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ORIGINAL ARTICLE

IMPACT OF HOSPITAL-ACQUIRED INFECTION ON THE COST AND DURATION OF HOSPITALIZATION IN THE NEONATAL INTENSIVE CARE UNIT

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ABSTRACT

OBJECTIVES: To determine the impact of hospital-acquired infections (HAI) on the cost and duration of hospitalization among neonatal intensive care unit (NICU) patients from a hospital-based perspective.
METHODS: A case control retrospective study was performed at the 15-bed/ crib NICU at PCMC from March 2008 to February 2009. Forty-four neonates who developed HAI while at the NICU were designated as "cases" matched to control subjects (1:1). Control subjects were matched to cases based on gestational age, final diagnosis and date of NICU admission. Eligible cases of HAI were identified retrospectively through the nosocomial infection logbook kept by the Infection Control Nurse. Data collection was done via review of the patient's medical record: gestational age, gender, diagnosis, underlying disease, appropriateness for age, surgical procedure, duration, urgency, classification of surgical intervention, therapeutic procedures prior to first HAI, antibiotic administration prior to diagnosis of first HAI, type of HAI. The length of hospital stay (duration of hospitalization), outcome of the patients and blood isolates of cases of HAI were likewise gathered from the hospital records of each patient. Cost data was obtained from the hospital database.
RESULTS: There was a higher mean cost of hospitalization for NICU patients with HAI Php 275,459 vs. Php 104,407 (USD 5,738 vs. USD 2,175). They also had a longer length of stay with a mean of 55.5 days vs. 29.3 days. In the analysis using multiple linear regression, the following factors: HAI grouping, length of stay and outcome (mortality) contributed significantly to increased cost.
CONCLUSION: HAIs were associated with increased cost and duration of hospitalization. These contribute significantly to economic burden to the patient and to hospital resources.

KEYWORDS:
hospital-acquired infections, NICU, neonatal intensive care unit, nosocomial infections

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INTRODUCTION

Healthcare costs have increased through the years. Hospital-acquired infections increase morbidity, mortality, and cost and length of stay far beyond what is expected based on the underlying disease state.[1,2,3] They generate substantial economic burdens not just to the patient but to the hospital resources as well. Economic evaluation has thus come to play an increasingly important role in healthcare. There are numerous studies in adult hospital-acquired infections or nosocomial infections. However, well-controlled studies on the cost of illness and length of stay of pediatric patients particularly in the neonatal intensive care unit with hospital-acquired infections are limited.

Healthcare decision-makers can be adequately informed using a substantial economic evaluation regarding the cost of illness and length of stay among neonatal intensive care unit patients with hospital-acquired infections. A comprehensive estimate of the cost of illness and length of stay can be determined using appropriate methods. Potential confounders would be taken into account and statistically analyzed. Using this information, specific areas/ aspects which can potentially decrease expenditure and increase savings can be identified. Resources can be allocated in a rational manner. Thus, healthcare decision-makers can formulate appropriate infection control programs which will benefit the hospital and the patient. Health outcomes will improve because excess morbidity and mortality risks are reduced. The objective of this study is to determine the impact of hospital-acquired infections on the cost and duration of hospitalization among neonatal intensive care unit patients from a hospital-based perspective.

METHODS

The study was done in the 15-bed/ crib Neonatal Intensive Care Unit at PCMC from March 2008 to February 2009. Those who developed HAI/ NI as determined by culture and/ or supporting clinical signs and symptoms while in the NICU was designated as "cases". Suspect HAI/ NI cases were not included. All cases were compared with 1:1 random sample of patients. Those who did not develop any HAI/ NI while in the NICU was designated as "control". Control subjects were matched to cases based on gestational age, final diagnosis and date of NICU admission (within 1-2 months from time of admission). If there were more than two potential control subjects, matching was based on the admission date nearest to that of the patient with HAI/ NI. Eligible subjects/cases of HAI/ NI were identified retrospectively through the Nosocomial Infection logbook/ record kept by the Infection Control Nurse.

