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Analysis of costs and benefits of transparent, gauze, or no dressing for a tunnelled central venous catheter in Canadian stem cell transplant recipients

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ABSTRACT

Catheter-related bloodstream infection (CRBSI), an avoidable risk in cancer nursing, contributes to patient morbidity, and increases health care spending. The objectives of the study were to evaluate the impact of three different nursing care strategies for tunnelled central venous catheter (CVC) exit sites on infection outcomes and compare costs of each strategy. The study hypothesis proposed that CRBSI and charges for nursing care differ in adult Canadian blood and marrow cell transplant recipients with a tunnelled CVC that use a transparent dressing, no dressing, or a gauze dressing. A sample of 432 records at a single centre compared CRBSI across dressing groups. A micro-costing approach was used to estimate dressing supply charges for an evaluation of the costs and benefits of each exit care strategy. Results of the study indicated *no significant differences in CRBSI, number of organisms, gram stain of organisms, or days until the onset of an infection between the three dressing groups. The gauze dressing was considerably more expensive than both the transparent dressing and the no dressing strategy. In terms of supplies and nursing labour fees, transparent dressings were most economical, closely followed by no dressing. The no-dressing strategy was arguably the best option overall, as removing the dressing presents several other non-monetary and monetary benefits too broad for measurement by this study.*

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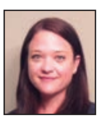
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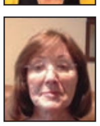
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Infection control, essential in minimizing health care costs, continues to challenge health care providers. Risk of infection is particularly concerning in blood stem cell transplant recipients given their weakened immune function and dependence on prolonged vascular access (Tomblyn et al., 2009). Nearly all blood stem cell transplant patients receive a tunnelled central venous catheter (CVC) to facilitate life-saving treatment as it poses the lowest infection risk of all long-term catheter choices given that implanted ports are typically not appropriate in this population (Faruqi et al., 2012; Scales, 2010a; Toscano et al., 2009). Catheter-related bloodstream infection (CRBSI) is typically associated with morbidity and expense rather than fatality (O'Grady et al., 2011). Blood stem cell transplant nurses are influential in preventing CRBSI and containing costs, as they manage and educate others on CVC care. Cost-benefit analysis compares the degree of expected costs to total expected benefits (Santerre & Neun, 2010). Different care strategies do not posit equal expenditure. Charges to the public payer for various exit site care strategies and the effects on infection outcomes are unknown in Canadian blood stem cell transplant recipients.

A tunnelled CVC features a cuff placed under the skin with the proximal end resting in the superior vena cava and a salient distal end (Scales, 2011). Immediate placement of a sterile dressing after CVC insertion secures the device until the cuff embeds into the surrounding tissue (tunnel healing), and protects the puncture sites (Macklin, 2010; Poole, 2010; Scales, 2011). Practice consultants, such as the Infusion Nurses Society (INS), claim a dressing on a healed CVC tunnel is unnecessary (2011) while others, including the United States Centers for Disease Control and Prevention (CDC), posit that they can make no recommendation on the issue (Joint Commission, 2012; O'Grady et al., 2011; Scales, 2010b; Toscano et al., 2009).

Dressing options should meet patient needs and provide equal protection against infection risks. Evidence of the clinical effectiveness of CVC exit site care in regards to CRBSI is limited. The feasibility of certain nursing strategies must also be evaluated within the economic capacity of the financing system (Tarricone, Torbica, Franzetti, & Rosenthal, 2010). Canadian CRBSI cost estimates (for all central venous catheter types) exceed $19,000 per incident (Raschka, Dempster, & Bryce, 2013). A recent analysis by these authors suggested CRBSI costs for Canadian blood stem cell transplant patients exceeded $45,000 per incident in 2013 (Keeler et al., 2015). Careful weighing of cost-to-clinical benefit supports accountability in publicly funded health care. Expected fees associated with adverse events and nursing care may strongly influence practice decisions. The two research objectives of this study were to evaluate the impact of nursing exit site care on 1) CRBSI, and 2) costs and benefits for Canadian blood stem cell transplant recipients with a long-term tunnelled triple lumen subclavian CVC.

REVIEW OF THE LITERATURE

CRBSI

CRBSI can develop from systemic microbes adhering to the catheter surface or the introduction of organisms on insertion, manipulation, or infusion (O'Grady et al., 2011). A primary bloodstream infection is deemed to be a CRBSI when an alternate source cannot be determined in a patient with a CVC in place for 48 hours or longer (Chopra, Krein, Olmsted, Safdar, & Saint, 2013). The most accurate diagnostic measure of CRBSI found by meta-analysis is paired blood cultures (Rodriguez et al., 2012). The measure compares a CVC blood sample to a peripheral sample from the same individual. Samples are grown in a medium to detect and identify organisms. Positive CVC results with negative peripheral results are strongly indicative of a catheter source of infection. A difference in growth time-to-positivity between samples or three fold or greater microbial load in one sample are also indicative of the location of an infection (Mermel et al., 2009). Paired blood cultures distinguish CRBSI from disease and treatment-related symptoms that a CVC was designed to manage (Macklin, 2010; O'Grady et al., 2011; Tomblyn et al., 2009).

Dressings

Popular CVC dressings are made of cotton fibre (gauze) or polyurethane (transparent). A gauze dressing covers the exit site with or without line securement such paper tape to attach the corners of the bandage, or a plastic disc that wraps around the line and is taped on top of the gauze. The adhesive on one side of a transparent dressing attaches directly to the catheter and surrounding skin. Dressings act as a barrier between the puncture site and the external environment. Microbes naturally collect in the first five layers of the stratum corneum, hair follicles, and sebaceous glands, and can re-colonize within 48 hours of disinfecting, necessitating dressing changes (Macklin, 2010). Guidelines recommend changing a gauze dressing every two days and transparent dressing no more than once every seven days unless either is wet or soiled (O'Grady et al., 2011).

