

Effect of an Intervention Training Program on Hospital Acquired Infection Rates in Intensive Care Units of Governmental Hospitals in Egypt

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Abstract

Introduction: Hospital acquired infection (HAI) is an infection acquired in health care facility by a patient who was admitted for a reason other than that infection, this infection is not present or incubating at admission. HAIs are among the leading causes of death and they cause significant morbidity among patients who receive health care. **Objective:** To implement an intervention program in the form of training of health care workers in the selected hospitals on infection control standard precautions including the preventive bundles. **Methods:** This intervention study was carried out over 13 months in 4 MOH hospitals comprising 11 ICUs. All hospitalized ICU patients were followed up starting from the date of their ICU admission till occurrence of one or more HAI. All age groups were included in the study. Case definitions of HAIs included in the study were based on CDC/NHSN Surveillance Case Definitions. The complete medical records for Neonatal ICUs were 482 patients, for medical ICUs were 590 patients and for medical / surgical ICUs were 1088 patients. **Results:** The overall patient infection rate, overall patient day rate, hospital acquired pneumonia rate, urinary tract infection rate and blood stream infection rate, all declined significantly after the intervention than that before the intervention. **Conclusions:** Implementation of the intervention in the form of training course to the health care workers on the recommended infection control standard precautions, including the preventive bundles resulted in significant reduction in HAI rates after the intervention than before the intervention.

Keywords: Infection control, Standard precautions, Surveillance, Intervention.

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Introduction

Nosocomial infection is an infection acquired in health care facility by a patient who was admitted for a reason other than that infection, this infection is not present or incubating at admission. Infection occurring more than 48 hours after admission is usually considered nosocomial infection¹.

Studies throughout the world documented that health care associated infections are among the leading causes of death and they cause significant morbidity among patients who receive health care².

A prevalence survey conducted under the auspices of WHO in 55 hospitals of 14 countries representing 4 WHO Regions (Europe, Eastern Mediterranean, South-East Asia and Western Pacific) showed an average of 8.7% of hospital patients had nosocomial infections. At any time, over 1.4 million people worldwide suffer from infectious complications acquired in hospital. The highest frequencies of nosocomial infections were reported from hospitals in the Eastern Mediterranean and South-East Asia Regions (11.8 and 10.0%

respectively), with a prevalence of 7.7 and 9.0% respectively in the European and Western Pacific Regions. The study had shown also that the highest prevalence of nosocomial infections occurs in intensive care units. Infection rates are higher among patients with increased susceptibility because of old age, underlying disease, or immunosuppression¹.

In the USA, the most frequent type of infection hospital wide is urinary tract infection (36%), followed by surgical site infection (20%), and bloodstream infection and pneumonia (both 11%)³.

Healthcare-associated infections are serious, common, and important patient safety issues in health care today. Infection prevention is a cornerstone of continuous quality improvement⁴.

In the USA, an educational intervention study was conducted in eight private long-term care facilities and showed a decrease in the incidence density rate from 6.33 to 4.15 per 1000 patient days⁵.

In Lithuania, a multimodal intervention study (including education of the staff and implementation of evidence-based infection control measures) was conducted in 3 pediatric ICUs showed a decreased in the incidence density from 19.1 per 1000 patient days before the intervention to 10.4 per 1000 patient days after the intervention⁶.

An educational intervention study was conducted in Madinah, KSA hospitals and showed a reduction in the incidence rate of HAIs from 5.5% to 4% after the conduction of seminars directed to health care staff⁷.

Objectives of the study: To measure the incidence rates of health care associated infections within intensive care units of some Ministry of Health and Population hospitals in Egypt and to implement an intervention program in the form of training of health care workers in the selected hospitals on infection control standard precautions and to evaluate the intervention training program by comparing incidence

rates of health care associated infections in the selected hospitals before and after conducting the program.

