Rapid response systems. Recognition and management of the deteriorating patient
Ludikhuize, J.

Citation for published version (APA):

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Chapter 6

Measuring adherence among nurses one year after training in applying the Modified Early Warning Score and Situation-Background-Assessment-Recommendation instruments

Jeroen Ludikhuize
Evert de Jonge
Astrid Goossens

Resuscitation 2011
Abstract

Background: Patients with a cardiac arrest or unplanned intensive care admission, show gradual decline in clinical condition preceding the event. This can be objectified by measuring the vital parameters and subsequently determining the Modified Early Warning Score (MEWS). Contact with the physician by nurses may be structured using the Situation-Background-Assessment-Recommendation (SBAR) communication instrument. The aim of our study was to evaluate whether nurses trained in the use of MEWS and SBAR tools were more likely to recognize a deteriorating patient.

Design and setting: This prospective quasi-experimental trial in the Academic Medical Center in Amsterdam, the Netherlands included three medical and three surgical wards.

Interventions: A group of 47 trained and 48 non-trained nurses were presented with a case of a deteriorating patient, and subsequent assessment and actions regarding the patient case were measured.

Results: Of the trained nurses, 77% versus 58% of non-trained group assessed the patient immediately. On subsequent assessment of the patient, respiratory rate was measured twice as frequently (53% trained versus 25% non-trained, p=0.025). No differences were found in the measurement of other vital parameters. The MEWS was determined by 11% of trained nurses. Subsequent notification of the physician was performed by 67% of the trained versus 43% of the non-trained nurses. The SBAR communication tool was used by only one nurse.

Conclusions: Trained nurses are able to identify a deteriorating patient and react more appropriately. However, despite rigorous implementing of MEWS/SBAR methodology, these tools were rarely used.
Introduction

Life-threatening adverse events (AEs) such as cardiac arrests and unplanned intensive care unit (ICU) admissions are generally preceded by a clear and measureable decline in organ function. In up to 80% of the patients experiencing such AEs, this can be detected by measuring vital parameters for up to 24 h preceding these events. 1-3 During these hours, quality of care has been demonstrated to be sub-optimal. 4 Due to the need to improve the care for these patients, rapid response systems (RRSs) have been developed and implemented worldwide. These systems rely on early recognition of the deteriorating patient on general wards, after which the appropriate personnel with critical care knowledge can be immediately called to the patient’s bedside. 5 Although widely adopted by hospitals, there is still no conclusive evidence for the effectiveness (including cost-effectiveness) of these systems. 6-8

A key element in RRSs is the afferent limb for identifying patients at risk for clinical deterioration. 9 The afferent limb consists primarily of two components. First, track-and-trigger systems (TTs) rely on measuring vital parameters using predetermined thresholds. Various forms of these systems exist with varying degrees of accuracy for early detection of deteriorating patients. 10-12 One system, the Modified Early Warning Score (MEWS), assigns from zero to three points for each specific vital parameter (e.g., heart rate, blood pressure), and values for each parameter are added together to obtain a summary score. 13 Then, when a predetermined threshold is reached the efferent limb is activated, which may consist of the rapid response team (RRT). Transferring information, including vital parameters is prone to error, 14 and various tools have been developed to aid this process. 15,16 One of these is the SBAR (Situation-Background-Assessment-Recommendation) tool, and implementing and adhering to these systems is crucial to the successful use of RRSs. 17,18

From the literature, little is known about how nurses actually use these systems in clinical practice. At the Academic Medical Center (AMC) in Amsterdam, the Netherlands, the MEWS and SBAR were implemented on four nursing wards within the framework of the COMET (Cost and Outcomes analysis of Medical Emergency Teams) study. 19 This is a multicenter study that analyzes the effectiveness and associated costs of implementing an RRS (manuscript of study protocol submitted). The current study tests whether using a simulated patient case – an educational intervention followed by one year of implementation – has changed how nurses behave when dealing with a deteriorating patient.
Methods

Hospital setting
The study was conducted between June and September of 2010 in the AMC, which is a 1000-bed teaching hospital. Six nursing wards were included: three (two medical and one surgical ward) had received training in MEWS/SBAR, and three (two surgical and one medical ward) were non-trained and had no knowledge or skills in MEWS/SBAR. All nurses were registered nurses. Throughout this document, the word ‘trained’ refers to nurses trained to use MEWS and SBAR.