The most recent Cochrane review reports a wide range of increased CRBSI with the use of transparent dressings, even while considering research bias (Gillies, O'Riordan, Sheriff, & Rickard, 2011). Issues such as comparing different central line types across different populations, lack of reporting effect size, lack of reporting missing data, and including overlapping variables are mentioned as result-limiting factors. None of the research in the meta-analysis compared dressing types to undressed sites. Preliminary studies report higher incidences of catheter-related infections with dressings than with no dressings in both renal and intensive care populations (Seiler & Pember, 2012; Toshiyuki et al. 2012).

No dressing

The debate for maintaining a dressing on a healed CVC tunnel began with a pilot study reporting no difference in line infections in a small sample of cancer patients without exit site dressings (Petrasino, Becker, & Christian, 1988). One random controlled trial by Olsin et al. (2004) revisited the issue. However, the small sample and early closure requires additional evidence to support practice recommendations based on study findings. This current state of the science contributes to questionable evidence guiding nursing care but, nonetheless, approximately 40% of Canadian blood stem cell transplant centres reported in 2013 that their policy is to remove the dressing from a healed tunnelled CVC site (Keeler, 2014).

Additional care strategies

Alternatives for preventing CRBSI can be found in the literature, for example, the practice of applying honey to the exit site has not been reported to significantly reduce CRBSI (Kwakman et al., 2012). More popular is trialing medical products and antiseptic solutions with varying reports of significance (O'Grady et al., 2011; Popovich, Hova, Hayes, Weinstein, & Hayden, 2010). Although the use of antibiotic ointment under the dressing is recommended with tunnelled lines in hemodialysis, it is counterproductive in the blood stem cell transplant population, as it is known to increase drug resistance and colonization of fungi in immune-compromised hosts (O'Grady et al., 2011; Tomblyn et al., 2009). Allergies, skin toxicities, contact dermatitis, and age younger than two months may render use of adhesive and antiseptic patch dressings inapplicable (Battistella, Bhola & Lok, 2011; Daniels & Frei, 2012; Tomblyn et al., 2009). Antimicrobial coated lines and impregnated cuffs are now available (Bard, 2012a; Bard, 2012b). Practice consultants only recommend use of these products if all other prevention efforts fail to decrease CRBSI incidence (O'Grady et al., 2011).

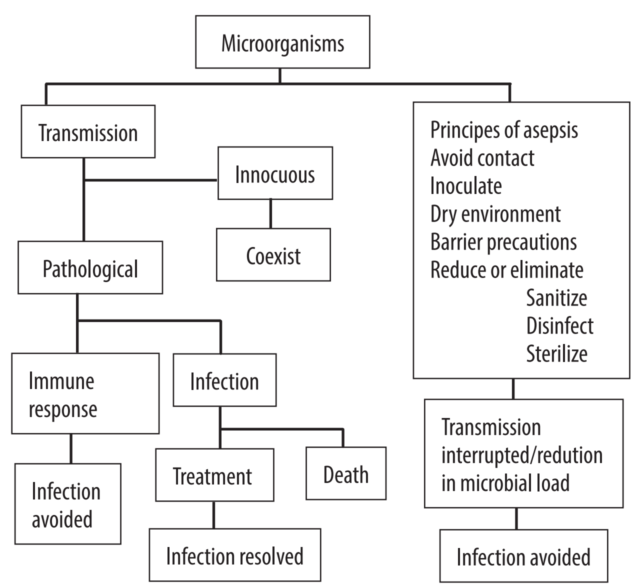

Figure 1. Model of Lister's Asepsis Theory

THEORY

Duval (2010) summarizes the evolution of Lister's 19th century theory of asepsis that continues to guide clinical practice and research today. The theory outlines human and animal coexistence with microorganisms that may be innocuous or cause illness. Pathological transfer of microorganisms can be prevented by natural immunity, inoculation, interrupting the cycle of transmission, or decreasing microbial load. Application of the theory has evolved into common reference to the principles of asepsis that are modelled in Figure 1. Conformity to aseptic principles incorporates preventing exposure and/or any activities or techniques that aim to decrease or eliminate microbial presence. Examples include avoiding contact, inoculation, maintaining a dry environment, or using products and strategies for sanitization, disinfection, or sterilization (Lister, as cited by Beck, 1895; Macklin, 2010; Medeiros, dos Santos, Soares, Costa, & Lira, 2012; Pallo, 2012; Scales, 2011).

Judgment is required for applying aseptic principles in clinical care. For example, the aim of inoculation is exposure to certain organisms to stimulate an immune response should repeat exposure occur. Infection prevention strategies are multifaceted depending on clinical context and body of epidemiological knowledge. Avoiding infection requires conscious multidisciplinary efforts and actions at all stages of care and treatment in blood stem cell transplant patients.

Variable selection

The purpose of this study was to determine if the type of dressing affects CRBSI incidence and the charges for dressing supplies and nursing time for performing dressing changes. Study variables were selected after consideration of all other strategies incorporating aseptic principles with CVC access at the study centre. The bundling strategy was used for catheter insertion. Bundling includes proper hand hygiene, using maximum barrier precautions (sterile gown, drape, gloves, equipment, and wearing a mask), using a >0.5% chlorhexidine skin prep solution, choosing the appropriate site if known, and a daily review of the necessity of the catheter with prompt removal when no longer essential (Faruqi et al., 2012; Moreau, 2009). In addition to the bundle strategy for insertion, all catheters were inserted by a radiologist under ultrasound guidance.

Policy and nursing standard operating procedures at the study site mandate nearly all CDC recommendations for CVC practice and incorporate several principles of asepsis. Initial and yearly education for CVC competency is required in accordance with program accreditation standards. The support of both clinical nurse educators and experienced clinicians is available for staff skill certification and troubleshooting catheter-related complications. Prior to delegating the task to care givers or patients themselves, registered nurses assess patients' and lay caregivers' competency with exit site care by return demonstration. CVCs are accessed/manipulated using needleless luer connections. The piggyback system is used for secondary infusions with replacement of all infusion sets every 24 hours if the system is interrupted, and every 72 hours if the system is uninterrupted. Sterile technique is mandated for dressing and cap changes with use of a sterile mask, gloves, and supplies, and 2% chlorhexidine skin antiseptic. Hand hygiene is routinely audited by the infection prevention and control department, and standard operating procedure mandates an alcohol scrub-the-hub for a minimum of 15 seconds strategy for sterilizing connections prior to accessing infusion ports.

