

# Effectiveness of Care Bundles to Prevent Central Line Associated Blood Stream Infection (CLABSI) in Patient Admitted in ICU - A Systemic Review

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**Abstract:** Care bundles are structured packages of evidence based practices that aim to improve patient care process and patient outcomes. Care bundles have been shown to be effective in reducing rate of CLABSIs in adult intensive care units (ICUs). A systematic review was conducted to assess the evidence for the effectiveness of care bundles in reducing CLABSI rate in intensive care unit (ICU). A systematic literature search was conducted from December 2016 to December 2021 by adapting Preferred reporting Items for Systemic Review and Meta - Analysis (PRISMA) guidelines. Research studies were searched in the electronic database (J Gate, Science Direct, com, PubMed, Google Scholar, Research Gate, DELNET and Medline library published) on effectiveness of care bundle to prevent CLABSI in patients admitted in ICU. Eleven studies were eligible for inclusion in this systemic review. Three studies (27.2%) were performed in North India, two (18.2%) in North Taiwan, one (9.1%) in Canberra, one (9.1%) in Korea, one (9.1%) in Tennessee, one (9.1%) in Greece, one (9.1%) in Australia and one (9.1%) in Turkey. All eleven studies included in this systemic review were non-randomized intervention studies. Analysis of all 11 studies reveals that there is a significant reduction in CLABSI rate after the introduction of a care bundle in intensive care unit. As the elements of care bundle were not explored in this systemic review, the researcher recommend that in future research focus on processes that promote recommendation, effective implementation to prevent infection and essential elements of bundle are recommended.

**Keywords:** Central line associated blood stream infection, central venous catheter, Care bundles, intensive care unit.

## 1. Introduction

A central line or central venous catheter is an intravascular catheter that terminates at one of the great vessels or close to the heart. It is used to withdraw blood, infusion, hemodynamic monitoring, or total parental nutrition. The central line also provides easy vascular access for hemodialysis and can use for emergency purposes like renal replacement therapy or in case of failure of arteriovenous fistula or graft.<sup>1</sup> Many researches show, in terms of morbidity and expended financial resources the cost of central line associated blood stream infection found substantial. Healthcare providers play a key role to reduce health care cost and to improve patient outcome. Healthcare providers act as regulators, patient advocate and insurers in reducing the incidence of central line associated blood stream infection.

Primary bloodstream infection that develops in a patient with a central line in place within 48 hours period before the development of bloodstream infection that is not secondary to an infection from another body site. Secondary bloodstream infection is seeded from another infectious body site like urinary tract infection, surgical site infection, or pneumonia. CLABSI results from colonization of microorganisms in the fluid pathway when the catheter is inserted or colonization in external surface or the course of its utilization.<sup>2</sup>

Prevention of central line associated blood stream infection is key for successful parenteral nutrition. The catheter hub or exit site are responsible for the contamination that leads to most infections. Health care providers needs to put

conscious efforts to follow protocols and guidelines for the care of the central venous catheter device before, during, and after its insertion. The most important way to prevent central line associated blood stream infection strict adherence to aseptic technique and hand - washing.<sup>3</sup>

Damoon Entesari - Tatafi, Neil Orford, Michael J Bailey conducted a study to assess effectiveness of a care bundle to reduce central line associated blood stream infections. Study was conducted in tertiary adult ICU. Study aimed to determine the effectiveness of care bundles in reducing the rate of CLABSI. The study results shows that CLASI rate fell from 2.2 per 1000 central line days to 0.5 per 1000 central line days before and after introduction of care bundle.<sup>4</sup>

According to CDC's checklist, there are three main components to prevent central line - associated bloodstream infection – insertion, maintenance, and removal of the central line. Insertion of central line practice must follow properly following hand hygiene, using aseptic technique, follow maximal sterile barrier precautions, selecting best insertion site, prepare the site of insertion with >0.5% chlorhexidine with alcohol and sterile gauze dressing over the insertion site. For the maintenance of central line proper handling with complying hand hygiene requirements. Performing routine dressing change with aseptic technique, replacing soiled dressing immediately, scrubbing the assess port thoroughly bathing patient with chlorhexidine preparation, properly changing of administration set for continuous infusion. The need for a central line should be assessed continuously and the unnecessary central line should be removed promptly.<sup>5</sup>

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are bundles are structured packages of evidence based practices that aim to improve patient care process and patient outcomes. Care bundles have been shown to be effective in reducing rate of CLABSIs in adult intensive care units (ICUs). Keystone project, 10 a US state - wide quality improvement (QI) project in adult ICUs in Michigan. They introduced bundles interventions with a patient safety programme, and was identified reporting zero CLABSI rates in post - implementation phase in adult ICUs and pediatric ICUs. Researchers concluded that despite a 48% reduction in pediatric CLABSI and attempt to replicate this result; this did not reach statistical significance.<sup>6</sup> Thus, the objective of this review was to evaluate the evidence concerning the effectiveness of care bundles to prevent central line associated blood stream infection (CLABSI).