MEWS and SBAR methods
The MEWS (based upon Subbe et al., 13 see figure 1) and SBAR tools (based upon Haig et al., 15 see supplementary figure 1) were introduced in our hospital in November 2009. Within one month, 95% of all nurses who had to be trained had received instruction during small (no more than 15 nurses) interactive training sessions that lasted 1 h. These sessions were all lead by a senior nurse with more than 10 years of experience in emergency medicine. Nurses were instructed to measure the MEWS as “clinically indicated”. This meant if at least one vital sign was abnormal (scoring at least one point), nurses were expected to calculate the entire MEWS. Also, physicians could decide to ask for more frequent MEWS determinations. A cut-off point of three was determined, at which point nurses were required to take action and inform the physician according to SBAR methodology. Implementation was further enhanced within the trained group with different interventions such as the use of posters, feedback sessions, face-to-face conversations, small posters in each nursing chart, and so forth. The non-trained group received no information regarding on these instruments, and due to their physical distance from the other wards, crossover effects were deemed minimal to non-existent.

Figure 1. The Modified Early Waming Score (MEWS).

MEWS system:

<table>
<thead>
<tr>
<th>MEWS score</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td></td>
<td>&lt;40</td>
<td>40-50</td>
<td>51-100</td>
<td>101-110</td>
<td>111-130</td>
<td>&gt;130</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>&lt;70</td>
<td>70-80</td>
<td>81-100</td>
<td>101-200</td>
<td>&gt;200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiration rate</td>
<td>&lt;9</td>
<td>9-14</td>
<td>14-15</td>
<td>21-30</td>
<td>&gt;30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>&lt;35,1</td>
<td>35,1-36,5</td>
<td>36,6-37,5</td>
<td>&gt;37,5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVPU score</td>
<td>A(Alert)</td>
<td>V(response to Voice)</td>
<td>P(reacting to Pain)</td>
<td>U(Unresponsive)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Worried about patient’s condition: 1 point
Urine production below 75 milliliter during previous 4 hours: 1 point
Saturation below 90% despite adequate oxygen therapy: 3 points
Upon reaching 3 or more points → call resident in charge

The MEWS instrument was implemented as a tool that ward staff can use to identify the patient at risk of deterioration. The described method was adapted from Subbe et al.13
Study protocol and case description

A quasi-experimental study design was employed to analyze the difference between trained and non-trained nurses in recognizing a deteriorating patient. Nurses were presented with the nursing chart of a fictitious deteriorating patient. They were asked to respond as they would in their clinical practice. The nurses included in the study were told that the research was concerned with general daily activities of nurses and were kept blind from the true reason. The head of the nursing of each department was notified of the study aims and instructed the nurses to participate.

Nurses from surgical wards were presented with a 58-year-old patient with a past medical history of essential hypertension 24 h after hemicolecotomy for a carcinoma of the colon. Nurses from medical wards were presented with a similar patient admitted with pneumonia. The patient was unwell, and vital signs taken 30 min earlier would, if calculated, be equal to a MEWS of 2. The vital signs for the surgical patient are shown in table 1, and these vital signs were similar to the medical case. In addition, the nursing entries into the log are shown in Supplementary figure 2.

The study protocol is shown in figure 2. After nurses were given ample time to read the nursing chart (step 1), a voice recorder was turned on to collect all subsequent data. Step 2 included the assessment of the patient after nurses decided to take action. Upon request, the researcher (JL and AG), provided the vital parameters listed in table 1, time point 3.30 pm. In Step 3, trained nurses were expected to notify the physician utilizing the SBAR instrument. If nurses said they would call a physician, they were instructed to actually phone the physician on call (who was informed about the research protocol).