A policy change in September of 2011 incorporated removing the dressing from a healed tunnelled exit site and use of protective coverings over puncture sites and connections during showering. Registered nurses were educated on the new policy and confirmed understanding of changes by signing off on the unit standard operating procedures manual. Prior to the current policy, transparent dressings were used when adhesive was tolerated; gauze dressings were used for individuals with skin sensitivities. After the policy change all patients were instructed to remove the dressing after tunnel healing. Prior to the time of the policy change, use of the no dressing practice was rare. After the policy change, 52.7% of the patients used no dressing, 34.5% used transparent dressing and 12.7% used gauze dressing. Adherence to the policy gradually increased over time. Although there was not perfect adherence to the new strategy, the change in policy provided an opportunity to compare outcomes of removing the dressing to alternative use of gauze and transparent dressings. These three options require different items to perform the procedure that incurs fees to the public payer. Furthermore, nursing labour to perform the procedure is another important factor that needs to be considered for investigating overall charges for each strategy. Within this study, charges were operationally defined as fees billed to the public payer for any product, item, or service by a registered nurse (in terms of wages per hour) dedicated to a CVC dressing change.

A recent survey of Canadian CVC practice in blood stem cell transplant reports registered nurses spend 15 to 30 minutes for a single dressing change (type of dressing unspecified in the survey) (Keeler, 2014). A review of collective agreements for nursing wages in Canada in 2013 (Table 1), reveals that the national average hourly wage for a level I registered nurse (excluding the Territories and Quebec) is $35.28.

In spite of adherence to CDC guidelines and asepsis, CRBSI still occurs. According to the Institute for Healthcare Improvement (IHI), a CRBSI is criterion-based infection diagnosed when no other source is apparent. Confirmation that an infection is related to a CVC is obtained through comparative blood cultures. The Canadian Nosocomial Infection Surveillance Program (CNISP) criteria (2005) were used to operationally define CRBSI as the dependent variable for the study. The independent variable was the type of exit site care provided for a tunnelled CVC at three levels: transparent dressing, no dressing after tunnel healing, or gauze dressing. The literature revealed a gap in the evidence regarding dressing maintenance after tunnel healing, which generated the study hypotheses that 1) there are differences in CRBSI incidence by dressing type (transparent dressing, no dressing, or gauze dressing) for adult Canadian blood stem cell transplant

Table 1: Year 2013 registered nursing wages (CAD$) per hour									
Increment	**BC**	**AB**	**SK**	**MB**	**ON**	**NB**	**NS**	**PEI**	**NFLD**
1	30.79	35.00	34.94	31.02	30.17	29.86	32.84	29.57	30.77
2	31.96	36.34	36.59	32.10	30.91	31.87	33.82	30.77	31.98
3	33.16	37.69	37.43	33.19	31.12	33.05	34.91	32.16	33.28
4	34.33	39.04	38.28	34.32	32.65	34.42	36.13	33.53	34.88
5	35.52	40.39	39.19	35.428	34.2	35.76	37.39	34.91	36.46
6	36.71	41.72	40.09	36.572	36.12	36.80	38.69	36.03	38.10
7	37.90	43.08	41.45	-	38.06	37.88	-	-	-
8	39.02	44.35	42.81	-	40.01	-	-	-	-
9	40.42	45.93	44.08	-	42.85	-	-	-	-
Average	31.04	40.39	39.43	33.77	35.94	34.23	35.63	32.82	34.25
National Average	35.28								

*Excluding QC and the Territories
* For level I registered nurses excluding education/shift/weekend/long-service differentials, or retrospective lump sum payments
Sources: British Columbia Nurses' Union (2012), United Nurses of Alberta (2010), Saskatchewan Nurses' Union (2011), Manitoba Nurses' Union (2012), Ontario Nurses Association (2013), New Brunswick Nurses Union (2013), Nova Scotia Nurses Union (2013), Prince Edward Island Nurses' Union (2011), Newfoundland and Labrador Nurses' Union (2011).

recipients with a long-term tunnelled triple lumen subclavian CVC, and 2) there are differences by type of dressing in charges for supplies (as measured by fees billed to the public payer) and nursing labour dedicated to dressing changes. The objectives of the study were to evaluate the impact of the three different nursing care strategies for tunnelled central venous catheter (CVC) exit sites on infection outcomes and also compare the charges incurred for each strategy.

METHODS

Design

Following study approval by institutional and health board ethics committees, archived data from a single Canadian transplant centre were accessed. The post-test-only control group design was used to compare the dependent variables (CRBSI and charges) after a specific treatment condition (type of dressing) among groups. A micro-costing approach was used to estimate the charges to the public payer for using a transparent dressing, no dressing, or gauze dressing, according to supplies and frequency of care. Nursing labour costs were estimated based on national average hourly wage and average time (22.5 minutes) dedicated to a dressing change reported by the national survey on central line practice in Canadian stem cell transplant recipients (Keeler, 2014).

Sample/setting

The study aimed to compare documents noting completion of blood and/or marrow cell transplant and use of a long-term tunnelled cuffed triple lumen subclavian CVC across three equal dressing groups. The clinical records of 898 adult blood and marrow cell transplant recipients (ages 18–74) from a single Canadian centre treated between 2008 and 2013 were reviewed. Figure 2 models the progression of records selected for final inclusion in the study.

