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ORIGINAL ARTICLE

A Lean approach to improve the organisation of unplanned intensive care admissions: A before-after analysis

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Abstract

Background: Unplanned admissions of intensive care patients demand well-organised team work. Lack of an intensive care unit (ICU) admission protocol may lead to insufficient preparations or unclear task allocations. It was hypothesised that using a Lean approach, the organisation and perceived quality of care of unplanned ICU admissions could be improved.

Methods: Using Lean, the organisation of unplanned admissions was analysed by measuring the perception of the quality of care amongst physicians and nurses. These results led to a new protocol describing logistical and organisational measures. After six months of implementation, a survey was performed to evaluate the effect using a modified t-test.

Results: After implementation, 27 questionnaires were filled in and compared with 27 baseline questionnaires. The satisfaction of nurses with the quality of admission, expressed in the admission score (M, on a scale of 1-10) improved (pre: M=7.4; SD=1.3; post: M=8.2; SD=0.9; p=0.001). On a scale of 1-5 the score for clear task allocation improved (pre: M=3.3; SD=1.2; post: M=4.3; SD=0.9; $p < 0.001$) as well as the score for effective communication (pre: M=4; SD=0.8; post: M=4.4; SD=0.7; p=0.01). Physicians reported an improvement in the score for clarity about task allocation (pre: M=3.2; SD=1.2; post: M=4.1; SD=1.3; p=0.001) and the content of task (pre: M=3.6; SD=1.1; post: M=4.1; SD=1; p=0.001).

Conclusion: By using a Lean approach, the implementation of a survey-based protocol resulted in a perceived improved quality of unplanned admissions at the ICU.

Introduction

Worldwide, millions of people are admitted to an intensive care unit (ICU) annually.[1] There are important differences in the rate of ICU admissions and available ICU beds per capita between the US and European countries.[2] In the past decade, a sharp increase in the number of ICU admissions from the emergency department (ED) was observed in the United States (2.79 million in 2002-2003 to 4.14 million in 2008-2009).[3] Although the organisation of acute hospital care in the US and the Netherlands is not similar, we also noticed a more gradual increase in unplanned ICU admissions in Dutch hospitals, both from the ED and general hospital wards.[4]

Because our department is a general ICU we admit patients with a variety of critical conditions. A substantial number of them are haemodynamically unstable, in respiratory distress, or both, regardless of the underlying disease. Those patients need prompt resuscitation after admission. This study evaluated the improvement, using a Lean approach, of the perceived quality of care of the unplanned admissions to the ICU.

The Lean method engages the frontline healthcare professionals to improve safety, quality and service.[5] The Lean philosophy is derived from the Toyota Production System (TPS) and was originally developed as a system to improve quality.[6] One of the main features of Lean is to reduce 'waste' and to add 'value' in small steps, which is easy to understand in a manufacturing process, but more difficult when it concerns healthcare. Although there are examples of successful Lean-based quality improvement projects in healthcare,[7] there is not much supporting evidence for the Lean approach in a healthcare setting.[8-10] Because of our own positive experiences with Lean as a tool for quality improvement, we decided to study the effect of implementing new strategies to improve the acute care of unplanned ICU admissions.[10] We hypothesised that, using a Lean approach, the organisation and perceived quality of unplanned ICU admissions could be improved.

Objective

The objective of this study was to measure the improvement, using a Lean approach, of the perceived quality of care of unplanned admissions to the ICU.

Methods

Setting

Our department is a mixed ICU with in total 32 beds

during maximum occupancy. It is situated in a tertiary care teaching hospital and staffed with intensivists, fellow intensivists, residents and ICU nurses. The intensivists have an anaesthesiology, internal medicine, cardiology or neurology background; the specialties of the residents are equally diverse. But next to the aforementioned specialties, there are residents from pulmonary medicine and cardiac and non-cardiac surgery. The ICU is known to have a high throughput of new residents.

Lean

The Lean philosophy is used to improve the quality and efficiency of care in our department. In one of the stand-up meetings, concerns about the perceived potential of improvement of quality of care of the unplanned admissions were brought to attention. In response to this meeting, a project group was formed with the goal to analyse the improvement potential and set up a proposal for possible improvement. This proposal was the outcome of several meetings of the project group and discussions during stand-up meetings. The project group developed and carried out a survey in order to evaluate the perceived quality of care of the unplanned admissions to the ICU.

