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Original Research

Improving the quality of the intensive care follow-up of ventilated patients during a national registration program

P. Reper [a,b,c,*], D. Dicker [a], P. Damas [c,d], L. Huyghens [c,e], M. Haelterman [a]

[a] Ministry of Public Health, Belgium
[b] Brugmann University Hospital, Université Libre de Bruxelles, Brussels, Belgium
[c] Ministry of Public Health, College of Physicians for Intensive Care Medicine, Belgium
[d] CHU Sart Tilman, Université de Liège, Liège, Belgium
[e] UZ Brussel, Vrije Universiteit Brussel, Brussels, Belgium

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ABSTRACT

Objectives: The Belgian Public Health Organization is concerned with rates of hospital-acquired infections like ventilator-associated pneumonia (VAP). Implementing best practice guidelines for these nosocomial infections has variable success in the literature. This retrospective study was undertaken to see whether implementation of the evidence-based practices as a bundle was feasible, would influence compliance, and could reduce the rates of VAP.

Study design: We utilized easily collectable data about regular care to rapidly assess whether interventions already in place were effectively successfully applied. This avoided cumbersome data collection and review.

Methods: Retrospective compliance rates and VAP ratios were compared using z tests with *P*-values < 0.05 considered statistically significant. This data review attempted to examine the impact of education campaigns, staff meetings, in-services, physician checklist, nurse checklist, charge nurse checklist implementation, systematic VAP bundle application, and systematic protocols for oral care and sedation protocols. Additionally, VAP ratio could be registered by the participating centers.

Results: A total of 10,211 intensive care unit (ICU) patients were included in the study which represents 66,817 ICU days under artificial ventilation with an endotracheal tube. The general compliance for VAP bundle raised from VAP was 61% in February 2012 and 74.16% in December 2012 ($P < 0.001$). The incidence rate of VAP went from 8.34 occurrences/1000 vent days in 2009 to 4.78 occurrences/1000 vent days in 2012 ($P < 0.001$—Pearson test).

Conclusions: Efforts to improve physician and staff education, and checklist implementation resulted in an increase in compliance for VAP bundle and a decrease in VAP ratio. This study confirms the applicability of best practice guidelines about regular care but results on VAP incidence have to be confirmed.

* *Corresponding author*. Critical Care Department, Brugmann University Hospital, VanGehuchtensquare 4, B1020 Brussels, Belgium.
E-mail address: pascal.reper@chu-brugmann.be (P. Reper).

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Introduction

Each year, about 5% of hospitalized patients develop a hospital-acquired infection.[1] Ventilator-associated pneumonia (VAP) and central line-associated blood stream infection (CLA-BSI) are two of the most common hospital-acquired infections. Eighty-three percent of pneumonia's in US intensive care units (ICUs) are associated with mechanical ventilation.[2,3] VAP occurs in approximately 25% of patients receiving mechanical ventilation at a rate of 4–25 episodes per 1000 ventilator days by some estimates.[3] VAP may account for 50% of the antibiotics prescribed in mechanically ventilated patients.[4–6] VAP has a significant economic cost ranging from $10,000 to $40,000.[5,6] Studies also suggest that patients with VAP have increased mortality.[7,8]

The Centers for Disease Control recorded in the United States 18,000 cases of CLA-BSI in ICU patients in 2009. The CLA-BSI has a reported mortality of 12%–25%. The CLA-BSI and associated complications have been reported in some series to average 43% of the total care cost.[9,10] Both VAP and CLA-BSI are associated with significant mortality, increased costs, and multidrug resistant organisms which can influence hospital bacterial ecology.[9]

In 2010, the Belgian Department of Health and Human Services set a national goal of reducing nosocomial infections and promote the use of care bundles. For VAP, healthcare worker hygiene, patient positioning techniques, ventilator device care, oral hygiene, and non-invasive ventilation are some examples of strategies to reduce the rate of infection.[2] Respiratory infections could be reduced through implementation of care bundles, use of chlorhexidine, fully sterile procedures, and improved adherence to existing policies. The Pittsburg Regional Health Initiative and the Michigan Keystone Project Recent data from the literature demonstrated that increased adherences to established best practices can reduce the rate of both VAP and CLA-BSI. Yet increased adherence requires significant educational commitments and high rates of compliance to achieve success.[2]

