RESEARCH PAPER

Reducing Healthcare-associated Infections in Neonates by Standardizing and Improving Compliance to Aseptic Non-touch Techniques: A Quality Improvement Approach

SUPREET KHURANA, SHIV SAJAN SAINI, VENKATASESHAN SUNDARAM, SOURABH DUTTA AND PRAVEEN KUMAR

From Division of Neonatology, Department of Pediatrics, Post Graduate Institute of Medical Education and Research, Chandigarh, India

Correspondence to: Dr Praveen Kumar, Professor, Division of Neonatology, Department of Pediatrics, Post Graduate Institute of Medical Education and Research, Chandigarh, India. drpkumarpgi@gmail.com

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Objective: To standardize and improve compliance to Aseptic non-touch techniques (ANTT) for commonly performed procedures in Neonatal intensive care unit (NICU) through application of Model for improvement, and study its impact on Healthcare-associated infection (HCAI) rates.

Design: Quality improvement project utilizing multiple Plan-Do-Study-Act (PDSA) cycles.

Setting: Tertiary-care neonatal unit.

Participants: All resident doctors and nurses working in neonatal unit were subjects for assessment of compliance to ANTT. All admitted neonates staying in hospital for more than 48 hours were subjects for HCAI data collection.

Procedure: Most frequently performed procedures in NICU were identified and pictorial Standard Operating Procedures (SOP) were developed. Implementation and uptake was reinforced by means of PDSA cycles. Compliance to ANTT was assessed as proportion of components to which adherence was documented. Trend of HCAI rates in unit were analyzed using process control charts.

Main outcome measure: Change in compliance to ANTT for most frequently performed procedures.

Results: Significant improvement in compliance to ANTT practices was observed, specifically in use of procedure tray/ trolley (16% to 49%, *P*=0.001), iv hub scrubbing (0% to 60%, *P*=0.001), local skin cleaning (33% to 67%, *P*=0.004), personal protective equipment use (55% to 80%, *P*=0.02) and disposal (27% to 51%, *P*=0.03), use of non-touch technique (50% to 70%, *P*=0.001) and reduction in key part contamination (45% to 31%, *P*=0.03). A modest decrease in HCAI rates was seen in the short period of observation after implementation.

***Conclusions*:** Substantial improvements in compliance to aseptic non-touch techniques can be ensured by adopting a combination of initial intensive teaching and sustaining through multiple PDSA cycles, targeting specific areas revealed by audits.

Keywords: *Infection control, Neonatal sepsis, Nosocomial infection.*

Newborns in resource-constrained developing countries are 3 to 20 times more likely to acquire Healthcare-associated infections (HCAIs) than those in developed countries [1]. The major methods to reduce the burden of HCAIs include improvements in reporting and surveillance systems [2], identification of local determinants of infection [3], implementation of standard precautions and use of care bundles [4], with particular attention to aseptic techniques, and improving staff education [5], competency and skills [3].

Sick and preterm neonates undergo significant instrumentation during their hospital stay, which predisposes them to acquire HCAIs. Failure to use fastidious aseptic techniques during instrumentation and procedures, which involve breaches in skin and mucosal barriers leads to HCAIs. Devices and procedures are considered two of the most important risk factors for HCAIs [6]. Aseptic Non-Touch Technique (ANTT) based on a set of well-defined principles, aims to standardize common procedures by maintaining an aseptic field and protecting Key parts and Key sites from touch with potentially contaminated hands and items [7,8]. Although evidence based interventions to decrease HCAIs are well described, there exists a significant gap between theory and practices. This results in wide variations in patient care practices with regard to aseptic techniques [9].

In this quality improvement project, we aimed to standardize and improve compliance to aseptic non-touch techniques by developing and implementing SOPs for the most frequently performed invasive procedures in neonates and to study the change in incidence of HCAIs with improvement in compliance.

METHODS

This was a quality improvement project carried out in a tertiary-care neonatal unit of an academic institution from August 2015 to December 2016. The unit comprises of 22 intensive care beds, 18 step-down beds, and 10 observation cots in the labor room. The average nursing strength is 5-7, 2-3 and 1-2 nurses per shift for the three areas, respectively. About 100-130 neonates are admitted per month. The timeline of the study with details of activities is shown in ***Web Table* I**. All resident doctors and nurses working in the neonatal unit were subjects for assessment of compliance to ANTT. All admitted neonates staying in hospital for more than 48 hours were subjects for HCAI data collection. Infants diagnosed to have blood stream infection (BSI) (clinical or microbiologically confirmed) or pneumonia or meningitis at or after 48 hours of hospital stay were eligible to be part of numerator data.

