

Prevention and Control of Blood Stream Infection Using the Balanced Scorecard Approach

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ABSTRAK

Tujuan: penelitian ini bertujuan memperoleh satu formulasi strategi untuk mengatasi infeksi aliran darah (IAD) di rumah sakit yang efektif dan efisien. **Metode:** penelitian ini menggunakan desain riset operasional, dengan pendekatan kualitatif dan kuantitatif. Penelitian dibagi menjadi dua tahap. Tahap I merupakan riset operasional dengan pendekatan pemecahan masalah menggunakan metode kualitatif dan kuantitatif. Tahap II dilakukan dengan metode kuantitatif, merupakan penelitian intervensional penerapan strategi yang sebelumnya telah disusun pada tahap I. Strategi yang efektif dan efisien untuk pencegahan dan pengendalian infeksi di Unit Perinatal Rumah Sakit Cipto Mangunkusumo (RSCM) dilakukan dengan pendekatan Balance Scorecard (BSC) yang meliputi beberapa proses yang saling terkait. **Hasil:** strategi dengan pendekatan BSC ini terbukti secara bermakna menurunkan IAD dari 52,31‰ menjadi 1,36‰ pada kelompok berat lahir 1000-1499 g ($p=0,025$) dan dari 29,96‰ menjadi 1,66‰ pada kelompok berat lahir 1500-1999 g ($p=0,05$). Pola kuman penyebab IAD masih didominasi oleh kuman gram negatif. Hasil simpulan sementara diduga asal kuman berasal dari lingkungan tempat perawatan (filter air keran dan cairan humidifier di inkubator). Ditemukan juga secara bermakna penurunan angka kematian neonatus dengan berat lahir 1000-1499 g, lama rawat, biaya rawat, dan peningkatan kepuasan pelanggan. **Kesimpulan:** pencegahan dan pengendalian infeksi dengan pendekatan BSC secara efektif dan efisien dapat menurunkan secara bermakna angka IAD. Pendekatan ini dapat diterapkan untuk pasien dewasa di unit perawatan intensif dengan berbagai penyesuaian.

Kata kunci: balanced scorecard, berat lahir 1000-1999 g, infeksi aliran darah, neonatus.

ABSTRACT

Aim: to obtain formulation of an effective and efficient strategy to overcome blood stream infection (BSI). **Methods:** operational research design with qualitative and quantitative approach. The study was divided into two stages. Stage I was an operational research with problem solving approach using qualitative and quantitative method. Stage II was performed using quantitative method, a form of an interventional study on strategy implementation, which was previously established in stage I. The effective and efficient strategy for the prevention and control of infection in neonatal unit Cipto Mangunkusumo (CM) Hospital was established using Balanced Scorecard (BSC) approach, which involved several related processes. **Results:** the BSC strategy was proven to be effective and efficient in substantially reducing BSI from 52.31‰ to 1.36‰ in neonates with birth weight (BW) 1000-1499 g ($p=0.025$), and from 29.96‰ to 1.66‰ in BW 1500-1999 g ($p=0.05$). Gram-negative bacteria still predominated as the main cause of BSI in CMH Neonatal Unit. So far, the sources of the microorganisms were thought to be from the environment of treatment unit (tap water filter and humidifying water in the incubator). Significant reduction was also found in neonatal mortality rate weighing 1000-1499

g at birth, length of stay, hospitalization costs, and improved customer satisfaction. **Conclusion:** effective and efficient infection prevention and control using BSC approach could significantly reduce the rate of BSI. This approach may be applied for adult patients in intensive care unit with a wide range of adjustment.

Key words: balanced scorecard, birthweight 1000-1999 g, bloodstream infection, neonates.

INTRODUCTION

Healthcare-associated infections (HAIs) are infections occurring in a patient in a hospital or other health care facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge, and also occupational infections among staff of the facility. The most common HAIs is blood stream infection (BSI). These infections are serious infections typically causing a prolongation of hospital stay and increased cost and risk of mortality. About 20-30% preterm neonates hospitalized may have two or more HAI episodes. Neonatal infection remains one of the three main causes of neonatal death in developing countries. Appropriate and low cost intervention are required for the prevention and control of infection during peripartum and neonatal period in both community and hospital settings.¹ For the neonates, BSI as a major cause of neonatal infection in hospital settings.² Data from Cipto Mangunkusumo (CM) Hospital shows a very high number of BSI, 50.28‰ in 2009, and 30% of neonatal death caused by BSI.³

The balanced scorecard (BSC) is an executive performance measurement method consisting of four perspectives, namely financial, customer, internal business processes, and also learning and growth. In addition, BSC can translate the mission, vision, basic belief, and strategy into a number of comprehensive, coherent, scalable, and balanced strategic targets.⁴ During its development, BSC has been utilized for system management from strategic formulation stage to monitoring and implementation. There are 43 hospitals in Canada that have implemented BSC in their management system. About 75% of the hospitals showed evidence of significant changes towards better performance.⁵ The advantage of BSC compared to other strategic planning tools are presence of linkage and continuity of financial perspective,

customer, internal business processes, also learning and growth in achieving strategic goals.