Those who developed HAI/ NI as determined by culture and/ or supporting clinical signs and symptoms while in the NICU was designated as "cases". These cases of HAI/ NI were already deliberated upon during the bi-monthly meeting of the Infection Control Committee attended by the ICC head, ICC nurse, Pediatric Infectious Disease consultants and fellows using the preset definition for HAI/ NI (Appendix 1). Data collection was done via review of the patient's medical record. The following data were obtained: gestational age, gender, diagnosis, underlying disease or abnormality (infectious vs. non-infectious), administration of steroid (maternal), appropriateness for age (appropriate, large or small for gestational age), surgical procedure/ intervention (such as exploratory laparotomy, TEF ligation, others), duration of surgical procedure (less than or equal to 4 hours vs. more than 4 hours), urgency of surgical intervention (emergency vs. elective), classification of surgical intervention (clean, clean contaminated, contaminated, dirty), therapeutic procedures/ intervention prior to first HAI/NI (intravenous fluid therapy, peripheral venous cut-down, blood extraction, suctioning of secretions, nebulization, urinary bladder catheterization, lumbar puncture, NGT/ OGT insertion, parenteral nutrition, umbilical catheterization, ventricular tap, blood transfusion, endotracheal intubation, mechanical ventilation), antibiotic administration prior to diagnosis of first HAI/NI (one vs. two or more antibiotics), type of HAI/ NI (clinical sepsis, bloodstream infection, pneumonia, VAP, surgical site infection, soft tissue infection). The length of hospital stay was gathered from the hospital records of each patient. The outcome of NICU patients with HAI was obtained from the review of the patient's medical record. This refers to either survival or death of the patient. The blood isolates of cases of HAI in the NICU was acquired from the medical records and laboratory data.

Operational Definition of Terms and Variables

Operational definition of terms for the purpose of the study was derived from "A Hospital-wide Epidemiologic Study on Nosocomial Infections (NI) at the Philippine Children's Medical Center: 2003" done by Villanueva et.al.[4]

Main Outcome Measures

The length of hospital stay for each patient admitted was calculated. This refers to the overall length of hospital stay (duration of hospitalization). Cost data was obtained from the hospital database. The cost refers to the direct costs, not the indirect costs. They are represented as the sum of costs required to provide healthcare services and medications that directly relate to the patient's diagnosis and care. This is subdivided into (1) pharmacy and floor expense procedures (2) room and board (includes personnel costs) (3) laboratory & radiology expenses. Costs of patients with and without HAI/ NI was presented and controlled for the effect of confounders. Rates of cost was based on the 2008-2009 standard rates.

Statistical analysis

Statistical software used was EPI INFO ver.10 and MINI-TAB ver.14. Mean, standard deviation and frequency counts were used to describe data. To analyze data, chi-square was used to compare categorical variables. T-test and ANOVA 1-way were used to analyze continuous variables. Multiple linear regression was also used to determine factors affecting dependent variables (cost and length of stay). For all tests, a two-sided P value of < 0.05 is declared to be statistically significant.

RESULTS

From the nosocomial infection logbook/ record, there were a total of 49 HAI cases in the NICU from March 2008 to February 2009. However, five subjects were excluded because one had no chart, another was a medico-legal case, and three had no matched control. Only 1:1 matching of the cases and control was done. Thus, a total of 44 patients with HAI were matched to 44 control cases. It should be noted that out of the 44 cases of HAI, there were 30 subjects with a single incidence of HAI and seven subjects with two incidences of HAI. Majority of the patients with HAI were preterm 75% (n=33) and of male gender 55% (n=24). Subjects with HAI and those without HAI were essentially similar in their demographic and clinical profile (Table 1A and 1B).

Table 1A. Demographic profile of patients with and without hospital-acquired infection admitted at the neonatal intensive care unit.

	With HAI	Without HAI	P value
Gestational Age			
Preterm	33	32	1.00
Term	11	12	
Profile of Preterms			0.383
27-28	5	5	
29-30	8	8	
31-32	12	7	
33-34	2	7	
35-36	6	8	

Gender			1.00
Male	24	24	
Female	20	20	

For both groups, the most common diagnosis was sepsis, and the number of patients with this diagnosis was essentially similar in both groups. Nosocomial BSI candida was the next most common diagnosis in the HAI group. The number of patients with sepsis candida was significantly larger in the HAI group. The proportion of infectious cases in the HAI and non-HAI group was essentially similar. There was a higher number of non-infectious cases noted in the non-HAI group. In the therapeutic intervention/ procedures category, the following were significantly different for both groups: blood transfusion, endotracheal intubation, mechanical ventilation, nebulization, parenteral nutrition, peripheral venous cutdown, umbilical catheterization and urinary bladder catheterization. There were more therapeutic procedures done in the HAI group than in the non-HAI group. All of the HAI patients received two or more antibiotics prior to the diagnosis of HAI.