Subjects and methods

This intervention study was carried out over 13 months to measure the healthcare associated infection rates before and after training of health care workers on infection control standard precautions in intensive care units (ICUs).

The study was conducted in 4 MOH hospitals including 2 general hospitals and 2 specialized medical hospitals (also called international hospitals) comprising 11 ICUs that were chosen by the MOH to implement a laboratory based surveillance system for hospital acquired infections within these ICUs.

All hospitalized ICU patients were followed up starting from the date of their ICU admission till occurrence of one or more HAI. All age groups were included. Case definitions of HAIs included in the study were based on CDC/NHSN Surveillance Case Definitions of Healthcare-Associated Infection and Criteria for Specific Types of Infections in the Acute Care Setting⁽⁸⁾ were used to define each type of the following infections: Urinary tract infection (UTI), blood stream infection (BSI) and hospital acquired pneumonia (HAP).

Sample size

Using the Power and Sample Size Calculations Program, the sample size was calculated as follows:

1. For NICUs: Sample size was calculated assuming an overall infection rate of 25% before the intervention and 15 % after the intervention, using power of the study=80% and alpha level=0.05, a sample of 250 patient was required before the intervention and 250 required after the intervention, given a total sample of 500 patients in the NICUs. In this study the complete medical records were 482 patients, which represent 96.4% of the calculated sample size in the NICUs.

2. For medical ICUs: Sample size was calculated assuming an overall infection rate 30% before the intervention and 20 % after the intervention, using power of the study=80% and alpha level=0.05, a sample of 293 patient was required before the intervention and 293 required after the intervention given a total sample of 586 patients in the MICUs. In this study the complete medical records were 590 patients, which exceed the calculated sample size in the MICUs.

3. For medical/surgical ICUs: Sample size was calculated assuming an overall infection rate 24% before the intervention and 17 % after the intervention, using power of the study=80% and alpha level=0.05, a sample of 548 pt. was required before the intervention and 548 required after the intervention given a total sample of 1096 patients in the M/SICUs. The complete medical records were 1088 patients, representing 99.3% of the calculated sample size in the M/SICUs.

Study phases:

Orientation was done to the local infection control teams within the study hospitals, ICUs link nurses and the attending physicians. This orientation included overview of the intervention, methods of data collection, use of the Personal Digital Assistant (PDA) and CDC/NHSN Surveillance Case Definitions.

Implementation of the study was done in three phases (pre intervention phase, intervention phase and post intervention phase) as follows:

- **Phase one (pre intervention):**

Data collection and calculation of incidence rates of HAIs was done for a period of six months before the intervention which included follow up of 994 patients (all admitted patients) in the studied ICUs prospectively during their stay, starting from the date of their ICU admission till occurrence of one or more HAI.

- **Phase two (intervention):**

The intervention was done for one month in the form of training course to the health care

workers in the study ICUs on the infection control standard precautions, including the preventive bundles for UTI, BSI and pneumonia.

This training was in the form of theoretical training with working groups followed by on job training.

- **Phase three (post intervention):**

Recollection of data and calculation of HAI rates was done for another six months following the intervention which included follow up of 1166 patients (all admitted patients) in the studied ICUs prospectively during their stay, starting from the date of their ICU admission till occurrence of one or more HAI.

Comparison between pre and post intervention results was done

Data collection methods and tools:

The surveillance officers (Link nurses) were responsible for entering the data using the Personal Digital Assistant (PDA).

Personal Digital Assistant (PDA) is a small mobile hand-held device (a smart phone like device) that provides computing and information storage, with organized software that acts as an information manager (9).

Denominator data was presented in two denominator sheet forms (one for the adult ICUs and one for the neonatal ICUs) to collect daily data about: total number of patients, number of patients with a central line, number of patients with a urinary catheter and number of patients on a ventilator, in each ICU.