The objective of this study was to obtain an effective and efficient formulation of problem-solving strategies of HAI, especially in Neonatal Unit CM hospital. Furthermore, this study also intended to look for the sources of microorganisms that has caused BSI. The results of this study can be applied for adult patients to reduce HAI in Intensive Care Unit.

METHODS

The design of this study was the operational research,⁶ with qualitative and quantitative approaches. There were two stages in this study. Phase I was an operational research with problem-solving approach using qualitative and quantitative methods. The focus in this stage was problem identification, problem formulation, up to the determination of measures of prevention and infection control strategies. Phase II was an interventional study on the implementation of strategies that have previously been prepared in stage I. Phase II was performed using quantitative methods. The research was conducted at the Neonatal Unit CM hospital, Central Medical Unit (CMU) Building, 3rd floor, for 10 months.

Inclusion criteria for employees were all employees categorized as directly related to the incidence of BSI at Neonatal Unit CM hospital, 3rd floor of CMU Building. Exclusion criteria were administrative employees and/or having their leave/illness during the study. Inclusion criteria for neonates are neonates with birth weight (BW) 1000-1999 g who had been treated ≥ 48 hours in the CMH Neonatal Unit, 3rd floor CMU Building. Exclusion criteria were neonates with symptoms and signs of infection associated with infection in other organs (e.g. pre-existing infection caused by patient's own course of illness, such as intestinal perforation; or infection due to other medical procedures such as surgical wound infection,

infection as a result of ventilator use, urinary catheterization, or drainage).

Qualitative data collection was performed through discussions and agreements among the responsible persons involved in the neonatal unit by means of focus group discussion (FGD) and consensus decision making group (CDMG). Quantitative data was obtained from the documents/ data and fetomaternal reports of Neonatal Unit CM hospital, which includes the incidence of BSI, neonatal mortality rate, length of stay, and cost of patient care. Customer satisfaction data obtained from the results of satisfaction questionnaires. Customer satisfaction questionnaires were used the patient satisfaction questionnaire (PSQ) instrument. This questionnaire was developed by Hays et al.⁷ covering seven aspects of customer satisfaction. Seven aspects in the health care system in general translates into satisfaction, technical ability, interpersonal relationship, communication, monetary/financial, time spent with medical personnel, and access/convenience. The instrument should meet the validity requirements using Pearson correlation and reliability requirements by using the Cronbach alpha technique. Qualitative

data derived from the FGD and CDMG were processed through data reduction, data presentation, and conclusion drawing. The quantitative data obtained from the research process was processed using SPSS Statistics version 15.

Furthermore, through analysis of qualitative data, a chosen strategy is translated into strategic goals, and mapped to determine a causal relationship to the four BSC perspectives. To measure the achievement of goals, key performance indicators were set. This step was performed by analyzing quantitative data as the initial profile before the BSC were implemented. The Final step was the determination of targets and programs to be implemented in the Neonatal Unit CM hospital. Once set, the strategies, targets, and programs to be performed in the CM hospital Neonatal Unit were implemented.

RESULTS

Algorithm of effective and efficient prevention and infection control at the Neonatal Unit CM hospital were performed using BSC approach, that included several inter-related processes (**Figure 1**). The process started