All healthcare providers, area heads and in-charges of neonatal care areas were informed about the study through presentations and posters. Individual consent from healthcare providers was not sought. The Institute Ethics Committee approved the study and gave waiver of individual consent. The study phases were as follows:

Phase 1: Over a 4 week period, prospective data was collected for type and frequency of various procedures performed on all admitted neonates during first 10 days of life. This was done by attaching a procedure frequency performa to the nursing observation sheets of all babies. The period of first ten days of life was selected based on our previous experience which showed that majority of HCAIs occurred within 2-10 days of life in Indian context [10]. From this data, ten most frequently performed invasive procedures with potential contribution to HCAIs were shortlisted.

Phase 2: A generic ANTT audit tool, based on existing literature and guidelines was formalized for gathering baseline information on procedural practices in the unit [11]. A group of nurses was trained to carry out this activity.

Phase 3: Formulation of SOPs was done after reviewing original ANTT material [12], local practices and resources, scientific literature, and several rounds of discussions with clinicians and nurses. For this activity, teams of nurses and doctors were assigned specific procedures. Procedure specific SOPs were then finalized and pictorial depictions of procedures based on ANTT using color-coded guidelines were made. The dissemination of SOPs was done by group discussions, video demonstrations, posters and pictorial guidelines. For rapid cascading uptake, 'each one teach one' strategy was utilized for 1:1 demonstration of ANTT based SOPs. Competency checks were done by means of checklists and feedbacks by the allocated team of nurses and doctors.

Phase 4: Re-audits by generic ANTT based tool and audit of compliance to procedure specific ANTT based SOPs were conducted in each clinical area to check change in compliance rates.

Continuous surveillance of HCAIs and collection of denominator data was carried out throughout the study period. We included clinical and microbiological confirmed blood stream infections, pneumonia and meningitis as defined by German neonatal nosocomial infection surveillance system [12]. Superficial infections and UTI were not included.

Statistical analysis: The compliance to ANTT for a particular procedure was assessed as proportion of components to which adherence was documented. Inter-group comparison of categorical variables was done by Chi square or Fischer exact test. HCAI rates were expressed per 1000 patient days. The trend of HCAIs over time was analyzed using statistical process control charts and significant changes interpreted as per standard rules. The change in HCAI rates before and after implementation of ANTT was compared by interrupted time series analysis.

RESULTS

A total of 6929 procedures were performed on 60 neonates during 399 patient-days (procedure rate, 17.3 procedures/neonate/day). Most frequently performed procedures were oro-gastric feeding (43%) followed by intravenous fluid and drug preparation (11.4%) and administration (9.8%) (***Web Fig*. 1**).

During the second phase, 143 audits for shortlisted procedures were conducted; seven major components with further sub-components were audited (***Table* I**). In re-evaluation phase, 111 audits were done to check for compliance (***Table* I**). Thereafter, we targeted improvements in specific areas by conducting multiple Plan Do Study Act (PDSA) cycles. One such example is illustrated in ***Table* II** and ***Web Fig*. 2**, where the focus was improvement in compliance to scrub the hub technique for intravenous line handling.

During the pre-ANTT implementation period, 2152 admitted neonates were observed for 14,019 patient days. Of them, 235 neonates developed 279 episodes of HCAIs (incidence, 19.9 episodes/ 1000 patient-days). Post-ANTT implementation, a gradual decline in incidence

