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Feasibility and acceptability of a serious game to study the effects of environmental distractors on emergency room nurse triage accuracy: A pilot study

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ABSTRACT

Background: Emergency triage, which involves complex decision-making under stress and time constraints, may suffer from inaccuracies due to workplace distractions. A serious game was developed to simulate the triage process and environment. A pilot study was undertaken to collect preliminary data on the effects of distractors on emergency nurse triage accuracy.

Method: A 2 × 2 factorial randomized controlled trial (RCT) was designed for the study. A sample of 70 emergency room nurses was randomly assigned to three experimental groups exposed to different distractors (noise, task interruptions, and both) and one control group. Nurses had two hours to complete a series of 20 clinical vignettes, in which they had to establish a chief complaint and assign an emergency level.

Results: Fifty-five nurses completed approximately 15 vignettes each during the allotted time. No intergroup differences emerged in terms of triage performance. Nurses had a very favorable appreciation of the serious game focusing on triage.

Conclusion: The results show that both the structure of our study and the serious game can be used to carry out a future RCT on a larger scale. The lack of a distractor effect raises questions about the frequency and intensity required to find a significant impact on triage performance.

1. Background

Since the 2000s, ensuring patient safety has become a critical challenge for health care systems. Preventing and minimizing risks to patients is now a key public health priority [1,2]. This emphasis on safety is especially pertinent for health care professionals in challenging settings such as emergency departments (EDs), where the complexity of care is heightened [3–6]. The pressure of time constraints and the limited information available during patient care can lead to judgment errors, with significant implications for patient safety [7,8]. This is particularly evident in triage situations, where quick decisions based on predetermined severity scores are crucial for prioritizing patients in relation to their medical condition [9–12]. Ensuring the accuracy of triage is essential for maintaining patient safety [13]. There are two types of triage errors, namely, undertriage (i.e., underestimating the urgency or severity of a patient's condition, which is considered to be below the gold standard) and overtriage (i.e., overestimating the urgency or severity, which is considered to be higher than the gold standard). Both types of errors are undesirable outcomes of the triage process [14], resulting in delayed emergency care, insufficient medical treatment with

Abbreviations: EDs, Emergency Departments; SG, Serious Game; SGTRI, Serious Game Triage; SETS®, Swiss Emergency Triage Scale®.

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consequent risks for patient health [8], and, in more urgent cases, not receiving more immediate care [15] or in EDs being needlessly overburdened. A systematic review [16] revealed that the level of accuracy of emergency nurses' decisions is medium to low, with nurses erring on the side of both overtriage [17,18] and undertriage [8,19]. While nurses' performance has been researched extensively [16], the reasons behind their performance have rarely been investigated. Studies that have addressed this issue have focused on individual and contextual groups of factors as possible causes [20–22]. Individual factors include characteristics specific to nurses, such as personality (flexibility, decision-making autonomy), cognitive processes (critical thinking, prompt decision-making), behavioral processes (working under pressure, being organized), and nursing experience (confidence in one's decision-making) [20,23,24]. Contextual factors include distractors present in the environment [25–28], such as task interruptions, noise, and workload changes. All these factors can affect nurses' performance by causing a loss of information and concentration, particularly when nurses perform complex activities. These elements have been the subject of little exploration in the literature. However, a theoretical framework recently modelized by Carayon et al. [29] attempts to conceptualize the links between all these variables.

Triage research has used different methods to evaluate the accuracy of clinical decisions in triage, namely, retrospective reviews of records or nurse-assessed written clinical vignettes. These methods lack realism, which some authors [30] consider a critical element in evaluating ED nurses' performance and clinical decision-making. The utilization of serious games (SGs) that simulate both ED nursing tasks and the ED triage environment [30,31] would alleviate this limitation. SGs are defined as games that are designed to encourage learning and include the aspect of entertainment [32]. They are widely used in the fields of professional development and training, education, and scientific research [33,34]. Such SGs provide a unique opportunity that allows nurses to be immersed in more realistic situations, are useful for investigating triage and clinical decision-making [35,36], and have already proven to be a pertinent research method [37,38]. To further address this issue, the SGTRI was developed. It runs on a web interface using the Wegas platform (https://wegas.albasim.ch/) for development. Fig. 1 presents the graphical interface of the SGTRI.