Data management and analysis plan:

- To calculate the incidence rates of the NIs, monthly census data was collected from each ICU to calculate the numerator and denominator data as follows:

Numerator data: Total no. of HAIs, device associated infections (DAIs), UTIs, Catheter associated urinary tract infections (CAUTIs), BSIs, central line associated blood stream infections (CLABSIs), HAPs and ventilator associated pneumonias (VAPs).

Denominator data: Total no. of patients admitted in the ICU, patient days, urinary

catheter days, ventilator days, and central venous line days.

To assess and compare the risk of HAIs in the different ICUs, the device utilization ratio (DUR) were calculated.

The collected data were revised, coded, tabulated and analyzed by using statistical package for social science (SPSS 16 for windows; SPSS Inc, Chicago, IL, 2007) and epi info 7 soft ware, CDC.

Results

Table (1) showed that: the overall patient infection rate (PIR) in the 11 selected ICUs declines significantly from 29.87% before the intervention to 16.29% after the intervention, also, the overall patient day rate (PDR) declined significantly after the intervention than before (29.59 and 19.07 / 1000 pt. days respectively). Similarly, the HAP rate (12.56 and 8.23 / 1000 pt. days respectively), the UTI rate (7.28 and 4.62 / 1000 pt. days respectively) and the BSI rate (9.77 and 6.22 / 1000 pt. days respectively), declined significantly after the intervention than before.

Table (2) showed that: the Device associated infection (DAI) rate in the 11 selected ICUs declined significantly from 21.13 before the intervention to 11.74 / 1000 pt. days after the intervention. Similarly, the VAP rate (24.8 and 17.68 / 1000 ventilator days respectively), the CAUTI rate (13.05 and 9.19 / 1000 urinary catheter days respectively) and the CLABSI rate (15.64 and 8.87 / 1000 central line days respectively) declined significantly after the intervention than that before the intervention. At the same time, the device utilization ratio (DUR) and the mean length of stay (LOS), declined significantly after the intervention than before.

Table (3) showed that: the overall PIR in the medical ICUs declined significantly from 29.81% before the intervention to 16.31% after the intervention, also, the overall PDR declined significantly after the intervention than that before the

intervention (from 35.81 to 23.08 / 1000 pt. days). But, the HAP rate (16.77 and 10.89 / 1000 pt. days respectively), the UTI rate (9.07 and 5.23 / 1000 pt. days respectively) and the BSI rate (9.97 and 6.97 / 1000 pt. days respectively), declined but not significantly after the intervention than before.

Table (4) showed that: the overall DAI rate in the MICUs declined significantly from 26.29 before the intervention to 15.24 / 1000 pt. days after the intervention. But the VAP rate (30.94 and 23.33 / 1000 vent. days respectively), the CAUTI rate (12.6 and 8.23 / 1000 catheter days respectively) and the CLABSI rate (19.09 and 12.82 / 1000 central line days respectively) did not decline significantly after the intervention than that before the intervention. At the same time, the DUR and the mean LOS, declined significantly after the intervention than that before the intervention.

Table (5) showed that: The overall PIR in the medical / surgical ICUs declined significantly from 30.48% before the intervention to 16.55% after the intervention, also, the overall PDR declined significantly after the intervention than that before the intervention (from 33.98 to 21.86 / 1000 pt. days).The HAP rate (13.99 and 9.01 / 1000 pt. days respectively) and the UTI rate (11.77 and 7.66 / 1000 pt. days respectively) declined significantly after the intervention than that before the intervention, but the BSI rate (8.21 and 5.18 / 1000 pt. days respectively) did not decline significantly after the intervention than that before the intervention.

Table (6) showed that: the overall DAI rate in the M/SICUs declined significantly from 27.76 before the intervention to 15.55 / 1000 pt. days after the intervention. But, the VAP rate (29.89 and 19.72 / 1000 vent. days respectively), the CAUTI rate (13.23 and 9.59 / 1000 catheter days respectively) and the CLABSI rate (10.74 and 6.11 / 1000 central line days respectively) did not decline significantly after the intervention than that before the intervention. At the

same time, the DUR and the mean LOS, declined significantly after the intervention than that before the intervention.

