Outcomes of Implementing the Central Venous Catheter Bundle at a Tertiary Care Hospital in North India, at AIIMS, New Delhi

Shanmugam Krishnan[1], Arvind Kumar[2], Prayas Sethi[2], Manish Soneja[3], Immaculata Xess[4], Arti Kapil[5], RM Pandey[6], Naval K Vikram[7], Ashutosh Biswas[7], Naveet Wig[7*]

Abstract

Introduction: Central venous catheter (CVC) associated infection are many times higher in India compared to western countries. A group of interventions called as CVC bundle, if implemented effectively prevents CVC related complication.

Methodology: Our study was a prospective quasi-experimental study. The study evaluated the level of compliance with the central venous catheter bundle in the management of patients in our Medicine wards and Intensive care unit (ICU).

Results: In the study, the incidence of central line associated bloodstream infection (CLABSI) was zero and the incidence of pneumothorax was 5%. Most of the patients had higher Acute physiology and chronic health evaluation (APACHE II) at baseline and multi organ dysfunction. The compliance with whole CVC bundle improved from 0% at baseline to 10% in post-intervention phase. Compliance of many components increased significantly in the post intervention period. These were Hand washing before insertion (15% to 72.5%, p<0.001), Maintenance (0% to 52.5%, p<0.001), Prompt removal of catheters (40% to 70%, p=0.007), Skin antisepsis with chlorhexidine increased approaching significance (0% to 12.5%, p=0.055). Avoidance of femoral catheters was done in more than 95% of the cases. The predictors of mortality were higher APACHE II (OR 1.23 [CI 1.03-1.47], p=0.020) and duration of hospital stay (OR 0.87 [CI 0.78-0.97], p=0.022).

Conclusion: This study done at All India Institute of Medical Sciences showed improved outcome in terms of catheter infection and mechanical complications. CVC bundle compliance increased significantly though adherence to full bundle was less. In future, with rectification of barriers to bundle completion, the compliance with CVC bundle can be further improved.

Introduction

Healthcare – associated infection (HAI) as defined by CDC is a localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent or its toxin that was not present on admission to the acute care facility.[1] Healthcare-associated infections from invasive medical devices in the intensive care unit (ICU) particularly CLABSI has been shown to pose the greatest threat to patient safety, hospital cost and stay.[2] Device associated infections in developing countries are up to 13 times higher than in USA.[3] Studies done in the developed countries have shown that strict institutional protocol

[1]Resident, [2]Assistant Professor, [3]Associate Professor, Department of Medicine, [4]Additional Professor, [5]Professor, Department of Microbiology, [6]Professor, Department of Biostatics, [6]Professor, Department of Medicine, All India Institute of Medical Sciences, New Delhi; *Corresponding Author
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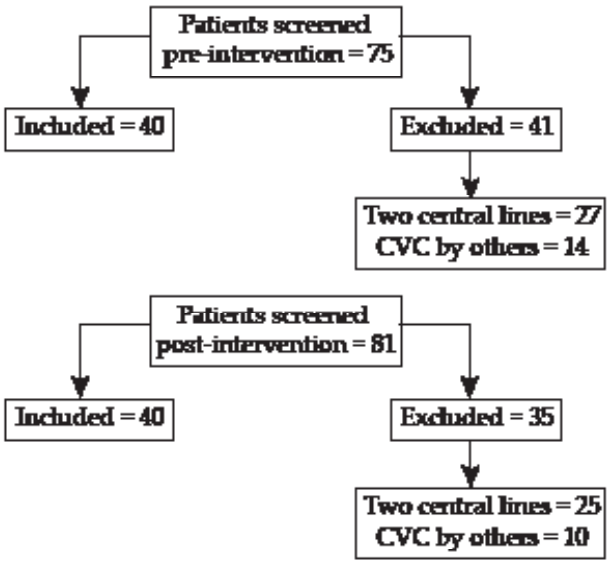

Fig. 1: Flow diagram showing the recruitment of patients in the pre-intervention and the post intervention period

Table 1: Comparison of baseline characteristics of patients in the pre intervention and post intervention period