As part of an overall dedication to quality patient care at the Public Health Ministry, specific attention was made to reduce the incidence of VAP in the ICU. Several strategies using regular care interventions were discussed to promote care bundles in an attempt to reduce rates to better than or comparable to benchmark institutions. It was important to evaluate current methods considered as regular care before resorting to implementation of more expensive measures such as for example silver-impregnated endotracheal tubes (ETs). Additionally, this study assesses change without extensive data mining. We hypothesized that those initiatives considered as regular care could improve compliance to VAP bundle implementation and probably also influence or ideally decrease the incidence of VAP.

Methods

Study population

At the beginning of 2010, a nationwide quality-improvement project for VAP bundle was launched and supported by the Belgian government. At the start of this VAP bundle program, Belgium already had a high density of acute hospitals with ICU (120 centers for 11 million inhabitants) that provided round-the-clock service. National meetings were organized to promote the concept of a VAP bundle network in concordance with the recommendations of the College of ICU physicians, part of the Health Ministry in charge of practice evaluation in Belgian ICUs.

A total of 76 of the 120 acute hospitals participated actively and voluntarily in this database. Of all participating initial hospitals 27 were excluded for final study analysis by incomplete data transmission or unreliable data values. After exclusion of these hospitals the study could involve 49 hospitals with complete data ready for statistical evaluation.

For the same reasons of reliability and data completion the study period was decided from 01 February to 31 December 2012; data collected in January 2012 were considered as test period started in September 2011 for the practical implementation of the VAP bundle and proposed collection tool.

At the time of the analysis, the registry included a total of 10,361 ventilated patients who were admitted to one of the 49 study hospitals between February 2012 and December 2012. All hospitals were previously informed about the VAP bundle program modalities and provided standard medical care to ventilated patients in ICUs according to the recommendations of the pilot group for the project. Fig. 1 shows the distribution of beds between the ICUs of the community hospitals retained as study group. This group is a good sample of the landscape of the acute hospitals in Belgium. The majority of these acute hospitals are located in urban areas.

The data collection is managed by an independent electronic data capture program that also manages internal data quality for the Health Ministry. The data validity was not checked by an external auditing commission. The database was approved by the Belgian Data Protection Agency for Privacy.

This study included sequential all patients who needed artificial ventilatory support admitted to the ICU of the participating hospitals from early to late 2012.

Definitions

VAP surveillance was performed in the study hospital by the infection prevention department utilizing international definitions proposed by the pilot group of the Health Ministry and the College of Belgian Physicians for intensive care medicine. The results were reported each month to the pilot group of the Health Ministry using the proposed collection electronic tool through the local Infection Prevention Committee, Critical Care Task Force, and Medical Executive Committee.

As our primary objective was to enhance VAP bundle implementation and the secondary objective to evaluate or ideally if possible reduce the rate of VAP regardless of patient illness severity, comparison with benchmark institutions avoided extensive data mining.

Outcomes

Primary outcome
Implementation of VAP bundle and compliance.

Secondary outcome
Incidence rate of VAP between February and December 2012.

