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# Reducing Health Care Associated Infections in a Neonatal Intensive Care Unit through Quality Improvement Approach, Tibebe Ghion Specialized Teaching Hospital, Bahir Dar University, Bahir Dar, Ethiopia-Mirror of the Health Care Quality

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## ABSTRACT

**Background:** Health-care-associated-infections are infections occurring while receiving health care that first appear 48 hours or more after hospital admission, or within 30 days of receiving health care.

**Objective:** Measure the impact of quality improvement interventions on health-care-associated-infection in the Neonatal Unit of Tibebe Ghion Hospital.

**Method:** We conducted pre-post Interventional Study between February 01, 2022 and May 01, 2023. Multifaced interventions; implementing recommended minimum NICU standards, re-enforcing WHO IPC Guideline and Hand Hygiene practice, were introduced. NICU Standards achieved, Hand hygiene compliance, WHO IPC guideline Implementation and Health-care-associated-infections were surveyed. Comparison of Health-Care-associated-infection rates before and after the intervention was conducted.

**Results:** Recommended NICU Design standards status was improved from 8% pre-intervention to 79% and 79.5% during and post-intervention respectively. Hand Hygiene compliance in the unit was 10% pre-intervention and improved to 79.5% and 81.3% during and post-intervention respectively. The WHO IPC implementation status was 15% pre-intervention and maximized to 58% both during and post-intervention. These package of interventions were associated with reduction of Health-Care-associated-Infections. [X2 (Degree of Freedom=1, Sample Size=432) 8.2, p=004]

**Conclusion:** Infection Prevention practice, Hand Hygiene Compliance and improving NICU Design standards were associated with decrease in health-care-associated-infection rates.

**Keywords:** NICU; Health care associated infections; Quality improvement

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## INTRODUCTION

Health Care-Associated Infections (HCAIs) are infections that occur while receiving health care, developed in a health care facility that first manifests 48 hours or more after hospital admission, or within 30 days after having received health care [1,2]. HCAIs reflects the extent of health care quality in the health care system [3]. It is the leading, preventable adverse event in acutely ill patients and is associated with considerable morbidity, mortality, and additional use of resources [4,5]. HCAIs ruin patient expectations of quality medical care and increase negativity towards the formal health system in favour of other options, especially since the costs of HAIs are borne by the patients themselves in many developing countries [6]. It also causes unnecessary pain and suffering for patients and their families, prolong hospital stays and are costly to the health system [7].

Reducing the risk of HCAIs faced by populations in developing countries is a major priority of the WHO [8]. Successful approaches for preventing and reducing harms arising from HCAIs involve applying a risk-management framework to manage 'human' and 'system' factors associated with the transmission of infectious agents.

HCAI is a potentially preventable adverse event rather than an unpredictable complication and it is possible to significantly reduce the rate of HCAIs through effective infection prevention and control practice, Hand Hygiene Compliance, meeting minimum NICU design Standards for level III and IV NICUs and other evidence based Interventions [9-13]. The purpose of this study was to evaluate the impact of Quality improvement intervention in reducing HCAIs among neonates in NICU.

## METHODS

### Setting and Participants

The study was conducted from February 1, 2022 to May 01, 2023., in the Neonatal Intensive Care Unit of Tibebe-Ghion Specialized Hospital, a teaching hospital of Bahir Dar University, a large referral center that provides primary and tertiary medical care for residents of Bahir Dar city, Amhara National Regional State and the surrounding National Regional States.

Approximately 2,000 neonates are admitted annually to the fifty six (56)-bed NICU. There was scarcity of Hand-washing facilities throughout the unit. Though limited practice, use of alcohol-based hand rub has been the primary method for hand hygiene. The NICU ward Infrastructure design is lacking the minimum recommended NICU Design Standards [13,14].The WHO recommended IPC guideline Implementation status was below the expected (0–200) [10].

### Study Design

Institution based Pre-Post-Interventional study was conducted. The study was conducted in three phases. The Baseline phase (Phase 1, 6 months) consisted of studying the Health Care set up as per the recommended minimum NICU Design standards for level III and IV NICUs, assessing the Unit's WHO recommended Infection Prevention and Control Practice implementation status, surveying Health Care Workers (HCWs) Hand Hygiene Compliance, and conducting Pre-Intervention prospective data collection by simple random sampling technique and analysis of the health care associated infection rate and its associated factors [9-11,13]. The intervention phase (Phase 2, 6 months) was approached through "the Model for Improvement approach" and was based on the results of Phase 1 assessments. Continuous prospective surveillance of HCAIs was performed throughout the entire phase. Hand Hygiene Compliance, the WHO Infection prevention and control guideline Implementation and the recommended minimum NICU Design Standards assessment were being done every two weeks. The Follow up Phase (3 months) was conducted in phase 3 of the study with no active intervention. Prospective data collection by simple random sampling technique was conducted to assess the post intervention status of HCAI.