Parameter	Pre-intervention (Mean±SD)	Post- intervention (Mean±SD)	p value
Age(years)	43.75 ± 20.70	48.78 ± 20.10	0.14
APACHE II	19.18±5.86	18.42±6.54	0.70
Systolic BP (mm Hg)	101.1±24.02	118.4±31.90	0.004
Diastolic BP (mm Hg)	66.85±14.75	72±14.99	0.063
Haemoglobin (g/dL)	10.22 ± 2.30	9.88± 2.62	0.73
WBC count (/mm3)	13550 (2300-31700)	14100 (2200-32800)	0.37
Platelet count (/mm3)	175000 (14000-461000)	138500 (15000-411000)	0.09
Creatinine (mg/dL)	1.1(0.5-6.4)	1.85(0.2-10.1)	0.035
Blood urea (mg/dL)	43(18-229)	75.5(16-230)	0.018
Total bilirubin (mg/dL)	0.8(0.4-3.9)	0.8(0.3-18.6)	0.22
Days on ventilator	6(2-23)	7(3-26)	0.104
ICU stay in days	8(4-24)	10.5(4-34)	0.185
Foley's catheter days	6(0-32)	8(0-26)	0.064
Endotracheal tube in days	6(0-14)	6(0-26)	0.112
Ryle's tube days	4(0-32)	6(0-32)	0.015
No. of catheter days	8(4-32)	9(4-27)	0.16

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Methods

Setting

The study was conducted in Medicine ICU and Emergency wards of All India Institute of Medical Sciences, New Delhi after getting an ethical clearance from hospital ethical committee. It was conducted from January 2013 to October 2014, as quality improvement interventional study on a Quasi-Experimental pre-post

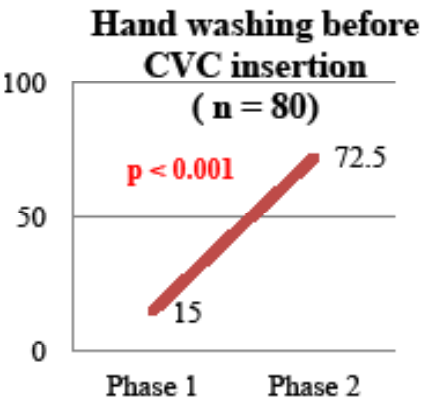

Fig. 2: Graph showing the change in compliance with hand washing before catheter insertion from pre-intervention period to post intervention period

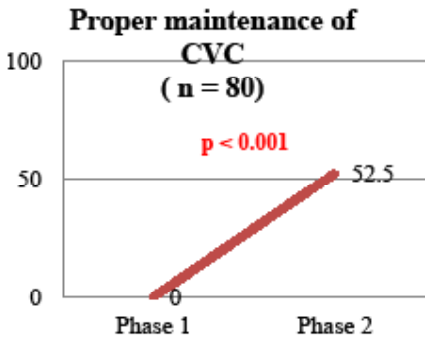

Fig. 3: Graph showing the change in compliance with central venous catheter maintenance from pre-intervention period to post intervention period

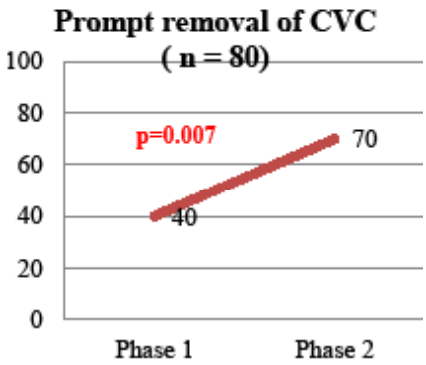

Fig. 4: Graph showing the change in compliance with prompt removal of central venous catheter from the baseline phase through the quality improvement phase

Design model with three phases; Pre-intervention phase (Nine months of assessment of current practices in the CVC insertion, maintenance and removal), Quality improvement or Intervention phase (Three months of sensitisation, education and feedback to residents regarding guideline based protocol in CVC insertion, maintenance and removal via discussion, lectures, posters, notes distribution, What's app and face books) and Post intervention phase (9 months reassessment of any change in practices of central line insertion, maintenance and removal from case files with the help of the proforma), on 40 patients in each pre-and post-intervention group. Each quality indicator was assigned as 1 if graded correctly, 0 if not done correctly.