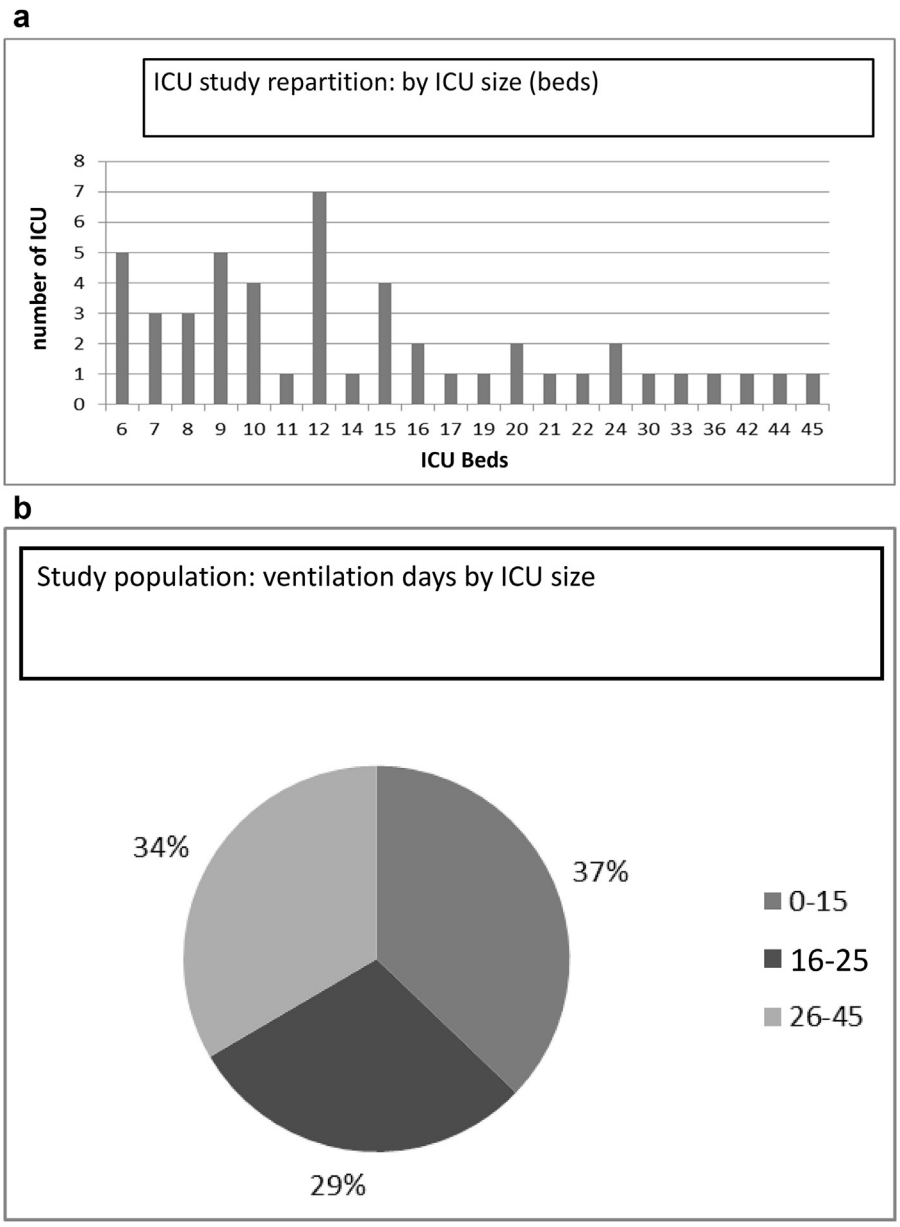

Fig. 1 – a) ICU repartition by ICU size (number of ICU with the same ICU bed number) and (b) ventilation days repartition by ICU size (number of beds): 33 ICU with less than 15 beds, 10 ICUs with 16–25 beds and 6 ICUs with 26–45 beds. ICU, intensive care unit.

Statistical analysis

The National Healthcare Safety Network was used to report the rates using z tests with *P*-values of <0.05 considered statistically significant.

Differences in VAP rates were compared using the Pearson test. Summary statistics are provided as annual VAP rate (VAP cases per 1000 ventilator days) with *P*-value. Annual percentage of compliance was compared via 95% confidence intervals.

Interventions: general initiatives to decrease hospital-acquired infections

Interventions to reduce the rate of VAP centered on education, bundle improvement, and compliance. Patient and family-centered care education also encouraged patients and families to ask healthcare workers to wash their hands. Campaign posters served as educational tools and visual reminders (Appendix A). The posters were placed on the department bulletin boards outside the patient's room. The critical care educator was required to attend staff meetings and conduct in-services on VAP. Multidisciplinary rounds involved respiratory therapists and the patient's nurse focusing on VAP bundle compliance. Additionally, the ICU nurses' check out included checklist information on VAP bundle compliance. The ICU nurse in charge of a ventilated patient was given a VAP checklist to address each bundle element daily and during every daily nurse shifts (morning, afternoon, and night shifts). All these measures were implemented during a five month test period between 01 September 2011 and 31 January 2012.

Specific initiatives to decrease VAP

These included head of bed elevation, oral care (with chlorhexidine gluconate proposed as treatment of choice), daily sedation vacation, daily assessment of readiness to wean and measurement of endotracheal cuff pressure, minimum three times daily, one time per nursing shift. The VAP checklist was required as part of each nursing shift assessment.