## 2. Methods

This systemic review is planned, undertaken and reported using the Preferred Reporting items for Systematic Review and Meta - analyses (PRISMA) guidelines.

### Data sources and search strategy:

A systematic literature search was undertaken Of medical literature databases including J Gate, Science Direct. com, PubMed, Google Scholar, Research Gate, DELNET and Medline library published from December 2016 to

December 2021. Key words and title searches included a combination of: “care bundle”, “prevention”, “effectiveness”, “Central Line Associated Blood Stream Infection”, and “intensive care unit”.

### Inclusion and exclusion criteria:

The eligibility for inclusion of research papers into in this systemic review is considered independently by the researcher. Only trials of the effectiveness of care bundle to prevent CLABSI in patients admitted in ICU in English language will include. A care bundle was defined as any intervention with multiple interacting components. Review papers, population admitted outside ICU will be excluded. Furthermore studies that used other methods like educational intervention, self - instructional module or information booklet as intervention to prevent CLABSI will be excluded.

### Search outcomes:

The systematic search yielded 8728 articles. After removing duplicates, reading titles, and abstracts, it was found that 8680 articles were not relevant to the objective of the review, leaving 48 items for full - text review. After the review of 48 full - texted articles, only 11 articles that met all the inclusion criteria were included in the systemic review (Figure 1).

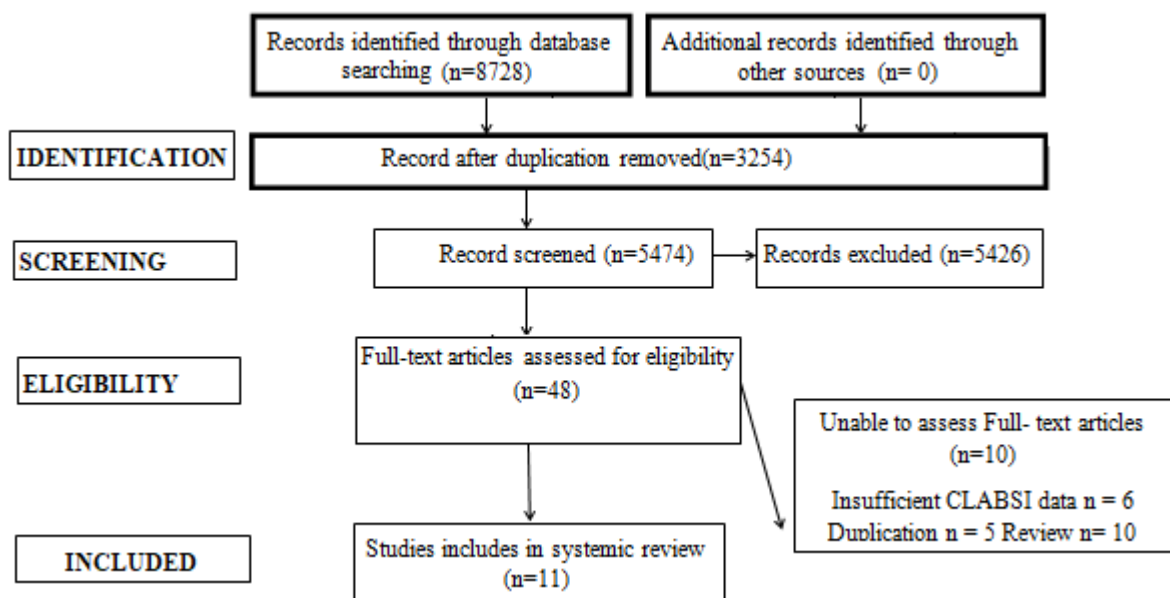


Figure 1: Preferred Reporting Items for Systemic Reviews and Meta analysis (PRISMA) flow chart.