Survey

We performed a survey measuring the perception of the quality of acute care during unplanned admissions of unstable patients as well as time measurements of the acute care process. The survey consisted of a written questionnaire for nursing staff and physicians involved in these admissions measuring quantitative, i.e. duration of admission until stabilisation, and qualitative data, i.e. satisfaction and perceived quality of care *(see supplement 1 for the questionnaire and table 1 for the results)*. The items in our questionnaire were based on the short form of the Self-Assessment Questionnaire (SAQ), a well-established and validated method to measure teamwork and safety climate.[11] After an acute admission, this questionnaire was offered to the team involved in the admission by staff not involved in the current admission. A rating was given on different subjects: clear task allocation, clarity about their role, clarity about which doctor or nurse to assist, whether or not the content of their task was clear, quality of the communication in general and safety of the procedure. All were scored with a Likert scale ranging from one (strongly disagree) to five (strongly agree). The overall admission satisfaction was scored on a scale of one to ten. The questionnaire was used to evaluate the perceived quality of care before and after the intervention described below.

Table 1. Results of the questionnaires of the nursing staff and physicians

Nurses			
Observations N (forms)	**N = 46**	**N = 46**	
Score 1 to 5[1]	**Before**	**After**	**Difference (95% CI), p value[2]**
Clear task allocation	3.3 (1.2)	4.3 (0.9)	-0.98 (-1.43 to -0.54), p<0.001
Clarity about role	3.5 (1.2)	4.2 (1)	-0.65 (-1.11 to -0.2), p=0.01
Clarity on which doctor to assist	3.8 (1.3)	4.4 (0.9)	-0.58 (-1.06 to -0.1), p=0.02
Clear content of task	3.6 (1)	4.3 (0.8)	-0.61 (-0.98 to -0.25), p=0.001
Good communication	4 (0.8)	4.4 (0.7)	-0.44 (-0.76 to -0.13), p=0.01
Clear which contact person	4 (0.8)	4.5 (0.6)	-0.51 (-0.81 to -0.21), p=0.001
Safety of procedure	4.3 (0.7)	4.6 (0.5)	-0.3 (-0.56 to -0.03), p=0.03
Admission score	7.4 (1.3)	8.2 (0.9)	-0.8 (-1.28 to -0.33), p=0.001
Physicians			
Observations N (forms)	**N = 44**	**N = 47**	
Score 1 to 5[1]	**Before**	**After**	**Difference (95% CI), p value[2]**
Clear task allocation	3.2 (1.2)	4.1 (1.3)	-0.92 (-1.45 to -0.4), p=0.001
Clarity about role	3.8 (1)	4.2 (1.1)	-0.44 (-0.89 to 0.01), p=0.054
Role nurses clear	3.4 (1.4)	4.3 (1)	-0.93 (-1.46 to -0.41), p=0.001
Clear content of task	3.6 (1.1)	4.4 (1)	-0.77 (-1.19 to -0.34), p=0.001
Good communication	4.1 (0.8)	4.4 (0.9)	-0.33 (-0.67 to 0), p=0.051
Safety	4.4 (0.6)	4.6 (0.7)	-0.21 (-0.48 to 0.06), p=0.131
Admission score	7.5 (1.3)	8.2 (1.5)	-0.71 (-1.3 to -0.12), p=0.019

[1] Although the data have, strictly speaking, an ordinal measurement level, we assume that the distances between the five item levels are equal, so analysis on an interval level is possible.
[2] p-value modified t-test, known as Welch's t-test that adjusts the number of degrees of freedom when the variances are thought not to be equal to each other.

Development and implementation of the new protocol

The results of the survey before the intervention were analysed and used to develop a protocol describing both logistical and organisational measures to improve the perceived quality of the admission of unplanned, unstable patients *(supplement 2)*. In short, the following work flow was implemented. We assigned a bed and a team comprising at least two nurses and two physicians on one of our units for unplanned emergency admissions. When a patient was in direct need of respiratory or haemodynamic support it was classified as an emergency admission. Every patient with an emergency admission either from the ward or from the emergency department (ED) could be included in the study. The nurses and physicians were assigned to clearly described roles. We composed a checklist with items necessary for an emergency admission. The assigned nurses were responsible for all the necessary items being present and functioning. Just before transport from the ward or ED to the ICU, the attending physician called the supervising nurse to announce the arrival of the emergency patient. This announcement included the latest vital signs and necessary measures to resuscitate the patient. We divided these into haemodynamic measures, respiratory measures or both. Based on this announcement, the supervising nurse alerted the team, which assembled at the designated bed in the ICU. During the admission all members of the team performed the tasks belonging to their roles; only the responsible team members were present. Over a period of six months the new protocol was implemented; during this period several clinical teaching sessions for both nursing staff and physicians were given, there was a publication of the protocol in our database, multiple notifications in our department newsletter and members of the project group stimulated its use. After these six months a new survey was performed using the same questionnaire to assess if the interventions had led to the desired results.