The VAP checklist was therefore placed on the ICU team's daily note for attending acknowledgment. Additionally, chart audits for VAP bundle compliance were performed. Compliance with the VAP bundle is defined as the percentage of intensive care patients on mechanical ventilation for whom all five of the elements of the ventilator bundle are documented on daily goals sheets in the medical record.

Results

Sixty-seven percent of the ICUs (33 out of 49) had less than 15 beds (and more than six beds); this represents a good sample of all 120 Belgian acute hospitals; Fig. 1 (A and B) shows the ICU beds repartition of the participating hospitals: there are more small or middle non-academic care centers than big or academic hospitals in Belgium. Thirty-three ICUs with less than 15 beds, 10 ICUs with 16–25 beds, and 6 ICUs with 26–45 beds can be considered as 'large ICUs' in the Belgian landscape.

About 10,211 ICU patients were included during the study period representing 66,817 ICU days under artificial ventilation with endotracheal intubation (or tracheostomy): 3262 patients were ventilated for only 01 day (postoperative) and 6 patients with more than 100 days; mean ventilatory period was 6.54 days during this study.

Fig. 2a shows the repartition of ventilator tubes used in this artificially ventilated ICU population. Tracheostomy rate is 18% and use of ET with subglottic aspiration which was an optional use for this survey is 13%. This demonstrates that the use of this proposed tube even optional but with financial implications was followed by the participating centers. Also, Fig. 2b shows a significant use of chlorhexidine solution for mouth care compared with the use of isobetadine products, 51% vs 48%.

The use of these two optional bundle elements reflects that local evaluation of the techniques used to implement the bundle was performed and that a significant number of ICUs decided to follow the recommendations of the VAP bundle pilot group; they used these two optional elements routinely during the study period.

Both VAP bundle compliance with timing of specific interventions and VAP rate for 2012 are shown in Figs. 3 and 4. The general compliance for VAP bundle raised from for VAP was 61% in February 2012 and 74.16% in December 2012 ($P < 0.001$; Fig. 4). The incidence rate of VAP went from 8.34 occurrences/1000 vent days to 4.78 occurrences/1000 vent days ($P < 0.001$; Fig. 4).

A control chart depicts the VAP rate in early and late 2012 in the ICU and the associated rate per 1000 ventilator days. After an initial strong increase, probably influenced by the ICU population during this period of the year, the rate of VAP began to decrease from March 2012, and the trend continued into late 2012 but no cases of VAP were identified. The VAP