Table 1. Vital parameters are depicted for the surgical case. In case of empty fields, these represent variables that were not measured.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Temperature</th>
<th>Pulse</th>
<th>Blood pressure</th>
<th>Saturation (+ or − O2)</th>
<th>VAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-4-2010</td>
<td>07.00 am</td>
<td>37.2</td>
<td>65</td>
<td>110/60</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>16/4</td>
<td>05.15 pm</td>
<td>37.4</td>
<td>75</td>
<td>130/90</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>16/4</td>
<td>11.00 pm</td>
<td>90</td>
<td>120/85</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17/4</td>
<td>02.45 am</td>
<td>36.8</td>
<td>90</td>
<td>110/65</td>
<td>99 (-O2)</td>
<td>6</td>
</tr>
<tr>
<td>17/4</td>
<td>01.00 pm</td>
<td>36.7</td>
<td>95</td>
<td>110/60</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>17/4</td>
<td>03.00 pm</td>
<td>36.4</td>
<td>96</td>
<td>100/50</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Temperature</th>
<th>Pulse</th>
<th>Blood pressure</th>
<th>Saturation (+ or − O2)</th>
<th>Respiratory rate</th>
<th>Consciousness</th>
<th>Urine production</th>
<th>VAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>17/4</td>
<td>3.30 pm</td>
<td>36.4</td>
<td>100</td>
<td>100/50</td>
<td>93 (-O2)</td>
<td>18</td>
<td>Alert</td>
<td>Not measured</td>
<td>3</td>
</tr>
</tbody>
</table>
After steps 1 and 3, nurses were excluded from further participation if they said they would take no action at all.

**Data analysis and statistics**

Data analysis was performed in SPSS version 18.0. First, a comparison was made between trained and non-trained nurses for recognizing a patient at risk. Then, the specific usage of the MEWS and SBAR instruments by trained nurses was analyzed alongside the specific vital parameters, and subsequent actions to notify the physician were recorded. Continuous data were presented as medians with interquartile range (IQR). Categorical data were presented in percentages (rounded to integer numbers) and cross tabulation was used when appropriate. The \( \chi^2 \) squared and Mann-Whitney test were used for group comparisons. A post-hoc analysis of Steps 1 and 3 of the protocol was performed that excluded Ward C (see Section 3.1).

**Ethics**

The research protocol was not subjected to the AMC’s Medical Ethics Committee. According to a memorandum on behavioural research from the Dutch Central Committee on Research Involving Humans Subjects (CCMO), the study investigated the retention and application of knowledge in fields of organizational psychology, and was therefore exempt from ethical approval.

**Results**

**Demographics**

A total of 95 nurses participated; 47 of these nurses were trained and 48 were non-trained. The demographics are shown in Table 2. Eighty percent of respondents were female, and the median age was 28 years. Median time since certification was four years, and work experience on the ward was two years. The characteristics of the trained and non-trained nurses did not differ, except for nurses from one specific department.

**Table 2.** Characteristics of respondents. “Number of years certified” represents the time since graduation from nursing school. “Number of years on the ward” is the amount of consecutive time spent on the specific study ward. Data are medians with IQR, unless stated otherwise.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Trained nurses</th>
<th>Non-trained nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of nurses (% of total)</td>
<td>95 (100)</td>
<td>47 (49,5)</td>
<td>48 (50,5)</td>
</tr>
<tr>
<td>Gender (no and % females)</td>
<td>80 (84,2)</td>
<td>40 (85,1)</td>
<td>40 (83,3%)</td>
</tr>
<tr>
<td>Age</td>
<td>28 (20 - 60)</td>
<td>26 (21 – 59)</td>
<td>28,5 (20 – 60)</td>
</tr>
<tr>
<td>No of years certified</td>
<td>4,0 (0,1 - 40,0)</td>
<td>4,0 (0,1 – 36,0)</td>
<td>4,5 (0,1 – 40,0)</td>
</tr>
<tr>
<td>No of years at ward</td>
<td>2,0 (0,1 - 30,0)</td>
<td>2,0 (0,1 – 25,0)</td>
<td>3,0 (0,1 – 30,0)</td>
</tr>
</tbody>
</table>
(ward C, non-trained) who were older (44.5 (IQR 32-53) versus 28 (IQR 20-60) and more experienced than nurses from the other wards (16.0 (IQR 9.3-25.8) versus 4.0 (IQR 0.1-40.0) (Supplementary table 1).

**Taking action after reading nursing charts**

After reading the case description (Step 1), 36 (77%) of the trained and 28 (58%) of the non-trained nurses said they would review the patient immediately, \( p = 0.056 \) (see Figure 2). At ward level, noticeable differences were observed between the wards, and the range of nurses taking action varied from 37 % to 88 %. In a post hoc analysis in which Ward C was removed from the results, the difference in awareness between trained and non-trained wards became statistically significant (77% trained versus 53% non-trained, \( p = 0.026 \)). All nurses who did not assess the patient immediately (23% trained and 43% non-trained) were excluded from participation in the study.