TABLE I GENERIC AUDIT OF COMPLIANCE TO ANTT DURING BASELINE AND POST-INTERVENTION PHASES

Component	*Sub-steps*	*Pre-ANTT*	*Post-ANTT*	*P value*
Type of technique	Procedure tray/trolley used with clean gloves and non-touch technique	23/143 (16%)	55/111 (49%)	0.001
	Other technique used*	63/143 (44%)	30/111 (27%)	0.005
Hand decontamination	Multi-step technique used for ≥30 s	88/143 (61%)	73/111 (66%)	0.488
	Hands cleaned at appropriate times	95/143 (66%)	82/111 (74%)	0.201
	Hands cleaned immediately after glove removal	52/105 (49%)	47/76 (62%)	0.115
	Hands re-cleaned if contaminated	25/88 (28%)	29/71(41%)	0.128
Glove usage	Sterile gloves worn appropriately	31/39 (79%)	27/30 (90%)	0.327
	Non sterile gloves worn appropriately	9/104 (9 %)	14/81 (17%)	0.078
	Gloves changed if contaminated	11/71 (15%)	10/51 (20%)	0.553
	Gloves applied at appropriate time	91/143 (64%)	77/111 (69%)	0.338
Equipment decontamination	Equipment cleaned as per local policy	98/143 (68%)	76/111 (68%)	0.991
	IV hubs scrubbed for 15 s and dried	0/28 (0%)	12/20 (60%)	<0.001
	Procedure tray and trolley cleaned as per local policy	77/143 (54%)	69/111 (62%)	0.184
	Skin cleaned for 30 s with alcohol	16/49 (33%)	18/27 (67%)	0.004
Personal protective equipment	Correct PPE used for procedure	22/40 (55%)	28/35 (80%)	0.022
	PPE applied at appropriate times	19/40 (47%)	21/35 (60%)	0.279
	PPE disposed off appropriately	11/40 (27%)	18/35 (51%)	0.034
Aseptic field management	Main aseptic field used	81/143(57%)	71/111 (64%)	0.184
	Main aseptic field compromised	33/81 (41%)	29/71 (41%)	0.843
	Key parts protected when not in use	61/143 (43%)	60/111 (64%)	0.071
Non-touch technique	Non-touch technique used	71/143 (50%)	78/111 (70%)	0.001
	Key parts touched by HCW*	64/143 (45%)	35/111 (31%)	0.032
	Key parts touched by non-aseptic equipment and surfaces*	68/143 (47%)	41/111 (37%)	0.090

**Components-Decrease in percentage indicates better compliance with ANTT; HCW: Healthcare worker; PPE: Personal protective equipment.*

TABLE II SUMMARY OF PDSA CYCLES FOR IMPROVING COMPLIANCE TO 'SCRUB THE HUB'

PDSA cycle	*Aim*	*Plan*	*Do*	*When*	*Study*
I	Improve scrub the hub compliance from 0 to 80%	IV line pictorial SOP(scrub the hub was part of this) Intensive teaching	One to one teaching over a period of 1 mo Pictorial SOP posted	Oct 16 - Nov16	Improvement from 0% to 60%
II	Improve compliance of scrub the hub to 80% in each patient care area Understand the reasons for non compliance	Inspiring Whatsapp messages twice a day about significance of scrub the hub 'Scrub the hub' posters in all unit Determine reasons for non compliance by feed back	Whatsapp messages were sent twice a day Catchy Posters were put up in all areas Group discussions with nurses to under-stand barriers	1-14 - Dec 16	Compliance to scrub the hub in different areas improved NICU-70% Stepdown unit- 80% Labor room-60% Identified concerns- potential contamination of swabs and belief that they are inferior to prepacked swabs.
III	Improve compliance in individual areas to >80%	Feedback of individual area compliance Address concern of swab contamination	Positive feedback for compliance improvement Local adaptation as auto claved swab tray to allay fears	21-27 Dec16	Compliance in individual areas improved to >80%, with average compliance of 85%

with maximum fall to 15.3 episodes/ 1000 patient–days was observed (***Fig.* 1**).

DISCUSSION

In the first phase of our study we identified preparation and administration of oro-gastric feeding, intravenous fluids and drugs, as the most commonly performed procedures during initial ten days of life in a neonate. Unlike the developed countries, majority of HCAIs occur at a much earlier age in our set-ups. This is likely due to the number and intensity of 'unclean' procedures performed in the delivery room and initial days of illness, and comparatively shorter hospital stays. Their importance lies in the frequency with which they happen and are performed with less than usual alertness, they have significant potential to contaminate and colonize with pathogenic bacteria. The use of long-stay central lines is also lesser in our context as compared to West, possibly because of poorer survival of extremely small infants and more aggressive feeding strategies. Therefore, the relative importance of target procedures for improvement in Indian context, is slightly different from that in developed countries.

During baseline audits, we found significant variations in the way procedures were performed. Standardization has enormous potential to improve healthcare and outcome [13]. The Institute of Healthcare Improvement (IHI), USA 'model for improvement' in healthcare quality has been shown to be very successful in improving healthcare practices by empowering the nurses and doctors to improve their own practices [14]. Based on our previous experience and success with this model, we chose to adopt this for standardizing and improving the usage of aseptic non-touch techniques during procedures performed in the NICU.