Records were excluded if the transplant occurred outside the approved study time by the ethics committee (17), the transplant was not done (8), the record indicated a catheter was still in place (3), a tunnelled line was not used (16), or if there was no documentation when the catheter was removed (56). Unavailable, duplicate, and records for individuals that relocated with their CVC in situ were also excluded (30). Records indicating known source or exposure to infection

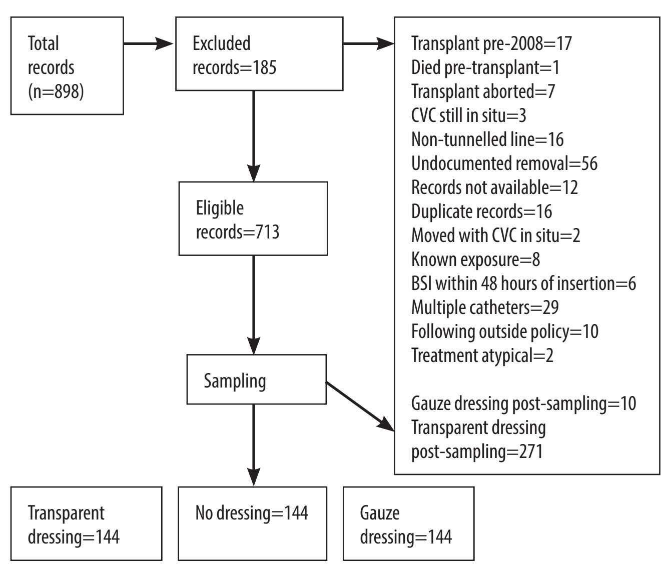

Figure 2. Record selection

not related to CVC, for example broken lines, cap disconnections etc., (8), infection within 48 hours of CVC insertion (6), use of multiple catheters at once, for example chest tubes, stents, intrajugular lines, etc. (29), and non-adherence to the study centre's standard policy and procedure for exit site care, line insertion and/or treatment (12) were also excluded. Following initial exclusion criteria 713 records were eligible for sample selection.

The number of eligible records according to transparent dressing, no dressing and gauze dressing were unequal. The no-dressing group was the smallest group overall, therefore all eligible records indicating dressing removal after tunnel healing (n=144) were included in the sample. A random sample of 144 records was selected from the gauze group, and the remaining 10 records not selected were excluded from the study. The transparent group was the largest group overall. A random sample of 144 records was selected from the transparent group, and the remaining 271 records were excluded from the study. Sampling resulted in three equal dressing groups (N=432).

Instruments

Blood culture results were interpreted and confirmed using federal surveillance standards for reporting hospital acquired infections and practice recommendations from the Infectious Diseases Society of America (CNISP, 2005; Mermel et al., 2009). Electronic flow sheets and multidisciplinary progress notes were consulted to confirm individual dressing strategies. Nursing CVC policy and procedure and inventory price lists for supplies were used as measures for estimating weekly item charges for each dressing strategy. The national average wage in Canadian dollars per hour (as indicated in Table 1) was used to estimate nursing labour charges incurred by dressing changes.

Procedure

For the first research objective, study data were de-identified and converted to an electronic data set. Analysis was performed using the Statistical Package for the Social Sciences (SPSS) Version 21 (International Business Machines Corporation, 2012). Infections prior to tunnel healing (day 14 post catheter insertion), and repeat infections were excluded from the analysis. Second infections were only included when all diagnosing criteria were met. Parameters for statistical significance were set at α at .05. Since none of the variables were normally distributed, non-parametric tests were used. For continuous variables, Kruskal-Wallis tests were used. The Pearson Chi square test for contingency tables was used to analyze categorical data (Field, 2009).

For the second research objective, an inventory list indicating prices for supplies that were billed to the public payer by the inpatient blood stem cell transplant nursing unit was accessed. Charges for all supplies listed in the nursing policy and procedure document and unit standard operating procedures were tallied according to dressing strategy: for example, gloves, chlorhexidine swab sticks, dressing type, shower covers, etc. According to policy, transparent dressings are changed after seven days, daily care is performed by patients themselves after showering for the no dressing group, and gauze dressings are changed after 48 hours. Weekly costs were adjusted for use of securement devices (once a week in the no dressing and gauze dressing groups). As indicated by the national survey of central line practice, registered nurses spend between 15–30 minutes (M=22.5 minutes) on dressing changes (Keeler, 2014). Nursing labour charges were calculated by the following equation:

$$\frac{22.5 \text{ minutes}}{60 \text{ minutes}} (\$35.28/hr) = \$13.23$$

RESULTS

Table 2 gives sample characteristics. The final sample represented 45,223 catheter days *(M=104.68, SD=70.96)* for 432 recipients of allogeneic (47%), autologous (52.3%), and syngeneic (0.7%) blood and/or marrow cell transplant. To ensure there were no confounding effects, hypotheses tests were conducted on several potentially influential variables to see if there are significant differences in these variables across dressing groups. Overall, Table 2 shows there were more males than females in the entire sample. However, the distribution of gender within each dressing group was similar. A Kruskal-Wallis (H, distributed as χ^2 with degrees of freedom equal to one less than the number of groups) test indicated that there was not a significant difference in the gender distribution across the three dressing groups (H (2)=3.02, p=.22). Kruskal-Wallis tests were also non-significant when comparing groups according to age (H (2)=.521, p=.771) and body mass index (H (2)=1.464, p=.481). Pearson chi square results for a 3×5 contingency table analysis showed significant differences in general diagnosis between groups, χ^2 (8)=24.98, p=.002. There were more myeloma patients in the no-dressing group. However, we do not have reason to believe that there was an intentional policy difference in use of dressing types across the five diagnosis groups. Rather it appears that there were a few more myeloma patients (18.6% of the total) appearing for treatment after September 2011 compared to before (13.6% of the total). There was also a significant difference in catheter days (H (2)=7.296, p=.026). This probably relates to the fact that leukemia patients generally have lengthier recoveries from treatment, and, once again, there happened to be a few more leukemia patients in the transparent and gauze dressing groups and a few more myeloma patients in the no dressing group.) A 3×3 contingency table analysis showed no difference in the type of transplant (allogeneic, autologous, or syngeneic), χ^2 (4)=6.75, p=.15. A 3×27 contingency table showed no significant difference in the type of treatment protocols (combinations of chemotherapeutic agents) used between groups χ^2 (52)=54.99, p=.362. There were slight differences in the incidence of infection: 24.86% for the transparent group, 23.61% for no dressing, and 20.83% for the gauze dressing group. There were also slight differences in the prevalence (number of infections per 1,000 catheter days) of infection between groups; 2.64 for transparent, 2.41 for no dressing, and 2.03 for gauze dressing.

