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Effects of communication on the performance of nursing students during the simulation of an emergency situation

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Abstract

Aim. To explore how nursing performance is impacted by different forms of team communication including a message transmitted through an earpiece which triggers reflective thinking in the simulation of a deteriorating patient situation.

Background. Communication can either support team performance or produce interruptions potentially leading to error. Today, technology offers the opportunity to use devices that can permit communication.

Design. An experimental protocol was used with quantitative and qualitative analyses.

Methods. Pairs of nursing students (N = 26) were dispatched to either an experimental group having to wear an earpiece priming reflective thinking, or to a control group. The study was conducted between October 2013–April 2014.

Results. The number of spontaneous information exchanges between pairs of participants was positively correlated with overall performance (actions performed and physician call) and with actions performed at the right moment. The number of questions in the team was positively correlated with overall action performance. No quantitative effect of the earpiece message on the performance indicators was found. But, a qualitative observation showed that this message can allow for error avoidance. Subjective evaluation of the earpiece as an aid was negatively correlated with overall action performance. Its evaluation as a disturbance was also negatively correlated with the measurement of actions performed at the right moment.

Conclusion. The ability to exchange information and to ask questions seems to contribute to performance in care delivery. The use of communication devices to trigger reflective thinking must be studied in more depth to assess their capacity to improve performance.

Keywords: communication, deteriorating patient, nurses, nursing student, performance, simulation

Why is this research or review needed?

- A positive relationship between the technical team's performance and the overall level of speaking up from nurses in physician-nurse teams has been demonstrated.
- Communication has also been observed as constituting interruptive events which interfere with performance.
- The potential contribution of information communication technology to team communication, and reflective thinking, needs to be assessed.

What are the key findings?

- Information shared and questions posed in a nursing team facilitate performance.
- The less efficient the nursing teams are, the more sensitive they are to the effect of the earpiece message on their performance.
- A message sent by an earpiece that triggers reflective thinking of the current action can have an impact on awareness that regulates potential error.

How should the findings be used to influence policy/practice/research/education?

- Remote communication systems during a simulation exercise can become an educational tool to enhance in situ reflective thinking, particularly for less efficient students.
- Practices which facilitate questions and information sharing must be developed for nursing education.

Introduction

The paramount role played by non-technical skills in the quality of care is becoming more frequently noticed. This kind of skill is particularly important for nurses whose job partly consists in transmitting critical information in the medical team (Mitchell & Flin 2008, Miller *et al.* 2009). Classically, non-technical skills are defined as corresponding to cognitive, social and personal resources that complement technical skills and contribute to a safe and efficient performance (Cooper & Cant 2014). Among non-technical skills, some frequently identified are the capacity to communicate, to lead, to make decisions or to ensure situational awareness (Reader *et al.* 2006, Yule *et al.* 2006). In this set of skills, communication occupies a particular place as exchanges in the team can facilitate the other competencies, i.e. leadership, decision-making and situational awareness. Indeed, orders in a team refer to the expression of leadership. Questions can induce decision-making. And finally, information spontaneously expressed by members of the team contributes to the emergence of a shared team situational awareness.

Background

The positive effects of team communication on the care delivery process have been largely pointed out (see for instance, Chant *et al.* 2002). In one particular case, a positive relationship between speaking up, i.e. questioning, correcting or clarifying current task-relevant observations and technical performance was experimentally demonstrated in a two-person anaesthesia care team, composed of a physician and a nurse during a simulated scenario (Kolbe *et al.* 2012). In this experiment, the technical team performance was significantly predicted by the level at which the nurses spoke up, but not the residents.

In practice, different strategies have been explored to promote team communication (Wright & Endsley 2008, Bleakley *et al.* 2013) and avoid social barriers that contribute to human error (Boyle & Kochinda 2004, McGilton *et al.* 2006). With this aim in mind, the use of communication supporting devices presents two main advantages. Firstly, a communication device is a material medium that concretely permits team communication to induce situational awareness. Secondly, individual interaction with a device also allows for self-communication, that is, internal dialogue that fosters reflective thinking (Kuiper & Pesut 2004). Reflective thinking is a metacognitive process that allows the agents to step away from their own activity. Reflective thinking creates meaning that contributes to guiding action (Schön 1983, Teekman 2000). The communication devices that have been commonly studied are journals (Plack *et al.* 2005) and check-lists (Lingard *et al.* 2008). But currently, information communication technology for health proposes more and more solutions that can not only potentially assist communication, but also improve reflective thinking by eliciting the internal mental state (While & Dewsbury 2011).