Description and definitions

The Quality indicators were defined for the comparison between pre-intervention and post-intervention phases. Quality indicators were based on Institute for Healthcare Improvement (IHI) bundle and American Society of Anaesthesiologists (ASA) insertion checklist. Each quality indicator is discussed here in detail separately. Blood cultures and central line tips were sent for cultures at the time of removal or when there was a suspicion for CLABSI.

Quality Indicators used in the study

1. **Hand washing:** Hand washing was considered as optimal when alcohol based rub was used optimally as defined by WHO and CDC guidelines during central line insertion.
2. **Full barrier precautions:** Full barrier precautions included the use of sterile body drape, cap, mask, gown and sterile gloves and the status was maintained throughout the procedure. No contact with aseptic devices were allowed.
3. **Cleaning the skin with povidone iodine/ Chlorhexidine:** Cleaning the skin was considered optimal when the insertion site was cleansed with alcoholic chlorhexidine which was allowed to dry before insertion. In case of non-availability of chlorhexidine, povidone iodine 10% aqueous solution which was available commonly was assessed with the use of alcoholic disinfectant.
4. **Maintenance:** In maintenance parameters assessed were dressings at the site of catheter, dressing changes made in accordance with the current recommendations. Along with assessment of ports in which aseptic technique was followed with proper hand washing and cleaning the hub with alcohol soaked swab or gauze before access to the ports.
5. **Prompt removal of catheters:** Prompt removal of catheters was assessed by a daily assessment of catheter need and the delay to removal in days was also noted.
6. **Avoidance of femoral catheters:** Catheter site of insertion was noted.

Complications

Pneumothorax

Pneumothorax is air in the pleural cavity. It can be diagnosed by chest x ray or USG chest. In our study, pneumothorax was diagnosed by a radiologist with chest x rays.

Arterial puncture

Arterial punctures were defined in our study when bright red pulsatile flow was noted during needle insertion. ABG and USG were also used if doubt arises.

Hematoma

Hematoma was defined in our study as an area greater than 3 cm of bruising or swelling around the site of insertion.

Statistical Analysis

All data collected were entered in Microsoft Excel spreadsheet and the data was analysed using STATA software version 11.0. Pearson Chi-square test/ Fischer exact test was used for analysis of categorical data. Unpaired student t-test was used for analysis of continuous data in normal distribution. Wilcoxon Mann–Whitney test was used to compare data in skewed distribution. Data were presented as mean±SD for normal distribution. For skewed variables, data were presented as median (minimum-maximum). Univariate and multivariate logistic regression was performed for predictors of mortality. Multivariate analysis was done for variables with a p value of less than 0.20 on Univariate logistic regression. A p value of less than 0.05 was considered significant.

Results

A total of 156 patients were screened in both the phases and 76 patients were excluded as 52 patients had a dialysis catheter in addition to triple lumen catheter and 24 patients had central

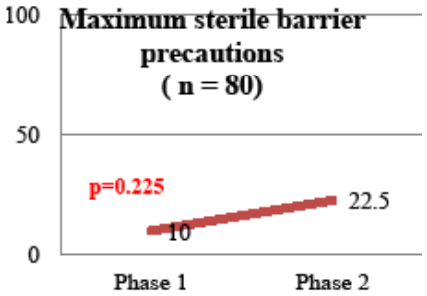

Fig. 5: Graph showing the change in compliance with maximum sterile barrier precautions from pre-intervention period to post intervention period

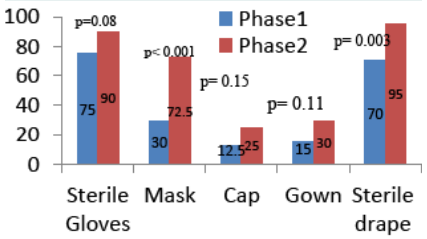

Fig. 6: Graph showing the change in compliance with individual components of maximum sterile barrier precautions from pre-intervention period to post intervention period