Clinical data collection

The demographics of patients and of the acute care procedure were collected after completing the admission procedure. The admission time was set at the moment that all team members agreed that the emergency patient was adequately stabilised.

Statistics

The results of the questionnaire consisted of data of an ordinal measurement level. Most answers were scored on a scale of one to five. It was assumed that the distances between the five item levels were equal so analysis on an interval level was possible. Furthermore the p-value modified t-test was used to calculate a 95% confidence interval.

Continuous normally distributed variables were expressed by their mean and standard deviation or when not normally distributed as medians and their interquartile ranges. Categorical variables were expressed as n (%). To test groups, Student's t-test was used, if continuous data were not normally distributed the Wilcoxon test was used. Categorical variables were compared with the Chi-square test. Appropriate statistical uncertainty was expressed by 95% confidence levels. Statistical significance was considered to be at p=0.05. Analyses were performed using R (version 3.4; R Foundation for Statistical Computing, Vienna, Austria).[12]

Results

Perceived problems during Lean approach

During the first stand-up meetings it became clear that the chief complaint was the absence of a clear task allocation during unplanned ICU admissions. This was thought to be due to the lack of a protocol, leading to insufficient preparation before admission and unclear allocation of tasks during the admission. Missing equipment was also mentioned as a cause of delay during admission. Before implementation of the new protocol, an unplanned emergency patient was brought in after notifying the ICU specialist and nurse in charge on the unit by our rapid response team. Tasks were not further explained nor allocated in advance to the nurses and doctors involved. Also, equipment was not checked according to a checklist.

Baseline measurement

The baseline measurement was done for 27 unplanned admissions during a period of four months *(table 2)*. In total 46 nurses and 44 physicians filled in the questionnaire. Nurses and physicians were randomly assigned to the emergency admission. Of the patients, 22% were female. The mean age was 57.7 (range: 27-89) years. The majority of the patients were referred via internal medicine (37%) and surgery (33%). Results of the survey before the intervention were as follows. On a scale of 1 to 5 the nurses' scores varied from 3.3 for the clearness of task allocation to 4.3 for their sense of safety during the admission. Their overall admission score was 7.4 on a scale of 1 to 10.

Table 2. Demographic data of patients admitted during the two evaluation episodes (before and after intervention)

Demographic data	Before	After	
Inclusion period	20-02-2016 - 06-05-2016 (76 days)	26-09-2016 - 08-04-2017 (194 days)	Difference (95% CI), p value
Observations (N)	27	27 (1 patient lost to follow-up)	
Gender:			
Female	6/27 (22%)	10/27 (37%)	-14.81 (-38.08 to 9.89), p 0.37
Male	21/27 (78%)	16/27 (59%)	18.52 (-6.57 to 41.68), p 0.24
Age	57.7 (27 – 89)	63.4 (22-83)	-9 (-14 – 1), p 0.10
NICE score APACHE IV	72.3 (30-127)	79.8 (35-145)	5.43 (-20 to 9.27), p 0.46
Length of stay (days)	7.1 (0 – 37)	8.0 (0-32)	3 (-3.5 to 1), p 0.18
Referring specialisms:			p 0.61
Cardiology	1 (4%)	2 (7%)	
Cardiothoracic surgery	0 (0%)	1 (4%)	
Gynaecology	0 (0%)	2 (7%)	
nternal medicine	10 (37%)	11 (41%)	
Neurology	4 (15%)	3 (11%)	
Neurosurgery	2 (7%)	1 4%)	
Orthopaedics	1 (4%)	0 (0%)	
Surgery	9 (33%)	6 (22%)	

The physicians' scores varied from 3.2 for the clearness of task allocation to 4.4 for the sense of safety during the procedure. The overall admission score was 7.5. The median duration of the acute care procedure was 45 (18-77) minutes. The median duration of the acute care procedure without delay was 40 (16-60) minutes. In 18% of the admissions, a delay was reported. Several reasons were reported as a cause for the delay: a non-functioning capnograph, an unclear task description or not enough personnel because the doctor was needed elsewhere.