However, research has put forward some nuances on the benefits brought by communication. Based on the moment at which communication occurs, it can produce interruptions in the course of the activity that disturb the reflection process (Grundgeiger & Sanderson 2009). Interruptions are a significant factor in the explanation of medical error (Wiegmann *et al.* 2007, Kilner & Sheppard 2010). In an emergency department, Spencer *et al.* (2004) showed that one third of the communication led to interruption causing events. Moreover, the necessity to transmit or receive information can mean a supplementary workload for the clinician. It is particularly true for newly registered nurses, who are not accustomed to coping with multiple task constraints (Kapborg & Fischbein 1998). Additionally, communication requires time that is hardly available when an emergency arises, like the rapid and acute deterioration of a patient (Laxmisan *et al.* 2007). In these contexts, the triggering of communication through a technical device, and direct communication in the team, can disturb rather than help the nursing activity.

The study

Aim

Faced with this conflicting evidence on the expected benefits of communication in a medical team, the aim of this study was to explore how clinical performance was affected by different forms of spontaneous team communications and a remote interruptive message triggering reflective thinking, transmitted through an earpiece in the context of a simulated deteriorating patient situation. Our hypotheses were twofold: firstly, the message transmitted through the earpiece to nursing students would facilitate reflective thinking in the course of action and consequently would improve performance. Secondly, there would be some significant positive correlations between the communication in nurse teams and their performance.

Design

An experimental protocol was used, with primarily quantitative measurements on the frequencies of expected actions, expected information transmitted to a physician by phone and spontaneous communication between participants. Qualitative components of the study concerned the analysis of an event during a simulation session and the measurement of subjective evaluations of the earpiece during the debriefing stage.

Participants

Nursing students (*N* = 52; 26 pairs of participants), seven men and 45 women, between 22–45 years of age, in the final year of their nursing education (3rd year) participated in the experiment. They were recruited by mail on a voluntary basis and were randomized in pairs. The inclusion criterion was their year of education. The exclusion criterion was the knowledge of the scenario content before participating in the experiment. No participant confessed knowledge of the scenario before the experiment. The confidentiality of scenario contents was a well-integrated practice among students. But to reinforce this aspect, two different scenarios were alternately used during the experiment.

Data collection

The experience took place in a simulation room divided into two parts by a partition with a one-way mirror. This room contained a high-fidelity, realistic and interactive mannequin with physiological cues, like heart rate, blood pressure, breathing and verbal expression via a microphone. A set of classical medical equipment was available in the bedroom. The students wore a microphone and an earpiece allowing them to receive a message addressed via a walkie-talkie system.

The experiment comprised three stages: briefing, simulation and debriefing. During the briefing and after an initial test with the audio material, brief descriptions of the patient and of the medical treatments to apply were given to the participants. Each pair of participants confronted one of two comparable alternately used scenarios. Both scenarios had the same context in that there was an emergency ward where the house physician was not available because he had been called into the stabilization room. The house physician could be contacted by phone, but with difficulty. When the two participants arrived at the simulated bedroom, they took over for their colleague. Each scenario lasted 8 minutes. At minutes M2, M4 and M6, a progressive deterioration of the patient's state was simulated by the experimenter through a remote computerized system. One of the scenarios was a 'respiratory' scenario that simulated respiratory distress in a patient who had fallen and was under the influence of toxic substances. The patient was quite aggressive in his words. The second scenario was a 'haemorrhage' scenario describing a thigh injury with a haemorrhagic shock after a fall from a scooter. The patient was stressed. Although different, these two scenarios were comparable on some dimensions. Each patient had a fracture in his right leg. Their psychological state was such that they frequently asked the nursing students questions, a situation that did not facilitate the students' activity. Participants had to respond to reassure the patient and to be aware of the gradual deterioration of his condition. The order of the scenarios was counterbalanced in two groups: an experimental group consisting of 12 pairs of participants and a control group consisting of 14 pairs. In the experimental group, each participant received a message sent twice to the earpiece (participant n°1 at M1 and M3; participant n°2 at M5 and M7). This message was: 'Do you hear me? Well, tell me what you are doing right now.' The purpose of this question was to initiate awareness in the individual with regard to the action currently being performed in the context. We supposed this question was intuitive as previous research had shown that reflective thinking among professional nurses usually concerns action planning rather than a diagnosis of the situation (Schön 1983, Teekman 2000). In the control group, participants also wore the earpiece but did not receive the message. They were warned that the message was likely to occur, but without certainty. During the briefing, it was emphasized that there was no right or wrong answer to this question. The participants had to freely say what came to mind at this time. During the debriefing phase, the participants saw their recorded activity on a TV screen and were asked to answer to the same experimenter's question at the same moments of the scenario. The content of the participants' answers were not integrated into the set of data presented in this article. They referred to issues and theoretical aspects that went beyond the purposes of the present study. At the end of the debriefing stage, the participants individually completed a questionnaire with a subjective assessment of the earpiece (physical discomfort, mental disturbance, aid). It should be noted that one pair of participants in the experimental group unfortunately did not answer the questionnaire on the earpiece (n = 11 pairs of participants).