![Study design and major findings](image)

**Figure 2.** Study design and major findings. The study protocol contains three steps. In the first step, nurses should recognize the severity of the patient’s clinical condition. Trained nurses were expected to measure the MEWS (step 2) and all nurses to call the physician (step 3), which both represent “action undertaken”. If nurses did not taken action during either step 1 or 3, they were excluded from further participation.

**Measurements of vital signs and MEWS**

Pulse, arterial blood pressure, temperature and saturation were the parameters that nurses requested most often (see figure 3). These parameters were requested by 78-84 % of respondents in both groups. The proportion of respondents requesting the
respiratory rate differed between groups (53% of trained versus 25% of non-trained nurses, \( \chi^2 = 5.038, p=0.025 \)). Apart from parameters of the MEWS, pain measurement using a visual analogues scale (VAS) was requested by 50% of all nurses. Subjective measurements regarding breathing (25%), such as pattern, depth and/or frequency, were requested more often than objective measurements like respiratory rate. Of the trained nurses that assessed the patient, only four nurses (11%) determined and calculated the MEWS correctly.

**Notification of the physician**

After assessing the patient and measuring the vital signs according to step 3 of the study protocol, the physician had to be alerted according to the MEWS protocol. Twenty-four nurses (67%) in the trained group and 12 (43%) in the non-trained group contacted the physician immediately (p = 0.059).

Interestingly, nine (32%) of the non-trained nurses opted to wait and contact the physician during the “evening” round that was expected to take place in the late afternoon. In the post hoc analysis that excluded Ward C (due to the large differences in demographics compared to the other non-trained wards), the difference in percentages of trained and non-trained nurses who notified a physician (67% versus 22%) reached statistical significance (p = 0.037).

We further evaluated the use of the SBAR communication instrument by the trained nurses who actually contacted the physician. The SBAR was used by only one (4%) of the trained nurses. In a subsequent analysis, the separate components and more precisely,
the communication of measured vital signs were analyzed. Overall, measured parameters were only transferred to the physician in about 60% of the phone calls. If it had been measured, respiratory rate was relayed twice as frequently by trained compared than by non-trained nurses (83% versus 40%), which did not reach statistical significance (p=0.117).

**Action taken upon positive MEWS**

In the four cases in which the MEWS was calculated (11% of trained nurses), one nurse (2%) followed the protocol correctly and called the physician. Two nurses took no action and one checked the patient again at a later point in time. Despite having measured all the parameters (including the MEWS), the nurse who called the physician did not mention the MEWS value itself to the physician.

**Discussion**

RRs have been implemented without conclusive evidence of their effectiveness. A key component of an RRS is the early detection of the deteriorating patient by nurses on the ward according to readily available vital signs in the hours preceding adverse events. There is evidence that implementing the afferent system in itself may have direct positive effects on patient outcomes. The current study has evaluated the level of adherence to the afferent limb (MEWS and SBAR) and also the link between the afferent and efferent limb in one of the hospitals participating in the COMET trial.

Overall, there was no difference between trained and non-trained nurses in the number of vital signs “measured”, although trained nurses measured respiratory rate more often. In this study, trained nurses called the physician more often after identifying the patient as being at risk for deterioration. Surprisingly, a year after relatively extensive training and additional implementation interventions, only few trained nurses actually calculated the MEWS and followed the MEWS protocol to the letter. In our study, no difference was found between trained and non-trained nurses with respect to the criterion of being “worried”. This may reflect the maturity of our system as suggested by Young et al., which identified “worried” as the major RRS call criterion in mature systems. Communication with the physician remained hampered by the absence of a clear structure. The SBAR was used only once, when vital signs were measured, they were only mentioned in 60% of all communication. Our results are in accordance with previous studies which report that the introduction of an RRS, or a track-and-trigger system for that matter, resulted in higher surveillance of vital parameters. In accordance with our data, this was found especially for the documentation of respiratory rate.