Table 1B. Clinical Profile of patients with and without hospital-acquired infection

	With HAI N=44	W/O HAI N=44	P value
Diagnosis			
Sepsis	26	23	0.519
Nosocomial BSI candida	21	N/A	----
Neonatal Pneumonia	18	14	0.375
RDS	9	12	0.453
Septic shock	7	2	0.157
Sepsis candida	6	0	*0.026*
Nosocomial sepsis	6	N/A	-----
PDA	5	2	0.433
NEC	5	1	0.202
Gastrochisis	5	4	1.00
Hyperbilirubinemia	5	5	1.00
Others	70	38	0.096
Underlying disease/abnormality			
Infectious	42	42	1.00
Non-infectious	41	14	*0.0001*
Appropriateness for Age			0.290
AGA	33	37	
SGA	11	7	
LGA	0	0	
Surgical Intervention			
Exploratory laparotomy	8	4	0.214
Chest tube insertion	7	4	0.333
Ileostomy	5	3	0.713
Percutaneous peritoneal drainage	5	0	0.055
Transfer bag placement	5	3	0.713
Thoracotomy with repair of T-E fistula	4	4	1.00
Needling of pneumothorax	4	2	0.676
Fascial closure	3	2	1.00
Others	18/704	17/704	1.00
Urgency of surgical intervention			0.588
Emergency	11	9	
Elective	9	5	
Classification of surgical intervention			0.254
Clean	3	0	
Clean/contaminated	11	7	
Contaminated	5	4	
Dirty	1	3	
Therapeutic procedures/ Intervention (for HAI/NI cases, prior to diagnosis)			
Blood extraction	44	44	1.00
Blood transfusion	43	31	*0.005*
Broncoscopy/ Esophagoscopy	2	0	0.494
Endotracheal intubation	40	30	*0.008*
Intravenous fluid therapy	44	44	1.00
Lumbar puncture	5	2	0.433
Mechanical ventilation	40	28	*0.002*
NGT/ OGT insertion	44	43	1.00
Nebulization	28	16	*0.010*
Parenteral nutrition	39	26	*0.002*
Peripheral venous cutdown	37	20	*0.0001*
Suctioning of secretions	44	41	0.241
Umbilical catheterization	28	9	*0.00004*
Urinary bladder catheterization	13	7	*0.025*

Majority of NICU patients with HAI had bloodstream infection 63.64%.

Table 2. Types of HAI in NICU patients.

Types of HAI/ NI	**Number**	**Relative Frequency (%)**
Bloodstream infection	28	63.64
Clinical Sepsis	5	11.36
Pneumonia	4	9.09
Surgical Site Infection	4	9.09
VAP	2	4.55
Soft Tissue Infection	1	2.27
Total	44	

The difference in outcome (mortality vs. survival) between subjects with HAI and those without HAI was highly significant. With an odds ratio of 11.9, a patient with HAI is 12x more likely to die than for a patient without HAI.

Table 3. Outcome of NICU patients with and without HAI.

	With HAI	Without HAI	P value
Died	20	3	0.00004 OR = 11.9 (2.77-54.15)
Survived	24	41	

Cost of Hospitalization

There was a higher mean cost of hospitalization for NICU patients with HAI Php 275,459 (USD 5,738) vs. Php 104,407 without HAI (USD 2,175). The cost of hospitalization is twice more expensive for NICU patients with HAI than those without.

The hospitalization costs is subdivided into (1) pharmacy and floor expense procedures (2) room and board (includes personnel costs) (3) laboratory & radiology expenses. For both groups of NICU patients (with and without HAI), the pharmacy and floor expense procedures incurred the majority of hospitalization cost.

Table 4. Direct hospitalization cost (in PhP) of NICU patients with and without HAI.

	With HAI	Without HAI	P value
Mean	275,459 (USD 5,738)	104,407 (USD 2,175)	*0.0000*
SD	207,362	96,222	
Range	39,874 to 783,920	7,205 to 417,469	
95% CI for µC1-µC2	102, 117 to 239, 988		

Table 5. Breakdown of Hospitalization Cost (Php) of NICU patients with HAI & without HAI

Hospitalization Cost	With HAI	Without HAI
pharmacy and floor expense procedures	8,161,657 (USD 170,034)	2,704,905 (USD 56,352)
room and board	2,148,883 (USD 44,768)	1,031,445 (USD 21,488)
laboratory & radiology expenses	1,809,678 (USD 37,701)	858,339 (USD 17,882)
Total hospitalization cost	12,120,218 (USD 252,504)	4,594,689 (USD 95,722)

The direct hospitalization cost of NICU patients among the different types of HAI was not significantly different.