Ethical considerations

The informed consent of all participating students was obtained. Individual data were processed to become anonymous. The study was approved by the ethical committee of the CRPCC laboratory (University of Bretagne-Sud).

Data analysis

The participants' performances were measured with observation scales specifically built for each scenario. According to the expected sequence of clinical actions, between M0 and M2 minutes, participants should take several actions related to the initial management of the patient including various clinical assessments such as neurological, hemodynamic, respiratory check-up and pain evaluation. Between minutes M2 and M4, the deterioration of the patient's state should lead participants to contact the physician by phone and spontaneously implement various activities in connection with this first threshold. Between M4 and M6, which corresponds to a second threshold of deterioration, the participants must call the physician again and take the necessary emergency measures. Between M6 and M8, the last degradation threshold, participants should implement actions related to medical prescriptions. The percentage of expected actions being taken and the expected percentage of actions taken at the right time of the intervention sequence were calculated. A specific observation scale was developed to assess the quality of the call to the physician based on the SBAR technique (Situation-Background-Assessment-Recommendation) usually learnt by nursing students. As both scenarios potentially involved two calls to the physician, whenever a pair of participants actually made both calls, we only retained the call that was the most informative in the framework of the SBAR rule. Communication between a pair of participants was coded on the basis of its frequency of occurrence. Orders, questions and shared information were counted.

Two experimenters coded the actions and SBAR performances while viewing the videos. Each coder had previously received training in the analysis of behavioural data and one of the coders was a Registered Nurse. Finally, a general questionnaire including a subjective assessment of the earpiece was proposed to the participants. Three scales concerning the earpiece were used. The first scale concerned physical discomfort with the statement: 'Wearing the earpiece bothered me in my movements.' The second scale concerned mental disturbance with the statement: 'The message transmitted by the earpiece disrupted me.' The third concerned mental aid with the statement: 'The message transmitted by the earpiece helped me.' Each scale ranged from 1–5, with 1 = not at all true, 3 = moderately true, 5 = very true. Participants could justify their answers in writing. The quantitative data were analysed using SPSS version 12·0. (SPSS Inc., Chicago, IL, USA).

Rigour

The observation scales were elaborated by a nursing teacher and validated by an emergency medical doctor. All the video recordings were jointly coded by the same two people who were blinded to the hypotheses. Any disagreements were solved through discussion.

Result

Firstly, we present findings on participants' performance (actions and SBAR communication) and secondly, we present the effects of communication on performance (spontaneous communication and communication primed with the earpiece device).

Performance on expected actions

Results showed that the performances measured in actions were relatively low. On average, a pair of participants performed 46·5% (SD 9·1%) of the expected actions in the two clinical scenarios, with significant difference between the two scenarios (Mann–Whitney *U*-tests = 34·0, $P < 0·01$): 'respiratory' scenario mean = 51·0%, SD 7·1% [min. 37·5–max. 62·5] and 'haemorrhage' scenario: mean = 42·1%, SD 8·8% [min. 26·7–max. 60·0]. As both scenarios were counterbalanced in groups, this statistical difference had no impact on the measurements involving the effects of explanatory variables (use of the earpiece, communication). Considering the most demanding performance criterion of the right action at the right time that we called 'sequential performance,' overall only 26·5% (SD 7·7%) of the actions were performed at the right time in the sequence of expected actions. There was no significant difference between the two scenarios (Mann–Whitney *U*-tests = 72·0, $P = 0·52$, 'respiratory' scenario: mean = 28·4%, SD 8·3% [18·8-43·8]; 'haemorrhage' scenario: mean = 24·5%, SD 6·9% [13·3-40·0]). A detailed analysis of action frequencies allowed for specifying the least implemented actions by the participants (Table 1).

First, we observed a strong proximity in frequencies for the first shared actions between the two scenarios, i.e. neurological evaluation, parameter analysis, respiratory frequency, arterial blood pressure, pain scale, neurovascular assessment and the first call to the doctor. Some essential actions such as clinical observation of the leg were relatively low despite their clinical importance (respectively 46·2% and 53·9%). Critical actions to increase clinical patient assistance due to the continuing deterioration of his condition were poorly implemented (high concentration mask in the 'respiratory' scenario': 46·2%, increase in the rate of infusion in 'haemorrhage' scenario: 15·4%). For the 'respiratory' scenario, we observed that the Glasgow Coma Scale – used for assessing the patient's level of consciousness in terms of verbal, motor and eye opening response – was deconstructed in practice despite its routine nature. Only the verbal response test was frequently applied. Finally, the second call to the physician was poorly implemented, if at all (respectively 0·0-23·1%).