All records indicated treatment with a conditioning chemotherapy protocol followed by a blood stem cell transplant. Of the 432 patients, 98 individuals developed 107 separate CRBSIs (89 people with one infection and 9 people with

Table 2: Study sample characteristics and catheter history				
	Transparent Dressing	**No Dressing**	**Gauze Dressing**	**Total (N=432)**
Gender				
Male	89	93	79	261
Female	55	51	65	171
Age	50.4±12.4	51.15±12.95	50.26±12.84	50.6±12.71
BMI	25.36±6.08	25.54±4.8	25.86±5.50	25.59±5.48
Diagnosis				
Acute Leukemia	52 (36.1%)	43 (29.9%)	51 (35.4%)	146 (33.8%)
Chronic Leukemia	14 (9.7%)	8 (5.6%)	14 (9.7%)	36 (8.3%)
Lymphoma	55 (38.2%)	50 (34.7%)	58 (40.3%)	163 (37.7%)
Myeloma	16 (11.1%)	40 (27.8%)	13 (9%)	69 (16%)
Other	7 (4.9%)	3 (2.1%)	8 (5.6%)	18 (4.2%)
Stem Cell Type				
Allogeneic	74 (51.4%)	55 (38.2%)	74 (51.4%)	203 (47%)
Autologous	69 (47.9%)	88 (61.1%)	69 (47.9%)	226 (52.3%)
Syngeneic	1 (.7%)	1 (.7%)	1 (.2%)	3 (.7%)
Catheter Days M, SD	16,313 113.28±68.06	14,116 98.03±62.79	14,794 102.74±80.48	45,223 104.68±70.96
Infections (CRBSI)	43	34	30	107
Incidence	29.86%	23.61%	20.83%	24.77%
Prevalence *	2.64	2.41	2.03	2.37
Number of Organisms**	1.00±.40	1.10±.60	1.29±.76	1.11±.59
Number of Gram + Organisms**	.51±.56	.48±.57	.57±.69	.52±.60
Number of Gram — Organisms**	.54±.64	.61±.62	.71±.60	.61±.62
Days until Onset of 1st infection**	79.51±49.81	66.90±49.29	64.86±73.52	71.34±57.21
Days until Onset of 2nd infection***	125.25±62.49	150.00±62.36	140.00±62.23	136.78±55.27

Other= disease or malignancy treated with blood stem cell transplant.
*The number of infections (CRBSI) per 1000 catheter days
**For persons who had an infection.
*** For persons who had a second infection. Note that there are only 9 persons who had a second infection.

two infections). Multiple infections that met the criteria for being a new infection were included in the analysis for a total incidence of 24.77%. CVC replacement due to CRBSI was required in 78 cases (71.56%). A tunnelled CVC was used for replacing the line in 33 cases, an intrajugular line was used for replacement in eight cases, and a peripherally inserted central catheter was used for replacement in 37 cases.

The initial hypothesis posed differences in CRBSI between the three dressing groups. Three other aspects of infection were also investigated. Additional hypotheses testing considered more than the frequency of infection occurrence (the number of CRBSIs). 1) The number of organisms (one or more separate organisms) grown on blood cultures were compared between groups, as poly-organism infection was a possibility. 2) When an infection developed (onset) in relation to CVC insertion was compared to determine if any of the groups were more likely to develop an infection earlier than another group. 3) The nature of each organism, being the cell wall structure, as indicated by laboratory gram staining, was also compared between groups (Table 3).

Incidence rates indicated on Table 2 revealed slight differences in the number of infections according to dressing group. Kruskal-Wallis test results (Table 3) show that the differences between dressing groups are non-significant for the number of infections, the number of organisms, the onset of infection, and the type of infection (gram + or gram -). The non-significant findings across all tested aspects of infection indicate that the type of dressing is not associated with the development of infection in this population. Therefore, analysis of the charges for each dressing strategy was subsequently performed to identify the most economical strategy.

Table 3: Test of differences in CRBSI, organisms, onset, and gram stain, among dressing groups (post tunnel healing)

	Kruskal-Wallis		
	H	*Df*	*p*
*CRBSI	2.632	2	.268
Number of Organisms	1.833	2	.4
Days until Onset of First Infection	3.761	2	.152
Days until Onset of Second Infection	.676	2	.713
Gram + Organisms	1.399	2	.497
Gram — Organisms	.047	2	.977

*Total number of separate infections developed by an individual subject.

Cost of Dressing Strategies

Specific items used for each strategy and the frequency of care for each strategy, were different for each dressing group (Table 4). Supply differences resulted in different charges for each care strategy. The transparent dressing group required care once a week for estimated supply charges plus nursing wages, totalling $51.79/week. The no dressing group required daily care (that could be delegated to the individual subject in the majority of cases) for estimated charges of $56.34/week. The gauze dressing group required care every 48 hours (or when wet/soiled) for estimated charges of $103.72/week.

DISCUSSION

Results from this study comparing the incidence of CRBSI among blood stem cell transplant recipients whose tunnelled catheter sites were managed with either transparent dressing, no dressing, or gauze dressing suggest that the type of CVC exit site dressing is not associated with CRBSI in this population.

Table 4: Weekly supply and nurse charges for each dressing strategy

		Transparent		No Dressing		Gauze	
Supply	**Cost ($)/unit**	**Units**	**Cost ($)**	**Units**	**Cost ($)**	**Units**	**Cost($)**
Mask	3.78	1	3.78	-	-	2.5	9.45
Glove	1.77	1	1.77	-	-	2.5	4.43
Sterile Glove	8.87	1	8.87	-	-	2.5	22.18
Swabstick	1.64	3	4.92	21	34.44	7.5	12.3
Alcohol Swab	.05	4	.20	28	1.40	10	.50
2x2 Gauze	.02	1	.02	-	-	2.5	.05
4x4 Perforated Gauze	.22	-	-	-	-	5	1.10
4x4 Gauze	.05	-	-	-	-	2.5	.13
Transparent Dressing	1.85	1	1.85	-	-	0	
Shower Cover	2.45	7	17.15	7	17.15	7	17.15
Securement Device	3.35	-	-	1	3.35	1	3.35
Supply Total			38.56		56.34		70.64
Nursing	Wage	Hours	Cost			Hours	Cost
RN	35.28	.375	13.23	-	-	.9375	33.08
Weekly Total			$51.79		$56.34		$103.72