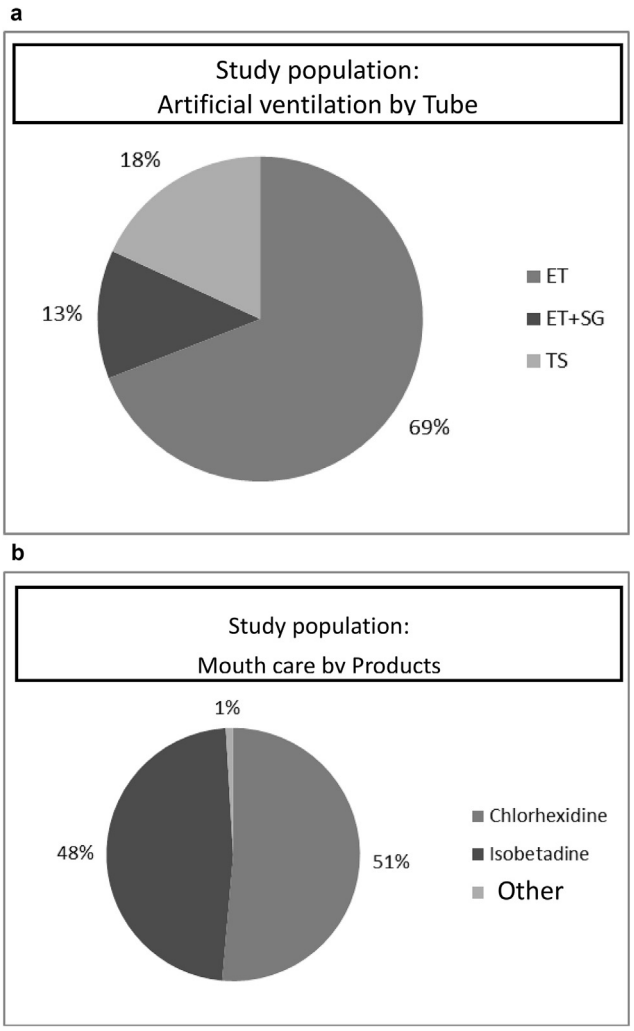

Fig. 2 – a) Artificial ventilation by tube: 69% ventilated with endotracheal tube (ET), 13% with endotracheal tube with subglottic aspiration (ET + SG) and 18% with tracheostomy (TS). (b) Mouth care by products: 51% of patients with chlorhexidine mouth care, 48% of patients with isobetadine mouth care and 1% of patients with mouth care with other products Selective Digestive Decontamination (SDD).

was reported each month to the board of directors of the pilot group. The incidence rate of VAP went from 8.34 occurrences/1000 vent days to 4.78 occurrences/1000 vent days ($P < 0.001$) from early and late 2012.

Discussion

Our study shows success of the several different strategies in bundle compliance and VAP prevention through the use of checklists, education, and accountability. We have demonstrated a better bundle compliance and results on VAP incidence after the systematic implementation of initiatives to decrease these infections. The major changes made to VAP prevention were the use of checklists and the facultative

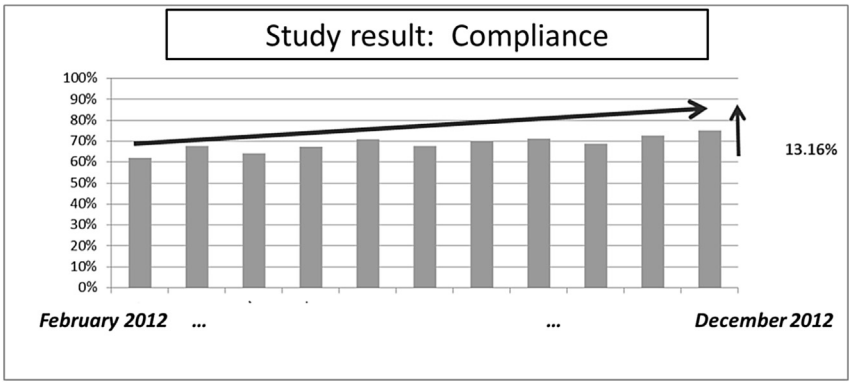

Fig. 3 – Compliance to VAP Bundle: evolution through study period (February to December 2012): compliance raised with 13.16% between the beginning and end of the study period 2012. The general compliance for VAP bundle raised from for VAP was 61% in February 2012 and 74.16% in December 2012 ($P < 0.001$—Pearson test). VAP, ventilator-associated pneumonia.

addition of ET with subglottic aspiration and chlorhexidine oral care. We believe that the use of the checklist and accountability increased compliance with existing best practice measures.

The individual elements of the bundle we implemented in the Belgian ICUs are supported by the literature. For instance, studies have demonstrated that head of bed elevation could reduce the incidence of VAP.[9–12] Further studies have also shown oral care with chlorhexidine and daily sedation vacations could reduce the incidence of VAP.[13,14] While the individual bundle elements have shown to decrease hospital infection, they are not always systematically applied. While the Pittsburg Regional Healthcare Initiative and Michigan Keystone Project demonstrated that increased adherence to best practice care result in decreased rates of VAP and CLA-BSI, others have found significant barriers to educational strategies including scarcity of resources, patient discomfort, disagreement with trial results, fear of potential adverse effects, and costs.[15,16]

Through the use of compliance to bundle, our comparison is simple and easily obtainable. Expected rates of infection for VAP patients seem to decrease in the participating centers as provided. These data are collected in a national database and could be used as a measure of the quality of care provided by a particular institution. We have shown an improvement in our expected VAP rate through the use of this data and a better compliance to VAP bundle.