Figure 1 shows that there was no relationship between the two performance indicators (overall and sequential performance). Statistical analysis showed neither a significant linear relationship (linear regression: $R^2 = 0·03$, d.f. = 24, $F = 0·77$, $P = 0·39$) nor a non-linear relationship (3rd order polynomial regression: $R^2 = 0·17$, d.f. = 23, $F = 2·27$, $P = 0·13$) between the two performance indicators. Participants can perform the actions needed at the right time, while their overall number of right actions performed remains low. Conversely, some pairs can achieve a high number of expected actions, while these actions did not frequently follow the expected sequence.

Performance during the physician call (SBAR)

Regarding the content of the SBAR script when calling the physician, the same levels of success were observed as action performance. Only an average of 47·7% (SD 26·0%) of the information was effectively transmitted despite the small amount of information contained in the script. We observed a significant difference between the two scenarios (Mann–Whitney *U*-test = 37·5, $P < 0·02$): 'respiratory' scenario, mean = 35·4%, SD 24·7% [0·0-80·0] and 'haemorrhage' scenario: mean = 60·0%, SD 21·6% [0·0-100·0].

Table 1 Mean frequencies of expected actions for each scenario. In bold, actions specific to a given scenario.

'Respiratory' scenario	%	'Haemorrhage' scenario	%
Neurological assessment	100	Neurological assessment	100
Parameters analysis on scope	100	Parameters analysis on scope	100
Manual checking of respiratory frequency	23·1	Manual checking of respiratory frequency	30·8
Checking of arterial blood pressure on the scope	92·3	Checking of arterial blood pressure on the scope	92·3
Pain scale administration	61·5	Pain scale administration	84·6
Clinical observation of lower leg	46·2	Clinical observation of thigh	53·9
Neuro-vascular assessment of leg and feet	0·0	Neuro-vascular assessment of leg and feet	7·7
Inhalation mask or nasal cannula (3-4 L.)	76·9	Phone call n°1	92·3
Phone call n°1	84·6	**Elevating the end of the bed**	0·0
High concentration inhalations mask (6-8 L.)	46·2	**Increasing the infusion rate**	15·4
Glasgow C.S. – verbal response	100·0	**Second intravenous route**	0·0
Glasgow C.S. – motor response	46·2	Inhalation mask or nasal cannula (3-4 L.)	23·1
Glasgow – eyes opening response	23·1	Phone call n°2	23·1
Recovery position	0·0	High concentration inhalations mask (8 L.)	15·4
Phone call n°2	0·0	**Preparation of large molecule**	0·0
Intubation preparation	0·0		

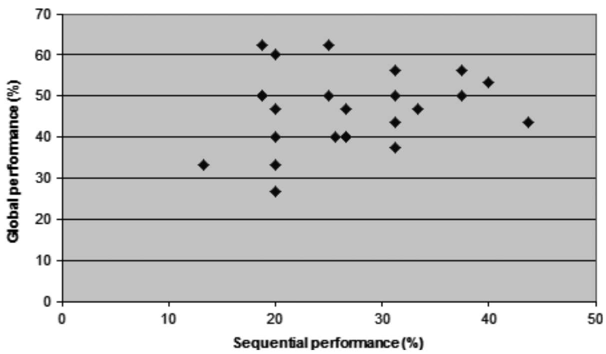

Figure 1 Distribution of the pairs of participants according to their overall performance in expected actions (in ordinate, percentages of action occurrences) and their performance measured through the respect of the order of expected actions (sequential performance, percentages of occurrences in abscissa).

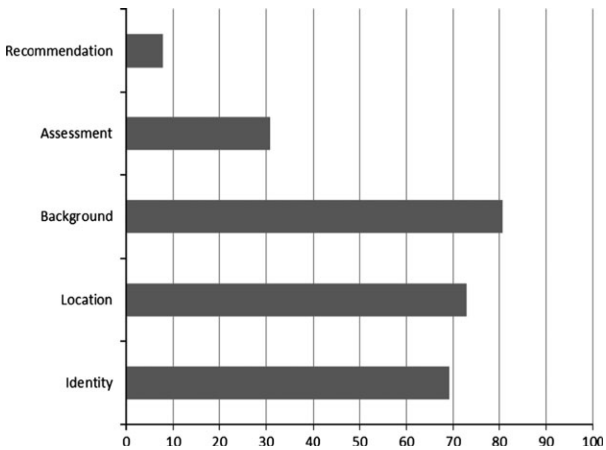

Figure 2 Global mean frequencies in percentages of occurrence for the pieces of information composing the SBAR script: Situation (Identity and Location), Background, Assessment, Recommendation.