It is inherently difficult to implement interventions, especially complex interventions that impact how daily care is organized and potentially conflict with the established
In our study, the chosen implementation strategy was rather elaborate, with an experienced trainer training all of the nurses, regular feedback sessions, posters and email notifications.

There are some limitations to this study. First, these data represent single-center data. Although implementation was done according to the COMET protocol, the training session (although interactive and with small groups) lasted only 1 h, and these data may not represent the level of adherence or change in behaviour in other hospitals. 31 Second, although the patient case is an actual representation of a deteriorating patient, nurses did not have the opportunity to physically assess the patient themselves. However, our case does resemble an actual situation in clinical practice, when nurses are provided with only written information from their colleagues at the beginning of their shift. In these circumstances, they have to prioritize their actions based on information on paper and without having seen the actual patient. Because they did not take the actual measurements and have no “picture” of the patient, this might only hamper subsequent decision making and may underestimate their accuracy of decision making in real life. Nevertheless, based on the case description, all nurses should at least have been “triggered” by the worsening parameters and clear signs of pending circulatory shock as stated in the patient chart. We can only speculate on why trained nurses outperform non-trained nurses in alertness, since this difference in ability to recognize the clinical state is not correlated with MEWS usage. According to the paper by Smith, 32 the “chain of recognition” is hampered by its weakest link. No study has yet been conducted on whether this is related only to knowledge and skills, or possibly more to an appreciation of clinical urgency by nurses. Feedback sessions were organized with each participating ward to qualitatively explore possible explanations for the low degree of adherence to the MEWS/SBAR, and for the distinct cluster effects between the wards. Important barriers most frequently identified were (i) the voluntary nature of measuring the MEWS, (ii) a lack of involvement by physicians (including young physicians) who were not properly informed about the protocol and so were unfamiliar with the clinical significance of the MEWS/SBAR, and (iii) immediate notification of the physician was hampered by the established culture. Possible solutions for some of these problems are being investigated, and some have already been published. Continuous electronic measurement of the vital signs might offer nurses earlier and easier identification. 33-35 Also, making MEWS measurement compulsory rather than voluntary might improve recognition of deteriorating patients, which in turn would improve nurses’ knowledge of patho- and normal physiology. Clearly, not only nurses but also physicians should be encouraged to use the MEWS to recognize patients at risk of deterioration, which in turn would greatly stimulate implementation. Mandatory bedside evaluation rather than telephone consultations by physicians might improve usage of these tools and may result in more immediate treatment of the deteriorating patient. 36 The recent adaptation of the MEWS known as ViEWS
(VitalPACTM-EWS) uses supplementary oxygen therapy and incorporates a scale for peripheral saturation. This system outperforms all existing track-and-trigger systems. Therefore, in future research proposals it would be interesting to evaluate these options as single or combined interventions. However, it remains clear that to complete the chain of prevention, also these interventions have to first be implemented successfully, and then prove themselves in clinical practice.

Conclusions

In summary, the present study has shown that although trained nurses identify the deteriorating patient more frequently than non-trained nurses, there is ample room for improvement. While assessing the patient, the trained nurses measured respiratory rate twice as frequently. Subsequent action by notifying the physician on call was higher in the trained group. Surprisingly, despite specific training in the use of MEWS and SBAR, behavioural change was minimal. Communication was still hampered by the absence of structure and subsequent loss of information. All in all, one year after implementing the MEWS and SBAR tools, adherence is low. To improve patient safety, future research should focus on new implementation strategies that could be more effective than the ones now used in our hospital.

Conflict of interest statement

No conflict of interest declared.

Acknowledgements

We like to thank Anouk Knops (MSc) for her role as physician on call who answered the nurses’ calls during the study.
Reference List


Supplementary table 1. Demographics of participating wards. Data are medians with IQR, unless stated otherwise. The Wilcoxon-Mann-Whitney test was used on the continuous data and the $\chi^2$-squared test was used on categorical data.