**Baseline study (Phase One): From February 01, 2022-July 31, 2022:** Pre-Intervention data for Sociodemographic, HCAIs associated factors, and comorbidities were collected by simple random sampling technique. Structured observation and assessment sessions were conducted to evaluate the Infection prevention practice and Hand Hygiene compliance using the WHO IPCAF tool and Hand Hygiene Compliance assessment formats. The NICU design standard was also assessed as per the recommended Minimum standard for level III and IV NICU care [13]. Descriptive analysis was done. The output from the analysis was used to formulate high impact low cost interventions to be implemented in phase 2 of this study to reduce the HCAI incidence.

**Intervention (Phase two): From August 1, 2022-January 31, 2023:** We Used "The Model for Improvement Approach" to implement change ideas/interventions which were generated during root cause analysis/RCA sessions after the baseline/ Phase one assessment. Aim statement formulated, root cause analysis done to generate change ideas from the phase one findings and prioritized by focusing matrix for implementation. Using the Plan–Do–Study–Act (PDSA) Cycle methodology, change ideas were implemented simultaneously with small scale and escalated subsequently throughout the intervention phase to implement at larger scales [15].

The Change Ideas generated were grouped under three umbrella categories; Hand Hygiene Practice, Infection prevention and control guideline implementation status and the recommended minimum NICU standards. Hence; we use the WHO Hand hygiene Compliance Checklist, the WHO Infection Prevention and Control Assessment Framework (IPCAF) and the Recommended NICU Design Standards for level III and IV NICUs [9-11,13]. The interventions and HCAIs rate were being monitored every two week and Plotted to monitor the process throughout the Intervention phase.

Four teams were organized with a team leader to handle HCAI surveillance, Hand Hygiene Compliance assessment, Infection Prevention and control Practice assessment and the NICU Design standards assessment. The changes from the interventions were plotted to monitor the process and analyse the significance of the intervention by run chart [16].

**Minimum recommended NICU design standards for level III and IV NICUs:** 13 surveys including the baseline assessment were conducted by the team who were trained before the

intervention period to assess the unit as per the recommended NICU Design Standards. They see the status of the unit against list of the standards in team and score it from hundred (%) twice in a month. Percent achieved in the implementation status of the NICU Design Standards was considered as process indicator and plotted on run chart to follow progress [9,12,13].

**Hand hygiene compliance:** 13 surveys including the baseline assessment were conducted by the team assigned and trained to assess, monitor and provide feedback on the status. The Hand Hygiene compliance was assessed using the WHO Hand Hygiene compliance assessment checklist [11]. The team was assessing the health care providers and auxiliary staff practicing in the unit after providing onsite trainings. Assessment was being done twice in a month. Percent achieved during assessment was used as process indicator and Plotted on run chart to follow progress.

**Infection prevention and control guideline implementation:** Using the WHO Infection Prevention and Control Assessment Framework (IPCAF), surveys were done to assess the implementation status of the WHO Infection Prevention and control by the team trained and deployed to assess, monitor, and provide feedback. The tool categorizes facilities level in to four after computing the scores (Inadequate (0%–200% or 0%–25%); Basic (201%–400% or 25.1%-50%); Intermediate (401–600 or 50.1%-75%) and Advanced (601%–800% or 75.1%-100%) [10]. Surveys were being done twice in a month for a total of thirteen times including the baseline. Percent achieved was used as process indicator and plotted on run chart to follow progress.

**Surveillance of health care associated infection:** The team conducted prospective surveillance of Health Care associated infection. All neonates were being followed from admission to discharge. HCAI was diagnosed by chart review, direct patient evaluation, laboratory finding interpretations and information from the round team [17,18]. Updated information was provided to the research team on twice in a month basis. Percent achieved every two week was used as process indicator and plotted on run chart [16,19].

**Follow up (Phase three): From February 01, 2023–April 30, 2023:** Sociodemographic parameters, HCAIs associated factors and comorbidities were collected for the determined sample size on prospective basis using simple random sampling technique. This was computed with the pre–intervention.

## Sample Size and Selection

Sample Size formula for Two Independent Samples with Dichotomous Outcome was used to estimate the difference in proportions between two independent populations (HCAI before Vs. after intervention). Level of significance=5%; margin of error=0.05%; proportion of HCAIs (one category=0.076). With this, sample size was calculated to be 216 for each of pre–and Post–Intervention groups. Simple random sampling method using Microsoft excel was used for sampling.

## Exclusion Criteria

Newborns admitted after diagnosis of HCAIs at some other health facility.

Newborns with Incomplete documentation.

Newborns whose caregivers were not willing to participate in the study and

Newborns who stayed less than 48 hours before discharge.

## Definitions, Diagnosis and Classification

**Health care associated infections(HCAIs):** Are infections that occur while receiving health care, in a hospital or other health care facility that first appear 48 hours or more after hospital admission, or within 30 days after having received health care [2,20,21].