Concerning the respect of the SBAR sequence, we observed an average performance of 32·3% (SD 27·8%). A significant difference was also noticed between the two scenarios (Mann–Whitney *U*-tests = 31·5, $P < 0{\cdot}006$): 'respiratory' scenario, mean = 18·5%, SD 23·8% [0·0-80·0] and 'haemorrhage' scenario: mean = 46·2%, SD 25·0% [0·0-100·0]. Note that the standard deviations were particularly large, showing a wide disparity in the call. Figure 2 shows the overall frequency of occurrence of the various elements of information from the SBAR script. While information on the clinical background (80·8% of cases) were rather highly expressed, some essential information was sometimes absent, like the location of the patient (73·1%) and the identity of the nurse (69·2%). The least expressed information concerned clinical analysis and actions that have been completed (30·8%) and particularly, the proposal of recommendations to solve the problem (7·7%).

Concerning the relations between these performance indicators, a strong positive correlation was found between overall SBAR performance and the sequential SBAR performance (Rho = 0·93, $P < 0{\cdot}01$). The more often pairs of participants provided the necessary information to the physician, the more the information was given in the expected order of formulation.

Effects of communication on team performance

During the 8-minute unfolding of a scenario, when considering all the pairs, the average asked 5·8 questions (SD 5·0). They sent 3·4 orders (SD 1·7) and 8·2 shared information (SD 5·0). No statistical difference was observed in the average number of questions, orders or information exchanges according to the group of participants, i.e. with an earpiece (experimental group) or not (control group).

In general, the percentage of expected actions was significantly correlated with the number of questions (Rho = 0·39; $P < 0{\cdot}05$) and the quantity of shared information (Rho = 0·39, $P < 0{\cdot}05$). The higher the performance, the higher the quantity of questions and information shared between a pair of participants (Table 2). The correlation between performance and number of orders was not significant (Rho = 0·18, $P = 0{\cdot}39$). No significant correlation appeared between the expected percentage of actions taken at the right time (sequential performance) and the different forms of communication. We noticed a significant negative correlation between the quantity of exchanged information in the team and the subjective evaluation of the earphone system as uncomfortable (Rho= 0·79, $P < 0{\cdot}01$). The more participants spontaneously shared information, the less they considered the earphone system uncomfortable.

The overall SBAR performance was only correlated with the amount of information shared in the team (Rho = 0·42, $P < 0{\cdot}04$). The more information was fully provided from the SBAR script the higher the quantity of information shared between participants in a pair.

The effect of an earpiece on actions and SBAR performance

In terms of overall action performance, there was no significant difference between the group of participants who benefited from the earpiece (mean = 46·0%, SD 9·9%) and the control group (mean = 46·9%, SD 8·7%), nor was significant difference in sequential performance found between

Table 2 Non-parametric correlations (Rho of Spearman) between performance indicators, subjective earpiece evaluation and spontaneous communication, with effective (*n*) and statistical significant level: (*)$P < 0·05$; (**)$P < 0·01$.

	SBAR sequence	Overall SBAR	Disturbance	Discomfort	Aid	Action sequence	Overall actions	Question	Order	Information
SBAR sequence	1·00	**0·93**(**)	−0·30	−0·24	−0·14	0·09	−0·03	0·12	0·01	0·38
n		26	11	11	11	26	26	26	26	26
Overall SBAR		1·00	−0·25	−0·30	−0·25	0·06	0·05	0·17	0·12	**0·42** (*)
n			11	11	11	26	26	26	26	26
Disturbance			1·00	−0·23	0·07	**−0·63**(*)	0·17	0·21	−0·00	0·43
n				11	11	11	11	11	11	11
Discomfort				1·00	0·43	−0·13	−0·35	−0·07	0·08	**−0·79**(**)
n					11	11	11	11	11	11
Aid					1·00	0·23	**−0·62**(*)	0·32	−0·06	−0·35
n						11	11	11	11	11
Actions Sequence						1·00	0·08	0·32	−0·03	0·37
n							26	26	26	26
Overall Actions							1·00	**0·39**(*)	0·18	**0·39** (*)
n								26	26	26
Question								1·00	**0·42**(*)	**0·80** (**)
n									26	26
Order									1·00	0·31
n										26

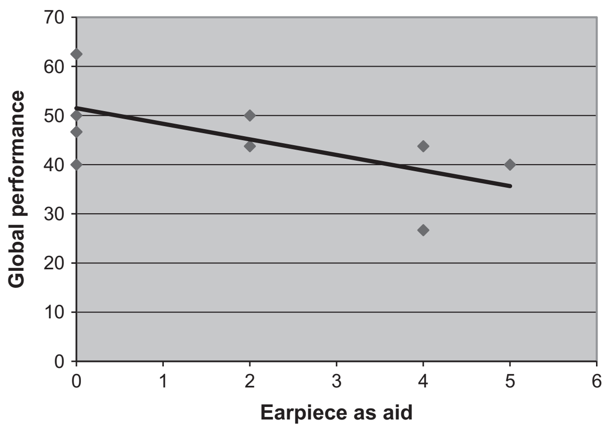

Figure 3 Linear relation between overall action performance in percentages and subjective evaluation of the earpiece as an aid (sum of the individual scores inside a pair of participants).

the experimental group (mean = 25·7%, SD 8·1%) and the control group (mean = 27·0%, SD 8·2%).