The SGTRI aims to simulate all these elements by creating a matrix of questions and answers based on an existing interactive simulator enabling a simple exploration of clinical vignettes [39]. It uses a series of 20 clinical vignettes that include the patient's sociodemographic details, along with anatomical and clinical information, such as vital parameters, medical history, and biological values. Triage nurses can investigate them by entering keywords that lead to predefined questions or by clicking on icons representing parameter values, such as a pulse oximeter. At the end of the triage process, the user assigns an emergency level and enters the chief complaint. Additionally, we added to the simulation the two distractors most frequently indicated in the literature [26,27,40], namely, noise and task interruptions, which were programmed to occur at random in the SGTRI via modal pop-ups or sound effects that were played at levels up to 80 dB. Such noise refers to recurrent salient sounds frequently occurring in the ER, i.e., phones ringing, drilling, helicopters landing, babies crying, medical equipment alarms pinging, and thunder clapping. According to previous research [40,41], this noise can interfere with nurses' activities, such as anamnesis and vital sign measurement.

The aim of this study was to evaluate the SGTRI in terms of user experience and to describe the preliminary effects of two distractors, namely, noise and task interruptions, on ED nurses' triage accuracy.

2. Method

A pilot study design with a 2 × 2 factorial randomized controlled trial (RCT) was used. This design was dictated by the two distractors that were tested separately and jointly [42]. This was done for four conditions: (a) "no distractor" control; (b) "noise" intervention; (c) "interruption" intervention; and (d) both "noise and interruption" intervention. Nurses were distributed across these groups by block randomization. The aim was to have four groups as equal in size as possible.

The study comprised both cross-sectional and longitudinal measures. Sociodemographic and personal data were collected from participants prior to starting the SG. The performance data were evaluated after each vignette. Moreover, nurses were asked to rate how confident they were in regard to each emergency level assigned.

3. Population and sample

Triage nurses were recruited from 20 EDs across five cantons in Switzerland (Geneva, Vaud, Fribourg, Jura, and Neuchâtel), where the Swiss Emergency Triage Scale (SETS)® is used. We set the same two eligibility criteria that have been used in previous studies of triage accuracy [21,43,44]: (1) nurses had to consent to participate, and (2) nurses had to perform triage in an ED where an emergency triage scale was used, in our case, the SETS®.

Using power analysis, we calculated a minimum sample size of 1396 vignettes completed, assuming a triage accuracy rate of 0.85 for the control group [39], a minimum decline of 0.15 for the experimental groups, and a statistical power of at least 0.80. Assuming that each nurse