**Hand hygiene:** Handwashing, antiseptic handwash/hand rub, or surgical hand antisepsis [22].

**Hand rubbing:** With an alcohol-based (75% vol/vol, isopropanol) preparation of chlorhexidine gluconate (0.5%) was defined as the standard procedure for hand hygiene before and after patient care activities, unless hands were visibly soiled [23].

**Hand washing:** Is the act of cleaning one's hands with the use of any liquid with or without soap for the purpose of removing dirt or microorganisms [22].

**Diagnosis:** HCAI is considered, when reported as infection acquired while receiving Medical care based on culture confirmation or clinical and laboratory methods [17,18].

## Classification

**Blood stream infections (BSI):** A first positive blood culture ≥ 48 hours after hospital admission or within 48 hours of discharge from hospital [26].

Lower respiratory tract infections: Respiratory decompensation with new and persistent infiltrates on CXR or Infants with worsening gas exchange and at least 3 of the following [27]:

- Temperature instability with no other recognized cause.
- min (white blood cell count <4000/min)
- Change in character of sputum or increased respiratory secretions.
- Apnea, tachypnea, nasal flaring, or grunting.
- Wheezing, rales, rhonchi, or cough.
- Bradycardia (<100/min) or tachycardia (>170/min).

**Surgical site infections:** Infections occurring up to 30 days after surgery and affecting either the incision or deep tissue at the operation site [28].

**Urinary tract infections:** Catheter-associated urinary tract infection (CAUTI) is defined as a urinary tract infection (UTI) where an indwelling urinary catheter was in place for more than 2 calendar days on the date of event, with day of device placement being day 1, and an indwelling urinary catheter was in place on the date of event or the day before [29].

**Skin and soft tissue infections:** A patient without any evidence of infection on admission and who was culture positive >48 h after admission [30].

**Nosocomial diarrhea:** Diarrhea that develops during a hospital

stay or up to 3 days after discharge [31].

## Statistical Analysis

"The Model for Improvement Approach" was used to do the intervention (phase two) [15]. Goal was set using the best achievements worldwide so far [32]. Run chart was utilized to determine the statistical significance of the intervention and monitor process indicators during intervention [16].

Phase one and three were compared to evaluate the impact of the intervention implemented during phase two on the prevalence of HCAIs. Categorical variables were compared using Chi–squared test. Adjusted odds ratio (95%CI) was computed for variables. P-value<0.05 was considered statistically Significant. We used SPSS Version 25 for analysis.

## Ethical Considerations

Our protocol was approved by Bahir Dar University, College of Medicine and Health Sciences, IRB with protocol number 793/2023. Formal letter of cooperation was secured from Tibebe–Ghion Specialized Hospital. Informed consent to participate in the study was obtained from all parents or legal guardians. All information collected was kept in the way that could not interfere in personal confidentiality during data collection, analysis and then after.

# RESULTS

## Socio-Demographic Characteristics of Patients

432 neonates (216 neonates in each pre–and Post–Intervention group) admitted in the unit for ≥ 48 hours who were selected and fulfil the inclusion criteria were included in the analysis. Patient Socio-Demographic Parameters are described in **Table 1** below. Case mix as estimated by Age of the newborn, Gestational age, Birth Weight, Gender, Mode of Delivery, Place of Delivery, and Maternal age was comparable over the study period (both Pre– and post–Intervention).

**Table 1:** Socio-Demographic characteristics of Neonates across study Phases: Bahir Dar University Tibeb-Ghion Specialized teaching Hospital NICU, February, 2022-April, 2023

| Characteristics | | Pre-Intervention | | Post-Intervention | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| Age of Newborn | Less than 24 hours | 116 | 53.70% | 118 | 54.60% |
| | 24 hours-72 hours | 28 | 13% | 31 | 14.40% |
| | ≥72 hours-7 days | 34 | 15.70% | 29 | 13.40% |
| | ≥7 days | 38 | 17.60% | 38 | 17.60% |
| Sex of the newborn | Male | 142 | 65.70% | 128 | 59.30% |
| | Female | 74 | 34.30% | 88 | 40.70% |
| Gestational Age | Very Preterm | 17 | 7.90% | 10 | 4.60% |
| | Late Preterm | 50 | 23.10% | 53 | 24.50% |
| | Term | 146 | 67.60% | 139 | 64.40% |
| | Post-term | 3 | 1.40% | 14 | 6.50% |
| Birth Weight of Newborn | Extremely LBW | 2 | 1% | 0 | 0 |
| | Very LBW | 17 | 7.90% | 21 | 9.70% |
| | LBW | 54 | 25% | 59 | 27.30% |
| | Normal Birth Weight | 140 | 64.80% | 131 | 60.60% |
| | Macrosomia | 3 | 1.40% | 5 | 2.30% |
| Maternal Age | 15-24 years | 60 | 27.80% | 51 | 23.60% |
| | 24-34 years | 129 | 59.70% | 136 | 63% |
| | >34 years | 27 | 12.50% | 29 | 13.40% |
| Mode of Delivery | Spontaneous Vertex | 149 | 69% | 150 | 69.40% |
| | Assisted Delivery | 15 | 6.90% | 5 | 2.30% |
| | C/Section | 52 | 24% | 61 | 28.20% |
| Place of Delivery | Home Institute | 100 | 46.30% | 97 | 44.90% |
| | Other Institute | 107 | 47.70% | 113 | 52.30% |
| | Home Delivery | 9 | 4.20% | 6 | 2.80% |

