. This pilot study will help redress this shortcoming by proposing an SG that incorporates common distractors such as noise and task interruptions. This represents a technological innovation.

Abbreviations

CV
clinical vignette ; ED:emergency department ; SETS®:Swiss Emergency Triage Scale ; SEIPS:Systems Engineering Initiative for Patient Safety ; SG:serious game

Declarations

Acknowledgements

Our acknowledgements go to all emergency departments and nurses who took part in this study.

Funding.

The study is supported by the health Science faculty fund of the University of Applied Sciences and Arts Western Switzerland (HES-SO)

Availability of data and materials

The datasets generated and/or analysed in the course of this study will not be publicly available owing to privacy regulations. However, they will be made available in anonymised form by the corresponding author upon reasonable request.

thics approval and consent to participate

The project has been vetted by the Swiss Human Research Ethics Board. Participation in the project will be voluntary and will require participants to provide signed written informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

Authors' contributions

All authors contributed to the conception and design of the proposed study. PD and AF have drafted the initial protocol, which has been subsequently modified and supplemented by all of the other authors. D.J, J.H, A.F, G.S, A.K, J.S, O.R, O.H, C. GK, S.V created the serious game in the content and graphical interface. M.A, P.D, A.F, G.S organized pretest and collected the first pretest data. J.S, A.F and M.A will be involved in recruiting participants and collecting data. A.F will also handle the logistics of the study and data collection. M.A, P.D, J.P, A.F will contribute specifically to the statistical analysis. JP has supervised the allocation mechanism for intervention and control sample. All the authors will read and approve the final manuscript

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