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Dept. A</th>
<th>Dept. B</th>
<th>Dept. C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surgery (abdominal)</td>
<td>Surgery (Oncology)</td>
<td>Internal Medicine (Hematology)</td>
</tr>
<tr>
<td>Trained?</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>No of nurses (% of total)</td>
<td>19 (20,0)</td>
<td>15 (15,8)</td>
<td>14 (14,7)</td>
</tr>
<tr>
<td>Gender (no and % females)</td>
<td>17 (89,5)</td>
<td>13 (86,7)</td>
<td>10 (71,4)</td>
</tr>
<tr>
<td>Age</td>
<td>26,0 (22,0 - 36,0)</td>
<td>28,0 (23,0 - 30,0)</td>
<td>44,5 (32,0 - 53,0)</td>
</tr>
<tr>
<td>No of years qualified</td>
<td>3,0 (1,0 - 13,0)</td>
<td>2,0 (1,0 - 7,0)</td>
<td>16,0 (9,3 - 25,8)</td>
</tr>
<tr>
<td>No of years at ward</td>
<td>1,5 (0,8 - 10,0)</td>
<td>2,0 (1,0 - 5,0)</td>
<td>5,5 (1,5 - 18,3)</td>
</tr>
</tbody>
</table>

Supplementary figure 1. The Situation-Background-Assessment-Recommendation (SBAR) instrument

SBAR communication instrument

**Situation:**
I’m calling about (name of patient, ward and room number)
The problem I’m calling about is (problem)

**S**
The vital parameters are (Heart rate, Blood pressure, Breathing rate, Saturation with/without suppl. Oxygen, Temperature, AVPU scale, Urine production, other non-specified parameters)
MEWS score (score)
I’m concerned about (define problem)

**Background:**

**B**
Admissions diagnosis and admission date
If relevant: Medical history and other clinical information

**Assessment:**

**A**
I think the problem is (describe problem) or
I’m unsure what the problem is, but the patient (is deteriorating/unstable)

**Recommendation:**
I think that you should (describe exactly what needs to happen at this moment)
1. You should evaluate the patient now and/or
2. You should evaluate the patient (set specific time interval) and/or
3. Determines medical policy

**R**
What should I do now?
How often do you want the vital parameters checked and at which thresholds do you want to be called again?

**Repeat-back:**
We have agreed on the following (repeat the medical policy systematically and who does what and when)
Write the determined policy up into the patients records
Supplementary table 1. Demographics of participating wards. Data are medians with IQR, unless stated otherwise. The Wilcoxon-Mann-Whitney test was used on the continuous data and the χ²-squared test was used on categorical data.

<table>
<thead>
<tr>
<th>Dept. D</th>
<th>Dept. E</th>
<th>Dept. F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Medicine (general)</td>
<td>Internal Medicine and GE</td>
<td>Surgery (trauma)</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>16 (16,8)</td>
<td>17 (17,9)</td>
<td>14 (14,7)</td>
<td></td>
</tr>
<tr>
<td>15 (93,8)</td>
<td>14 (62,4)</td>
<td>11 (78,6)</td>
<td>0,75</td>
</tr>
<tr>
<td>28,5 (24,3 - 31,5)</td>
<td>25,0 (23,0 - 36,0)</td>
<td>25,0 (24,0 - 43,5)</td>
<td>0,026</td>
</tr>
<tr>
<td>4,0 (1,6 - 8,5)</td>
<td>3,0 (1,0 - 10,5)</td>
<td>4,0 (2,0 - 19,0)</td>
<td>0,04</td>
</tr>
<tr>
<td>3,0 (1,1 - 6,0)</td>
<td>1,0 (1,0 - 4,3)</td>
<td>1,5 (0,9 - 4,6)</td>
<td>0,359</td>
</tr>
</tbody>
</table>

Supplementary figure 2. Case nursing case descriptions

Case descriptions: Surgery case

Reason for admission: Data of admission 4/15/2010 due to colon carcinoma. Date of surgery 4/16/2010, procedure hemicolectomy right-sided. History essential hypertension, well controlled, with Enalapril 5 milligrams daily. One times daily vital signs (pulse, blood pressure and temperature) were ordered until moment of surgery.

Nursing chart entries with date and shift:

4/15/2010 day: Patient was admitted to hospital. No special needs except that patient use high blood pressure medications (tension was good at admittance). Anesthesiologist still needs to visit the patient. The resident has drawn blood for pre-operative screening. The patient is calm and waits patiently for the day of tomorrow.

4/15/2010 evening: The patient had a normal evening meal. The patient passed on stool containing melaena. Anesthesiologist has visited the patient including the resident and surgeon who will operate on the patient tomorrow. The patient is ready for surgery and will be kept fasted according to protocol.