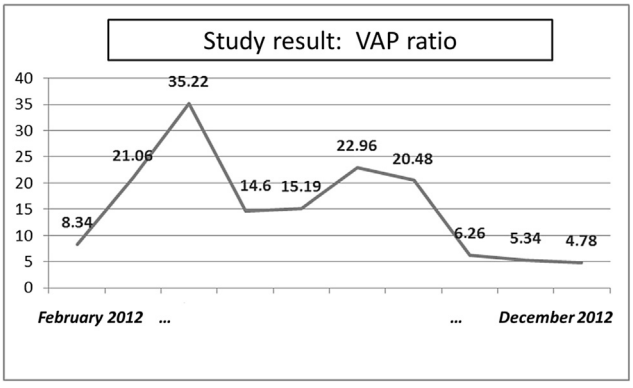

Fig. 4 – VAP ratio evolution through study period (February to December 2012): ratio decreases from 834 episodes in February 2012 to 478 episodes/1000 ventilated days in December 2012. VAP, ventilator-associated pneumonia.

Our results show that a concentrated effort at implementing VAP prevention, educating nursing and medical staff and patients, and the use of checklists can decrease the incidence of VAP. Additionally, the participating centers had to discuss and actualize sedation and weaning protocols and oral care protocols as a result of this implementation. The use of ETs with subglottic aspiration also raised during the study period. Recent data suggest that chlorhexidine could be one of the products of choice for mouth care in ICU patients to prevent nosocomial infections; oral care with chlorhexidine seems also to be often used in the participating centers of our study.

A retrospective review of hospital actuarial data should be necessary to confirm the decrease of VAP incidence and to determine if a decrease in mortality adjusted for expected mortality could be observed. Although other confounders likely are in place, and this is not an outcome of the study, it is encouraging information but high variability in VAP ratio results remains a problem. Showing a decrease in cost is beyond the scope of this study. Yet, given prior estimates of the cost of each case of VAP and the relatively inexpensive measures employed, it is likely that overall costs and use of antibiotics could have been reduced as well.[8–11]

Our study has some limitations. It is a multicenter study performed in academic and non-academic institutions with closed ICUs. Both factors limit the external validity of our findings. Additionally, we did not perform an external control of the ICU data quality on ventilated patients included by the participating ICUs in the study. We also did not compare extensive patient characteristics such as age, gender, Acute Physiology and Chronic Health Evaluation (APACHE II), or Sequential Organ Failure Assessment (SOFA) scores but have avoided these comparisons in favor of an approach that is less labor and cost intensive than other approaches, given the retrospective nature of the study. Furthermore, compliance data on the changes implemented were tracked after the completion of these interventions. Thus, we have specific data regarding compliance evolution, but with dedication of more resources this could serve as a future area of investigation. Additionally, it would be interesting to note whether the act of

only tracking compliance data results in decreased infection rates. Applying different diagnostic criteria to the same patient population can also result in wide variation in the incidence of VAP. The use of different criteria can also influence the time of diagnosis and the associated mortality rate.[17]

Further research would establish if bundle application in hospitals with different structures (e.g. regional non-academic hospitals) is feasible and whether (and to what extent) the organizational structure of an ICU influences success in implementing bundle recommendations. Additionally, data could be reviewed for comparison of severity of illness between the patients examined.

We conclude that the systematic implementation of initiatives to decrease hospital-acquired infections in general hospitals is feasible and does indeed lead to a better implementation and compliance to bundle application, regrouping interventions in ICU patients considered as regular care. This was the primary objective of the study. This could explain the decrease in the nosocomial VAP ratio in the study population but further studies are necessary to confirm the results of this National Health Program and particularly for VAP ratios, which have to be taken with carefulness.

Author statements

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Ethical approval

None sought.

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Competing interests

None declared.

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Appendix A. VAP' campaign poster.

This mnemonic device was used as an educational tool for staff and to increase awareness of our goal to introduce a ventilator-associated pneumonia (VAP) bundle in Belgian acute hospitals.

It illustrates the nurse compliance and checklist created by the intensive care unit (ICU) charge nurses. This checklist was created to track bundle compliance and serve as a shift-by-shift reminder to nurses that VAP bundle compliance is an expectation.

