Binding communication to improve peripheral venous catheter monitoring

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ABSTRACT

Background: Optimizing the monitoring of peripheral venous catheters is essential. We developed a nursing record system at bedside (Patient Smart Reader®) to track peripheral venous catheters acts.

Aims: Improve peripheral venous catheter monitoring. To improve the quality of monitoring, we aimed to increase the usage rate of nursing record system at bedside.

Methods: We developed a "commitment intervention" course based on binding communication paradigm. Evaluation of its performance on monitoring was analyzed using a p-chart and time series analysis.

Findings: Nurses observed a significant improvement in compliance with catheter monitoring over time (shifts after shifts), ranging from 27.6% (CI = [25.3; 30.0]) of compliance before commitment intervention to 47.4% (CI = [45.0; 49.9]) after training. The commitment intervention increased the chances of carrying out monitoring through the tool for acts related to peripheral venous catheter by 2.42 (odds ratio) (CI = [1.88; 3.11]).

Conclusion: Binding communication provides an effective method for changing nurses' behaviors in terms of safe care. The determinants of engagement (individual vs. collective) can be indicators for defining future communication and training strategies in care centers for all Health care workers.

INTRODUCTION

The incidence of peripheral venous catheter (PVC)- related bloodstream infections was reported to be 0.1-0.5 /1000 catheter-days [1] [2] . A prolonged dwell time and catheter insertion under emergency conditions increased the risk of PVC-related bloodstream infection. Approximately 200 million PVCs are inserted into adult patients each year in the United States [3], and some suggest, based on the literature, that over 100,000 of these patients are infected with a crude and attributable mortality rates of 12.9% and 5.7% respectively [4] .

Other PVC-related adverse events are not negligible. In the CATHEVAL project [5], the incidence of PVC-related adverse events was 21.9/100 catheter-days, with infections occurring 0.4/100. The most prevalent PVC-related adverse events are phlebitis (20.1/100), hematoma (17.7/100), and liquid/blood escape (13.1/100) [5]. The rate of phlebitis exceeds 50% by day 4. Replacing or removing peripheral intravenous catheters as clinically indicated rather than in a set time period of three to four days has recently been suggested [6].

Consequently, reducing insertion of PVC and optimizing monitoring to remove such catheters as soon as possible has been shown in the literature to be a very successful way to reduce catheter-related bloodstream infection[7] [8]. However, in routine practice, these guidelines lead to short-term changes only [9] or a not significant reduction[10]. One of the reasons for that not significant reduction is the inappropriate and not sustained monitoring of PVC use. To overcome the lack of monitoring, we developed a nursing record system at bedside using a bar code to trace nursing care named the Patient Smart Reader® (PSR®); it considerably improves monitoring compared to standards of care [11]. Consequently, PSR® was used to evaluate the performance of nurses to monitor PVC.

To improve the adherence of PSR® usage in PVC recording, we conducted an intervention based on binding communication. Binding communication paradigm is at the crossroads of

commitment theories and participatory communication. It is based on the principle that an individual adopts a behavior not because of his or her ideas but because of behaviors already realized and identifiable in regard to the expected behavior [12]. Work on commitment shows that knowledge has very little influence on our behaviors [13]. The individual's commitment in a behavior does not depends on his or her knowledge but on behaviors which already achieved and linked to the targeted behavior [14]. Targeted behavior is the result of a logical sequence of acts for the person who performing them. Actions are therefore linked by the coherence that the individual gives them: "Why I did not do that? I already did this!". The justification of the act is reinforced by the realization of precedent act, reducing cognitive dissonance. The cognitive dissonance is the internal state tension due to the contradictions on mind and beliefs. The human mind attempts naturally to reduce this contradiction. This succession of act reinforces individual's commitment, thus favoring the realization of other acts. It is also called "cascade of commitment": the more an individual realized voluntary acts, the more he is likely to do others acts. According to literature, these behaviors, called "commitment acts", must also be carried out under specific conditions: they must be easy to do, reiterated, linked and consistent to the final behavior, and carried out publicly in a context of total freedom without no rewards or punishments [15–17].

This paradigm can be declined in framework and has already been mobilized to improve behavior regarding the protection of the environment [18], to improve organ donation [19], and to reduce high-risk behaviors related to HIV transmission [20], alcoholism [21] or hospital hygiene and safety of care [22,23]. To our knowledge, this kind of framework was never applied to improve PVC monitoring or traceability of care. Our aim was to evaluate the impact of binding communication-based interventions on the compliance with PSR® usage on PVC recording.