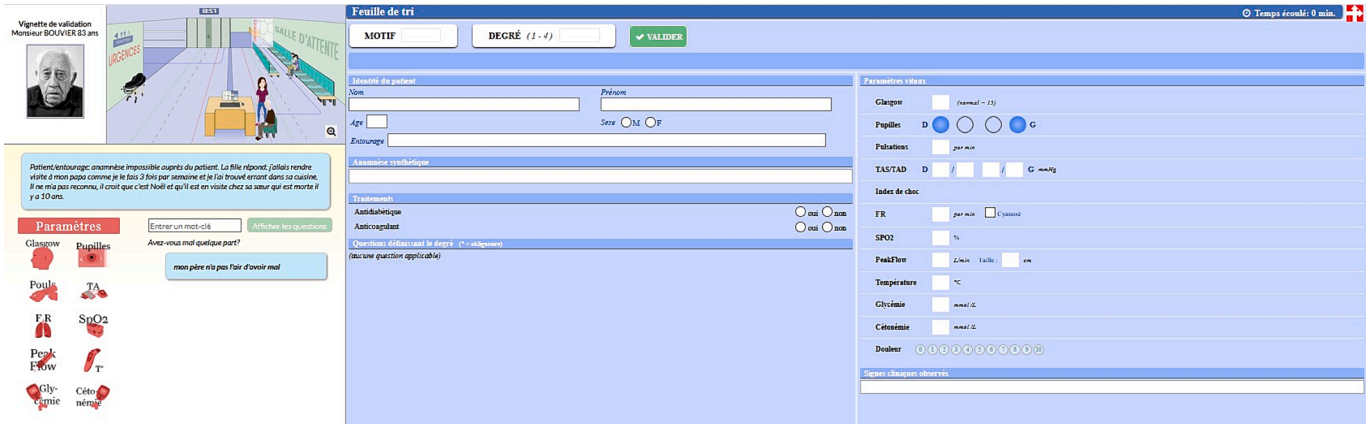

Fig. 1. The SGTRI interface in French version. At top-left corner: a photo with name and age of the patient. At middle-left: a blue rectangle with a description of the chief complaint. At the bottom-left: buttons to access vital parameters. At the center of the interface: a space dedicated to the nurse's assessment. At the top-center: an aera dedicated to the chief complaint and Swiss Emergency Triage Scale level. At middle-right: an area dedicated to the documentation of vital parameters. At top-right: elapsed time.

would complete at least 20 vignettes, we needed a total sample of 70 nurses. After completing the recruitment process, 77 nurses consented to participate in the study.

3.1. Procedure

The participants were each assigned an ID for data collection purposes. They underwent 30 min of training focused on familiarizing themselves with the use of the SG and the related equipment (headphones, laptops). For the actual test, nurses had to complete as many vignettes as possible in two hours. For each vignette, they had to assess the situation by questioning the patient or using instruments that the SG provided. Nurses completed each evaluation by formulating a chief complaint and assigning an emergency level. A group of experts had already established the correct chief complaint and the correct emergency level for each evaluation in advance. Nurse performance was evaluated by comparing their answers against this gold standard. After the evaluation, a visual scale was presented to the nurses, which allowed them to move a cursor to indicate their confidence level regarding their evaluation.

4. Instruments

Feasibility was assessed as prescribed by Sidani and Braden [45] and Feeley et al. [46]. Our procedure included evaluating the accessibility of the target population, the appropriateness of the inclusion and exclusion criteria, participation and withdrawal rates, the presence and frequency of issues encountered during delivery [comprehension, utilization, and clarity], participant satisfaction, and the presence and frequency of missing data and outliers.

The acceptability of the SGTRI was evaluated by the French version of the self-administered AttrakDiff 2 inventory [47]. Initially developed in German by Hassenzahl et al. [48], this instrument consists of a 28-item scale that evaluates the hedonic and pragmatic qualities of interactive systems. It comprises the following four seven-item subscales: usability, functionality, social impact, and attractiveness. For each item, nurses had to rate the quality on a semantic differential scale ranging from −3 to +3, anchored by a pair of antonyms. A rating of 0 or +1 was considered neutral; a rating of +2 or +3 was considered positive; and a rating of −1, −2 or −3 was considered negative. Negative ratings would suggest that the SG needed improvement. The French-language version of the AttrakDiff 2 has been shown to have satisfactory psychometric properties, with a Cronbach's α of 0.75 for each of its dimensions [47].

For the preliminary data on the effects of distractors on nurse triage performance, the nurses assigned an emergency level to each vignette according to the SETS® criteria on a scale ranging from 1 (a vital emergency) to 4 (a nonurgent case). Sociodemographic data were collected through a questionnaire developed based on elements gathered in previous studies of triage accuracy [21,43,49]. The questionnaire covered both the personal characteristics (sex, age, family structure) and professional status (job type, total years of experience in profession, total years in current unit) of the participants.

A visual scale was used to record nurses' confidence in their evaluation. The position of the cursor on the scale was automatically translated into a digit where 0 indicated no confidence at all and 100 indicated full confidence.

4.1. Data analysis

First, the database was prepared for analysis by verifying compliance with the inclusion criteria and identifying missing data and outliers. Second, we carried out descriptive analyses by examining the distribution of all the variables considered. Third, triage accuracy was measured by the level of agreement between the emergency levels assigned by the nurses and the preestablished gold standard defined by the panel of experts. This operation resulted in a categorical variable with the following three categories: accurate triage [nurse rating the same as the gold standard], overtriage (rating higher than the gold standard), and undertriage (rating lower than the gold standard). Fourth, random intercept multinomial regression models were used to study the individual and combined effects of the distractors on triage accuracy. For these analyses, triage accuracy was further reduced to two categories, namely, accurate or inaccurate. The use of random intercept models was necessary owing to the presence of clusters, as the nurses were naturally grouped into work units.

For all the tests, a frequentist approach was used with a statistical significance threshold of $p = 0.05$. All the data were analyzed using R statistical software [50].