Bundle de soins pneumonie acquise sous ventilation (VAP)

Données du 01/01/2012 au 07/11/2012

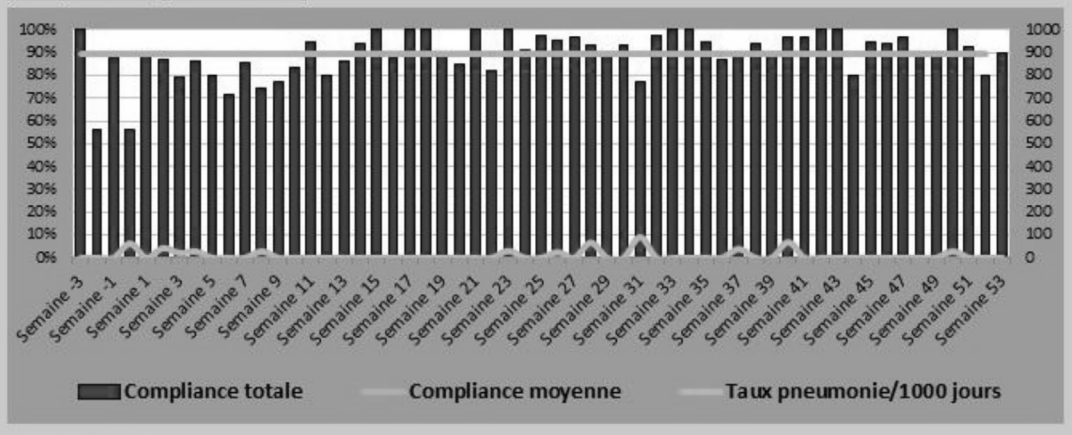
Jours de respiration invasive: 1493

Nombre de patients: 206

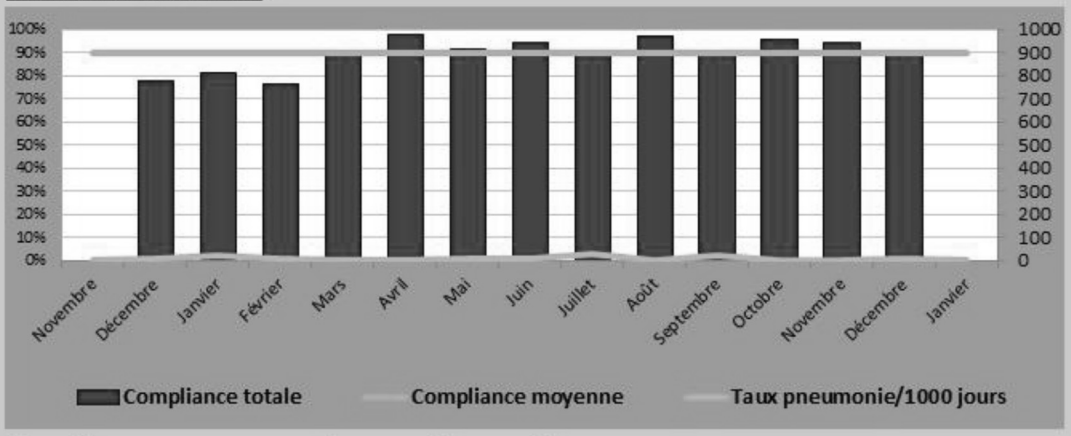
Compliance totale: 90% ⇔ Objectif: 100%

(% chez qui toutes les interventions sont réalisées)