RN=Registered Nurse
*Prices obtained from a single centre in Canadian dollars

Lack of significant findings, considering when an infection occurred (onset), and the number and type of organisms (gram stain + or -) further support that the implanted cuff and tunnel itself are adequate barriers to surface organisms. Bloodstream contamination at the tunnel site is unlikely when the site is kept dry beneath dressings or by dressing removal. Initial dressings prevent exposure to host bodily fluids and catheter slippage until the tunnel site has healed. O'Grady et al. (2011) suggest moisture catalyzes microbial tunnel migration and increases surface colonization thereby advising to protect access sites from unsterile precipitation. Recommendations are based on case reports of water borne infections likely introduced via unprotected connections and cross-contamination by skin colonies. Covering all sites and connections during showering, adherence to skin asepsis in the early stages of insertion, and maintaining vigilance with asepsis when accessing devices are more influential on CRBSI reduction than the type of dressing.

This study supports the use of no dressing after tunnel healing that has received virtually no attention from comparative studies in the literature. It appears the recent trend to remove the dressing from a healed tunnelled exit site is a safe strategy in terms of infection risk and presents other benefits. Long-term use of a CVC poses greater risk for post insertion complications and compounding charges for care. O'Grady et al. (2011) advise to use careful judgment with dressing maintenance for a prolonged period of time. Since the three dressing options do not seem to vary in terms of infection risk, it is useful to compare the costs of each strategy.

Gauze dressings incurred much higher charges than the other two strategies and pose a higher weekly labour burden on nursing staff. This study recommends the use of a gauze dressing as a last resort. The no-dressing strategy incurred higher than expected charges due to the expense of using daily skin antiseptic as opposed to cleansing once a week when a transparent dressing is used. The highest priced items were sterile gloves, shower covers, and securement devices rather than actual dressing materials that are relatively inexpensive. Supply fees are secondary concerns for frontline staff, as patient needs take precedence. Although the transparent dressing strategy incurred the lowest weekly charges (supplies and nurses fees), this finding should be interpreted with discretion.

The total difference in charges between the transparent and no-dressing strategies is relatively small ($4.55/week). This study did not factor in charges for wasted items or use of extra supplies at the bedside, which, over time, inflates costs beyond the no-dressing strategy. For example, a single break in sterile technique while changing a transparent dressing, requiring sterile glove replacement, incurs a charge of $8.87—more than four and a half times the price of the transparent film itself and almost double the weekly difference in charges for the no-dressing group. An early dressing change, due to excess perspiration or soiling for example, doubles the weekly fee for transparent dressings. Additional products used to troubleshoot integumentary issues with dressing changes were not factored in to this study for example, using hydrocolloids or topical skin barriers beneath transparent dressings, disc securement devices with gauze dressings, or absorbent padding overtop of gauze dressings. The use of biopatches (an antiseptic sponge) beneath a transparent film dressing was not a practice followed at the study centre. Inclusion of a biopatch (or any other material beneath a transparent dressing) would increase the weekly transparent dressing costs beyond the weekly cost of following the no-dressing strategy. Similar studies comparing infectious outcomes between biopatch dressings and removing the dressing (for healed tunnelled lines) are needed to distinguish if antiseptic sponges impact CRBSI in this population with the understanding that the strategy remains inapplicable to young infants and individuals with skin toxicities.

The total difference in nurse fees between the transparent and no dressing group was $13.23 per week. The study did not factor nursing labour costs for instructing patients on how to independently care for their line after the dressing is removed. However, it was assumed that the initial instruction was minute in comparison to weekly dressing procedures. The average nursing labour charges did not factor in differentials in pay for experienced nurses, extra time required at the bedside for training new nurses in the procedure or the additional time that novice nurses may require, all of which may also inflate average nursing labour charges for a dressing change.

All dressings require nursing labour, supplies, and accommodation of nurse-patient schedules. This study did not factor patient time undergoing dressings, the time patients, families, and lay caregivers spend on performing and learning how to perform dressings, or the added charges for outpatient supplies that are often higher than bulk pricing offered to hospitals. The no-dressing strategy requires fewer procedural steps, allowing support staff, and lay caregivers to assist with simplified line care for patients that may need assistance. Dressing removal relieves care burden on patients by simplifying the amount of education needed and minimizing the number of tasks required for eventual self-care. Removing the dressing encourages autonomy for patients already heavily reliant on the system. Møller and Adamsen (2011) report findings from hematology patients, that increased self-care with a long-term CVC fosters independence, self-efficacy, and a greater sense of control for patients, which positively affected psychological outlook.

Furthermore, the no dressing strategy may be a more comfortable option to use of a dressing. Less exposure to adhesive reduces pruritus, and decreases the potential for developing contact dermatitis. Sites open to air do not require frequent adhesive removal, which may cause excoriation or even skin tearing. In addition to less chance of wasted products at the bedside, savings in labour charges, and reduced exposure to adhesive, the no-dressing strategy may provide additional benefits. In accordance with asepsis theory, the embedded cuff suffices as a barrier while removing the dressing maintains a dry environment. Daily skin cleansing with the no-dressing strategy encourages more frequent attempts to reduce microbial load around the exit site. Studies comparing the three dressing types to tunnel infection and skin integrity around the exit site are warranted to further delineate optimal exit site care.

Further cost containment is possible with removing a tunnelled CVC exit site dressing. Some nurses refer to brand name shower covers and securement devices as 'luxury items' from which medical supply companies profit. Practice guidelines do recommend use of securement devices to prevent catheter slippage/tunnel injury and potential need for line replacement (O'Grady et al., 2011). Medical products designed for these purposes may not be feasible in low-income countries or may be intentionally overused in for-profit areas. Studies comparing accidental catheter dislodgement are needed to provide clinical evidence that securement devices reduce accidental dislodgment of catheters. All patients should receive equal quality and commission of essential health care. Affordable options such as using cellophane and waterproof tape may be viable solutions to overcoming the expense of using brand name shower covers without reducing care quality. Overall, the no-dressing policy has the potential to contain a wide variety of overall costs absorbed by the system worth consideration given lack of evidence that the strategy heightens infection risk.