Table (7) showed that: the overall PIR in the neonatal ICUs declined significantly from 28.63% before the intervention to 15.68% after the intervention, also, the overall PDR declined significantly after the intervention than that before the intervention (from 19.55 to 12.39 / 1000 pt. days) and the BSI rate declined significantly from 11.73 before the intervention to 7.12 / 1000 pt. days after the intervention. But, the HAP rate did not decline significantly after the intervention than that before the intervention (7.82 and 5.27 / 1000 pt. days respectively).

Table (8) showed that: the overall DAI rate in NICUs declined significantly from 8.72 before the intervention to 4.03 / 1000 pt. days after the intervention. But, the VAP rate (14.27 and 10.69 / 1000 vent. days respectively) and the CLABSI rate (47.62 and 19.51 / 1000 central line days respectively) declined but not significantly after the intervention than before. At the same time, the DUR and the mean LOS, declined significantly after the intervention than that before the intervention.

Discussion:

The current study showed that the overall patient infection rate in the 11 selected ICUs, decreased from 29.87% before the intervention to 16.29% after the intervention, showing a highly significant difference and these rates were higher than that estimated in an educational intervention study conducted in Madinah, KSA hospitals which showed a reduction in the incidence rate of HAIs from 5.5% to 4% after the conduction of seminars directed to health care staff⁷. Similarly, the present study, also showed that, the overall patient day rate decreased from 29.59 per 1000 patient days before the intervention to 19.07 per 1000 pt. days after the intervention, showing a highly significant difference and these rates were also higher than that

estimated from an educational intervention study conducted in eight private long-term care facilities at the USA which showed a decrease in the incidence density from 6.33 to 4.15⁵ and this difference may return to the type of facilities, being private.

The present study, showed that, the VAP rate decreased from 24.8 per 1000 ventilator days before the intervention to 17.68 per 1000 ventilator days after the intervention, showing a significant difference and it was proven that most episodes of nosocomial pneumonia occur in patients undergoing mechanical ventilation (MV)¹⁰, however, the pre and post intervention rates in our study were higher than that estimated in Saudi Arabia, through the intervention study conducted in adult ICUs of a private general hospital by implementation of VAP prevention bundle and the study showed a significant reduction in VAP rate from a mean of 9.3 cases per 1000 vent. days before the intervention to 2.2 cases per 1000 vent. days after⁽¹¹⁾. At the same time, the pre-intervention VAP rate in our study agreed with that estimated in Canada in the intervention study conducted by implementation of VAP prevention protocol in the ICU of Montreal General Hospital and the study showed a reduction in the VAP rate from 25 cases/ per 1000 vent. days before the intervention to 22.3 cases per 1000 ventilator days after implementation of VAP prevention bundle¹², However, the pre-intervention VAP infection rate in our study was less than that estimated in Cuba in the prospective active before and after surveillance study conducted to evaluate the impact of the International Nosocomial Infection Control Consortium (INICC) multidimensional approach on the reduction of ventilator-associated pneumonia (VAP) in adult ICU in an INICC member hospital in Havana, Cuba and the study showed a significant reduction in the VAP rate from 52.63 per 1,000 ventilator-days before the intervention to 15.32 per 1,000 vent. days after¹³.

The current study, showed that, the CAUTI rate decreased from 13.05 per 1000 urinary catheter-days before the intervention to 9.19 per 1000 urinary catheter-days after the intervention, showing a significant difference, and it was noticed that, the pre-intervention CAUTI infection rate in our study was less than that estimated in another intervention study done in Egypt in an intensive care unit (ICU) in a rural hospital through implementation of CAUTI prevention bundle and the study showed a reduction in the CAUTI infection rate from 90.12 per 1000 catheter days before the intervention to 65.69 per 1000 catheter days after the intervention¹⁴, however, the pre-intervention CAUTI rate in our study agreed with that estimated in Lebanon in a before & after prospective active surveillance study conducted in an adult intensive care unit through implementation of a multidimensional approach including a bundle of infection control interventions and education and the study showed a significant decrease in the rate of CAUTIs by 83% from 13.07 per 1000 urinary catheter-days before the intervention to 2.21 per 1000 urinary catheter-days after the intervention¹⁵.