5. Results

Even though 77 nurses were recruited, only 55 nurses participated in the study due to the period of recruitment that occurred during the first waves of COVID-19. The nurses who participated in the study completed a total of 828 vignettes. Power calculations indicated that a minimum difference of 0.19 would be detectable with such a sample. While this value was greater than the initial fixed level of 0.15 in the present study, we deemed it acceptable.

The sociodemographic characteristics of our final sample of 55 nurses are reported in Table 1. The nurses had a median age of 36 years, with an average nursing experience of 13 years, and 80 % had received specific training in triage. An average of two out of three of the participants were women, and more than 60 % had studied in France. Among the participants, 18.2 % had a bachelor's degree.

Regarding user experience and evaluation of the SG, the nurses scored all the dimensions explored with AttrakDiff 2 on the positive side [Table 2]. The hedonic dimensions that scored highest were those related to the simulation, followed closely by global attractiveness, which suggests that the SG was very well received by the users. The pragmatic dimensions, which measured SG usability, were scored lower but nonetheless > 1, as were the hedonic identity dimensions, which measured user identification with the simulation.

Finally, regarding nurses' triage performance, the participants assigned the correct emergency level 89 % of the time. Across the vignettes, the accuracy ranged from 51 % to 100 %. Nurses undertriaged (with a maximum of 23 % and a minimum of 0 %) and overtriaged with a maximum of 49 % and a minimum of 0 %) rather evenly, i.e., an average 5 % and 6 % of the time, respectively.

Regarding the effects of distractors on triage accuracy, the results of our random intercept regression analysis [Table 3] reveal no differences

Table 1
Sociodemographic characteristics of our sample.

	Medians	IQR
Age	36	13.5
Year of experience, total	13	11.5
Year of experience, in triage	7	8.0
Year of experience, in the service	6	8.5
	N	**%**
Gender		
Men	13	23.6 %
Women	42	76.4 %
Degree		
Bachelor	10	18.2 %
Swiss Vocational school	11	20.0 %
French Vocational school	34	61.8 %
Trained in triage		
Yes	44	80.0 %
No	11	20.0 %

Table 2
Values of the attrakdiff 2 dimensions.

	Mean	SD
Pragmatic	1.06	0.76
Hedonic-simulation	1.92	0.82
Hedonic-identity	1.03	0.69
Global attractiveness	1.76	0.83

Table 3
Differences between experimental and control groups.

	β	*p*
Fixed effects		
(Intercept)	1.00	0.99
Group Interruption	0.01	0.81
Group Noise	−0.01	0.79
Group Interruption + Noise	0.04	0.21
Control variables		
Age	≈0.00	0.35
Sex (man)	≈0.00	0.72
Education (bachelor)	−0.06	0.35
Education (French vocational school)	−0.01	0.79
Education (Swiss vocational school)	−0.11	0.11
Work experience, total (years)	≈0.00	0.73
Work experience, ER unit (years)	≈0.00	0.32
Work experience, triage (years)	≈0.00	0.82
Activity rate	≈0.00	0.50
Graduate-level education program (yes)	−0.01	0.72
Triage education program (yes)	0.01	0.71
Confidence level	−0.01	0.37
Time to complete the vignette	0.01	0.45
Random effects		
Emergency department 1	−0.03	0.39
Emergency department 2	−0.12	0.04
Emergency department 3	−0.01	0.14
Emergency department 4	0.06	0.81

across the groups exposed to noise, task interruptions, or both types of distraction compared with the control group.

6. Discussion

The key findings of this study indicate that the SGTRI was well received. However, the results related to distractors, including noise and task interruptions, did not show a significant association with the quality of decision-making among triage nurses.

6.1. Game design and content

User experience in SGs is an important aspect of study. Herein, this aspect was measured with an AttrakDiff 2 instrument. All the dimensions considered were considered to be either positive or neutral. Attradkiff2 was previously used to assess an SG in another study that obtained the same results as those obtained for the SGTRI [51]. In the field of health, the observations made during testing showed that some participants asked for help, usually because of technical problems such as freezing sessions or adjusting to the full-screen view on the laptops. Participants gave the SGTRI a high rating for realism, averaging 8.1 out of 10. However, certain aspects of the design process took longer than expected, particularly the initial analysis of cognitive sorting tasks, which turned out to be more numerous and complex than anticipated. Additionally, some adjustments were needed for better playability, such as increasing the speed when capturing vital parameters.

