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Reducing healthcare-associated infections by improving compliance to aseptic non-touch technique in intravenous line maintenance: a quality improvement approach

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ABSTRACT

Background Lack of standardisation and failure to maintain aseptic techniques during procedures contributes to healthcare-associated infections (HCAI). Although numerous procedures are performed in neonatal intensive care units (NICU), handling peripheral intravenous lines is one of the simple and common procedures performed daily. Despite evidence-based care bundle approach variability is higher, and compliance to asepsis is less in routine clinical practice. In this study, we aimed to standardise and improve compliance with Aseptic non-technique (ANTT) in intravenous line maintenance of neonates admitted to NICU to reduce HCAI by 50% over 6 months.

Methods All nurses were subjects of assessment for compliance with intravenous line maintenance. All admitted neonates with intravenous lines were subjects for the HCAI data collection. At baseline, the current practices for intravenous line maintenance were observed on a generic ANTT audit proforma. Pictorial standard operating procedure (SOP) was developed based on ANTT. Implementation and sustenance were ensured by Plan-Do-Study-Act cycles. Audit data on compliance to ANTT and trends of HCAI rates were displayed using run charts monthly. Qualitative experience from the nursing staff was also recorded.

Results Significant improvement was seen in compliance to various components—use of the aseptic field (0% to 100%), closed ports (0% to 100%), key part contamination reduction (80% to 0%), and intravenous hub scrubbing (0% to 72%). SOP of intravenous line maintenance based on ANTT could be implemented and sustained throughout for 9 months. There was a reduction of HCAI from 26 per 1000 patient days to 8 per 1000 patient days. Qualitative experience showed the main determinant of compliance to scrub the hub was the neonate's sickness level.

Conclusions Using a quality improvement model of improvement, ANTT in intravenous line maintenance was implemented stepwise. Improving compliance with ANTT principles in intravenous line maintenance reduced HCAI. Scrub the hub requires longer sustained efforts to become part of the practice.

INTRODUCTION

Problem description

Healthcare-associated infections (HCAI) are a common challenge faced by most neonatal intensive care units (NICU). Common risk factors include instrumentation and procedures.[1 2] Previous studies have demonstrated that these invasive procedures are not carried with high standards.[3–5] There has been practice variability, inadequate risk assessment, and thus causing uncontrolled standards of practice. A multimodal approach is required to reduce the burden of HCAI, mainly involving the healthcare professionals' education, implementing evidence-based care bundles with attention to aseptic techniques, standardisation of procedures, and identifying local determinants of infection and improvement in reporting and surveillance for infections.[3–7] Intravenous fluid and drug- preparation and administration are one of the frequent procedures performed in NICU.[4] Although they are performed frequently, there is a lack of standardisation and failure to use aseptic techniques, thus causing HCAI. This easily preventable HCAI leads to increased stay and adds to this vulnerable population's morbidity and outcomes.

Setting

The Ovum Woman and Child Speciality Hospital is a tertiary care hospital in Bangalore rural district, India. It is a referral hospital that caters close to 300–400 outborn admissions each year in the NICU. The unit has 12 intensive care beds, with an average occupancy of 80%. The unit has five ventilation beds, including high-frequency ventilation. There were a total of 12 nurses with an attrition of 30% per year. Average nursing strength was around three per shift with a

patient: nurse ratio of 1:2–3. There were two consultant doctors (6 hours onsite followed by on-call) and three resident doctors (one per day) were available on-site round the clock. Since it was an out-born hospital, the referred patients' sickness level was high, and they ended up getting invasive procedures. It was relatively a newer hospital when the study began (4 months) and had a varied nurses' skill set. Despite acceptable hand hygiene practices, the unit had an HCAI rate of 26 per 1000 patient days. There was variability of aseptic techniques with poor adherence to the protection of critical parts on handling invasive devices.