The present study, showed that, the CLABSI rate decreased from 15.64 per 1000 central line days before the intervention to 8.87 per 1000 central line days after, showing a significant difference, but it was noticed that the pre-intervention rate of CLABSI in the current study was higher than that estimated in the USA in the intervention study conducted in 108 ICUs in Michigan by implementation of CLABSI prevention bundle and the study showed a significant decrease in the CLABSI rate from 7.7 per 1000 catheter-days before the intervention to 1.4 per 1000 cath. days after⁽¹⁶⁾, similarly, the pre-intervention rate of CLABSI in our study was also higher than that estimated in the educational intervention study conducted in Spain and the study showed a decrease in the CABSI rate from 6.7 per 1000 cath. days to 3.7 per

1000 catheter-days after the implementation of the educational program¹⁷.

Conclusions:

Utilization of medical instruments as ventilator, urinary catheter and central line in the intensive care units showed increased burden on the patients resulting in increased risk of acquiring infection and increasing the mean length of stay.

Implementation of the intervention in the form of training course to the health care workers in the study ICUs on the recommended infection control standard precautions, including the preventive bundles for each of UTI, BSI and pneumonia resulted in significant reduction in the HAI rates after the intervention than before.

Recommendations:

Implementation of surveillance program on health care associated infections should be done in all Egyptians hospitals to have strong data of health care associated infections in each hospital upon which strong actions can be taken.

Use of medical instruments as ventilators, urinary catheters and central lines should be done only when indicated and removed as soon as its indication is not present to decrease risk of acquiring health care associated infections to ICU patients.

There must be a strong monitoring & supervision system at the MOH central level to assess the implementation of infection control and surveillance programs in all governmental hospitals, to have strong data that can be compared to that of CDC and other countries data on regular basis and put future plans for improvement.

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Table (1): Overall Patient infection rate (PIR), overall patient day rate (PDR) and PDR by site of infection in the 11 selected ICUs, before and after the intervention.

		Before	After	Z (P)
Overall PIR	Total no. of HAIs	297	190	6.627 (0.00)
	Total no. of patients	994	1166	
	Incidence rate (%) (95% CI)	29.87 (26.58 - 33.48)	16.29 (14.06 - 18.78)	
Overall PDR	Total no. of HAIs	297	190	4.77 (0.00)
	Total no. of patient days	10034	9963	
	Incidence density (%) (95% CI)	29.59 (26.33 - 33.16)	19.07 (16.46 - 21.98)	
HAP rate	Total no. of pneumonias	126	82	3 (0.003)
	Total no. of patient days	10034	9963	
	Incidence density (%) (95% CI)	12.56 (10.46 - 14.95)	8.23 (6.546 - 10.22)	
UTI rate	Total no. of UTIs	73	46	2.436 (0.015)
	Total no. of patient days	10034	9963	
	Incidence density (%) (95% CI)	7.28 (5.703 - 9.148)	4.62 (3.38 - 6.159)	
BSI rate	Total no. of BSIs	98	62	2.801 (0.005)
	Total no. of patient days	10034	9963	
	Incidence density (%) (95% CI)	9.77 (7.929 - 11.9)	6.22 (4.771 - 7.978)	

Table (2): Overall device associated infection (DAI) rate, DAI rate by site of infection, device utilization ratio (DUR) and mean length of stay (LOS) in the 11 selected ICUs, before and after the intervention.