## Clinical Characteristics of Patients

The clinical Profile case mix of newborns enrolled in the study was stable throughout both the pre–and Post–Intervention period as characterized by comorbidity and Health Care associated Infection risk factors with an exception for Perinatal asphyxia and esophago-Gastro-Intestinal surgical disorders which had decreased by about a half and Meconium aspiration Syndrome which had doubled during Post–Intervention period. Detailed Clinical Parameters are described in **Table 2**.

**Table 2:** Clinical characteristics of Neonates across study phases: Bahir Dar University Tibebe-Ghion Specialized teaching Hospital NICU, February 2022-April 2023.

| Characteristics | | Pre-Intervention | | Post-Intervention | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| Comorbidity | Yes | 209 | 96.80% | 208 | 9630.00% |
| | No | 7 | 3% | 8 | 3.70% |
| Comorbidity Types | Syndromic/Chromosome | 12 | 5.60% | 11 | 5.10% |
| | TORCHS | 6 | 2.80% | 2 | 1.00% |
| | Perinatal Asphyxia | 19 | 8.80% | 10 | 4.60% |
| | Necrotizing Enterocolitis | 9 | 4.20% | 9 | 4.20% |
| | Esophago-Gastro-Intestinal | 24 | 11.10% | 11 | 5.10% |
| | Renal Diseases | 8 | 3.70% | 3 | 1.40% |
| | Respiratory Distress Syndrome | 35 | 16.20% | 33 | 15.30% |
| | Cardiac Disorders | 8 | 3.70% | 10 | 4.60% |
| | Sepsis | 141 | 65% | 165 | 76.40% |
| | Neurologic Disorders | 15 | 6.90% | 18 | 8.30% |
| | Bleeding | 25 | 12% | 19 | 8.80% |
| | Meconium Aspiration Syndrome | 14 | 6.50% | 24 | 11.10% |
| | Neonatal Hyperbilirubinemia | 42 | 19.40% | 33 | 15.30% |
| | Others | 30 | 13.90% | 30 | 13.90% |

## Characteristics of Health Care Associated Infections

The proportion of health care–associated infections across the study phases were 13% and 5% in phases 1 and 2, respectively. Blood stream Infections are the leading across the study period.

The proportion of Health Care associated infection among term neonates has reduced markedly compared to the other categories of neonates. **Table 3** shows the number of infected neonates and the distribution of health care associated infections across the study phases.

**Table 3:** Health Care associated infections characteristics across study phases: Bahir Dar University Tibebe-Ghion Specialized teaching Hospital NICU, February 2022-April 2023.

| Characteristics | | Pre-Intervention | | Post-Intervention | |
|---|---|---|---|---|---|
| | | # | % | # | % |
| Health Care Associated Infection | Yes | 28 | 13.00% | 11 | 5.00% |
| | No | 188 | 87% | 205 | 95.00% |
| Site of Health Care Associated Infection | Blood Stream Infection/BSI | 13 | 46.4% | 5 | 45.50% |
| | Pneumonia | 7 | 25.00% | 1 | 9.10% |
| | Surgical Site Infection | 1 | 3.60% | 0 | 0.00% |
| | Skin and Soft tissue Infections | 0 | 0.00% | 1 | 9.10% |
| | Meningitis | 7 | 25.00% | 4 | 36.30% |
| HCAIs against Gestational Age | Term | 15 | 53.60% | 4 | 36.30% |
| | Very Preterm | 6 | 21.40% | 4 | 36.30% |
| | Late Preterm | 7 | 25.00% | 3 | 27.40% |
| | Post term | 0 | 0% | 0 | 0.00% |

## Risk factors associated with Health Care Associated Infection

Comorbidities like Necrotizing enterocolitis (NEC) and Esophago–Gastro–Intestinal surgical disorders, and Invasive Procedures like Continuous Positive Air way Pressure (CPAP) are strongly associated with Health Care associated infection with adjusted Odds ratio of 10.8 (1.28, 91.4); 26.5 (2.7, 258) and 25.3 (2.1, 300) respectively. The impact of the intervention remained significant after adjustment for possible confounders (**See Table 4 for details**).