Evidence

Rowley proposed the standardised approach to aseptic technique called ANTT. It is based on a set of well-defined principles that aim to standardise common procedures by maintaining an aseptic field and stresses the protection of key parts and key sites from touch to reduce HCAI.[5 7] The ANTT has six core concepts: hand hygiene, correct glove usage, key part and key site protection, non-touch technique (of the critical parts), key part disinfection, and aseptic field management (both before and during an invasive procedure). Adherence to evidence-based catheter practices has been shown to reduce HCAI across various age groups admitted in intensive care units, including neonates.[4 8–11] Despite evidence for best practices, implementing and sustaining practices is a challenge. Quality improvement approaches are known to reduce this know-do gap by improving the system's processes and improving patient safety.[12]

We realised that intravenous fluid and drug preparation and administration were common invasive procedures. We decided to address this issue first to reduce HCAI. We aimed to implement the Aseptic Non-Touch Technique (ANTT) clinical practice framework in intravenous line maintenance. Intravenous line maintenance involved preparation of intravenous fluids, drug dilution and administration through peripheral intravenous cannula.

Aim

We aimed to improve compliance with ANTT in intravenous line maintenance in neonates admitted to NICU to reduce HCAI by 50% over 6 months.

METHODS

Design and ethical considerations

A multidisciplinary quality improvement (QI) team was formed, comprising of two NICU nurses, one nurse in-charge and two consultants. The study was conducted in the NICU from February 2018 to November 2018. All nurses working in the unit were subjects of assessment for compliance to ANTT in intravenous line maintenance. All admitted neonates with an intravenous catheter (peripheral intravenous line) staying in NICU for more than 48 hours were subjects for HCAI data. As the study did not involve an alteration in the admitted neonates' clinical management and was a quality improvement study based on an evidence-based care bundle, IRB approval was not sought as per hospital policy.

Patient involvement

Patients were not directly involved in the design or conduct of the implementation.

Measurements

An episode of HCAI was considered if there was clinical or microbiologically confirmed bloodstream infection or meningitis or pneumonia as defined by the German neonatal nosocomial infection surveillance system.[13] Total episodes of HCAI in the unit were used as the numerator. Patient days were used as the denominator for HCAI. Compliance with individual aseptic techniques were the process measures. HCAI rates were the outcome measures. Audits were done by the three nurses who were the project leads. Nurses were exclusively responsible for intravenous maintenance. As fluid preparation happened predominantly in the morning shift, initial audits were done during that time. After two phases, audits were extended to night shifts during antibiotic administration. One nurse and one baby were audited only once during the day by direct observation. Hand hygiene was also recorded as done before and after intravenous line handling as part of ANTT audit proforma by the project lead nurses. The quality of hand hygiene (steps and duration) was not recorded.

Statistical analysis

The compliance to individual components of ANTT was assessed as the proportion of components to which adherence was documented. HCAI rates were expressed per 1000 patient days. The change in compliance rates to aseptic techniques and HCAI was displayed using run charts from Microsoft Excel software. We followed the Standards for QUality Improvement Reporting Excellence (SQUIRE) 2.0 guidelines for reporting.[14]

Strategy

Baseline period (8 February 2018–19 February 2018): QI team identified gaps in aseptic techniques while handling the intravenous line. They identified gaps in the usage of gloves, maintenance of aseptic fields, use of closed ports over intravenous cannula, compliance to scrub the hub, and protection of key parts before intravenous access through generic ANTT audit proforma for 12 days. The team formulated standard operating procedure (SOP) for intravenous line handling based on ANTT principles in a pictorial poster and was displayed in the unit (online supplemental figure 1). A group meeting was conducted involving 10 nurses and 4 doctors of the unit to understand barriers. Apart from awareness of ANTT, the cost of using gloves and availability of closed ports were concerns (Fish bone, online supplemental figure 2). After the baseline period, we implemented the ANTT in intravenous line maintenance sequentially in 4 Plan-Do-Study-Act (PDSA) cycles. The results of each PDSA informed the change strategy for the next cycle.

PDSA cycles

PDSA cycle # 1 (20 February 2018–27 February 2018): the nurses of the QI team disseminated information to other nursing staff through teaching sessions (twice weekly), Whatsapp messages (once daily), and SOP pictures. Instead of sterile rubber gloves, sterile paper gloves were made available to reduce cost. Open ports of 10 cm extension were replaced by closed ports of 10 cm extensions. Nurses were sensitised that handling of intravenous lines (asepsis by sterile gloves, closed ports, and scrub the hub using alcohol swabs) by ANTT reduces HCAI and hospital stay of the neonates and thus less cost of care. Sterile paper gloves, closed ports, and sterile alcohol swabs were made available in the pharmacy. Audit of compliance with aseptic techniques and data of HCAI were collected.