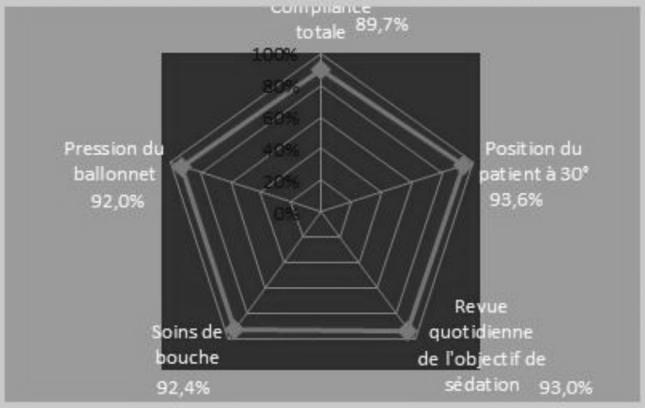
Compliance par semaine



Compliance par mois



Compliance moyenne par intervention, total



Source : SJKI - Izegem

BAPCOC

Appendix B. 2012 participating hospitals

Stedelijk Ziekenhuis Roeselaere (Roeselare); Centre Hospitalier Regional (Namur); Centre Hospitalier De La Haute Senne (Soignies); Grand Hopital De Charleroi (site Gilly) (Gilly); Algemeen Ziekenhuis St. Blasius (Dendermonde); Algemeen Ziekenhuis Maria Middelares (Gent); Centre Hospitalier Peltzer—La Tourelle (Verviers); Clinique Andre Renard (Herstal); Algemeen Ziekenhuis St.-Maarten (Mechelen); Grand Hopital De Charleroi (site Notre Dame) (Charleroi); Algemeen Ziekenhuis Alma (Eeklo); Cliniques Universitaires (U.C.L.) Mont-Godinne; Centre Hospitalier Du Bois De L'Abbaye Et De Hesbay (Seraing); Algemeen Ziekenhuis St.-Jan Brugge-Oostende (Brugge); Jan Yperman Ziekenhuis Vzw (Ieper); Algemeen Ziekenhuis Turnhout (Turnhout); Centre Hospitalier Régional De Huy (Huy); Centre Hospitalier Universitaire Brugmann (Bruxelles); Centre Hospitalier Universitaire Tivoli (La Louviere); Heilig HartZiekenhuis V.Z.W. (Lier); Heilig Hartziekenhuis V.Z.W. (Mol); Regionaal Ziekenhuis Sint-Maria (Halle); Regionaal Ziekenhuis Heilig Hart (Leuven); Regionaal Ziekenhuis Heilig Hart Vzw (Tienen); Kliniek St.-Jan—Clinique St. Jean (Brussel); Europaziekenhuizen–Cliniques De L'Europe (Brussel); St.-Jozefskliniek V.Z.W. (Izegem); St.-Vincentiusziekenhuis (Deinze); Algemeen Ziekenhuis St. Lucas (Brugge); Universitair Ziekenhuis Brussel (Brussel); Centre Hospitalier De Jolimont—Lobbes (Haine-Saint-Paul); Hopital Universitaire Des Enfants Reine Fabiola (Huderf) (Bruxelles–2); Centre Hospitalier Chretien—St. Joseph (Liege); Algemeen Ziekenhuis Oudenaarde (Oudenaarde); Algemeen Ziekenhuis Jan Portaels (Vilvoorde); AZ St Elisabeth (Zottegem); Jessaziekenhuis (Hasselt); Centre Hospitalier De Mouscron (Mouscron); Centre Hospitalier De Dinant (Dinant); Algemeen Ziekenhuis Lokeren (Lokeren); Algemeen Ziekenhuis St. Lucas (Gent); Universitair Ziekenhuis Antwerpen (Edegem); Algemeen Ziekenhuis St.-Elisabeth (Herentals); Algemeen Ziekenhuis St. Augustinus (Veurne); Algemeen Ziekenhuis Heilige Familie (Reet); Centre Hospitalier Interrégional Edith Cavell (CHIREC) (Bruxelles); Centre Hospitalier Tubize—Nivelles (Nivelles); Ziekenhuis Oost—Limburg (Genk); St.-Rembertziekenhuis V.Z.W.(Torhout); Gezondheidszorg Oostkust (Knokke-Heist); Cliniques Universitaires De Bruxelles Hopital Erasme (Bruxelles); Clinique Notre-Dame De Grace (Gosselies); Algemeen Ziekenhuis St.-Jozef (Malle); Algemeen Ziekenhuis Glorieux (Ronse); Algemeen Ziekenhuis Nikolaas (Sint-Niklaas); Universitair Ziekenhuis Gent (Gent); Imelda Ziekenhuis (Bonheiden); Clinique St.-Luc (Bouge); Algemeen Ziekenhuis St.-Dimpna (Geel); Algemeen Ziekenhuis Klina V.Z.W. (Brasschaat); Algemeen Ziekenhuis Diest (Diest); St. Franciskusziekenhuis (Heusden); Algemeen Ziekenhuis Vesalius (Tongeren); Ziekenhuis Maas En Kempen (Maaseik); Mariaziekenhuis Noord-Limburg (Overpelt); Clinique Ste. Anne—St. Remi (Bruxelles).