Table 6. Direct hospitalization cost (in Php) of NICU patients, by type of HAI.

	Bloodstream infection N=28	Clinical Sepsis N=5	Pneumonia N=4	Surgical site infection N=4	VAP + soft tissue infection N=3	P value
Mean	239,360 (USD 4,986)	407,976 (USD 8,499)	198,216 (USD 4,129)	319,573 (USD 6,657)	435,699 (USD 9,077)	0.250
SD	205,000	280,224	127,961	173,528	117,805	
Range	39,874 to 783,9201	75,606 to 783,920	102,129 to 382,102	190,631 to 478,305	302,519 to 526,274	

In comparing the direct hospitalization cost with the outcome (mortality vs. survival), those who died incurred more hospitalization cost.

Table 7. Direct hospitalization cost (in PhP) of NICU patients, by outcome.

	Died	Survived	P value
Mean	317,084 (USD 6,605)	144,941 (USD 3,019)	*0.0000*
SD	251,135	124,990	
Range	39,874 to 783,920	7,205 to 526,274	

Length of stay

NICU patients with HAI had a longer length of stay than those without, with a mean of 55.5 days vs. 29.3 days.

Table 8. Length of stay of NICU patients with and without HAI.

	With HAI	Without HAI	P value
Mean (days)	55.5	29.3	*0.0007*
SD	45.1	18.2	
Range (days)	7 to 307	1 to 81	

The length of stay among the different types of HAI was not significantly different.

Table 9. Length of stay, by type of hospital-acquired infection at the NICU.

	Clinical Sepsis N=5	Bloodstream infection N=28	Pneumonia N=4	VAP + soft tissue infection N=3	Surgical site infection N=4	P
Mean (days)	58.0	54.56	64.50	57.0	46.50	0.98
SD	27.78	57.16	15.07	13.23	25.90	
Range	29-89	7-307	50-78	42-67	16-69	

With regards to the outcome (mortality vs. survival) compared to the length of stay, they were also not significantly different.

Table 10. Length of stay, by outcome.

	Died	survived	P value
Mean (days)	47.0	63.0	0.65
SD	40.8	21.3	
Range (days)	1-307	8-88	

Among the blood isolates of patients with HAI, majority of the organisms were *Candida sp.* 58.7%.

Table 11. Blood Isolates of cases of HAI in the NICU.

Organism Isolated	Number	Relative frequency (%)
Candida sp.	**17**	**58.7**
Candida albicans	5	17.3
Coagulase negative staphylococcus(CONS)	2	6.9
Klebsiella pneumonia	2	6.9
Pseudomonas aeruginosa	1	3.4
Serratia marcescens	1	3.4
Acinetobacter lwolffi	1	3.4
Total	29	100

Linear regression

In the multiple linear regression with cost of hospitalization as the dependent variable, the following independent variables contribute significantly to increased cost: HAI grouping, length of stay and outcome (mortality). HAI grouping contributed significantly to increased cost. The longer length of stay leads to higher cost of hospitalization. Those who died also incurred a higher cost of hospitalization. R-Sq = 53.6% and R-Sq (adj) = 39.7% (Table 11). With length of stay as the dependent variable, the following independent variables are associated with longer LOS: HAI grouping, UB catheterization and cost. R-Sq = 37.7% and R-Sq (adj) = 19.1%. The higher the R-Sq (adj), the better is the accounting of factors affecting the dependent variable.

DISCUSSION

In 2005, a retrospective study done in Taiwan by Chen et. al. on the impact of nosocomial infection on cost of illness and length of stay in the ICU among adult patients (after covariates were adjusted for in the multiple linear regression) showed that nosocomial infection increased the total costs by USD 3,306 per patient and increased the length of stay by 18.2 days.[1] Studies reviewed showed that patients with HAI had significantly longer length of stay, higher unadjusted total mortality rate and hospital cost compared with uninfected patients (Warren, 2006).[5] A prospective cohort study on the effect of hospital-acquired infection on length of hospital stay and cost among adult patients in Australia done by Graves, et.al. in 2007 noted that existing literature may overstate the costs of HAI because of bias, such that they concluded that accurate estimates of the costs of hospital-acquired infection should be made and used in appropriately designed-analytic economic models that will make valid predictions of the economic value of increased infection control.[6]

Table 12. Cost of hospitalization - dependent variable.