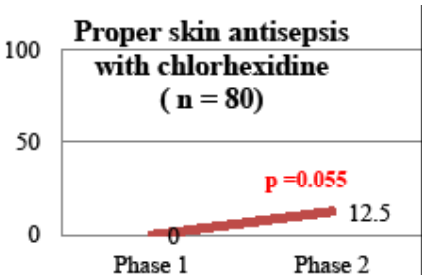

Fig. 8: Graph showing the change in compliance with skin antisepsis at the insertion site of central venous catheter with chlorhexidine/povidone iodine from pre-intervention period to post intervention period

line inserted by others (Figure 1). The mean age of the study population was 43.75 years and 48.78 years in the pre-intervention and post-intervention group respectively. The male and female sex distribution in pre-and post-intervention phase was 52.5%, 47.5% and 55%, 45% respectively.

The characteristics of both the groups like APACHE II, hemoglobin, total leucocyte count, platelet count and diastolic BP were comparable in both groups except for systolic BP, creatinine and urea which were significantly higher in the post intervention group

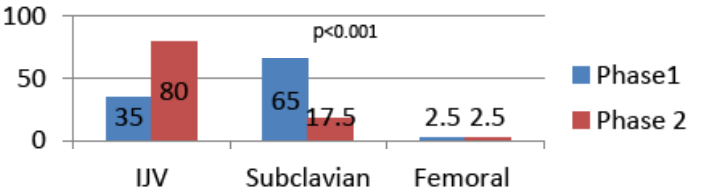

Fig. 7: Graph showing the change in the insertion site of central venous catheter from pre-intervention period to post intervention period

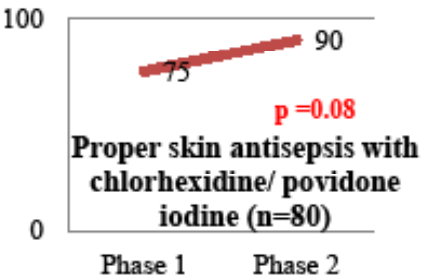

Fig. 9: Graph showing the change in compliance with skin antisepsis at the insertion site of central venous catheter with chlorhexidine from pre-intervention period to post intervention period

at the time of admission (Table1).

Comorbidities in both the phases like hypertension, hypothyroidism, connective tissue disease, Coronary artery disease, tuberculosis, Malignancy, congestive heart failure, cerebrovascular accident and COPD were comparable and the difference wherever was not significant.

The most common indication of central line at the time of insertion in pre-intervention and post-intervention group was hypotension (62.5% and 52.5%) requiring central venous (CVP) pressure monitoring and inotropic requirement followed by acute kidney injury (AKI) requiring CVP (30 and 40%) for fluid administration. Absence of peripheral lines constituted 6 cases in 7.5 and 7.5% respectively in two phases. Central lines were inserted most commonly in ward followed by ICU and in emergency ward around 42.5%/45%,30%/27.5% and 27.5%/27.5% respectively in pre/post intervention phase. There was no significant difference between the places of insertion. USG guidance during central line insertion was used only for internal jugular insertion in 78.57% and 96.88% in both the phases.

Comparison of Bundle implementation phases and compliance

Table 2: Comparison of parameters related to monitoring of central lines in patients in the pre-intervention and the post intervention period

Parameter	Phase 1	Phase 2	p value
Dressing	28(70%)	36(90%)	0.02
Dressing change	22(55%)	33(82.5)	0.01
Ports	0(0%)	22(55%)	<0.001
Trendelenburg position	35(87.5%)	32(80%)	0.36
Patency checked	32(80%)	33(82.5%)	0.77
No of attempts (Median min-max) by USG	1(1-6)	1(1-3)	0.034
X ray done	36(90%)	37(92.5%)	0.69
Documentation	10(25%)	27(67.5%)	0.001
Days delayed for removal Median (min-max)	1(0-6)	0(0-4)	0.001

Patient characteristics were summarized as previously described. Parameters were comparable except for creatinine, urea, systolic BP and COPD. Indications for central line were similar in both the phases.