		Before	After	Z (P)
Overall DAI rate	Total no. of DAIs	212	117	5.173 (0.00)
	Total no. of patient days	10034	9963	
	Incidence density (%) (95% CI)	21.13 (18.38 - 24.17)	11.74 (9.712 - 14.07)	
VAP rate	Total no. of VAPs	87	47	1.88 (0.043)
	Total no. of Vent. Days	3508	2659	
	Incidence density (%) (95% CI)	24.8 (19.86 - 30.59)	17.68 (12.99, 23.51)	
CAUTI rate	Total no. of CAUTIs	73	46	1.872 (0.044)
	Total no. of urinary cath. Days	5594	5005	
	Incidence density (%) (95% CI)	13.05 (10.23 - 16.41)	9.19 (6.728 - 12.26)	
CLABSI rate	Total no. of CLABSIs	52	24	2.331 (0.019)
	Total no. of central line days	3325	2707	
	Incidence density (%) (95% CI)	15.64 (11.68 - 20.51)	8.87 (5.679 - 13.19)	
VU	Total no. of Vent. Days	3508	2659	10.53 (0.00)
	Total no. of patient days	10034	9963	
	Vent. Utilization ratio (95% CI)	0.349 (0.338 - 0.361)	0.267 (0.257 - 0.277)	
UCU	Total no. of Urinary cath. Days	5594	5005	5.356 (0.00)
	Total no. of patient days	10034	9963	
	U.C. Utilization ratio (95% CI)	0.558 (0.543 - 0.572)	0.502 (0.489 - 0.517)	
CLU	Total no. of Central line days	3325	2707	7.681 (0.00)
	Total no. of patient days	10034	9963	
	C.L. Utilization ratio (95% CI)	0.331 (0.320 - 0.343)	0.272 (0.262 - 0.282)	
Mean LOS	Total no. of patient days	10034	9963	11.8 (0.00)
	Total no. of patients	994	1166	
	Mean length of stay/pt. (95% CI)	10.1 (9.898 - 10.29)	8.5 (8.378 - 8.714)	

Table (3): Overall PIR, overall PDR and PDR by site of infection in the medical ICUs, before and after the intervention.

		Before	After	Z (P)
Overall PIR	Total no. of HAIs	79	53	3.449 (0.0006)
	Total no. of patients	265	325	
	Incidence rate (%) (95% CI)	29.81 (23.6 - 37.15)	16.31 (12.21 - 21.33)	
Overall PDR	Total no. of HAIs	79	53	2.493 (0.013)
	Total no. of patient days	2206	2296	
	Incidence density (%) (95% CI)	35.81 (28.35 - 44.63)	23.08 (17.29 - 30.19)	
HAP rate	Total no. of pneumonias	37	25	1.682 (0.092)
	Total no. of patient days	2206	2296	
	Incidence density (%) (95% CI)	16.77 (11.81 - 23.12)	10.89 (7.05 - 16.07)	
UTI rate	Total no. of UTIs	20	12	1.528 (0.127)
	Total no. of patient days	2206	2296	
	Incidence density (%) (95% CI)	9.066 (5.536 - 14)	5.226 (2.698 - 9.13)	
BSI rate	Total no. of BSIs	22	16	1.097 (0.273)
	Total no. of patient days	2206	2296	
	Incidence density (%) (95% CI)	9.973 (6.248 - 15.1)	6.969 (3.981 - 11.32)	

Table (4): Overall DAI rate, DAI rate by site of infection, DUR and mean LOS in the medical ICUs, before and after the intervention.