PDSA cycle # 2 (6 March 2018–25 March 2018): apart from continuing group teaching (twice weekly), the display of process measures and outcome measures in the form of run charts helped create constant awareness. As 'scrub the hub' was slow to implement, a periodic video demonstration of the procedure was done apart from SOP teaching in group discussions. Qualitative experiences from nurses were collected in the form of anonymous responses to a questionnaire. The questionnaire aimed to record qualitative responses on ease of performing ANTT, pharmacy availability, and challenges of scrub the hub.

PDSA cycle # 3 (17 April 2018–3 June 2018): based on learning's from the previous PDSA cycle, principles of ANTT were incorporated into the on-boarding unit education. Earlier the on-boarding module in the unit consisted of 10 modules on essential and emergency newborn care, unit policies (indent/stock check), and infection control. ANTT was added as an 11th module to the training.

PDSA cycle # 4 (1 August 2018–17 November 2018): compliance with aseptic techniques was studied by the audits done twice a week by the project nurses. Reminder to the staff after each random audit ensured sustaining compliance to ANTT. The display of results of each phase also helped enhance the skills on ANTT. The qualitative experience was re-recorded to understand the fall in the scrub the hub in an anonymous response to a questionnaire.

RESULTS

A total of 143 neonates were part of this QI study. A total of 57 audits were performed randomly round the clock during these 897 patient days (table 1). SOP based on ANTT principles was formed in the baseline period, which had components of preparation, aseptic field usage, hand hygiene, protection of key parts, scrubbing the intravenous hub, and appropriate decontamination.

After the baseline period, PDSA cycles were sequentially introduced (table 2). In PDSA1, aseptic field usage (compliance improved from 0% to 100%), key part protection (compliance improved from 0% to 100%) and glove usage (compliance improved from 20% to 100%)

Table 1 Process indicators and outcome indicators

Characteristics	Baseline n (%) (8 February 2018–19 February 2018)	PDSA 1 n (%) (20 February 2018–27 February 2018)	PDSA2 n (%) (6 March 2018–25 March 2018)	PDSA3 n (%) (17April 2018–3 June 2018)	PDSA4 n (%) (1 August 2018–17 November 2018)
No. of neonates	7	5	16	28	87
No. of audits	5	7	13	10	22
Mean gestation in weeks (SD)	35 (2)	36 (2)	34 (1.9)	36 (3)	36 (3)
Mean birth weight in grams (SD)	2142 (591)	2360 (638)	2407 (839)	2520 (701)	2012 (1126)
Male sex	4 (57)	4 (80)	12 (75)	17 (60)	55 (63)
Ventilated	3 (42)	3 (60)	6 (37)	11 (39)	46 (52)
Central lines	2 (28)	1 (20)	3 (19)	7 (25)	24 (27)
Hand hygiene prior to line handling	5 (100)	7 (100)	13 (100)	10 (100)	22 (100)
Aseptic field usage	0	7 (100)	13 (100)	10 (100)	22 (100)
Glove usage	1 (20)	7 (100)	13 (100)	10 (100)	22 (100)
Closed ports use	–	3 (60)	12 (92)	10 (100)	22 (100)
Key part protection	1 (20)	7 (100)	9 (69)	10 (100)	22 (100)
Scrub the hub ► Duration 15 s ► Drying 30 s	0 –	0 –	6 (46) 6 (46)	9 (90) 9 (90)	22 (100) 16 (72)
Decontamination appropriate	5 (100)	7 (100)	13 (100)	10 (100)	22 (100)
HCAI per 1000 patient days	26	25	12.8	16.9	6

HCAI, health-care associated infections; PDSA, Plan-Do-Study-Act.