At baseline, compliance with all the 6 parameters in combination were nil. There was vast scope of improvement in each and every sector of the bundle. The only indicator which was above 50% was avoidance of femoral catheters which was done in all the patients except for one patient in each of the groups (Figure 7); the site of insertion in phase I / phase II were IJV,subclavian and femoral were 35%/80%, 65% / 17.5% and 2.5% / 2.5% respectively. Out of the six individual components of the bundle three showed statistically significant improvement in the post intervention period. These bundle components were hand washing before insertion (15% in phase 1 to 72.5% in phase 2, p<0.001) as shown in figure 2, maintenance (0% in phase 1 to 52.5% in phase 2, p<0.001) as shown in figure 3 and prompt removal of catheters (40% in phase 1 to 70% in phase 2, p=0.007) as shown in figure 4. The delay in catheter removal in days also significantly

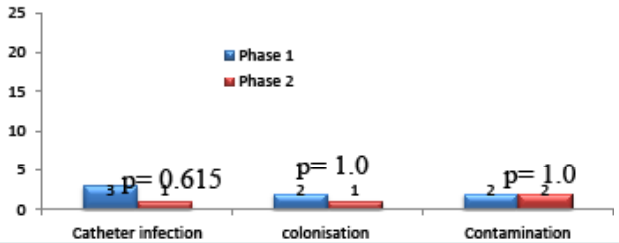

Fig. 10: Graph shows the change in infectious complications from pre-intervention period to post-intervention period

Table 3: Compliance with CVC bundle elements in AIIMS medicine wards and ICU

Parameter	Pre-intervention	Post-intervention	p value
Hand washing before insertion	15%	72.5%	<0.001
Maximum sterile aseptic precautions	10%	22.5%	0.130
Skin antisepsis with chlorhexidine	0%	12.5%	0.055
Maintenance	0%	52.5%	<0.001
Prompt removal of catheters	40%	70%	0.007
Avoidance of femoral catheters	97.5%	97.5%	1.0
Whole bundle completed	0%	10%	0.116

decreased from a mean of 1.65 days to 0.5 days with a p value of <0.001. Maximum sterile barrier precautions increased from 10% in pre-intervention period to 22.5% in the post intervention period (Figure 5). In maximum sterile barrier precautions, the use of mask and sterile body drape increased significantly from the baseline (Figure 6). Even though the usage of cap and gown increased, the increase was not significant.

The site of insertion changed significantly from subclavian to internal jugular vein (Figure 7). Chlorhexidine availability was limited; hence povidone iodine was used mostly in both the phases. Proper use of povidone iodine/ chlorhexidine with appropriate drying time was done in 75% of patients in pre-intervention period as against 90% in the post intervention period as shown in figure 8 and figure 9 During maintenance, parameters checked were dressing at the site of insertion, dressing change every 7 days in case of semi-transparent or every 2 days in case of gauze dressings if dressing is clean or changing whenever soiled. Also, the usage of ports was assessed both by direct inspection as well as questionnaires to junior residents and staff, whether sterile technique was used and proper scrubbing of hubs was done. There was significant improvement in all the three maintenance parameters seen (Proper dressing at the site of insertion from 70% to 90%, p=0.02; dressing change from 55% to 82.5%, p=0.01 and proper use of ports from 0 to 55%, p<0.001). Also, documentation on file improved from 25% to 67.5% (p=0.001).

Complications

Insertion complications

Insertion complications assessed in the study were hematoma, arterial puncture, pneumothorax and tip malposition. Although all the complications decreased in the postintervention period, only tip malposition (26 vs 25 with p value =0.041) achieved statistical significance. All 4 pneumothoraxes (3 in pre-intervention period vs. 1 in the post intervention period, p=0.615) that occurred in the study were diagnosed by chest X rays and required ICD insertion. There was a total of 3 hematomas in pre-intervention period ascompared to 2 in the post intervention period (p= 1.0).

Arterial punctures occurred in both the phases (5 in phase 1 vs. 4 in phase 2, p=1.0). None of the arterial punctures had a significant hematoma or complication. Tip malposition also occurred frequently in the study (52.5% in phase 1 vs. 37.5% in phase 2, p=0.041). The most common tip malposition was tip below the level of carina for right sided catheters. The only significant individual predictor of insertion complications was number of attempts (number of attempts>1, p<0.001).