The use or absence of the earpiece had no impact on either the overall amount of information correctly transmitted to the physician (experimental group: mean = 46·7%, SD 27·4%; control group: mean = 48·6%; SD 25·7%) or on the amount of well-ordered information transmitted (experimental group: mean = 36·7%, SD 29·3%; control group: mean = 28·6%, SD 26·8%).

In terms of the subjective evaluation of the earpiece use during the debriefing, there was a negative correlation between the overall performance of expected actions and the subjective evaluation of the earpiece as an aid (Rho = −0·62, $P < 0·05$). The lower the performance, the more participants considered the earpiece an aid (Figure 3).

A second negative correlation was observed between the proportion of expected actions performed at the right time and the subjective evaluation of the earpiece as constituting a disturbance (Rho = −0·69; $P < 0·04$; Figure 4). The lower the number of actions performed at the right time, the more the earpiece transmitted message was considered disturbing.

These two opposite impacts of the earpiece on action performance can be highlighted through reports made by some participants during the debriefing:

> It separates us from the health care, but at the same time, the earpiece allows us to step outside of the situation and to reflect on our acts. (Participant B7.P2: [discomfort = 1, disturbance = 5, aid = 3])

> The messages disturbed my actions since I had been focused on what I was doing. It bothers me to have someone stop me while I'm working. I had to step out of my situation and think about what I was doing while normally I would have done it without thinking. (Participant B11.P1: [discomfort = 1, disturbance = 5, aid = 1])

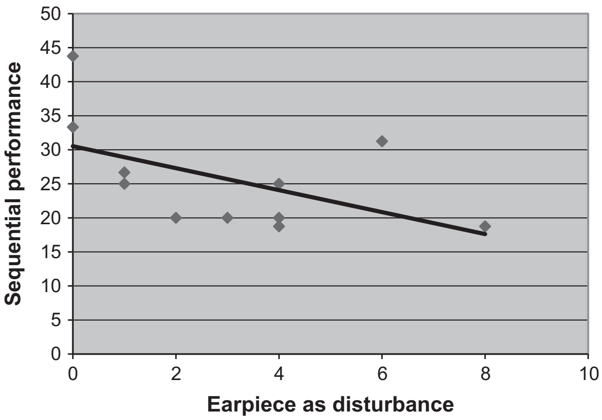

Figure 4 Linear relation between sequential action performance in percentages (expected actions at the right time) and subjective evaluation of the earpiece as a disturbance (sum of the individual scores between a pair of participants).

Example of awareness with the earpiece

While overall, we did not observe a quantitative effect of the use of the earpiece on performance, it seemed that the reflective question could positively influence performance. For example, Mary (pair B12) was questioned in the third minute by the experimenter about what she was doing. While she handled medication, she said: 'Here I am preparing, uh, 50 mg... Ah, it's 100 0... Oh no, that's right: 100 mg Tolpagic® in 0...' During the debriefing, Mary admitted to committing an error in dosage by preparing Tolpagic® 50 mg rather than the 100 mg prescribed during the briefing phase. During the debriefing, she said that she wanted to prepare the analgesic and inject the painkiller into the solute and suddenly she realized that she wasn't going to check the dosage of the vial. By thinking of her action in progress out loud, she was able to realize the mistake she had made.

During the evaluation stage of the earpiece, Mary noticed [discomfort = 1, disturbance = 1, aid = 5]:

> The message helped me in the preparation of the analgesic by making me verify the dose administered. Stating aloud what we do provides a methodical approach for implementation.

Discussion

To our knowledge, this is the first time that a performance measurement through an observation scale dissociates overall performance of the undertaken actions, from more accurate performance based on actions performed in the correct order. This distinction allows for the emergence of two indicators that are not necessarily correlated in our study. They seem to refer to different performance profiles. Notably, one profile involves a significant number of right actions performed at inappropriate moments, while the other performs the right action at the right time, but in small quantities. Some nursing students are able to activate the appropriate set of skills for coping with the experimental scenario, but this knowledge is still not embedded in procedures or the care plan that would be coupled with the progression of the patient's deteriorating state. This lack of action synchronization with the patient's state can be observed through the low frequency of actions with the purpose of enhancing the clinical assistance of the patient while his clinical state is deteriorating. This lack of synchronization can be observed when participants show difficulties in deciding to use the high concentration mask in the 'respiratory' scenario, or when it is necessary to increase the infusion rate in the 'haemorrhage' scenario. Some other participants perform appropriate actions at the right time, but sporadically as in the case the Glasgow Coma Scale which is not fully completed. As noted for Registered Nurses by Cioffi (2000), they usually recognize patient deterioration from feelings. They can feel that something is wrong, which can lead to a singular action adapted to a given time. However, they are not able 'to put their finger on it'.