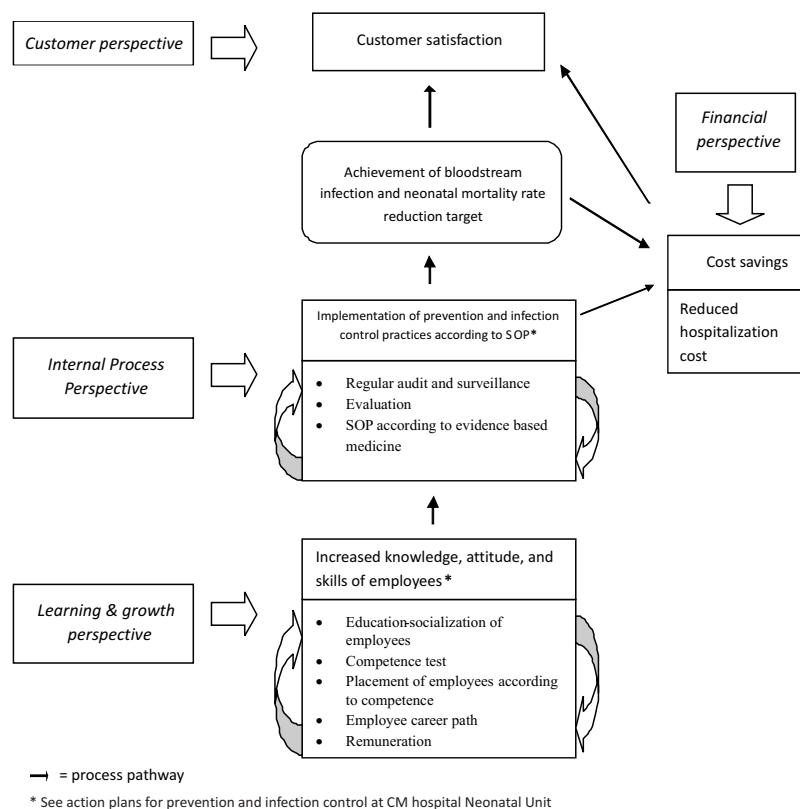


Figure 1. Algorithm for prevention and infection control using BSC approach

from the education-socialization of hospital employees about hospital infection, competency test, placement of employees according to their competency, implementation of employee career path, and calculation of remuneration. This process was continued with audits, periodic surveillance, and evaluation to ensure the prevention and infection control practices was according to the standard operating procedures (SOPs).

Table 1 describes the action plans of each item of existing strategies in learning and the growth perspective, internal process perspective, as well as financial and customer perspectives.

Prevention and control of infection using BSC approach is proven effective and efficient in achieving some of the targets below (**Table 2**).

Apart from above findings, this study also found that the pattern of microorganism causing BSI was still dominated by *Gram-negative*

Table 1. Action plans of prevention and infection control at CMH Neonatal Unit for learning and growth, internal processes, financial, and customer perspectives

A. LEARNING AND GROWTH PERSPECTIVE			
STRATEGY: increasing the knowledge, attitudes, and skills of employees			
Key performance indicators: $\geq 80\%$ of employees pass the competency test			
Strategy details	Performance indicators	Steps	Assessment
1. Education-socialization to employees	- All employees receive training at least 1x / year	- Prepare educational materials - Materials should be approved by the Head of Neonatal Unit, Hospital Infection Prevention and Control Committee (PIRS), and in accordance with evidence-based medicine (EBM)	List of attendance should be signed by the participant and recognized by the provider
2. Competence test	- Score ≥ 65 in written exam - For all employees who passed the written test, the check list score for practice exam $\geq 80\%$	- Perform a written test sheet and checklist sheet for practice exams - Organize written and practice tests to employees - Analyze the results - Make competence as a target of employee training	- Match the written test answer sheet with the answer key - Direct observation by the primary nurse or the nurse in charge of the ward
3. Placement of employees according to competence	- Neonatal nurse competency level I, II, III according to the target - Competence of junior, intermediate, senior residents, and fellows	- Prepare a list of nursing competencies for each level of service - Prepare a competence list of physicians and fellows	- Direct assessment by the head nurse and primary nurse - Direct assessment of doctors and fellows by supervisors
4. Employee career path	- $\geq 60\%$ of nurses have improvements in career level	- Registration of all nurses - Monitor the competency matrix and annually adapt to real condition	- Head nurse consults with the corporate HR
5. Remuneration	- Remuneration for $\geq 80\%$ of employees	- Setting up the unit's performance index (UPI) and individual performance index (IPI) for each employee	- Head nurse to assess the appropriate remuneration
B. INTERNAL PROCESS PERSPECTIVE			
STRATEGY: implementation of prevention and infection control practices according to the SOP			
Key performance indicators: $> 80\%$ implementation of prevention and infection control practices			
Strategy details	Performance indicators	Steps	Assessment
1. Periodic audits and surveillance	- Periodic audits and surveillance at least every month	- PPIRS assisted by trained general practitioners fill out an audit of employees - Primary nurses fill out the surveillance checklist	- Assessing the results in the audit sheet - Assessing the results in the checklist sheet
2. Evaluation	- Monthly internal meeting and for every discrepancy in practice found	- Evaluation and correction of discrepancies	- List of attendance - List of minutes of meeting

3. SOP according to EBM	- Availability of SOP and revised SOP every 6 months	- Ensure appropriate SOP and its revisions according to EBM	- SOP according to EBM approved by the division heads and the entire medical staff
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C. FINANCIAL PERSPECTIVE