The mean number of attempts in pneumothorax was 3.25±1.89 as against 1.35±0.08 in patients who did not have a pneumothorax. The mean number of attempts in arterial punctures was 2.78±0.52 as against 1.28±0.07 in patients who did not have it. The mean number of attempts in hematoma was 3.2±0.73 as against 1.33±0.07 in patients who did not have it. The mean number of attempts were significantly higher in patients who developed insertion complications.There were no independent predictors of arterial punctures or tip malposition.

Maintenance complications

Infectious complications were also assessed. There was no CLABSI or Catheter-related bloodstream infection(CRBSI) observed in this study. However, catheter infection as defined above decreased from 3 to 1 in the post intervention period, even though it did not attain statistical significance (Figure 10). In the catheter infection, two were diagnosed by clinical criteria and their fever responded promptly within 48 hours of removal of the catheter and empirical antibiotics. Another two patients grew MRSA on catheter tip and these two patients were treated with vancomycin for 2 weeks. There was 1 case of *Enterobacter* colonization and one case of *Candida* colonization in pre-intervention period, 1 case of *Acinetobacter* colonization in post intervention period, 2 cases of contamination in intervention period and 2 in the post intervention with all being Gram positive cocci. Blood cultures were sterile in all patients with catheter infection, colonization and contamination. There were only 4 blood cultures positive in the entire study as blood cultures before antibiotics were sent only in 15% of patients. All the 4 cases were secondary bloodstream infections with pneumonia, 2 being community acquired, 1 each of VAP and HAP.

None of the predictors of catheter tip infection were statistically significant except for the number of attempts which was more in patients who developed catheter tip infection. Even though improper hand washing, improper skin antisepsis and number of attempts were more in the catheter tip infection these were not statistically significant probably due to the low incidence of catheter tip infection and small sample size. The whole bundle compliance increased from 0% to 10% in the post intervention period. However, if proper skin antisepsis with povidone iodine is included, it improved from 0% to 17.5%.

Impact on Hospital mortality

None of the catheter complications had a significant impact on hospital mortality. The independent predictors of hospital mortality for all the patients combined were AKI, septic shock at admission, higher APACHE II and intubated patients. The mean duration

of hospital stay was lower in the patients who died probably due to higher APACHE II at admission and hence the mean duration of catheter days was also lower in the patients who died. Univariate and multivariate logistic regression was also done for mortality predictors. All patients who died were on ventilators and hence logistic regression was not possible. Each unit increase in APACHE II conferred an odds ratio of 1.23 for mortality. Duration of hospital stay and number of catheter days correlated inversely with mortality probably due to early deaths as expected in septic shock patients. On multivariate logistic regression, only APACHE II and duration of hospital stay were independent predictors of mortality.

Discussion

This study was conducted in the medicine wards and ICU of All India Institute of Medical Sciences, New Delhi, a tertiary level hospital in India to assess the level of compliance at the baseline with CVC bundle. The study also assessed the improvement in compliance with bundle quality indicators following intervention in the form of physician education and feedback. Baseline characteristics were comparable for both the groups. Quality indicators improved from 0% in the baseline to 10% in the post intervention phase. Proper hand washing, prompt removal of catheters and maintenance improved significantly in the post intervention period.