6.2. Evaluation of preliminary data on the effects of distractors

In this study, two distractors—noise and task interruptions—were evaluated in regard to nurse triage performance. No effect was observed. Studies conducted in the laboratory setting have shown that task interruptions, such as taking more time to perform the primary task or making more errors, can occur.

The participants exposed to noise, task interruptions, or both types of distraction did not differ from the gold standard. There are three possible explanations for this result. First, because our sample was rather small, we might not have had sufficient power to intercept a very small effect. The measured values suggest that once other confounding variables were integrated into the model, the intergroup differences were next to zero. Second, the chosen number of distractors might not have been enough to cause a noticeable interruption in the task. Some authors have proposed that some triage nurses are familiar with handling distractors, which is a common issue in EDs, especially during triage [30,52]. Determining the right intensity and frequency of distractors remains to be investigated. Third, we must not rule out the possibility that the results simply reflect reality. Research on the effects of distractors on ED nurses' triage performance is still limited [30]. Thus, it could be that distractors have little or no effect on performance, at least in our context.

7. Limitations

First, the Hawthorne effect could have been at play during data collection, as explained above. A suitable approach could involve the researchers exiting the room during the test or allowing the participants to complete the simulation at home, thereby allowing them to interact with the SG in isolation. Second, technical issues were noted during data collection. These issues were documented immediately and addressed following the completion of the study. Third, we obtained a smaller sample size than planned, which decreased the study's statistical power. Unfortunately, the COVID-19 pandemic significantly complicated the recruitment process. Finally, a significant portion of the participants had considerable expertise in the triage process, which potentially induced an effect of habituation. Future studies should continue to build on this work by exercising greater caution in recruiting to ensure a diverse mix of profiles in terms of triage experience.

8. Conclusion

According to Thabane et al. (2010), pilot studies are crucial for assessing the feasibility of larger-scale studies [53]. The results from our study suggest that there is a case for conducting a RCT to investigate the effects of two distractors—noise and task interruptions—on the accuracy of EDs nurse triage. Regarding the preliminary data on the effects of distractors on nurses' triage performance, no differences emerged across the four groups. This outcome raises questions about whether distractors have an actual effect, at what level noise distractors might have an impact on nurses' performance, and whether this level is realistic. In fact, the results suggest the need to improve the SGTRI to assess other factors that can limit accuracy in triage decisions. Triage is a complex procedure that can be affected by many external factors. Thus, it is crucial to determine which factors have an impact on patient safety. In addition, it is important to investigate the level of learnability of the SGTRI and to measure its effect on training, which is the main objective of such an SG. Further research must be considered in the educational field to assess the extent of nurses' knowledge in applying the triage process.

Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations. The study was approved by the Canton of Vaud

Research Ethics Board [CER-VD]. All participants provided written informed consent to participate in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during this study are not publicly available owing to privacy regulations; however, they are available from the corresponding author upon reasonable request.

Authors' contributions

P.D., A.F., M.A., O.H., S.V., and J.S. designed the study; D.J., A.K., and G.S. developed the SGTRI; M.A., P.D., J.S., and A.F. collected the data; J.P. analyzed the data; J.S., P.D., M.A., J.P., D.J., O.H., S.V., and A. F. interpreted the data; and M.A., A.F., O.KP., and P.D. contributed to drafting and editing the manuscript. All the authors have read and approved the final manuscript.

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CRediT authorship contribution statement

Fiorentino Assunta: Writing – review & editing, Writing – original draft, Validation, Investigation, Funding acquisition, Conceptualization. **Antonini Matteo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Vuilleumier Séverine:** Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Conceptualization. **Stotzer Guy:** Writing – review & editing, Software, Resources. **Kollbrunner Aurélien:** Writing – review & editing, Software, Resources. **Keserue Pittet Oriana:** Writing – review & editing, Writing – original draft. **Jaccard Dominique:** Writing – review & editing, Writing – original draft, Software, Methodology, Conceptualization. **Simon Josette:** Writing – review & editing, Software, Resources, Methodology, Investigation, Conceptualization. **Hugli Olivier:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Pasquier Jérome:** Validation, Methodology, Formal analysis. **Delmas Philippe:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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