In our study we could significantly improve procedure tray/trolley use. Fahy, *et al*. [15] found inappropriate use of aseptic precautions in about half of pediatric anaesthesia cases and hence recommended need for professional guidance and training. IV scrub hubbing and appropriate use of personal protective equipment (PPE) showed significant improvement in our study. Ho, *et al.* [16] used a bundled approach with education and training on hub disinfection and showed that use of mask and cap and proper hand hygiene was effective in reducing the burden of infections in their unit.

We could not show a significant improvement in the quality of hand hygiene. We assessed the quality of hand hygiene by checking compliance to its various components and not simply overall compliance to hand hygiene. Since availability of hand hygiene facilities and hand rub was not a problem, the main challenge involved human behavioral factors and redesigning work flows. This work is in progress and ongoing determination of hand hygiene compliance along with targeted solutions directed towards root causes of non-compliance are being taken care for further improvements. The impact on HCAI rates was modest as expected. Our study is limited by the fact that quality improvement projects with ambitious goals and broad aims are known to require a time frame of 2-7 years for significant impact. We are continuing PDSA cycles for continuous improvement in compliance rates to ANTT practices to see improvements in HCAI rates.

The adaption as per local context is crucial to the

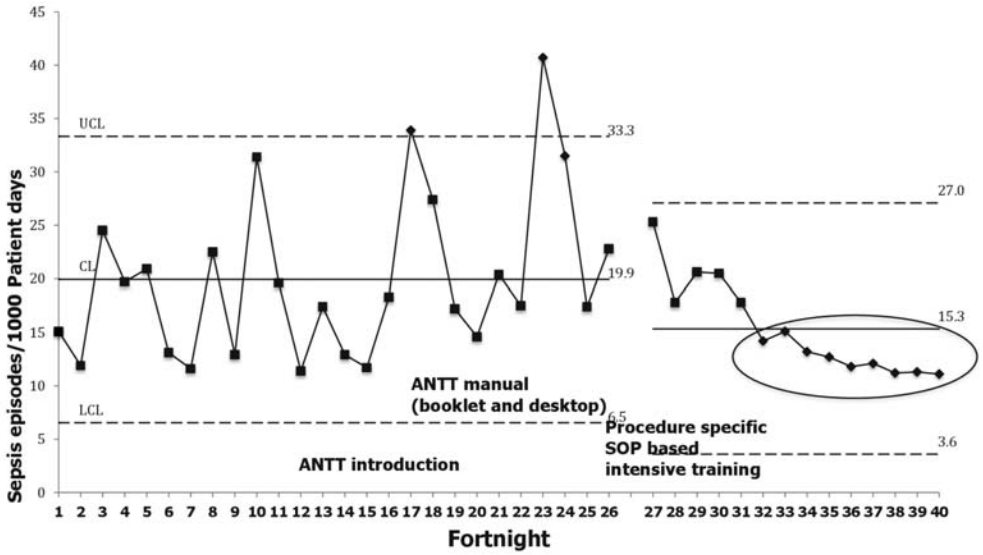

FIG. 1 *Healthcare-associated infections per 1000 patient days (C-chart).*

WHAT IS ALREADY KNOWN?

- Lack of compliance to aseptic techniques and variability in their practices play an important role in causation of Healthcare-associated infections.

WHAT THIS STUDY ADDS?

- A quality improvement model could be successfully used for standardizing and improving aseptic non-touch technique practices in a unit within the existing resources.

success of implementation. For example, practical limitations were faced in some clinical areas, as availability of separate designated area for performing aseptic procedures, though desirable, was not available. Therefore, a mobile steel trolley was earmarked for this purpose. Use of aseptic working fields that ensure a controlled and aseptic environment during clinical procedures is widely recommended worldwide by health care organizations [17].

Formulation and dissemination of local SOPs incorporating ANTT principles helped in significant improvement in compliance to various sub-components of ANTT even after a short period of implementation. Sustained improvement requires not only knowledge and awareness but also taking care of system and human factors. The current exercise has provided us vital insights with several specific areas to focus on and several ideas to overcome the barriers and improve the system. They have formed the basis of multiple PDSA cycles which are being incorporated and reinforced in regular fashion along with patient care processes of the unit for sustained improvement.