METHOD

To improve the adherence of PSR® usage on PVC recording, we have developed a specific intervention based on binding communication (commitment intervention) for nurses. Our intervention consisting of leading the nurses to perform a series of commitment acts related to the expected final behavior (using the PSR® for monitoring) comply with context's conditions describe in literacy. These commitment acts are intended to create a link between what is being done now, what should be done usually, and what will be done afterward. Each commitment acts respond to a specific commitment factor (Tab.1). For example, nurses were invited to participate in discussion (commitment act), animated by a trainer, on the interest in and issues related to the tool for monitoring (commitment factors: visibility, cost behavior, etc.). Everyone participated on a voluntary basis. The study was approved by our institutional ethical committee board N° 2016-018.

Binding Communication

Commitment acts and their associated commitment factors correspond to binding communication guidelines which define conditions for engaging an individual on a behavior. Consequently, we created different acts that comply with the guideline. For example, ~~a~~ participation to a discussion is considerate like an action realized and allow responded to 4 precepts: it is requesting a behavior cost (do effectively something), mark a visibility for other nurses, help to identifying the action level, reinforces the freedom context. These commitments were selected based on the work published by Burger J.M. [24] and Bernard F. and Joule R.V. [25], and describe in Table 1.

Study design and set up

The study was conducted from October 2018 to July 2019 in a medical ward specialized in infectious and tropical diseases of the Institute Mediterranean Infection (IHU) in Marseille, France. Essential information for the design of a study protocol was provided by our

118 experience in anthropology and innovative technologies [26,27] . We design a mixed-method,
119 combining cross-sectional qualitative and quantitative analyses using a p-chart and interrupted
120 time series in a mixed model.

121 We separated the study into three periods. The total duration of the study was 90 shifts (9
122 months). First 30 shifts (period *T*) basic training on standard PSR® usage procedure. This
123 training was provided to all the nurses and each new nurse joining the ward in any time, but
124 the research protocol provides for updating knowledge by involving all nurses in this initial
125 training. By doing this, all nurses have the same knowledge on PSR® use. Then, we observed
126 the nurses in their daily practice during at least 30 shifts to establish the baseline PVC
127 monitoring compliance for each nurse. When the last nurse completed the 30 inclusion shifts
128 needed by protocol, we asked all the nurses of the ward for their willing to participate in the
129 study and to sign an informed consent form during a plenary meeting. This signature
130 represented the first commitment act. Second 30 shifts (Period *T*)*, at the beginning of this
131 period we contacted the nurses one by one to establish an availability schedule. We offered
132 them two dates that were convenient for everyone. We invited them to participate in a
133 meeting (commitment intervention), stating again that they were free to accept or refuse. We
134 then delivered the "commitment intervention" by group. The last 30 shifts (period *T***) an
135 observational period to check sustainability of the intervention. A summary protocol is
136 available in the Grant diagram presented in Fig. 1. For reproducibility of the protocol, we
137 created a training guide (Supplementary material) and trained a trainer (RI) to provide the
138 training. ~~The~~ Investigators chose to be passive observers of the training.

139 ***The commitment intervention***

140 The intervention is detailed in the “training guide” (Supplementary material). To include all
141 participants, two interventions sessions were organized in the same week. In brief, after a
142 short introduction to remind the nurses of their freedom to participate in debates and

discussions, they were invited to debate, first, the interest in the monitoring tool (PSR®) and, second, the problems encountered with it. The trainer made the nurses interact among themselves with the goal of activating commitment factors. The realization of commitment acts was achieved by inviting nurses during a round table to classify acts related to peripheral venous catheters from lowest risk to highest risk; to anonymously complete a bulletin summarizing the 3 main items of interest in carrying out monitoring with the PSR®; to comment in a focus group on the responses recorded in the bulletins and read by the trainer; and to listen to a specific sentence at the conclusion of the training, with the aim of attributing positive social labeling to the nurses before proposing that they sign a unique summary document containing the main issues from the bulletins (Table 1, Supplementary material (A)). This document was displayed in the nurse's office (for visibility of commitment). Finally, we proposed that they wear a badge indicating their commitment (Supplementary material (B)).

On the summary document and the badges, we wrote two sentences: "I take care of my patients, using my PSR®" and "the monitoring of everyone is safety for all". These two sentences account for three levels of action identification [28]. The action identification creates a link between what an individual knows and what he or she does. Thus, "I take care of my patient" responds to a basal level of action, the direct reason: "I do something because I believe on something". "Using my PSR®", is the lowest level. It corresponds to the irreducible physical gesture in terms of reason: "I do something like this". "The monitoring of everyone is security for all" corresponds to the highest level of identification so that the individual can be part of a global and social approach: "I do something because it must be do for this". This last point allows to an individual to join an idea socially agreed and social group where some values are shared.