STRATEGY: decline of BSI, neonatal mortality rate (NMR), length of stay, and savings of hospitalization cost;
Key performance indicators: >20% cost savings

Strategy details	Performance indicators	Steps	Assessment
1. Decrease BSI	- 1000-1499 g: ↓ 50% - 1500-1999 g: ↓ 50%		
2. Decrease NMR	- 1000-1499 g: ↓ 2.5% - 1500-1999 g: ↓ 2.5%	Includes all the steps mentioned in the learning and growth perspective and the internal processes perspective	Includes all the steps mentioned in the learning and growth perspective and the internal processes perspective
3. Decrease length of stay	- 1000-1499 g: ↓ 12% - 1500-1999 g: ↓ 12%		
4. Decrease hospitalization cost	- 1000-1499 g: ↓ 23% - 1500-1999 g: ↓ 23%		

D. CUSTOMER PERSPECTIVE

STRATEGY: improved customer satisfaction

Strategy details	Performance indicators	Steps	Assessment
1. Improved customer satisfaction	Customer satisfaction score ≥ 80% plus: - BSI - 1000-1499 g: ↓ 50% - 1500-1999 g: ↓ 50% - NMR - 1000-1499 g: ↓ 2,5% - 1500-1999 g: ↓ 2,5%	- Select a customer satisfaction questionnaire to be used (in this case the PSQ questionnaire was used) - Develop questionnaire questions - Pilot test of questionnaire to at least 30 customers - Analysis of validity and reliability - Spreading the valid and reliable questionnaire	Calculating the total score of customer satisfaction obtained, divided by the maximum score, and multiplied with 100%

Table 2. Achievement of prevention and infection control using BSC approach in the CM hospital Neonatal Unit during October 2010-January 2011

		before BSC approach	after BSc approach	P value
Number of BSI	1000-1499 g	52.31‰	1.36‰	0.025
	1500-1999 g	29.96‰	1.66‰	0.05
Neonatal mortality rate	1000-1499 g	18.5%	7.3%	0.05
	1500-1999 g	8.5%	7%	0.810
Length of stay	1000-1499 g	50.88 (SD 44.37) day	33.64 (SD 24.65) day	0.001
	1500-1999 g	40.64 (SD 33.43) day	19.22 (SD 13.92) day	<0.0001
Hospitalization cost	1000-1499 g	Rp 48,183,742 (SD 16,922,324)	Rp 35,467,205 (SD 26,177,676)	0.004
	1500-1999 g	Rp 40,017,014 (SD 17,577,427)	Rp 19,414,039 (SD 18,590,725)	<0.0001
Total score of customer satisfaction	1000-1999 g	146.39 (SD 10.73)	150.81 (SD 10.22)	<0.0001

bacterias *Enterobacter asburiae*, *Pseudomonas aeruginosa*, *Enterobacter cloacae*, *Klebsiella oxytoca*. Temporary findings based on the antibiogram of bacteria is the similarity of bacteria found in the blood of BSI-suspected patients with the environment where the neonates are treated (tap water filter and water in the incubator humidifier). Cross-infection was found in the CM hospital Neonatal Unit.

DISCUSSION

A number of strategic steps in BSC approach that have been very influential to BSI rate reduction in this study was a set of processes which in particular involving the learning and growth of the Neonatal Unit CM hospital employees and internal processes. This step was performed continuously and linked to one another. These steps were translated into action with real working indicators. At the time of this study there had already been infection control and prevention efforts conducted by PPIRS CM hospital. Efforts made so far by the PPIRS CM hospital provided less reduction of BSI due to the inappropriate number of infection prevention and control nurse (IPCN) in charge of overseeing the work unit. There were no continuous monitoring and correction followed by direct improvements. In developing countries like Indonesia with a low level of employee educational level, also with un-independent attitude, the BSC approach is more relevant to be applied.

The relatively good achievement for BSI that was indirectly followed by neonatal mortality rate, length of stay, hospitalization costs, and customer satisfaction, needs to be maintained. Vermont Oxford Network, a collaborative non-profit organization, which until July 2011 have collected 903 neonatal intensive care units (NICU) across the world showed that the number of BSI to be achieved by a good neonatal unit was 3.1% (2007).^{8,9}

Maintaining or even further reducing the BSI rate to zero, requires commitment from the related unit with the hospital management. Optimal facilities and infrastructure will greatly support the success of the unit to achieve a good BSI. In addition, a good neonatal unit requires good cooperation with the department

of obstetrics and gynecology. This relationship is needed to maintain the delivery room condition and employee working habit for prevention and control of hospital infections. Neonatal care ward should be adjacent to the delivery room and equipped with adequate facilities.