4/15/2010 night: The patient has slept well after 10 mg sleeping medication. Has been kept fasted from midnight. No further details to report.

4/16/2010 day: The patient went to theater at 7.30. No further details to report.

4/16/2010 evening: The patient returned from the recovery ward at 5.15 pm. Recovery when without problems. Vital signs on the ward: BP 110/60, Pulse 65 and temperature 37.2°C. The patient was awake and took some drinking water without problems. The patient scored a 3 on the VAS for pain. 8 pm: No problems. Visiting hour was fine VAS for pain was 0. Vital signs no abnormalities. (See separate chart) The patients’ breath was a bit superficial.

11 pm. Patient had a bit more pain. (VAS 4) Resident came by. Patient received a non-steroidal-anti-inflammatory-drug.

4/16/2010 night: The patient slept at the beginning of the night shift. No vital signs were performed. 2.45 am. Patient was awake. Was thirsty and received water without problems. Vital signs were BP 130/85 and pulse 75. 6.00 am. Patient slept during round. No further details to report.

4/17/2010 day: The patient was washed on the bed. The patient endured pain during the nursing care. The patient had a good night sleep. Vital signs at 8 am; BP 110/65, Pulse 90, Temperature 36.8°C, VAS 6. Patient seemed to be a bit out of breath. Saturation without supplementary oxygen was 99%. During the morning round, the resident examined the patient. The abdomen was somewhat painful during examination. The patient...
has received 10 milligrams of morphine with good result. The abdomen is starting up again and the patient is passing some gas.

At 10 am the patient called. The pain was present again and he felt a bit short of breath. The resident was called to the bedside. He concluded that the pain was appropriate for 1 day post surgery and a conservative treatment was concluded. 1 pm; during round and measurement of vital signs, the patient was again painful and thus received 10 milligrams of morphine intra muscular. 3 pm; Pain was absent. Patient was asleep and vital signs were all well.

Case descriptions: Medical case

Reason for admission: Data of admission 4/16/2010 because of a nosocomial pneumonia. History essential hypertension, well controlled, with Enalapril 5 milligrams daily. Three times daily vital signs (pulse, blood pressure and temperature).

Nursing chart entries with date and shift:

4/16/2010 day: Patient was this morning admitted to hospital directly from the Emergency Room. He arrived on the ward around 10 am. Vital signs on arrival; BP 130/70, pulse 62, temperature 38.5°C, Saturation 99%. Augmentin infusion were started. Vital signs remained stable during the shift. Patient has some pain during breathing (pulmonary embolism was already excluded in the ER). Patient received some paracetamol at 2 pm because VAS for pain was 2.

4/16/2010 evening: The patient has a reasonable to well evening. Patient had something to eat although drinking is moderate. Vital signs at 8 pm; BP 130/90, pulse 75, temperature 38.1°C. Resident started a new iv because other iv caused local irritation. The patient has sometimes a bit of superficial breathing. Could this be caused by the pain? Supplementary oxygen was not necessary because saturation remained at 99%. No further details to report.

4/16/2010 night: The patient slept at the beginning of the night shift. Therefore, no vital signs were measured at that time.
2.45 am: Patient was awake. He was thirsty and water was offered. The water was consumed eagerly. Vital signs were Temp 37.8 °C, Pulse 75 and blood pressure 130/85.
6.00 am: Patient slept during rounds. No further details to report.

4/17/2010 day: The patient was washed on the bed. The patient reported to have had a good night sleep. The patient suffered from some pain during the washing. Vital signs at 8.00 am were Temperature 38.5°C, Pulse 90 (Saturation 99% without supplementary oxygen) blood pressure 110/65 and VAS pain 4.

The patient seemed to be a bit out of breath. During the morning rounds, the patient was reviewed by the attending. The patient still has some slight abnormalities over the lungs. There were no changes in medical policy.

At 10.00 am, the patient called. He keeps experiencing pain and feels weak. After consultation with the attending, conservative treatment was continued. At 1.00 pm vital signs remained the same. (Temperature 38.7°C, pulse 95 and blood pressure 110/60) At 3.00 pm, the patient experienced no more pain. The patient was sleeping on and off. Vital signs were good.