The unstructured nature of the performance is less present for the SBAR script during the phone call. Indeed, this is a shorter script routinely learnt by nursing students. Nevertheless, essential information can be frequently absent. In particular, the participants do not make a sufficiently precise diagnosis of the patient's condition to allow the engagement of a care plan. Overall, the rate of following the SBAR script stands low. This result is in accordance with a finding obtained among Registered Nurses showing that they provide the SBAR to a medical doctor who enters in the room only 43% of the time (Miller *et al.* 2009).

Otherwise, our results experimentally demonstrate the positive impact of team communication on clinical performance. The frequency of questions and information spontaneously shared are both in relation with the overall performance in care delivery. Shared information is also correlated with the overall SBAR performance. These two forms of communication stimulate decision-making and the shared situational awareness that in consequence, will overall facilitate the implementation of knowledge through actions. Nevertheless, information and questions are not sufficiently prescriptive to induce either the triggering of the correct actions at the right time, or the following the SBAR script. Orders, on the other hand could have this potential, but the frequency of orders is rather low and when they do occur, they are perhaps not sufficiently relevant. Observations made during the simulation show that in general, no leadership emerges from between the pairs of participants. The undergraduate status of the students does not facilitate leadership positioning (Kapborg & Fischbein 1998).

While information exchanges between pairs of nurses have a positive effect on the overall performance, the effect of communication with the earpiece device shows nuanced results. Group comparison (with earpiece vs. without) does not show any significant effect of the message on the performance indicators. However, a qualitative observation shows that priming reflective thinking of the action currently being performed by the nurse can facilitate consciousness and avoid a dosing error.

The subjective evaluation of the earpiece during debriefing brings complementary data that are not directly easy to interpret. According to the level of performance of the nurse team, the message with the purpose or priming reflective thinking is judged differently. The less efficient the nurse pairs are in the overall performance, the more they have a positive feeling about the aiding effect of the message. But if we consider the sequential performance indicator, the less efficient they are in this performance criterion, the more sensitive they are to the disturbance effect of the same message.

These effects of performance level could be explained by the fact that nurse teams with good performance are actually insensitive to the facilitating or disturbing effect of the earpiece message. More confident in their efficiency, they are less dependent on the positive and negative contributions of the earpiece. This hypothesis is sustained by the negative correlation found between the quantity of shared information in the team and the feeling of discomfort concerning the earpiece device. The nurses that are productive in their flow of information exchanges are less sensitive to the wearing of the device than those communicating less. We can suppose that teams with poor sequential performance talked about the disturbing effect of the auditory stimulation produced by the earpiece on their cognitive action planning. As stimulation, the message interfered with their ability to respect a cognitive plan for a good sequential performance. But, when teams with poor overall performance talked about the aiding effect of the earpiece device, they considered the positive effect of the earpiece message, as such, on their ability to develop reflective thinking.

Limitations of the study

This study focuses on undergraduate nursing students and thus, results cannot directly be generalized to Registered Nurses who for example would maybe produce more communication involving orders. Nursing students in the final year of their education are advanced beginners, who are able to cope with recurrent meaningful components of clinical situations, but possibly not sufficiently experienced to be sensitive to an attempt of reflective thinking priming during a difficult work situation (Benner 1982). Furthermore, asking questions through an earpiece device can lead participants to be less involved in the scenario that is only a simulated work situation. Concerning the results found on the subjective evaluation of the earpiece message, these findings are limited by the size of the sample ($n = 11$). We cannot also neglect the possibility that teams with poor performance would *a posteriori* justify their performance through their answers to the earpiece questionnaire. The debriefing stage during which they viewed their performance on a TV screen would help them to be aware of their poor performance level.

Conclusion

The contribution of team communication on clinical performance appears significant in this experimental study. Our simple categorization of communications through questions, information and orders highlights the importance of information sharing and questions in the implementation of technical skills among nursing students for coping with an emergency situation. Such a finding underlines the necessity to develop communication facility during care delivery. In this context, information communication technology represents an opportunity to facilitate these communication processes through information exchange and personal questioning that induces reflective thinking. The appropriate use of a remote communication device offers the opportunity to trigger *in situ* cognitive processes that can more efficiently orient the awareness of the trainees in the course of the action than after sessions as in the case of debriefing. The effects of this form of experimental intervention have to be studied in greater depth. It could become an actual training tool for enhancing non-technical skills among trainees, particularly nursing students with low performances. The diffusion of an affording message at some key moments in a scenario, rather than arbitrarily as we did, could be envisaged in the scope of a training procedure. Additionally, the analysis of participants' answer contents could permit us to characterize their mental states with regard to the gravity of the emergency situation at a given moment.

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Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/)]:

- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

References

Benner P. (1982) From novice to expert. *The American Journal of Nursing* **82**(3), 402–407.