The good BSI achievement is determined by environmental factors, and also influenced by the neonate itself which is an endogenous factor. After five days of treatment in the neonatal unit, approximately 40-90% of neonates had *Staphylococcus* colonization, mainly in the nostrils, umbilicus, and the skin surface. If medical personnel do not perform correct hand hygiene practice, then the spread of germs between patients can easily occur.¹⁰ Routine neonate bathing/cleaning has been reported to reduce hospital infection. In Neonatal Unit CM hospital, neonate bathing practices has not been routinely performed because the fear that it would lead to hypothermia and make the baby less stable. Research conducted by Tuke¹¹ in around 6000 neonates showed reduction of superficial infection in the eyes, skin, and umbilicus after routine bathing practice using chlorhexidine 0.4%. Another study conducted at two private hospitals in Sweden also reported a decrease in infection by cleaning the entire body of neonates using chlorhexidine 4% until the patient is discharged.¹² Clinical trials need to be performed on the benefits of regular bathing of neonates in Neonatal Unit CM hospital, including finding out the most effective and efficient antiseptic in reducing the BSI.

Research conducted together with the Department of Microbiology Faculty of Medicine Universitas Indonesia-CM hospital found similarity between the bacteria found in patient blood and the environment where the neonates were treated, using bacterial antibiogram results. For *Enterobacter asburiae*, in two patients the antibiogram similarity was found with the humidifier water of the incubator. *Pseudomonas aeruginosa* isolated from patient's blood, tracheal aspirate, and tap water filter also showed antibiogram similarities. *Enterobacter cloacae* were also found in both the patient's blood and fluid humidifier incubator. *Klebsiella oxytoca* was isolated from the patient's blood and the

plastic window of the incubator. Further research is needed involving molecular approach such as genotyping to confirm the presence of common bacterial strains.¹³

The reduction of BSI in this study was also followed by reduced mortality. Visible reduction seen in neonatal mortality from 18.5% to 7.3% ($p=0.05$) for birth weight group 1000-1499 g. Decline in neonatal mortality were also found in birth weight 1500-1999 g. Although there was a decrease from 8.5% to 7%, but it was not statistically significant ($p=0.810$). It was difficult to reduce mortality in the 1500-1999 g group to less than 7%. Many factors contributed to neonatal death, for example congenital abnormalities, presence of complications, referral of infants, the initial condition at birth. From the characteristics of the neonate original place of birth, neonatal mortality is more common in those who were born outside CM hospital.

The study by Gary et al.¹⁴ in a neonatal unit in Bangladesh showed that a simple, cost-effective, and simple technology for infection prevention and control strategies, has succeeded in reducing neonatal mortality. Prevention and infection control was done by hand washing, optimal waste management, asepsis before performing medical procedures, and policy settings in the use of antibiotics. However, the paper did not mention the proportion of statistical significance.

Gill et al.¹⁵ conducted an evaluation of prevention and infection control strategies in the form of interactive education to hospital staff and the hand hygiene program in neonatal units in the Philippines. The study stated that there was a significant reduction of neonatal mortality (12-15%). However, as a limitation of the study, it was not clear whether mortality was related to interventions outside the study.

From **Table 2** we can see that using BSC approach will reduce BSI also other parameters such as length of stay, hospitalization costs, and customer satisfaction. In the internal process perspective there was a remuneration strategy applied to all employees of Neonatal Unit CM hospital. This strategy had increased the cost for employee rewarding. The monthly cost was Rp 64,823,400.00 (details of the calculation not attached). Within one year, the expenses for

employee remuneration was Rp 777,880,800.00. Based on this analysis, it can be concluded that the total funds that can be saved annually after deducting the remuneration cost was Rp 1,823,239,588.62 - Rp 777,880,800.00, which equals Rp 1,045,358,788.62.

The BSC group had higher mean score of total customer satisfaction compared to non-BSC group ($p<0.0001$). This can occur due to a decreased number BSI, neonatal mortality, length of stay, and hospitalization costs.

CONCLUSION

The BSC can be used as an effective and efficient model for infection prevention and control. This approach may be applied for adult patients in Intensive Care Unit with a wide range of adjustment. Beside being able to lower the BSI, the BSC also managed to indirectly reduce neonatal mortality, length of stay, hospitalization costs, and improve customer satisfaction. The pattern of microorganism that caused BSI in the Neonatal Unit CM hospital was still dominated by *Gram-negative* bacteria. It is now seen that the microorganism are originating from hospital facilities.

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