Data gathering

To observe the PVC act opportunities, we conducted a daily visit in the ward, it carried out by a PhD student (OF) who recorded when a PVC was inserted, inspected, or removed for each hospitalized patient as well as which nurse provided the act. PVC recording was established by our developed bedside nursing recording system (PSR®) which allows to record the PVC act (insertion, inspection, and removal) in real time and transmitted to it the database Meditrace®. PVC act opportunities were entered at posteriori in the same database. Compliance with PSR usage on PVC recording was established from data captured in the database and defined as the ratio; the PVC acts recorded by the PSR® divided by the PVC act opportunities.

Statistical analysis

We performed the post-intervention analysis on the two successive periods of 30 shifts per nurse after commitment intervention. The period *T** aimed to observe the impact produced directly at the end of the training and the achievement of a threshold effect. The period *T*** aimed to observe the sustainability of the training impact over time (Fig. 1).

The impact of the commitment intervention on nurse behavior regarding monitoring the catheter was assessed both as a whole for the nurses using a p-chart and as individual behavioral change using time series analysis. A p-chart is a type of control chart of attributes. Here, a p-chart was used to compare the compliance with PSR usage on PVC training before and after the commitment training for all nurses included in the study. The p-chart describes the temporal evolution of compliance (variables "shift" – *T*, *T**, *T***) (p) and delimits two control limits. The p-chart was calibrated based on the 30 work shifts for each nurse before the intervention.

For time series analysis, we used a general additive mixed model [29] that takes into account a nonlinear effect of the number of work shifts and a nonlinear effect of the commitment

intervention. This model also considers a random effect of each nurse. The following mixed model was computed with *R Studio Desktop AGPL v. 3*:

$$logit\left(P\left(Y_{ij}=1 \mid b_i\right)\right) \stackrel{def}{=} \log\left(\frac{P\left(Y_{ij}=1 \mid b_i\right)}{1-P\left(Y_{ij}=1 \mid b_i\right)}\right) = \beta_0+\beta_1 T_{ij}+\beta_2 I_{ij}+\beta_3 T^{¿} ij+\beta_4 T^{¿*¿ij}+b_i ¿$$

$$b_i \rightarrow N\left(0, \sigma\right)$$

b_i: *difference between HCW i* $\wedge$ *the general mean*

$T = 30$ *shifts before the commitment intervention*

$I_1 =$ *commitment intervention indicator*

$T^{¿} = 30$ *first shifts after commitment intervention* $\left(T - t_0, if\ T > t_0 \wedge T \leq t_0 + 30\right)$

$T^{¿*¿} = 30$ *last shifts of the study* $\left(T - t_0 - 30, if\ T > t_0 + 30\right)¿$

RESULTS

Of the 14 nurses who signed the consent form, 12 agreed to participate in commitment intervention. 4,376 PVC acts opportunities were observed by direct observation (for insertions, inspection, and removal), 1490 PVC acts were recorded by PSR®. The period *T* runs from October 2018 to January 2019. The period *T** runs from February 2019 to April 2019. The period *T*** runs from May 2019 to July 2019.

The p-chart (Fig. 2) shows that the compliance with PSR usage on PVC recording increased in the period *T** then kept sustainable in the period *T***, (shifts after shifts), it was going from 27.6% (CI = [25.3; 30.0]) in the pre-intervention period (period *T*) to 47.4% (CI = [45.0; 49.9]) in the post-intervention period. The impact of the commitment intervention (Fig. 2) on compliance was significant ($p < 0.05$); it increased the usage rates of PSR® on PVC recording

(insertions, inspection, and removals), odds ratio (OR)= 2.42; CI = [1.88; 3.11]. Notably, the change in compliance began after the nurses signed the consent form.

Interrupted Time Series: Mixed model.

We selected 4 variables: period *T*: the number of shifts before the commitment intervention; period *T**: the number of shifts between the commitment intervention and the first thirty work shifts after the commitment intervention; the commitment intervention indicator (*I*) it indicates whether for each act the nurse received the intervention or not; period *T***: the last thirty shifts of the study. The results after binomial logistic regression are summarizes in Table 2. Each variable was treated independently.

In period *T*, each shift worked increased the rates of compliance with PSR usage by OR=1.03 (CI [1.01; 1.04]), suggesting that there was a small learning effect due to the number of shifts completed (time). The odds ratio for the commitment intervention was 4.12 (CI [2.96; 5.73]), suggesting that intervention had a strong positive effect on variations in compliance. In period *T** the odds ratio was 0.99 (CI [0.97; 1.00]), indicates a slowdown in compliance. In period *T***, there was no longer any effect induced by time and learning (OR = 0.99; CI [0.97; 1.01]) but effects were sustained.