Bleakley A., Allard J. & Hobbs A. (2013) 'Achieving ensemble': communication in orthopaedic surgical teams and the development of situation awareness—an observational study using live videotaped examples. *Advances in Health Sciences Education* **18**(1), 33–56.

Boyle D.K. & Kochinda C. (2004) Enhancing collaborative communication of nurse and physician leadership in two intensive care units. *Journal of Nursing Administration* **34**(2), 60–70.

Chant S., Jenkinson T., Randle J. & Russell G. (2002) Communication skills: some problems in nursing education and practice. *Journal of Clinical Nursing* **11**(1), 12–21.

Cioffi J. (2000) Nurses' experiences of making decisions to call emergency assistance to their patients. *Journal of Advanced Nursing* **32**(1), 108–114.

Cooper S.J. & Cant R.P. (2014) Measuring non-technical skills of medical emergency teams: an update on the validity and reliability of the Team Emergency Assessment Measure. *Resuscitation* **85**(1), 31–33.

Grundgeiger T. & Sanderson P. (2009) Interruptions in healthcare: theoretical views. *International Journal of Medical Informatics* **78**(5), 293–307.

Kapborg I.D. & Fischbein S. (1998) Nurse education and professional work: transition problems? *Nurse Education Today* **18**(2), 165–171.

Kilner E. & Sheppard L.A. (2010) The role of teamwork and communication in the emergency department: a systematic review. *International Emergency Nursing* **18**(3), 127–137.

Kolbe M., Burtscher M.J., Wacker J., Grande B., Nohynkova R., Manser T., Spahn D.R. & Grote G. (2012) Speaking up is related to better team performance in simulated anesthesia inductions: an observational study. *Anesthesia & Analgesia* **115**(5), 1099–1108.

Kuiper R.A. & Pesut D.J. (2004) Promoting cognitive and metacognitive reflective reasoning skills in nursing practice: self-regulated learning theory. *Journal of Advanced Nursing* **45**(4), 381–391.

Laxmisan A., Hakimzada F., Sayan O.R., Green R.A., Zhang J. & Patel V.L. (2007) The multitasking clinician: decision-making and cognitive demand during and after team handoffs in emergency care. *International Journal of Medical Informatics* **76**(11), 801–811.

Lingard L., Regehr G., Orser B., Reznick R., Baker G.R., Doran D., Espin S., Bohnen J. & Whyte S. (2008) Evaluation of a preoperative checklist and team briefing among surgeons, nurses and anesthesiologists to reduce failures in communication. *Archives of Surgery* **143**(1), 12–17.

McGilton K., Robinson H.I. & Boscart V. (2006) Communication enhancement: nurse and patient satisfaction outcomes in a complex continuing care facility. *Journal of Advanced Nursing* **54**(1), 35–44.

Miller K., Riley W. & Davis S. (2009) Identifying key nursing and team behaviours to achieve high reliability. *Journal of Nursing Management* **17**(2), 247–255.

Mitchell L. & Flin R. (2008) Non technical skills of the operating theatre scrub nurse: literature review. *Journal of Advanced Nursing* **63**(1), 15–24.

Plack M.M., Driscoll M., Blissett S., McKenna R. & Plack T.P. (2005) A method for assessing reflective journal writing. *Journal of Allied Health* **34**(4), 199–208.

Reader T., Flin R., Lauche K. & Cuthbertson B.H. (2006) Non-technical skills in the intensive care unit. *British Journal of Anaesthesia* **96**(5), 551–559.

Schön D.A. (1983) *The Reflective Practitioner*. Basic Books, New York.

Spencer R., Coiera E. & Logan P. (2004) Variation in communication loads on clinical staff in the emergency department. *Annals of Emergency Medicine* **44**(3), 268–273.

Teekman B. (2000) Exploring reflective thinking in nursing practice. *Journal of Advanced Nursing* **31**(5), 1125–1135.

While A. & Dewsbury G. (2011) Nursing and information and communication technology (ICT): a discussion of trends and future directions. *International Journal of Nursing Studies* **48**(10), 1302–1310.

Wiegmann D.A., ElBardissi A.W., Dearani J.A., Daly R.C. & Sundt T.M. III (2007) Disruptions in surgical flow and their relationship to surgical errors: an exploratory investigation. *Surgery* **142**(5), 658–665.

Wright M.C. & Endsley M.R. (2008) Building shared situation awareness in healthcare settings. In *Improving Healthcare Team Communication: Building on Lessons from Aviation and Aerospace* (Nemeth C.P., ed.), Ashgate Publishing, Aldershot, pp. 97–114.

Yule S., Flin R., Paterson-Brown S. & Maran N. (2006) Non-technical skills for surgeons in the operating room: a review of the literature. *Surgery* **139**(2), 140–149.