**Table 4:** Factors associated with Acquisition of Health Care-Associated Infection among Newborns: Crude and Adjusted Odds ratio-Bahir Dar University, Tibebe-Ghion Hospital, NICU, February 2022 to May 2023.

| Characteristics | | HCAI | | p-value | Crude OR, 95% CI | p-value | Adjusted OR, 95% CI |
|---|---|---|---|---|---|---|---|
| | | Yes | No | | | | |
| Age of Newborn | <24 hours | 2600.00% | 208 | – | 1 | 0.376 | 1 |
| | 24 hours to 72 hours | 300% | 56 | <0.001 | 18.67 (5.84, 59.64) | 0.609 | 1.74 (0.21, 14.54) |
| | ≥72 hours to <7 days | 300.00% | 60 | <0.001 | 20.00 (6.27, 63.68) | 0.594 | 0.48 (0.03, 7.29) |
| | ≥7 days | 700.00% | 69 | <0.001 | 9.86 (4.53, 21.45) | 0.177 | 0.21 (0.02, 2.02) |
| Gender | Male | 2200.00% | 248 | – | 1 | – | 1 |
| | Female | 1700.00% | 145 | <0.001 | 8.53 (5.16, 14.09) | 0.781 | 0.84 (0.24, 2.97) |
| Gestational Age | Term | 1900.00% | 266 | | 1 | 0.704 | 1 |
| | Very Preterm | 1000.00% | 17 | 18.30% | 1.70 (0.78, 3.71) | 0.292 | 0.16 (0.01, 4.84) |
| | Late Preterm | 1000.00% | 93 | <0.001 | 9.30 (4.84, 17.85) | 0.62 | 0.52 (0.04, 6.86) |
| | Post term | 0.00% | 17 | 99.80% | 2.56 (6.25, 7.94) | 0.998 | – |
| Birth Weight | Normal | 1600% | 255 | – | 1 | 0.822 | 1 |
| | Macrosomia | 100.00% | 7 | 6.90% | 7.00 (0.86, 56.89) | 0.371 | 0.15 (0.01, 9.69) |
| | LBW | 1300% | 100 | <0.001 | 7.69 (4.32, 13.71) | 0.551 | 0.47 (0.04, 5.77) |
| | Very LBW | 800.00% | 30 | 0.10% | 3.75 (1.72, 8.18) | 0.396 | 0.25 (0.01, 6.09) |
| | Extremely LBW | 100.00% | 1 | 100.00% | 1.00 (0.06, 15.99) | 0.998 | – |
| Maternal Age | 15-24 years | 1100.00% | 100 | – | 1 | 0.354 | 1 |
| | 24-34 years | 2600.00% | 239 | <0.001 | 9.19 (6.13, 13.78) | 0.194 | 0.39 (0.09, 1.62) |
| | >34 years | 200.00% | 54 | <0.001 | 27.00 (6.58, 110.74) | 0.983 | 0.98 (0.12, 8.30) |
| Mode of Delivery | Spontaneous | 2700% | 272 | – | 1 | 0.589 | 1 |
| | Assisted | 200.00% | 18 | 0.30% | 9.00 (2.09, 38.79) | 0.33 | 0.31 (0.03, 3.27) |
| | C/Section | 1000% | 103 | <0.001 | 10.30 (5.38, 19.71) | 0.831 | 1.19 (0.25, 5.69) |
| Place of Delivery | Home Institute | 2300.00% | 174 | – | 1 | 0.179 | 1 |
| | Other Institute | 1500.00% | 205 | <0.001 | 13.67 (8.09, 23.09) | 0.165 | 4.05 (0.56, 29.16) |
| | Home Delivery | 100.00% | 14 | 1.10% | 14.00 (1.8, 106.5) | 0.073 | 25.65 (0.74, 886.4) |
| NEC | Yes | 7 | 11 | | 1 | – | 1 |
| | No | 31 | 382 | <0.001 | 11.94 (8.32, 17.12) | 0.029 | 10.81 (1.28, 91.43) |
| Esophago-Gastro-Intestinal Disorder | Yes | 8 | 27 | – | 1 | – | 1 |
| | No | 31 | 366 | <0.001 | 11.81 (8.18, 17.04) | 0.005 | 26.52 (2.724, 258.2) |
| Invasive: CPAP | Yes | 18 | 69 | – | 1 | – | 1 |
| | No | 21 | 324 | <0.001 | 15.43 (9.92, 23.99) | 0.01 | 25.34 (2.14, 300) |
| New born Category | Pre-Intervention | 28 | 188 | – | 1 | – | 1 |
| | Post-Intervention | 11 | 205 | <0.001 | 18.64 (10.2, 34.2) | 0.007 | 8.03 (1.8, 35.9) |
| Remark: | We use Haldane's Correction for the zero values (and these zero values are Computed in MS excel). For Adjusted Odds ratio; If p-value shows no significance, we jumped calculating Odds ratio for Zero value. | | | | | | |

## Impact of Quality Improvement Intervention through "The Model for Improvement Approach" on Health Care Associated Infection

The Change Ideas generated were implemented and monitored every two weeks as a process indicator under the umbrella categories; The WHO Hand hygiene Compliance Checklist, The WHO Infection Prevention and Control Assessment Framework (IPCAF) and the Recommended NICU Design Standards for level III and IV NICUs together with the Health Care associated Infection pattern [9-13]. The incidence of Health Care associated Infection was much higher (28%) before than after the intervention (11%) and is statistically significant (**Figure 1**). [p-value=0.007, Adjusted Odds ratio with 95% CI=8.03 (1.79, 35.97)] (**Table 4**).