It was noted that adherence to the policy of removing the dressing was not rapidly incorporated at the study site. Clinical documentation indicated some patients were anxious and/or uncomfortable leaving the exit site open to air. Non-adherence to removing the dressing after the policy change could have result-limiting effects. Individuals who refused the no-dressing strategy were eligible to be included in the sample. It is unclear if individual choice increases vigilance with infection prevention. However, results do not indicate significant infection reduction in groups that used dressings. Policy for exit site care did not discriminate between diagnoses. The occurrence of more myeloma patients and fewer catheter days in the no-dressing group may influence the overall findings. However, it was noted that there was an increase in the amount of myeloma treated at the centre after the CVC policy change (5%).

CONCLUSION

The decision to dress and maintain a CVC dressing is the responsibility of clinicians who employ best practices based on empirical evidence, clinical expertise, and patient preference. The overall costs and benefits of each strategy require clinical judgment and consideration of negative outcomes, charges, and non-monetary costs. Differences in nursing care strategies are not necessarily disparities. Rather, the various care approaches may represent conscious efforts of nurses applying theoretical and practice-based experience at the bedside. Since the study did not find a significant difference across each dressing strategy in terms of infection risk, the focus now turns to costs of supplies and labour. Since the overall costs of supplies and labour for gauze dressing is considerably higher than for transparent and no dressing, there is little support for continuing to use gauze. Thus, the decision boils down to a comparison of the costs of supplies and labour between transparent dressing and no dressing. Although transparent dressings incurred the lowest weekly supply charges, the costs of labour for transparent dressings makes this strategy almost comparable in total cost to the no-dressing strategy. There is a greater potential for overall cost containment with dressing removal by reducing time constraints on nurses, patients, and families, outpatient supply costs, and product wastage at the bedside. Considering these additional benefits, it appears the no-dressing strategy should be the first consideration for tunnelled CVC exit sites in blood and marrow cell transplant recipients. Given the immune-compromised status of this population, it is likely that findings from this study are applicable in other clinical areas that employ the use of tunnelled CVCs.

REFERENCES

Bard Access Systems (2012a). *Hickman* / Broviac* / Leonard* Catheters*. Retrieved from http://www.bardaccess.com/picc-hick-brov-leon.php?section=Features

Bard Access Systems (2012b). *How to care for your groshong catheter*. Retrieved from http://www.bardaccess.com/assets/pdfs/patient/pg-grosh-cath.pdf

Battistella, M., Bhola, C., & Lok, C.E. (2011). Long-term follow-up of the hemodialysis infection prevention with polysporin ointment (HIPPO) study: A quality improvement report. *American Journal of Kidney Disease, 57*(3), 432–441.

Beck, C. (1895). *A manual of the modern theory and technique for surgical asepsis*. Philadelphia: W.B. Saunders. Digitized by Google. Retrieved from http://books.google.com.mx/books?id=qM3njRbYkVQC&printsec=frontcover#v=onepage&q&f=false

British Columbia Nurses' Union (2012). *Collective agreement*. Retrieved from https://www.bcnu.org/ContractAdministration/ContractAdministration.aspx?page=Collective%20Agreements

Canadian Nosocomial Infection Surveillance Program. (2005). *Central venous catheter-associated blood stream infections in intensive care units and recipients of hematopoietic stem cell transplant*. Ottawa: Public Health Agency of Canada Archives.

Chopra, V., Krein, S.L., Olmsted, R.N., Safdar, N., & Saint, S. (2013). *Prevention of central line-associated bloodstream infections: Brief update review. In: Making Health Care Safer II: An Updated Critical Analysis of the Evidence for Patient Safety Practices*. Agency for Healthcare Research and Quality, No.211. Rockville MD: USA. Available from http://www.ncbi.nlm.nih.gov/books/NBK133364/

Daniels, K.R., & Frei, C.R. (2012). Antimicrobial impregnated discs for prevention of intravenous catheter-related infections. *American Journal of Infectious Disease, 8*(1), 50–59.

Duval, L. (2010). Infection control 101. *Nephrology Nursing Journal, 37*(5), 485–489.

Faruqi, A., Medefindt, J., Dutta, G., Philip, S.A., Tompkins, D., & Carey, J. (2012). Effect of a multidisciplinary intervention on central line utilization in an acute care hospital. *American Journal of Infection Control, 40*, e211–215.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Thousand Oaks, CA: Sage Publishing.

Gillies, W.J., O'Riordan, E., Sheriff, K.L., & Rickard, C.M. (2011). *Gauze and tape and transparent polyurethane dressings for central venous catheters*. Cochrane Database of Systematic Reviews, 3. doi:10.1002/14651858.CD003827.pub2

Infusion Nurses Society. (2011). *Policies and procedures for infusing nursing*. (4th ed.). Philadelphia: Lippincott, Williams & Wilkins.

International Business Machines Corporation. (2012). *Statistical package for the social sciences v.21*. USA: Microsoft Corp.

Institute for Health Improvement. (2013). *Central line catheter-related bloodstream infection (CR-BSI) rate per 1,000 central line days*. Retrieved from http://www.ihi.org/knowledge/Pages/Measures/CatheterRelatedBloodstreamInfectionRate.

Joint Commission. (2012). *Preventing central line-associated bloodstream infections: A global challenge, a global perspective*. Oak Brook, IL: Joint Commission Resources. Retrieved from http://www.PreventingCRBSIs.pdf.

Keeler, M.E. (2014). Central line practice in Canadian blood and marrow cell transplant. *Canadian Oncology Nursing Journal, 24*(2), 67–71.

Keeler, M.E., Haas, B.K., Nieswiadomy, M., McConnel, C, Northam, S., & Savoie, M.L. (2015). Tunnelled central venous catheter-related bloodstream infection in Canadian blood stem cell transplant recipients: Associated costs. *Canadian Oncology Nursing Journal, 25*(3), 311–318.

Kwakman, P.H., Müller, M.C., Binnekade, J.M., van den Akker, J.P., de Borgie, C.A, Schultz, M.J., ... Zaat, S.A. (2012). Medical-grade honey does not reduce skin colonization at central venous catheter-insertion sites of critically ill patients: A randomized controlled trial. *Critical Care, 16*(5), R214.