		Before	After	Z (P)
Overall DAI rate	Total no. of DAIs	58	35	2.578 (0.009)
	Total no. of patient days	2206	2296	
	Incidence density (%) (95% CI)	26.292 19.96, 33.99	15.244 10.62, 21.2	
VAP rate	Total no. of VAPs	22	14	0.828 (0.408)
	Total no. of Vent. Days	711	600	
	Incidence density (%) (95% CI)	30.94 19.39, 46.85	23.33 12.75, 39.15	
CAUTI rate	Total no. of CAUTIs	20	12	1.178 (0.239)
	Total no. of urinary cath. days	1587	1459	
	Incidence density (%) (95% CI)	12.60 7.695, 19.46	8.23 4.245, 14.37	
CLABSI rate	Total no. of CLABSIs	16	9	0.962 (0.336)
	Total no. of central line days	838	702	
	Incidence density (%) (95% CI)	19.09 10.91, 31.01	12.82 5.851, 24.34	
VU	Total no. of Vent. Days	711	600	3.79 (0.00)
	Total no. of patient days	2206	2296	
	Vent. Utilization ratio (95% CI)	0.322 0.299, 0.347	0.261 0.241, 0.283	
UCU	Total no. of Urinary cath. days	1587	1459	3.423 (0.00)
	Total no. of patient days	2206	2296	
	U.C. Utilization ratio (95% CI)	0.719 0.684, 0.756	0.635 0.603, 0.669	
CLU	Total no. of Central line days	838	702	4.251 (0.00)
	Total no. of patient days	2206	2296	
	C.L. Utilization ratio (95% CI)	0.379 0.355, 0.407	0.306 0.284, 0.329	
Mean LOS	Total no. of patient days	2206	2296	5.511 (0.00)
	Total no. of patients	265	325	
	Mean length of stay/pt. (95% CI)	8.325 7.981, 8.679	7.065 6.779, 7.360	

Table (5): Overall PIR, overall PDR and PDR by site of infection in the medical / surgical ICUs before and after the intervention.

		Before	After	Z (P)
Overall PIR	Total no. of HAIs	153	97	4.777 (0.000002)
	Total no. of patients	502	586	
	Incidence rate (%) (95% CI)	30.48 (25.84 - 35.71)	16.55 (13.42 - 20.19)	
Overall PDR	Total no. of HAIs	153	97	3.427 (0.0006)
	Total no. of patient days	4503	4438	
	Incidence density (%) (95% CI)	33.977 (28.81 - 39.81)	21.857 (17.72 - 26.66)	
HAP rate	Total no. of pneumonias	63	40	2.193 (0.028)
	Total no. of patient days	4503	4438	
	Incidence density (%) (95% CI)	13.991 (10.75 - 17.9)	9.013 (6.438 - 12.27)	
UTI rate	Total no. of UTIs	53	34	1.969 (0.04)
	Total no. of patient days	4503	4438	
	Incidence density (%) (95% CI)	11.769 (8.816 - 15.4)	7.661 (5.305 - 10.71)	
BSI rate	Total no. of BSIs	37	23	1.751 (0.079)
	Total no. of patient days	4503	4438	
	Incidence density (%) (95% CI)	8.217 (5.785 - 11.33)	5.183 (3.284 - 7.776)	

Table (6): Overall DAI rate, DAI rate by site of infection, DUR and mean LOS in the medical/surgical ICUs, before and after the intervention.