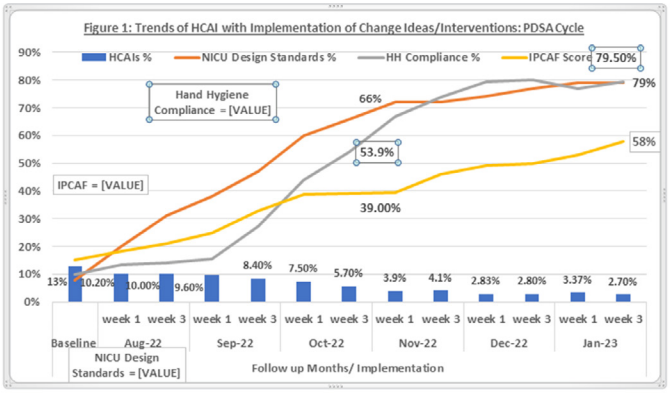


**Figure 1:** Trends of HCAI with implementation of change ideas/ interventions: PDSA Cycle

The Quality Improvement Intervention was computed with run chart to determine its significance.

- **Rule 1:** Trends: Greater than five consecutive points are moving in the same direction.
- **Rule 2:** Shift: 6 consecutive points exist on one side of the median.
- **Rule 3:** Runs: A non-random pattern or signal of change is indicated by too few or too many runs or crossings of the median line. Data line crosses the median once. Total run will be rule 2. Comparing with a probability table, the total run is too few (Lower limit=3 and upper limit=9). All the rules show that the change is not occurring by chance and is statistically significant [16]. See **Figure 2** below.

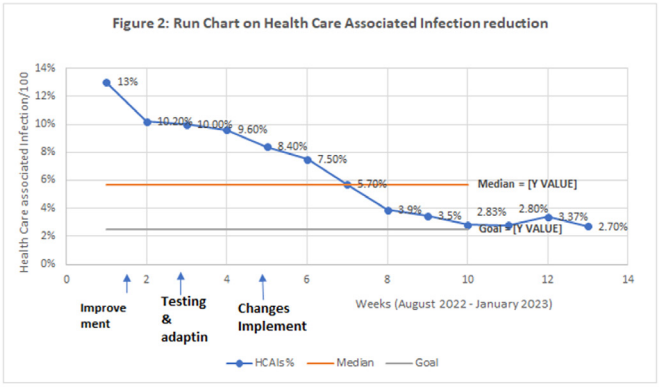


**Figure 2:** Run chart on health care associated infection reduction

A Chi–square test of independence was performed to examine the significance of health care quality improvement intervention on reduction of Health care associated infection rate. The finding was significant, X2 (Degree of Freedom=1, Sample Size=432)=8.2, p=004. This shows that the impact of the intervention remained significant after the intervention phase. (**See Tables 4 and 5**)

**Table 5:** Relative frequency of Newborns with Health Care associated Infections across the study period. Bahir Dar University, Tibebe-Ghion Hospital, NICU, February 2022 to May 2023.

| | | | Presence of HCAIs | | Total |
|---|---|---|---|---|---|
| | | | Yes | No | |
| Pre-Intervention | Count | 28 | 188 | 216 | 8 |
| | Expected Count | 19.5 | 196.5 | 216 | 8 |
| Post-Intervention | Count | 11 | 205 | 216 | 8 |
| | Expected Count | 19.5 | 196.5 | 216 | 8 |
| Total | Count | 39 | 393 | 432 | 8 |
| | Expected Count | 39 | 393 | 432 | 8 |
| **Chi-Square Tests** | | | | | |
| | | Value | df | Asymptotic Signifi-cance | 8 |
| (2-sided) | Exact Sig | 8 | 8 | 8 | 8 |
| (2-sided) | Exact Sig | 8 | 8 | 8 | 8 |
| (1-sided) | 8 | 8 | 8 | 8 | 8 |
| Pearson Chi-Square | 8.146 | 1 | 0.004 | – | – |
| Continuity Correctionb | 7.216 | 1 | 0.007 | – | – |
| Likelihood ratio | 8.4 | 1 | 0.004 | – | – |
| Fisher's exact test | – | – | – | 0.007 | 0.003 |
| Linear-by-Linear Association | 8.127 | 1 | 0.004 | – | – |
| N of valid cases | 432 | – | – | – | – |