Evaluation of the data collected in the baseline phase revealed that compliance with individual bundle components was low for most of the components. Compliance was greater than 50% only for avoidance of femoral catheters. This parameter was achieved in 97.5% of all cases. Prompt removal of catheters was relatively better than other parameters, being practiced in 40% of all patients. Proper hand washing was practiced in only 12.5% of all catheter insertions during pre-intervention period. This is in accordance with multiple studies emphasizing that proper hand washing is done in less than 40% of all insertions. During the post intervention period, hand washing improved significantly to 72.5%. This is in accordance with a study done by Zingg et al. who observed that hand washing improved from 59% in baseline to 65% in intervention period, even though proper hand washing in that study improved from 22.5% to 42.6%, p= 0.003.[7] A quasi-experimental study conducted by Apisarnthanarak et al. in Thailand also showed improved adherence to central line bundle particularly hand hygiene improved significantly after intervention from 8% to 54% and CABSI decreased significantly from 14 per 1000 catheter days to 1.4 per 1000 catheter days.[8] Maximum sterile barrier precautions were practiced in 10% of catheter insertions only. This is in accordance with a study done by Perez Parra et al. who reported that maximum sterile barrier precautions were the least practiced and was less than 50% even among experienced physicians and it improved significantly after educational intervention.[9] In the post intervention period, it improved to only 22.5% probably due to the limited availability of gown and cap in emergency and wards. The use of mask, however improved significantly from 30% to 72.5% in the post intervention period. Proper skin antisepsis with chlorhexidine was not practiced in any patient during pre-intervention period. This was partly due to poor availability of 2% chlorhexidine in emergency and medicine wards of our hospital. This was in accordance with a study done in Yemen which showed that none of the ICU units had 2% chlorhexidine solutions.[10] However, even povidone iodine was not used correctly. International Nosocomial Infection Control Consortium (INICC) study done in 15 developing countries also showed improvement in chlorhexidine antisepsis from 7% to 27%, p<0.001.[11] In our study, although chlorhexidine usage increased to 12.5%, still povidone iodine was used most commonly due to ease of availability of povidone iodine.

Maintenance parameters significantly improved from 0% in the baseline to 52.5% in the post intervention period. Proper dressing was done in 65% of all catheter insertions. This is in accordance with a study conducted in Yemen by Al-Sayaghi who found that the most frequently practiced correct parameter in central line bundle was hand washing and dressing materials.[10] The use of ports defined as scrubbing the hub with alcohol based scrub improved significantly from 0% in the pre-intervention period to 52.5% in the post intervention period. Miller et al. conducted a prospective study in 29 pediatric ICUs and found that maintenance bundle improved significantly from 65% in the baseline to 82% in the post intervention period, resulting in a decrease in CLABSI rates by 43% with maintenance bundle being the only independent predictor.[12] In our study, maintenance bundle compliance was less probably due to increased workload of the residents and the nursing staff. Prompt removal of catheters was done in 40% of cases in pre-intervention period, which improved significantly to 70% in the post intervention period. The number of idle catheter days decreased significantly from a mean of 1.65 catheter days from the baseline to 0.5 catheter days in the post intervention period. Burdeu et al. conducted a study in which approximately 26.2% of CVC days were idle, thus prompt removal of catheters was not done.[13] In a similar study done by Ilan et al., there was a significant decrease in the proportion of patients with nonessential CVC days from 51% to 26% after the intervention.[14]

Pneumothorax occurred in 4 cases (5%) more frequent in subclavian insertions than internal jugular vein insertions and also the chances of pneumothorax were more when the number of attempts were more. This is in accordance with multiple studies and a recent study conducted by Vinson et al. in community emergency centers also revealed a higher incidence of pneumothorax with subclavian rather than internal jugular vein insertions (2.3% vs. 0.1%, p<0.001) and also with failure at the first attempt (2.5% vs. 0.3%, p=0.05). In this study, the risk of pneumothorax also increased with positive pressure ventilation.[15] However, in our current study, there was no significant relation of pneumothorax with ventilator probably due to the small sample size. Arterial punctures occurred in 22.5% in our study, more in subclavian (18.75%) than in the internal jugular (6.5%). This is in accordance with an Indian study done by Jha et al who observed that arterial punctures were the most common complication and it occurred more commonly in subclavian (16.6% vs. 4.5%) as against internal jugular vein.[16] Even though previous studies have shown that the risk of arterial punctures is higher with internal

jugular than the subclavian route, the use of USG guidance during IJV insertions has been shown to decrease the rate of complications. Thus, the low rate of arterial punctures in IJV seen in our study is likely due to USG guided internal jugular insertions.

Hematomas occurred in 5 cases (12.5%), 3 in pre-intervention period and 2 in post intervention period. The incidence of hematomas is higher than the study conducted by Jha et al. who found an incidence of 2.5% with IJV and 4.5% with subclavian insertions. This suggests a great chance of improvement in this area pertaining to our experts.