Predictor	Std. Dev.	P
Constant	116861	0.000
Grp	52250	0.001
Length of stay	505.6	0.029
Sepsis Candida	68044	0.083
Septic Shock	61063	0.101
Non-infectious	51418	0.290
Percutaneous peritoneal drainage	75584	0.878
Blood transfusion	66603	0.764
Endoracheal intubation	130989	0.061
Mechanical ventilation	123814	0.083
Nebulization	37940	0.394
Umbilical catheterization	44031	0.410
Urinary bladder catheterization	44034	0.942
Parenteral nutrition	53844	0.390
Peripheral venous cutdown	44904	0.289
Gestational age	48243	0.454
Appropriate for gestational age	43713	0.855
Emergency Surgery	58684	0.137
Outcome	49187	0.001
Duration of Surgery	68004	0.323
Contaminated	39296	0.164

R-Sq = 53.6% R-Sq(adj) = 39.7%

In 1995 Gray et.al. made appropriately designed cohort studies of coagulase-negative staphylococcal bacteremia in newborn ICU's. They found increased length of stay (14 days longer), increased use of antibiotics, and increased hospital charges (USD 25,000) but no increased rate of mortality.[7] In 1997, a study done by Leroyer et.al. in France found that infants in a neonatal ICU who suffered a nosocomial infection were hospitalized 5 days longer than matched, uninfected controls and that the hospital costs were USD 10,000 higher for infected infants.[8] Studies done on pediatric patients also showed that costs and LOS associated with nosocomial bloodstream infection (BSI) in patients admitted to the PICU were significantly higher than controls (Slonin, 2001).[2]

Table 13. Length of stay as the dependent variable

Predictor	Std. Dev.	P
Constant	32.09	0.001
Grp	12.62	0.013
Sepsis Candida	16.02	0.195
Septic Shock	14.52	0.750
Non-infectious	12.07	0.625
Percutaneous peritoneal drainage	17.58	0.583
Blood transfusion	15.54	0.977
Endotracheal intubation	31.14	0.332
Mechanical ventilation	29.30	0.312
Nebulization	8.840	0.369
Umbilical catheterization	10.31	0.781
Urinary bladder catheterization	9.963	0.046
Parenteral nutrition	12.61	0.729
Peripheral venous cutdown	10.47	0.283
Cost	0.00002748	0.029
Gestational age	11.21	0.326
Appropriate for Gestational Age	10.05	0.177
Emergency Surgery	13.86	0.478
Outcome	12.36	0.342
Duration of Surgery	15.97	0.988
Cont aminated	9.294	0.876

R-Sq = 37.7% R-Sq(adj) = 19.1%

R-Sq – refers to the amount of variation that the variables account for
R-Sq (adj) – refers to the adjustment for the significant variables included

In a study done by Elward et.al. published in the Journal of Pediatrics in 2005, they found that the direct cost of PICU admission attributable to nosocomial primary BSI was USD 39,219.[9] Concurrent with this, in a study by Payne in 2004 on the marginal increase in cost and excess length of stay associated with nosocomial bloodstream infections in surviving very low birth weight infants, showed that nosocomial infections are associated with increased hospital treatment costs and LOS but by varying amounts depending on the birth weight.[10] In 1999, Sachdeva in his study on the cost of nosocomial infections in the intensive care unit underscored an important fact. To attribute a consequence to nosocomial infection, investigators must match infected and non-infected patients carefully by using criteria such as age, sex, presence of underlying conditions, severity of illness, operative procedures and length of stay, or they must adjust for these potential confounders by using multivariate statistical analysis.[11] In the local setting, a hospital-wide epidemiologic study on nosocomial infections at Philippine Children's Medical Center done by Villanueva et.al. in 2003 showed a cumulative incidence rate of 3.9% or 6.2 cases/1000 patient-days. The neonatal ward (13.1%) and the neonatal intensive care unit (10.6%) had the highest infection rate. After logistic regression analysis, the three variables that appear to have the greatest association with the acquisition of nosocomial infections were: presence of an intravenous line, prolonged hospital stay and stunting. The average number of hospital days for those with nosocomial infections was 44.2 days compared to the controls, 8.7 days. The average estimate cost of hospitalization of the controls was Php 14,988.52 while that of the cases was Php 82,605.03.[4] A study by Logronio-Reyes et.al. in 2001 on the factors associated with nosocomial infections in the NICU in PCMC and its containment showed that medical interventions such as mechanical ventilation, peripheral and umbilical vein catheterization, amino acid and lipid transfusion, pRBC and FFP transfusion, use of antibiotics particularly Ceftazidime and Imipenem, and maternal infection are the risk factors for neonatal nosocomial infections. Gram-negative bacteria such as *Burkholderia, Klebsiella, Pseudomonas*, and *Candida* accounted for many of the organisms.[12] In 2000 a study by Rogacion et.al. at the Philippine General Hospital showed that the cost of nosocomial infection at the pediatric wards were considerable from the points of view of the patient and the hospital. A total of Php 7.1 million were spent for 245 nosocomial infection episodes with Php 3.8 million as patient costs and Php 3.3 million as hospital costs, resulting in a cost of Php 49,000 per patient. Important costs contributing to the total NI cost were the maintenance and operating expenses of the hospital; cost of management and the indirect cost of time lost from work, both shouldered by the patients. [13]