Table 2 Summary of Plan-Do-Study-Act (PDSA) cycles

PDSA cycle	PDSA 1 (20 February 2018–27 February 2018)	PDSA 2 (6March 2018–25 March 2018)	PDSA 3 (17 April 2018–3 June 2018)	PDSA 4 (1 August 2018–17 November 2018)
Plan	Improve compliance to bundled care 1. Awareness 2. Resource availability	Improve compliance to **scrub the hub** by atleast 50% and improve usage of **closed ports**.	Sensitisation of ANTT for new staff	Sustain scrub the hub along with other components.
Do	Teaching sessions, **display of SOP**. **Provision** of closed ports, paper gloves in pharmacy; Availability of plastic trays	Teaching sessions with **video demonstration** of technique of scrub the hub. Record qualitative experience	Teaching of ANTT to **new staff. Display of results** of HCAI	**Display of results** of HCAI. 2 weekly training. ANTT made part of **on-boarding unit education**. Record qualitative experience
Study	Compliance to aseptic field use, glove use and key part protection 100%. Closed ports usage was 60%. **Scrub the hub not started** despite training. Most nurses were **not sure** of 'Scrub the hub' technique	Aseptic field usage and glove usage compliance sustained. Decline in protection of key parts (70%). Closed ports usage improved (90%). Scrub the hub improved (46%). Qualitative experience revealed forgetfulness and improved by reminder from fellow nurse	Protection of key parts compliance improved (100%). Scrub the hub improved (90%).	Scrub the hub duration sustained. Drying was less compliant (72%). Sickness level of the baby determined compliance. Other components sustained
Act	Adopt-aseptic field usage and glove usage. Continue implementation of other components especially 'Scrub the hub'.	Entry of new staff reduced compliance to protection of key parts (**barrier**). Continue implementation of scrub the hub.	Aseptic field use, closed ports, glove use, Key part protection sustained. Test sustaining of scrub the hub in particular. Make ANTT part of 'on-boarding' unit education	Continue two weekly audits and sustain.

ANTT, Aseptic Non-Touch Technique; HCAI, healthcare associated infection; SOP, standard operating procedure.

were implemented easily. While the compliance with the closed ports (60%) and scrub the hub was poor (0%). In PDSA 2, after regular video demonstration, compliance with closed ports usage improved considerably (60% to 92%), and scrub the hub practice was observed in 46% of the audits. There was a drop in compliance of key part protection (from 100% to 69%). This sudden drop was attributed to entry of the new staff to the unit who were not aware of the principles of ANTT. Qualitative experience was collected with all 12 nurses. All 12 nurses had understood principles of ANTT, no concerns of availability in pharmacy, no concerns with the usage of gloves and closed ports. Forgetfulness of 'scrub the hub' was a major reason for poor compliance of ANTT as per 4 out of 12 nurses. During intravenous line maintenance, 6/12 nurses felt reminder given by fellow nurses facilitates compliance to scrub the hub. In PDSA3, making ANTT part of on-boarding unit education helped us resolve variability in ANTT practices among nursing staff, especially the newer staff. With continued training, scrub the hub compliance improved to 90%. Over 26 weeks, implementation of ANTT principles could be done, and it was sustained over the next 14 weeks (figure 1 and table 1). The admitted neonates' sickness level, like the number of intravenous lines inserted, ventilation days were similar to the previous phase. Apart from this, scrub the hub took a long time to implementation. Scrubbing subcomponent could be sustained during scrub the hub process while drying for 30 s was partially sustained (figure 1).

The qualitative experience of all 12 nurses favoured the ANTT principles in intravenous line maintenance. The nursing staffs were happy that HCAIs could be kept under control by simple intravenous line maintenance. Out of them, four nurses felt the baby's sickness level was a major

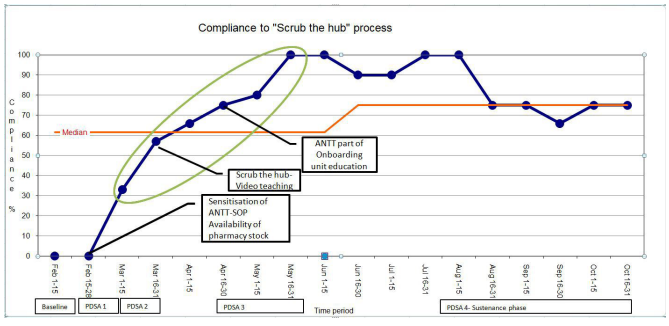

Figure 1 Compliance to "Scrub the hub" process (The oval shows a signal of trend). PDSA, Plan-Do-Study-Act.