Infectious complications

There was no CLABSI documented in our study in both the phases. This was a peculiar observation compared to previous studies. This may be due to the multitude of antibiotics received by our patients, including MRSA cover which was given in over 70% of patients and most of the patients had sepsis with a known focus of infection. A recent study in our ICU by Deepti et al. also revealed zero CLABSI in our ICU despite hospital acquired infections being present in 38.8% of cases.[17]

Catheter tip infection occurred in 4 cases (5%), 3 in pre-intervention period decreasing to 1 in post intervention period, even though the decrease was not statistically significant thus contributing to a total of 5.03/1000 catheter days, 2.15/1000 catheter days in IJV, 6.28/1000 catheter days in the subclavian and catheter colonization rate of 3.78/1000 catheter days. Deshpande et al. in an epidemiologic prospective observational study observed a rate of catheter infection of 4.01/ 1000 catheter days and catheter colonization rate of 5.07/1000 catheter days. The higher incidence of catheter tip infection in our current study is likely due to poor compliance with the CVC bundle.[18] Mortality in our study was 36.25% high due to sepsis with septic shock being the majority of our cases. However, the mortality of severe sepsis and septic shock is likely higher than our estimates since AKI requiring dialysis was excluded from our study. MOSAICS study, a prospective cohort study done in Indian ICU also showed a similar mortality rate of 38.3% in sepsis patients admitted in ICU.[19] The study conducted by Todi et al. in four ICUs in India over a 3-year period showed that in-hospital mortality in patients with severe sepsis was 65.2%. The study did not calculate the percentage of septic shock or the mortality in septic shock subgroup.[20]

The hospital stay was significantly more in patients who survived rather than patients who died likely due to higher APACHE II and organ dysfunction at diagnosis thereby resulting in early deaths. The average hospital stay in our study was 20.01 days. The national analysis of severe sepsis patients in Canada for 12 years also revealed a similar hospital stay of 20 days in severe sepsis patients.[21] There was no relation of hospital stay with catheter tip infection or insertion complications. However, 2 patients with MRSA infection received antibiotics vancomycin for 2 weeks and the other 2 patients with clinical catheter tip infection received empirical antibiotics for 1 week. One patient with mediastinal hematoma was admitted for 5 extra days for observation of hematoma. There was no significant difference in ICU stay between both the phases and also in the patients who developed complications.

Limitations of our Study

Our study had a small sample size. A larger study population could have shown CLABSI, CLRSI with an impact on hospital mortality and hospital length of stay.

Our study had a quasi-experimental design. We could not perform an RCT in our study population of patients because of ethical constraints as the CVC insertion bundle is the current standard of care in these patients. Also, CVC post insertion bundle is attaining important role to further decrease rate of CLABSI.

With our study design, we were able to control most of the threats to both internal and external validity. Our study has a strong external validity and the study results can be applied to the general population. The study was designed to minimize threats to internal validity. Even with a organized study, we were able to increase the compliance with the CVC bundle from 0% at the baseline to only 10% by the end of the study period. This means that there are many variables involved in the process improvement. But in our study, we did not measure these barriers to bundle compliance improvement including the contribution of physician behavior and CVC insertion cart. Identifying and rectifying these variables could have led to a better rate of compliance with the CVC bundle in our study.

Conclusions

The study done at All India Institute of Medical Sciences showed there were zero CLABSI events. Successful completion of the CVC bundle with quality indicators along with USG guidance during insertion is associated with improved outcome in terms of catheter infection and mechanical complications, although the difference was not significant. USG guided IJV insertion improved significantly in the post intervention period. CVC bundle compliance increased significantly for hand washing, maintenance and prompt removal of catheters. Special attention needed to be given to maximum sterile barrier precautions and chlorhexidine skin antisepsis as compliance related to these measures were the hardest to improve. The study showed that a CVC bundle could be implemented in our emergency setting. Repeated feedback to clinicians and training was crucial in improving compliance. In future, with identification and rectification of barriers to bundle completion, probably with separate CVC cart, the compliance with CVC bundle can be further improved.

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