### Appraisal of methodological quality:

The methodological quality of each studies (cross - sectional, correlational, and descriptive - comparative studies, Retrospective Cohort Study, Prospective Cohort study) was assessed by using modified versions of the Newcastle - Ottawa Quality Assessment Scale.<sup>41</sup> For each study the maximum achievable score was 9. Studies that fulfill all requirements in the category was gained highest score. Low scores studies was those who fulfill <50% of the requirement. The Mixed Methods Appraisal Tool (MMAT) was used by researcher to evaluate the methodological quality of each study.<sup>11</sup> Final studies were assessed on the basis of the existence of selection bias, the completeness of

the outcome results and the suitability of the measurements. The quality scores of all the included in the systemic review were ranging from 75% to 100% were good to excellent.

### Data extraction and synthesis:

All the studies are shorted out by reading titles and summarizing each article. All retrieved studies were screened after removing duplication studies. Full - text articles were analyzed for eligibility. Researcher then extracted relevant data from the articles. Data extracted from each paper included: First Author, Year of study, Location, Study design, Study duration, effect on CLABSI before and

after intervention and quality assessment score then consolidated it into an article review matrix (Table 1).

### Research design:

Three of the included studies used retrospective cohort study design<sup>7, 11, 15</sup>, six adopted prospective cohort research designs<sup>8, 10, 11, 12, 13, 14</sup>, one had retrospective and prospective study design<sup>17</sup>, and one had prospective observational study design<sup>16</sup>.

### Study settings and sample size:

The studies originated from Canberra, Kanpur, Tennessee, Greece, Australia. Two studies was originated from North India and North Taiwan. All the studies were conducted in ICU and involved registered staff nurses as the samples. The sample size varied from 100 to 1000 and included male and female nurses working in ICU.

### Measures of effectiveness of care bundle to prevent CLABSI:

All studies used pre and post intervention measurement of CLABSI rate per 1000 central venous catheter.

## 3. Result

A systemic search yielded 8728 titles and abstract. Duplication were removed and references were hand

searched for missing titles from the original search. Researcher initially excluded the studies by titles followed by an assessment of the remaining abstract and 48 full text studies were assessed.

### Study characteristics:

Eleven studies were eligible for inclusion in this systemic review. Three studies (27.2%) were performed in North India, two (18.2%) in North Taiwan, one (9.1%) in Canberra, one (9.1%) in Korea, one (9.1%) in Tennessee, one (9.1%) in Greece, one (9.1%) in Australia and one (9.1%) in Turkey. All eleven studies included in this systemic review were non - randomized intervention studies.

### Risk of bias assessment:

The mean New Castle - Ottawa quality assessment scale score were 6 (range 5 - 7, see table - 1) for a possible maximum score of 9. Lower score tended due to lack of control in intensive care unit. There were limited reporting of collection of data and its verification. All studies tended to have intervals between before and after groups.

### Reduction in CLABSI rate:

Analysis of all 11 studies reveals that there is a significant reduction in CLABSI rate after the introduction of a care bundle in intensive care unit (table - 1).

**Table 1:** Article review Matrix

S. No.	Study (first Author, Year, Country)	Location	Study design	Study duration (months)	CLABSI before	CLABSI after	Quality assessment score (maximum score 9)
1	Molly Bannatyne et. Al., 2018, Canberra Hospital.	Neonatal Intensive Care Unit	Retrospective Cohort Study	January 2011 and December 2016	8.8 per 1,000 central line days	4.9 per 1,000 central line days	6
2	Sang - Won Park et. Al., 2017, Tertiary hospital, Korea	surgical intensive care unit	prospective cohort study	August 2011 to July 2013	6.9 per 1,000 central line days	2.4 per 1,000 central line days	7
3	Wu - Pu Lin et. Al., 2017, northern Taiwan	Adult intensive care unit	before - after prospective study	January 2009 to December 2013	9.27 per 1,000 central line days	7.66 per 1,000 central line days	7
4	S. B. MISHRA et al., 2016, North India	Intensive Care Unit	prospective observational study	January 2014 to April 2015	17.04 per 1000 catheter - days	14.21 per 1000 catheter - days	5
5	Tracie Savage et al., 2017, Tennessee	Neonatal and Pediatric intensive care units	retrospective interrupted time series study	2006 and 2014.	3.80 out of 1000 line days	0.45 out of 1000 line days	6
6	Dimitrios Rallis, et al, 2016, Greece	a tertiary neonatal unit	prospective study	January 2012 - September 2013)	12 cases per 1,000 central vascular catheter	3.4 cases per 1,000 CVC days	7
7	ArvindKhodare, et, al, 2020, tertiary liver care center in North India	Liver Care Intensive Care Unit	prospective observational study	January 2017 to December 2018	11.78/1,000 catheter days	3.99/1,000 catheter days	6
8	Ho - TsungHsin, et al, 2016, northern Taiwan.	Cardiovascular intensive care unit	Prospective longitudinal cohort study.	January 2010 to June 2015	7.0 per 1000 catheter days	0.7 per 1000 catheter days	6
9	Rowena McMullan et. Al., 2016, Sydney, Australia	Level 5 neonatal intensive care unit	Retrospective cohort analysis	January 2012 to July 2014	8.5 per 1,000 central line-days	2.3 per 1,000 central line-days	7
10	DrVikas Mishra, et al., 2021, Kanpur, North India	intensive care unit	Retrospective and prospective	January 2017 to December 2020	3.6 1000 central line days	0.7 per 1000 central line days	6