We performed the same analysis by adding the type of shift (day/night) as a new variable to the model; there was no significant difference between the types of shift (day/night). The type of shift had no effect on compliance with PSR usage on PVC recording in our study. The small sample size of nurses include in the study has no influence on implication of findings. Indeed, the 12 nurses include in the study produced 4376 acts for PVC (insertion, monitoring, removal). Our analyzes are therefore based on this quantity of acts.

DISCUSSION

In our study, all actions were carried out to push the nurses to involve themselves in a cascade of commitment, to reach the expected final behavior and increase the usage rates of PSR® to track PVC acts. “The cascade of commitment” is a method that consists of making nurses realize a succession of acts, with the result being “the more acts they realized, the easier it will be for them to accept doing other acts”. This cascade of commitment led the nurses to reiterate their behavior, reducing the cognitive dissonance that occurs when a nurse holds contradictory beliefs, ideas, or values or participates in an action that goes against his or her beliefs, ideas, or values.

After commitment intervention, the PSR® usage on PVC recording increased from 27.6% (CI = [25.3; 30.0]) to 47.4% (CI = [45.0; 49.9]). To the best of our knowledge, there are only three comparable studies in the literature [22,23,30]. They also aimed to modify the behavior of healthcare personnel to improve care practices. Like us, they appealed to the paradigm of binding communication or psychosocial theories of engagement. Like these studies, we show that binding communication is a beneficial way to improve nursing quality. However, only one study assessed the effect of binding communication using an objective measure of behavior [22].

Girandola’s study reported a small improvement from 10% to 13% in the rate of influenza vaccination coverage in nurses [22]. The other two studies provide an assessment using either direct observation or self-reported practices by participants. Quintard et al. assessed the evolution of representations (how an individual considered a situation, an action). By evaluating and comparing the scores of responses to a questionnaire on preventive gestures, they showed that an intervention, whether engaging or not, had a positive effect on self-reported practices for 61% of their participants. The engaging intervention appeared to produce a significantly stronger effect than the standard condition. The nurses who received standard training seemed to have a better awareness of the reality of the problem of

nosocomial infections [23]. Almeida et al. assessed the effect of binding communication on the wearing of the wedding ring in routine care. They concluded that wedding ring wearing decreased significantly at post-intervention (43% pre-intervention/19% post-intervention) [30]. However, this study was based on a self-audit report which was sent to the subjects receiving the intervention. This method leads to biases, notably social desirability. Moreover, for PVC recording, the use of PSR tool removed potential Hawthorne effect which is linked to an observer.

As a matter of facts, field observation was conducted in three ways: checking all patients after nurses' visit (and not checking the nurses' work); gathering data collected from nursing handover and nursing record); and PSR® database exploitation. Thus, there was no interaction between the investigator (anonymous observer) and the HCW.

Similar to the studies cited above, we tried to respect the theoretical foundations of binding communication [24,25]. Indeed, we were attentive to respect the framework of freedom of participation, the repetition of commitment acts having a behavioral "cost", and the publicisation (diffusion outside of nurses group) and visibility of the acts (for other: HCW of ward and patients hospitalized).

Our study differed in the operationalisation of acts and the driven context. To ensure the repeatability and reproducibility of our study, the binding intervention was conducted by a professional care instructor (RI). This singularity is found in the study of Quintard et al. [23]. She was instructed not to infer information on monitoring in discussions between nurses. In this way, we intended to stimulate reflection by the nurses on the themes predefined in advance (interest in monitoring of care and the problems encountered in its application). Thus, we emphasize the expert knowledge of nurses and let them talk about the problems in compliance with monitoring that they daily encounter. This was accomplished by emulating

collective thinking, that is, pooling knowledge and individual practices without attempting to persuade.

Like Quintard et al. and Girandola [22,23], we used a focus group to engage the HCWs in behavior, but instead of inviting the HCWs to fill out a questionnaire (knowledge evaluation), we invited them to bring out their experiential knowledge through discussion, debate and completion of a summary bulletin. We also chose a different method of publicisation. In practice, in the studies of Girandola [22] and Almeida [30], a chart of commitment was signed. In contrast to our study, such charts were not created with information provided by the healthcare workers during the intervention. In those studies, and in ours, the charts were displayed under the same conditions: in front of the social group in a common place. We chose a last individual brand through a pin badge offered at the end of the training. It had a double interest: to make visible the participation and the commitment made and to serve as a reminder of the individual's commitment.

We question ourselves on the performance of improvements obtained after the end of study. It will be interesting to look at the long-term effects of the study, to know if the effects of the training were kept or if "booster shots" are necessary to maintain effects and/ or increase them again. In period T**, no significant improvement neither decreased PSR usage was observed all alone, suggests that at least for this period the effect of binding communication was sustained. In our study, binding communication clearly helped to improve the quality of PVC monitoring. The impact on the reduction in bloodstream infection now needs to be evaluated.

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