## DISCUSSION

The results of this pre–post–Interventional study indicate that abiding with Infection prevention and control practices, Hand Hygiene practice implementation and re-enforcing the recommended minimum standards of NICU seems to impact on Health care associated infection reduction. To the best of our knowledge, this study is the first of its kind to assess the impact of Hand Hygiene compliance, the WHO Infection Prevention Guideline implementation and NICU Design Standardization on reduction of Health Care associated Infection in the NICU all together in a single study through "the Model for Quality Improvement Approach". Implementation of these change Ideas/Interventions has significantly reduced the health care associated Infection incidence which was witnessed both during the Intervention phase (Run chart, Figure 2) and at the end of the study, Phase 3 [X2 (Degree of Freedom=1, Sample Size=432)=8.2, p=004]. Comorbidities like Necrotizing enterocolitis (NEC) and Esophago–Gastro–Intestinal surgical disorders (Surgical Intervention and Long stay), and Invasive Procedures like Continuous Positive Air way Pressure (CPAP) are strongly associated with Health Care associated infection with adjusted Odds ratio of 10.8 (1.28, 91.4); 26.5 (2.7, 258) and 25.3 (2.1, 300) respectively. This is in line with other researches done previously [33-35]. This increased risk can be explained by the invasiveness of the interventions and expected prolonged stay in the unit as it is expected from the diseases nature. Bloodstream infection was the main site for HCAI in neonates in our study (46.4 and 45.5%, Pre–and Post–Intervention) which is in line with other study done in Egypt [35-38].

This interventional study finding will help in achieving the WHO's major priority agenda to Reduce the risk of HCAIs faced by populations in developing countries as a spring board for further scale up of implementation and HCAI reduction in our country and elsewhere [8]. This succuss also changes the attitude of the clients to favour modern medical care as HCAIs ruin patient expectations of quality medical care and increase negativity towards the formal health system in favour of other options, especially since the costs of HCAIs are borne by the patients themselves in many developing countries [6]. In addition; by reducing the HCAIs, we can decrease unnecessary pain and suffering of patients and their families, prolonged hospital stays and cost to the health system [39]. This reduction in HCAIs helps us to reflect the extent of health care quality improvement in the health care system in the unit [3].

## CONCLUSION

Although it is important to generate additional scientific evidence for the impact of evidence based quality improvement interventions on Health Care associated infection rates in health care settings, our results indicate that improved clinical practices reduce the risk of health care–associated infection. This study has revealed that implementation of Infection Prevention and Control practice, Hand Hygiene Compliance and adopting the minimum NICU Design standards were associated with a significant decrease in infection rates among the newborns admitted to NICU of various reasons. It also represents a step forward toward improved neonatal care.

## RECOMMENDATIONS

Lessons learnt shall be shared with other service provision sites *via* intra/inter–facility experience sharing and other dissemination modalities.

Implementing this quality Improvement intervention at larger scale would make facilities, Health care providers and the customers beneficiary in terms of reducing the infections acquired while providing/receiving medical care at facility level.

Quality improvement interventions are not a one stop shot activities. Hence, maintaining the momentum at the unit is imperative in order to enhance the quality health care provision.

Hospital infection control strategies should be strengthened to reduce the burden of HCAIs.

## LIMITATIONS

The generalizability of this study is limited as it is a single site Interventional study. Because the intervention was multimodal, it is therefore impossible to assess the relative efficacy of each components of the intervention. It also needs additional research in different patient population as the open level intervention method might have distorted the observed outcome.

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## CONFLICT OF INTEREST

The authors report no conflicts of interest in this work.

## REFERENCES

1. Collins AS, Hughes R (2008) Patient safety and quality: An evidence-based handbook for nurses. Preventing health care-associated infections.
2. Revelas A (2012) Healthcare–associated infections: A public health problem. Niger Med J. 53(2):59.
3. Humphreys H, Cunney R (2008) Performance indicators and the public reporting of healthcare-associated infection rates. Elsevier 892-4.
4. Brady MT (2005) Health care-associated infections in the neonatal intensive care unit. Am J Infect Control 33(5):268-75.
5. Bennett JV, Jarvis WR, Brachman PS (2007) Bennett & brachman's hospital infections: Lippincott williams & wilkins. Clin Infect Dis.
6. Warraich HJ, Mahmood SF, Zaidi AK (2013) Infection control in the tropics, hunter's tropical medicine and emerging infectious disease. Elsevier 168-73.
7. Health N, Council MR (2019) Australian guidelines for the prevention and control of infection in healthcare:

Commonwealth of Australia.