After implementation

After the implementation of the protocol the demographic data of the evaluated patient population did not differ, although the inclusion period was 194 days compared with 76 days before the implementation. Unfortunately, data for one patient were lost during follow-up. The mean age and APACHE IV score did not significantly differ from the baseline APACHE IV score. The majority of patients admitted were surgical patients (22%) and internal medicine patients (41%).

Before-after comparison

See *table 1* for the before-after comparison. The overall admission score of nurses improved (pre: M=7.4; SD=1.3; post: M=8.2; SD=0.9; on a scale of 10; p=0.001). There was a significant improvement in the clarity about their task allocation (pre: M=3.3; SD=1.2; post: M=4.3; SD=0.9; p<0.001) and more clarity about their role (pre: M=3.5; SD=1,2; post: M=4.2; SD =1; p=0.01). The clarity about which doctor to assist improved (pre: M=3,8; SD=1,3; post: M=4,4; SD=0.9;

p=0.02) as did what the content was of their task (pre: M=3.6; post: M=4.3; SD=0.8; p=0.001). Their communication improved (pre: M=4; SD=0.8; post: M=4.4; SD=0.7; p=0.01) as well as clarity on who their contact person was (pre: M=4; SD=0.8; post: M=4.5; SD-0.6; p=0.001) and an improved sense of safety (pre; M=4.3; SD=0.7; post: M=4.6; SD=0.9; p=0.03).

Amongst physicians the overall admission score improved as well (pre: M=7.5; SD=1.3; post: M=8.2; SD=1.5; p=0.019). There was improvement in clarity about their task allocation (pre: M=3.2; SD=1.2; post: M=4.1; SD=1.3; p=0.001), more clarity about their own role (pre: M=3.8; SD=1; post: M=4.2; SD=1.1; p=0.01) and about the role of the nurses (pre: M=3.4; SD=1.4; post: M=4.3; SD=1; p=0.001). The sense of communication (pre: M=4.1; SD=0.8; post: M=4.4; SD=0.9; p=0.051) and safety improved (pre: M=4.4; SD=0.6; post: M= 4.6; SD=0.7; p=0.131), although the latter was not significant.

Additionally, the duration of the admissions was compared before and after implementation of a more structured admission protocol. Table 3 shows that, although there was a trend towards a longer duration of the acute care procedure at the admission (pre: median=40 minutes; post: median=60 minutes), there were less admissions in which a delay was reported, but this was not significant (pre: 18%; post: 4%; p=0.27). Reported reasons for delay were a too short oxygen saturation meter and one patient who was admitted before the team was ready. Shortage of personnel and an unclear task description were no longer given as a reason of delay.

Table 3. Results of the questionnaires about duration and delay

Data patient and acute care	Before	After
Inclusion period	20-02-2016 to 06-05-2016 (76 days)	26-09-2016 to 08-04-2017 (194 days)
Observations (N)	28 (in 27 patients)	27
Duration acute care procedure	Median (IQr) 45 (18 to 77) minutes	Median (IQr) 60 (30 to 60) minutes Min 15, max 120
Duration acute care procedure without delay	Min 6, max 210	Median (IQr) 60 (30 to 60) minutes Min 15, max 120
Delay reported	Median (IQr) 40 (16 to 60) minutes	4% (1/24) (2 not reported) (p=0.27 compared to before)
Reason of delay	1. Capnograph not functioning 2. Unclear task description 3. Not enough personnel because another patient had an acute problem as well 4. Not enough personnel, fellow doctor was at the emergency room. 5. Not enough personnel, unclear task description	1. Short oxygen meter cable, patient arrived too quickly to activate the team

Discussion

In this study, a Lean approach was used to improve the workflow regarding unplanned ICU admissions. The main findings of the study are 1) the Lean method has led to the implementation of a protocol which was associated with perceived improvement in communication and an improved sense of safety of unplanned ICU admissions; 2) The effect was more obvious among nurses compared with physicians; and 3) Implementation of a protocol for unplanned ICU admissions resulted in a trend towards a longer duration of acute care in an unplanned admission but with less delay.