For the past ten years, the incidence rate of nosocomial infections at PCMC ranged from 2%-5%, of which the majority of cases can be found in the neonatal ICU and pediatric ICU.[4] This study focused on the impact of nosocomial infections or hospital-acquired infections on cost of illness and length of stay (duration of hospitalization) in the NICU. It was found that HAIs were associated with increased cost and duration of hospitalization. There is a higher mean cost of hospitalization for NICU patients with HAI Php275,459 (USD 5,738) vs. Php 104,407 without HAI (USD 2,175). The cost of hospitalization is 2x more expensive for NICU patients with HAI than those without. The pharmacy and floor expense procedures incurred the majority of hospitalization cost (HAI > non-HAI) which may be attributed to increased use of antibiotics in the HAI group. This finding is similar to the study done by Gray et.al.[7] NICU patients with HAI had a longer length of stay than those without, with a mean of 55.5 days vs. 29.3 days. This study supports the findings of published reports in pediatric and adult age group that patients who had nosocomial infections in the ICU incurred enormous excess cost and increased length of stay. Studies using a matched control technique estimated that the costs of HAIs are higher than the costs for patients in the control group, ranging from USD 10,000 – USD 83,544 (Php 480,000 - Php 4,010,112) and increased LOS 8 -18 days.[1-11,15] The wide range may be due to differences in methods, population and severity of illness. However, the use of a matched case-control technique is susceptible to biases and overestimation of costs. In this study, rigorous criteria were used in matching cases. Statistical regression analysis was used to control for other confounders. As was highlighted in the study of Graves et.al, the use of statistical regression analysis can avoid selection bias completely and will address bias from omitted variables.[6] Severity of illness is also a significant potential confounder. In our study, matched control patients were chosen as close as possible to the eligible cases of NI based on gestational age, final diagnosis and date of NICU admission. A study by Haley et.al. stated that the matching on admitting diagnosis and the number of discharge diagnoses has been shown to be an adequate measure of the severity of illness.[16] In the multiple linear regression analysis, it was found that the following independent variables contribute significantly to increased cost: HAI grouping, length of stay and outcome (mortality). HAI grouping contributes significantly to increased cost. The longer length of stay/ duration of hospitalization lead to a higher cost of hospitalization. Those who died also incurred a higher cost of hospitalization. In this study, it was found that the direct hospitalization cost and length of stay of NICU patients among the different types of HAI was not significantly different. The difference in outcome (mortality vs. survival) between subjects with HAI and those without HAI was highly significant. A patient with HAI is 12x more likely to die than for a patient without HAI. This finding is in contrast to the study of DiGiovine in adut ICU patients, wherein they did not detect an association between primary nosocomial bloodstream infections and increased ICU mortality.[3] Data in this study is comparable to that done by Richards et.al. wherein the BSI's cover a vast majority of the site/ type of nosocomial infections in the pediatric ICU. Moreover even the commonly reported pathogens in the pediatric and neonatal ICU are comparable, which included CONS, fungi (*Candida sp.*) and gram-negative bacilli.[17] This could be explained by the fact that neonates especially the preterms belong to the immunocompromised group such that they are at risk for these infections.

CONCLUSION AND RECOMMENDATION

We found that HAIs were associated with increased cost of hospitalization and length of stay. These increases in the cost of hospitalization and length of stay contribute significantly to economic burden to the patient and to hospital resources. Thus, these underscore the need for appropriately-designed and cost-effective infection control measures. Our results provide costs from the hospital perspective to help make important decisions in implementing infection control measures. Further studies involving hospital-wide areas and multicenter studies are also recommended.

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