			study				
11	Aynur Atilla et. Al., 2016, Turkey	Surgical and Medical Intensive care Unit	prospective cohort study	July 2021 to July 2014	In Medical ICU - 6.20 per 1,000 central line days and In surgical ICU - 8.27 per 1,000 central line	In Medical ICU - 1.05 per 1,000 central line days and In surgical ICU - 3.73 per 1,000 central line	6

#### 4. Discussion

This systemic review suggests that care bundles are associated with significant reduction in rate of CLABSI in intensive care unit. This systemic review supported by a recent systemic review and meta - analysis by Victoria Panyne et al on the topic Care bundles to reduce central line - associated. 24 studies were included in this review. Meta - analysis reveals that introduction of care bundle statistically reduces CLABSI rate significantly (rate ratio= 0.40 (CI 0.31 - 0.51),  $p < 0.00001$ ) that is equal to a reduction of 60% in CLASI rate<sup>18</sup>.

In our analysis majority of the studies adopted Centre for Disease control (CDC) definition to measure CLABSII rate. Till date there is no study published in peer - review that have a negative effect on rate of CLABSI. Although heterogeneity found in the component included in the care bundle among studies selected for this review. Studies selected for the systemic review were non - randomized interventional studies that increase risks of bias. Apart from that uncertainty attributing cause of infection due to central line, challenges in data collection means, variation in counting line days and local interpretation. All the studies included in the review used a standardized primary outcome measure as CLABSI rate per 1000 CVC days.

Variability was found within the elements of bundle used in the studies. Most common elements that were included in the bundle were using maximum barrier precaution, specific skin preparation and dressing change protocol, education and training, using checklists and assessment of necessity of central line. In this review researcher did not attempted to establish any association between elements of bundle and rate of CLBSI.

This systemic review identified that implementation of care bundle significantly reduces rate of CLABSI. A systemic review and meta - analysis by Ista et al conducted to assess the effectiveness of insertion and maintenance bundles to prevent central line associated blood stream infections in critically ill patients of all ages. Result of the review shows median of CLABSIs incidence on adult ICUs were 5.7 per 1000 catheter days, 8.4 per 1000 catheter on NICUs and 5.9 per 1000 catheter on PICUs. After care bundle implementation CLABSI rate ranges from 0 to 19.5 per 1000 catheter days in all type of ICUs. Researcher concluded that implementation of central line bundles has that potential that significantly reduces the incidence of CLABSI. The result of study is similar to the result of this systemic review<sup>19</sup>.

#### 5. Limitations of review

In this systemic review selection of studies is restricted the studies that are relevant only to intensive care unit in the hospital and other areas of hospital setting were not included in the review hence study result cannot generalized to all hospital areas. Search of the studies were restricted in English language only. Studies in other language was excluded that might contribute different findings. Researcher included all possible studies that fulfill the inclusion criteria to the best of researches knowledge. Search of the study was limited from December 2016 to December 2021, hence, studies published before may have overlooked.

#### 6. Conclusions

This systemic review provides a substantial body of evidence that bundle care reduces CLABSI rate in intensive care unit. However elements of bundle were not explored by the researcher. This systemic review focuses on the potential of effectiveness of a care bundle implementation to reduce CLABSI rate. Future research should focus on processes that promote recommendation, effective implementation to prevent infection and essential elements of bundle.

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