While Crew Resource Management (CRM) is well known from the aviation industry, there is increasingly more attention for CRM in healthcare[13] and intensive care medicine in particular.[14,15] In a healthcare setting, CRM is applied to improve the cooperation of professionals leading to a better team performance and thus patient safety.[16] According to Haerkens et al. implementation of CRM is associated with a reduction in serious complications and a decrease in mortality in critically ill patients.[17] This study was performed in an ICU of a similar Dutch tertiary care hospital. Our study specifically resulted in improved team structure and communication. This facilitated providing and receiving effective feedback, which corresponds with the CRM key subjects of communication and creating and maintaining team structure and climate. In our study the significantly improved items (a clear task allocation and content of task, clarity about the role or who to assist or to contact) are contributing factors to a better team performance, a key component in CRM.

Our study was a qualitative study about the Lean approach to the implementation of an admission protocol. Similar to that of Kemper et al.[14] this study was implemented after acknowledgment of a performance gap. A Lean approach was used to improve the workflow regarding unplanned ICU admissions. This resulted in the development of a protocol that was implemented, leading to subsequently better communication and an improved sense of the safety of the admission procedure. These findings are in line with results from a study in which structured communication led to improved quality of communication between nurses and physicians.[15]

An important aspect of the Lean method is engaging healthcare professionals who are at the frontline, in the process of improving safety, quality and service.[5] After implementation of our protocol, improvement of communication and sense of safety of the procedure was found more among nurses compared with physicians. Some of the physicians working in our ICU are residents. This means they do a rotation of several months. During an emergency admission, a resident is supervised by a fellow or registrar. At least two nurses, but often more, are involved in the unplanned ICU admissions. The number of professionals, but also the fact that some of them are relatively new to the team, can lead to confusion about roles and subsequent tasks. Having a clear task description beforehand, the benefits could even be of more importance for nurses than physicians.

After implementation of the protocol, there was a trend towards less delay in the acute care of an unplanned emergency admission. This is a relevant factor in the efficiency of an admission procedure. However, the duration of the total acute care procedure increased. Whether this longer duration was associated with a better quality of care was not investigated. A possible explanation could be a more precise timing of the procedure, possibly due to better task allocation. Data from earlier studies[17] showed an association between CRM implementation with clinical tools such as briefings, debriefings and checklists and a reduction in serious complications and lower mortality in critically ill patients. In the study of Kemper et al.[18] CRM affected the thinking about errors and risks as well as the safety culture instead of affecting the patient outcomes.

Limitations

The number of observations could have been too small given the much larger number of personnel working on our ICU. This may have led to a reporting bias. The years of experience of the caregivers was not known. This could have been of influence in scoring the items of perceived quality, leading to a reporting bias as well. Also the number of observations was small compared with the amount of unplanned admissions. It is estimated that, after implementation of the protocol, 4% of unplanned admissions were included in this study. This percentage was thought to be a random sample as staff that were not involved in the admission handed over the questionnaires. The low percentage can partially be explained by limitations in collecting evening and night time admissions due to the absence of the research team during these moments. Moreover, we do not know whether or not admissions which were, for example, chaotic, were not reported and a well-executed admission was, thus leading to a selection and a (non) response bias. On the other hand, most physicians involved were rotating physicians thus not aware of the previous situation.

Furthermore the study was conducted in an ICU of a large academic centre which might be different from other healthcare settings in which the composition of the team is less variable. Additional CRM trainings were not implemented which could have further improved the results.

Conclusion

Unplanned ICU admissions require well-organised team work because of the critical status of the patients. A Lean approach resulted in an improvement of the logistics, communication and sense of safety of the unplanned admissions in the ICU in a tertiary care teaching hospital.

Disclosures

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Supplement 1: Questionnaire.pdf

https://njcc.nl/sites/nvic.nl/files/hd%2019-56%20Spaan%20Supplement%201%20Questionnaire.pdf

Supplement 2a: Role allocation edited IS.pdf

https://njcc.nl/sites/nvic.nl/files/hd%2019-56%20Spaan%20Supplement%202a%20Role%20allocation%20edited%20IS.pdf

Supplement 2b: Checklist equipment.pdf

https://njcc.nl/sites/nvic.nl/files/hd%2019-56%20Spaan%20Supplement%202b%20Checklist%20equipment.pdf

Supplement 2c: Checklist patient.pdf

https://njcc.nl/sites/nvic.nl/files/hd%2019-56%20Spaan%20Supplement%202c%20Checklist%20patient.pdf