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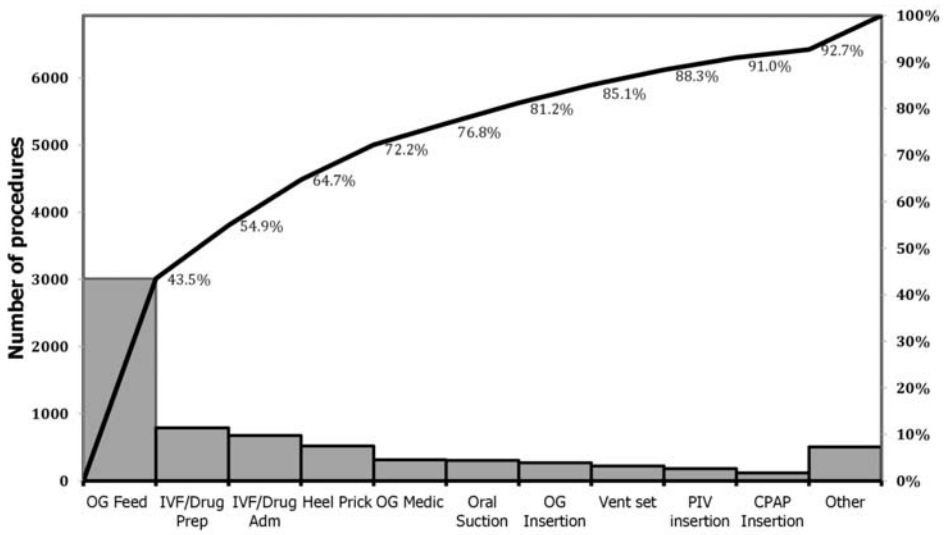
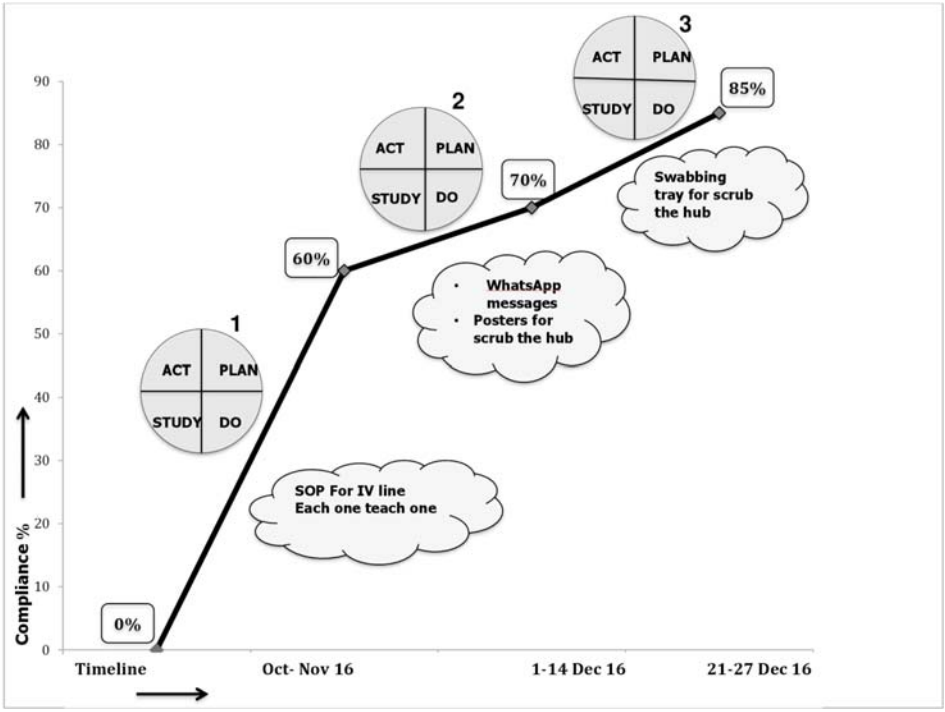
WEB TABLE I STUDY ACTIVITIES AND TIMELINE

Aug-Sep 15	*Oct-Dec 15*	*Jan-Feb 16*	*Mar-June 16*	*July-Oct 16*	*Nov-Dec 16*
Audits of frequency and type of procedures	Finalization of procedure specific audit tools	Audits of selected procedures and FGDs for current processes	Drafting of SOPs and conduct FGDs	Finalization of SOPs and pictorial ANTT Finalisation of Pictorial ANTT SOP	Re-audit of procedures for ANTT compliance
Finalization of generic ANTT audit tool		Creation of SOPs, teaching-learning materials, competency tools for selected procedures		Procedure specific audit tool as per SOPs	
			Implementation of SOPs/competency based teaching-learning		
			Ongoing active surveillance of HAI rates		

ANTT: Aseptic non-touch technique; FGD: Focused group discussions; SOP: Standard operating procedures.



WEB FIG. 1 *Pareto chart of frequency of various procedures in neonates.*



WEB FIG. 2 *Run chart for 'scrub the hub' compliance and PDSA cycles.*