8. Pittet D, Allegranzi B, Storr J, Nejad SB, Dziekan G, et al. (2008) Infection control is a major World Health Organization priority for developing countries. J Hosp Infect 68(4):285-92.
9. White RD, Smith JA, Shepley MM (2013) Recommended standards for newborn ICU design. J Perinatol. 33(1):S2-S16.
10. Organization WH (2018) Infection prevention and control assessment framework at the facility level. World Health Organization.
11. Sax H, Allegranzi B, Chraïti MN, Boyce J, Larson E, et al. (2009) The World Health Organization hand hygiene observation method. Am J Infect Control 37(10):827-34.
12. Fetus Co, Barfield WD, Papile LA, Baley JE, Benitz W, et al. (2012) Levels of neonatal care. Pediatrics 130(3):587-97.
13. Newborn C (2004) Levels of neonatal care. Pediatrics 114(5):1341.
14. White RD (2020) Recommended standards for newborn ICU design. J Perinatol 40(1):2-4.
15. Langley GJ, Moen RD, Nolan KM, Nolan TW, Norman CL, et al. (2009) The improvement guide: A practical approach to enhancing organizational performance: John Wiley & Sons.
16. Perla RJ, Provost LP, Murray SK (2011) The run chart: A simple analytical tool for learning from variation in healthcare processes. BMJ Qual Saf 20(1):46-51.
17. Sahile T, Esseye S, Beyene G, Ali S (2016) Post-surgical infection and antibiotic susceptibility patterns of bacteria isolated from admitted patients with signs of infection at Jimma University specialized hospital, Jimma, Ethiopia. 17(4):1-12.
18. Alemayehu T, Tadesse E, Ayalew S, Nigusse B, Yeshitila B, et al. (2019) High burden of nosocomial infections caused by multi-drug resistant pathogens in pediatric patients at Hawassa University comprehensive specialized hospital.
19. Courtlandt CD, Noonan L, Feld LG (2009) Model for improvement 1: A framework for health care quality. Pediatr Clin North Am. 56(4):757-78.
20. Hughes R (2008) Patient safety and quality: An evidence-based handbook for nurses.
21. Haque M, Sartelli M, McKimm J, Bakar MA (2018) Health care-associated infections-an overview. Infect Drug Resist 2321-33.
22. Boyce JM (1999) It is time for action: Improving hand hygiene in hospitals. Ann Intern Med 130(2):153-5.
23. Doll M, Bearman G, Feshea F (2018) Guide to infection control in the healthcare setting.
24. Zarb P, Coignard B, Griskeviciene J, Muller A, Vankerckhoven V, et al. (2012) The European Centre for Disease Prevention and Control (ECDC) pilot point prevalence survey of healthcare-associated infections and antimicrobial use. Euro Surveill 17(46):20316.
25. Polin RA, Denson S, Brady MT (2012) Epidemiology and diagnosis of health care-associated infections in the NICU. Pediatrics 129(4):1104-9.
26. Lenz R, Leal JR, Church DL, Gregson DB, Ross T, et al. (2012) The distinct category of healthcare-associated bloodstream infections. BMC Infect Dis 12(1):1-6.
27. Control CfD (2009) Prevention: Criteria for defining nosocomial Pneumonia.
28. Owens C, Stoessel K (2008) Surgical site infections: Epidemiology, microbiology and prevention. J Hosp Infect 70:3-10.
29. Nicastri E, Leone S (2018) Guide to infection control in the healthcare setting hospital-acquired urinary tract infection. Int Soc Infect Dis
30. Graffunder EM, Venezia RA (2002) Risk factors associated with nosocomial methicillin-resistant Staphylococcus aureus (MRSA) infection including previous use of antimicrobials. J Antimicrob Chemother 49(6):999-1005.
31. Hamad AJ, Albdairi AJ, Alkemawy SNY, Khudair SA, Abdulhadi NR (2022) Assessment of the incidence and etiology of nosocomial diarrhea in a medical ward in Iraq. J Med Life 15(1):132.
32. Organization WH (2011) Report on the burden of endemic health care-associated infection worldwide.
33. Noor A, Ishaq AR, Jafri L, Jabeen F, Rani R, et al. (2021) Health care associated infections (HCAIs) a new threat for world; U-turn from recovery to death. Campylobacter: IntechOpen.
34. Corrales FM, de Castro MGV, Ramírez LR, Bueno MJ, Puche RJ, et al. (2011) Factors that contribute to healthcare-related infection: How to avoid them. 26(6):367-75.
35. Kilic A, Okulu E, Kocabas BA, Alan S, Cakir U, et al. (2019) Healthcare-associated infection surveillance: A prospective study of a tertiary neonatal Intensive Care Unit. 13(03):181-7.
36. Mohammed GSEDM, Shoriet AH, Abdel-Aziz SM (2021) Incidence and risk factors of health-care-associated infection in the neonatal Intensive Care Unit of Assiut University Children's Hospital. J Curr Med Res Pract 6(1):48.
37. Sass L, Karlowicz MG (2018) Healthcare-associated infections in the neonate. Pediatr Infect Dis J. 560.
38. Holmes A, Dore C, Saraswatula A, Bamford K, Richards M, et al. (2008) Risk factors and recommendations for rate stratification for surveillance of neonatal healthcare-associated bloodstream infection. J Hosp Infect 68(1):66-72.
39. Committee ICGA (2019) 2010 Australian guidelines for the prevention and control of infection in healthcare.