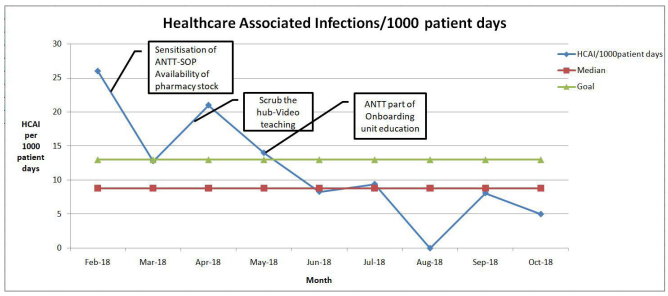

Figure 2 Healthcare associated infections (HCAI) per 1000 patient days.

determinant in following both the components of scrubs the hub (scrubbing 15 s and drying for 30 s). The compliance was poor, especially if the baby was critically sick example baby having seizure/shock/cardiac arrest. The sickness level was changing the priority of nurses from waiting for 30 s to intervening at the earliest.

Overall improvement in compliance to ANTT principles in the intravenous line maintenance followed a gradual decrease in HCAI in the unit from 26 per 1000 patient days to 8 per 1000 patient days (median) over 9 months (figure 2).

LESSONS AND LIMITATIONS

Reducing HCAIs constitute a significant challenge for most intensive care units. Apart from hand hygiene, maintenance of asepsis during invasive procedures can reduce HCAI. This study showed declining trends in HCAI rates following the QI approach to one of the most frequently performed procedures in the NICU. Compliance with ANTT principles, mainly aseptic field, protection of key parts, and scrub the hub could be improved by forming an SOP, training staff, continuous audits, and displaying data to sustain the infection control efforts. An improvement could be observed across all the monitored components. As seen in our study, the formation of SOP was just the starting point, and its implementation and sustenance required multiple PDSA cycles over 9 months. Standardisation reduced variations and, in the form of an SOP, helped us improve outcomes.[15]

More than the traditional teaching with SOP posters, access to video training of the procedure helped us achieve implementation faster. Another common challenge in many neonatal units is lack of equity of care especially with the entry of new staff. Graduation curriculum of nursing gives minimal neonatal exposure (less than a month).[16] In these relatively inexperienced nursing staff, on-boarding unit education improves equity of care, role clarity, staff retention, improves connectivity with peers.[17] In our unit, on-boarding unit education had 10 modules with components of resuscitation, equipment cleaning, essential newborn care, parental communication, and so on. Making ANTT part of on-boarding unit education helped us inculcate the ANTT skills in the newly joined staff from the beginning and helped us reduce variability in the unit.

It is logical to expect initial improvement in compliance with ANTT to be due to the Hawthorne effect. However, the improved compliance to components of ANTT over a long duration possibly rules out this effect and perhaps indicates culture change in standardised practices of intravenous line maintenance.

Implementing ANTT in intravenous line maintenance was associated with a reduction in HCAI by more than 70%. Other confounding elements for HCAI like gestation, weight, sex, central line usage, ventilation, and nurse: Patient ratios were not significantly different during the intervention phase. Another reason more significant reduction could be the QI project would have partially contributed to improvement in hand hygiene, central line maintenance[18 19] the non-touch technique of cannula insertion indirectly.

The study had a few limitations. Like other bundle approaches, improvements could not be linked with specific intervention.[18 19] Although infection rates improved, the scrub the hub subcomponent, drying for 30s, could only attain compliance up to 70% like other studies.[4 19]

In conclusion, the use of ANTT principles for common procedures like intravenous line maintenance by the QI approach was associated with a reduction of HCAIs. Major intervention to ensure compliance to ANTT was teaching and training, apart from ensuring availability of supplies and sharing data. Ensuring access to video training of procedures and making ANTT part of on-boarding unit education were successful ideas. Scrub the hub requires sustained efforts to get incorporated into the practice.

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Contributors SS: designed the data collection tool, collected the data, critically reviewed the manuscript and approved the final manuscript. ASA: conceptualised and helped in study design, analysed the data and drafted the initial manuscript and approved the final manuscript. SR: helped in study design, collected the data, reviewed the data and the manuscript and approved the final manuscript. VR: critically reviewed the manuscript and approved the final manuscript. PV: helped in study design and helped in analysis of results. Critically reviewed the manuscript and approved the final manuscript.

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Patient consent for publication Not required.

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