		Before	After	Z (P)
Overall DAI rate	Total no. of DAIs	125	69	3.919 (0.00009)
	Total no. of patient days	4503	4438	
	Incidence density (%) (95% CI)	27.759 (23.11 - 33.07)	15.548 (12.1 - 19.68)	
VAP rate	Total no. of VAPs	48	24	1.675 (0.093)
	Total no. of Vent. Days	1606	1217	
	Incidence density (%) (95% CI)	29.888 (22.04 - 39.63)	19.721 (12.63 - 29.34)	
CAUTI rate	Total no. of CAUTIs	53	34	1.47 (0.141)
	Total no. of urinary cath. Days	4007	3546	
	Incidence density (%) (95% CI)	13.227 (9.907 - 17.3)	9.588 (6.639 - 13.4)	
CLABSI rate	Total no. of CLABSIs	24	11	1.569 (0.117)
	Total no. of central line days	2235	1800	
	Incidence density (%) (95% CI)	10.738 (6.878 - 15.98)	6.111 (3.047 - 10.93)	
VU	Total no. of Vent. Days	1606	1217	6.935 (0.00)
	Total no. of patient days	4503	4438	
	Vent. Utilization ratio (95% CI)	0.357 (0.339 - 0.374)	0.274 (0.259 - 0.29)	
UCU	Total no. of Urinary cath. Days	4007	3546	4.673 (0.00)
	Total no. of patient days	4503	4438	
	U.C. Utilization ratio (95% CI)	0.889 (0.862 - 0.917)	0.799 0.772, 0.825	
CLU	Total no. of Central line days	2235	1800	6.386 (0.00)
	Total no. of patient days	4503	4438	
	C.L. Utilization ratio (95% CI)	0.496 (0.476 - 0.517)	0.406 (0.387 - 0.424)	
Mean LOS	Total no. of patient days	4503	4438	8.012 (0.00)
	Total no. of patients	502	586	
	Mean length of stay/pt. (95% CI)	9 (8.710 - 9.236)	7.6 (7.352 - 7.8)	

Table (7): Overall PIR, overall PDR and PDR by site of infection in the neonatal ICUs, before and after the intervention.

		Before	After	Z (P)
Overall PIR	Total no. of HAIs	65	40	3.04 (0.002)
	Total no. of patients	227	255	
	Incidence rate (%) (95% CI)	28.63 (22.1 - 36.5)	15.68 (11.21 - 21.36)	
Overall PDR	Total no. of HAIs	65	40	2.29 (0.022)
	Total no. of patient days	3325	3229	
	Incidence density (%) (95% CI)	19.549 (15.09 - 24.92)	12.388 (8.849 - 16.87)	
HAP rate	Total no. of pneumonias	26	17	1.277 (0.202)
	Total no. of patient days	3325	3229	
	Incidence density (%) (95% CI)	7.819 (5.107 - 11.46)	5.265 (3.065 - 8.43)	
BSI rate	Total no. of BSIs	39	23	1.917 (0.044)
	Total no. of patient days	3325	3229	
	Incidence density (%) (95% CI)	11.729 (8.34 - 16.03)	7.123 (4.514 - 10.69)	

Table (8): Overall DAI rate, DAI rate by site of infection, DUR and mean LOS in the neonatal ICUs, before and after the intervention.

		Before	After	Z (P)
Overall DAI rate	Total no. of DAIs	29	13	2.374 (0.018)
	Total no. of patient days	3325	3229	
	Incidence density (95% CI)	8.722 (5.84 - 12.53)	4.026 (2.142 - 6.885)	
VAP rate	Total no. of VAPs	17	9	0.704 (0.481)
	Total no. of Vent. Days	1191	842	
	Incidence density (95% CI)	14.274 (8.311 - 22.85)	10.689 (4.878 - 20.29)	
CLABSI rate	Total no. of CLABSIs	12	4	1.597 (0.11)
	Total no. of central line days	252	205	
	Incidence density (95% CI)	47.619 (24.58 - 83.18)	19.512 (5.25 - 49.95)	
VU	Total no. of Vent. Days	1191	842	7.081 (0.00)
	Total no. of patient days	3325	3229	
	Vent. Utilization ratio (95% CI)	0.358 (0.3381 - 0.3791)	0.261 (0.2434 - 0.279)	
CLU	Total no. of Central line days	252	205	1.886 (0.044)
	Total no. of patient days	3325	3229	
	C.L. Utilization ratio (95% CI)	0.076 (0.067 - 0.0858)	0.063 (0.055 - 0.072)	
Mean LOS	Total no. of patient days	3325	3229	5.899 (0.00)
	Total no. of patients	227	255	
	Mean length of stay/pt. (95% CI)	14.7 (14.15 - 15.15)	12.7 (12.23 - 13.11)	