Macklin, D. (2010). Catheter management. *Seminars in Oncology Nursing, 26*(2), 113–120.

Manitoba Nurses Union (2012). *Collective agreement*. Retrieved from http://www.nursesunion.mb.ca/resources/collective-agreement/wage-benefit-summary.html

Medeiros, A.B., dos Santos, A.A., Soares, M.J., Costa, M.M., & Lira, A.L. (2012). Wound dressing technique: Comparative study between nursing professionals and students. *Journal of Nursing UFPE online, 6*(6), 1352–1360. doi:10.5205/01012007

Mermel, L.A., Allon, M., Bouza, E., Craven, D.E., Flynn, P., O'Grady, N., ... Warren, D.K. (2009). Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 update by the Infectious Diseases Society of America. *Clinical Infectious Disease, 49*(1), 1–45.

Møller, T., & Adamsen, L. (2010). Hematologic patients' clinical and psychosocial experiences with implanted long-term central venous catheter: Self-management versus professionally controlled care. *Cancer Nursing, 33*(6), 426–435.

Moreau, N. (2009). Are your skin-prep and catheter techniques up to date? *Nursing, 39*(5), 15–16.

New Brunswick Nurses Union (2013). *Collective agreement*. Retrieved from https://www.nbnu.ca/nurses-part-iii/

Newfoundland and Labrador Nurses' Union (2011). *Collective agreement*. Retrieved from http://www.nlnu.ca/collective-agreements.asp

Nova Scotia Nurses Union (2013). *Collective agreement*. Retrieved from http://www.nsnu.ca/en/home/collectiveagreements/default.aspx

O'Grady, N.P., Alexander, M., Burns, L.A., Dellinger, E.P., Garland, J., O'Heard, S., ... Saint, S. (2011). Guidelines for the prevention of intravascular catheter-related infections. *American Journal of Infection Control, 39,* S1–34.

Olsin, K., Rennie, R.P., Hanson, J., Ryan, M., Glipin, J., Falsetti, M., ... Gaudet, S. (2004). Evaluation of a no-dressing intervention for tunnelled central venous catheter exit sites. *Journal of Infusion Nursing, 27*(1), 37–44.

Ontario Nurses Association (2013). *Collective agreement*. Retrieved from http://www.ona.org/ona_members/hospital.html

Pallo, R.J. (2012). Organization and training for aseptic operations. *Journal of GXP Compliance, 16*(2), 43–46.

Petrasino, B., Becker, H., & Christian, B. (1988). Infection rates in central venous catheter dressings. *Oncology Nursing Forum, 115,* 709–717.

Poole, D. (2010). Minimizing the risk of infection in patient with central venous catheters. *British Journal of Cardiac Nursing, 5*(10), 477–481.

Popovich, K.J., Hova, B., Hayes, R., Weinstein, R.A., & Hayden, M.K. (2010). Daily skin cleansing with chlorhexidine did not reduce the rate of central-line associated bloodstream infection in a surgical intensive care unit. *Intensive Care Medicine, 36,* 854–858.

Prince Edward Island Nurses' Union (2011). *Collective agreement*. Retrieved from http://peinu.com/member-services/collective-agreementnegotiations/

Raschka, S., Dempster, L., & Bryce, E. (2013). Health economic evaluation of an infection prevention and control program: Are quality and patient safety programs worth the investment? *American Journal of Infection Control, 41*(9), 773–777.

Rodriguez, L., Ethier, M-C., Phillips, B., Lehrnbecher, T., Doyle, J., & Sung, L. (2012). Utility of peripheral blood cultures in patients with cancer and suspected blood stream infections: A systematic review. *Supportive Care in Cancer, 20*(12), 3261–3267.

Santerre, R.E., & Neun, S.P. (2010). Health economics: Theory, insights, and industry studies. Mason, OH: Cengage Learning.

Saskatchewan Union of Nurses (2012). *Collective agreements*. Retrieved from http://sun-nurses.sk.ca/labour-relations/collective-agreements

Scales, K. (2010a). Central venous access devices part 1: Devices for acute care. *British Journal of Oncology Nursing, 19*(2), 88–92.

Scales, K. (2010b). Central venous access devices: Part 2 for intermediate and long-term use. *British Journal of Oncology Nursing, 19*(5), S20–25.

Scales, K. (2011). Reducing infection associated with central venous access devices. *Nursing Standard, 25*(36), 49–56.

Seiler, S., & Pember, A. (2012). Editorial: Shower and no-dressing technique for tunnelled central venous hemodialysis catheters: 2012—an update. *CANNT: Canadian Association of Nephrology Nurses and Technologists Journal, 22*(2), 16.

Tarricone, R., Torbica, A., Franzetti, F., & Rosenthal, V.D. (2010). Hospital costs of central line-associated bloodstream infections and cost-effectiveness of closed vs. open infusion containers. The case of intensive care units in Italy. *Cost Effectiveness Resource Allocation, 8*(8). doi:10.1186/1478-7547-8-8

Tomblyn, M., Chiller, T., Einsele, H, Gress, R., Sepkowitz, K., Storek, J., & Boeckh, M.A. (2009). Guidelines for preventing infectious complications among hematapoietic cell transplant recipients: A global perspective. *Biology Blood Marrow Transplant, 15,* 1143–1238.

Toscano, C.M., Bell, M., Zukerman, C., Sheltor, W., Novicki, T.J., Nichols, W.G., & Jarvis, W.R. (2009). Gram-negative blood stream infections in hematapoietic stem cell transplant patients: The roles of needless device use, bathing practices, and catheter care. *American Journal of Infection Control, 37,* 327–334.

Toshiyuki, N., Koshuka, S., Toshihasa, A., Yoshikawa, T., Fakuda, K., & Satu T. (2012). Low incidence of catheter-related complications in patients with advanced pulmonary arterial hypertension undergoing continuous epoprostenol infusion. *Chest, 14*(1), 272–273.

United Nurses of Alberta (2010). *Collective agreements*. Retrieved from http://www.una.ab.ca/collectiveagreements