A Continuous Quality Improvement Project to Decrease Hemodialysis Catheter Infections in Pediatric Patients: Use of a Closed Luer-Lock Access Cap

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Catheter infections are a significant problem in pediatric hemodialysis. To reduce infection rates, the use of closed luer-lock access connectors, which create a mechanically and microbiogically closed system while allowing unobstructed blood flow, was implemented. Infection rates fell from 7.8 infections per 1000 patient days to 3.65 infections per 1000 patient days after the switch to the closed connector (p = 0.04). The adoption of a closed connector system appeared to produce a significant reduction in bloodstream infections.

Goal

To provide an overview of a quality assessment and performance improvement program regarding central venous catheter infection control in pediatric patients on hemodialysis.

Objectives

1. Explain the complications that can increase patient morbidity and mortality, and shorten catheter survival, in patients on hemodialysis.
2. Describe the quality assessment and performance improvement program as presented by these authors to attempt to reduce bloodstream infections through the use of Tego® connectors.

Background

Percutaneous central venous catheters (CVCs) are frequently used in children on long-term hemodialysis (Ramage et al., 2005). Long-term vascular access in small children is limited by difficulties in creating and maintaining patency of arteriovenous (AV) fistulas and AV grafts. According to 2008 North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS) data, 2,369 or 77.7% of pediatric patients on hemodialysis are using percutaneous CVCs (NAPRTCS, 2008). Bacteremia, thrombosis, and catheter malfunction are common complications associated with the use of CVCs. These complications increase patient morbidity and mortality, and shorten catheter survival. Infectious complications are costly to the patient and provider in many ways, including economic, catheter and possibly central vein loss, hospitalized days, and increased exposure to antibiotics, putting the patient at risk for immunological and bacterial resistance. Furthermore, even though catheters are used in children with the thought they will undergo transplantation quickly, recent data demonstrate this is not the case. Therefore, the duration of exposure to these risks may be significant (Fadrowski, Hwang, Neu, Fivush, & Furth, 2009).

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Table 1
Comparison of Bloodstream Infections and Line Revisions Pre- and Post-Tego® Connectors

Quarter	Bloodstream Infections			Line Revisions		
	Number of Infections/ Patient Months of Observation Time	Rate per 1000 Patient Days		Number of Infections/ Patient Months of Observation Time	Rate per 1000 Patient Days	
Pre-Tego® Experience						
2001 Q1	5/25.9					
2001 Q2	6/28.4					
2001 Q3	3/28.1					
2001 Q4	1/15.4					
2002 Q1	6/26.2			3/26.2		
2002 Q2	1/32.1			1/32.1		
2002 Q3	1/29.6			1/29.6		
2002 Q4	3/35.1		5.36	2/35.1		
2003 Q1	2/24.7			6/24.7		4.76
2003 Q2	6/26.9	5.85		4/26.9		
2003 Q3	8/27.9			10/27.9		
2003 Q4	8/30.2			2/30.2	4.64	
2004 Q1	5/25.7			5/25.7		
2004 Q2	6/17.7			6/17.7		
2004 Q3	4/17.9			3/17.9		
2004 Q4	0/16.3			0/16.3		
2005 Q1	5/19.2		7.80	3/19.2		4.27
2005 Q2	6/22.4			4/22.4		
2005 Q3	7/16.8			2/16.5		
Experience with Tego® Connectors						
2005 Q4	4/19.4			4/19.4		
2006 Q1	0/16.4			0/16.4		
2006 Q2	2/14.9	3.65	3.65	0/14.9	3.32	3.32
2006 Q3	3/22.1			5/22.1		
2006 Q4	2/26.0			1/26.0		

Bloodstream infections: The incidence rates per 1000 patient days are shown in the above table. The BSI incidence rate ratio was 0.47 (95% CI: 0.23 to 0.96), which indicates the BSI rate with Tego was less than half the BSI rate in the preceding five quarters. This is a statistically significantly reduction ($p = 0.04$).

Line revisions: The incidence rates per 1000 patient days are shown in the above table. The incidence rate ratio for line revisions was 0.78 (95% CI: 0.29 to 2.04), which does not represent a statistically significantly reduction ($p = 0.61$).

As a part of the authors' ongoing quality assessment and performance improvement (QAPI) program, infections are tracked on a monthly basis for all patients on hemodialysis. The number of catheter-related blood stream infections (CRBSIs), number of line revisions, and total patient-months of time at risk for these events are compiled by month. In review of the QAPI trend data for CRBSIs, a decrease was noted after implementing use of Tego® connectors, a neutral valve closed-system connector.

The decision to switch to Tego connectors was motivated largely by high bloodstream infection (BSI) rates observed during the first three quarters of 2005. In the comparison to the preceding five quarters, the incidence rate of CRBSIs was 7.8 infections per 1000 patient days during this control period. During the five quarters observed after the switch to Tego connectors, the rate was 3.65 infections per 1000 patient-days. The CRBSI incidence rate ratio was 0.47 (95% CI: 0.23 to 0.96), indicating the BSI rate with Tego connectors was less than half the BSI rate in the preceding five quarters. This is a statistically significantly reduction (p = 0.04). Line revision data show an incidence rate of 0.78 (95% CI: 0.29 to 2.04), which does not represent a statistically significantly reduction (p = 0.61) for the five-quarter period preceding the switch to Tego connectors (see Table 1).

A second factor that influenced the use of the Tego connector had to do with the costs associated with CVC infections. The cost for each Tego connector runs approximately $3, making the cost roughly $6 per week for most lines. The cost of a suspected infection is $98 x 4 or $392 for cultures (aerobic and anaerobic for each lumen). Antibiotics are $160 ($80 each for a dose of vancomycin and a dose of gentamicin); levels are then needed to determine dosing schedule at $112 for vancomycin level and $93 for a gentamicin level. The cost of a single-line infection treated as an outpatient with antibiotics can run $3000; this amount can increase if an emergency department visit is required, the line needs to be surgically removed, the patient is admitted to the hospital, and/or the infection takes longer to clear. Some patients require hospitalization with line infections and may require several temporary catheters to clear the infection and allow a more "permanent" CVC to be placed. This can drive the cost for a single infectious episode well over $10,000.

Repeated CVC lines can cause central vein loss, hospitalized days, and increased exposure to antibiotics, putting the patient at risk for immunological and bacterial resistance in addition to quality-of-life issues for these patients. Given the life-long nature of end stage renal disease, pediatric patients who undergo successful transplantation are likely to return to dialysis in the future. This mandates the patient's vasculature be preserved as much as possible.

Plan

The authors decided on a continuous quality improvement (CQI) project using Tego connectors on their chronic outpatient hemodialysis population. They used the CQI problem-solving model of Plan, Do, Check, Act (PDCA) cycle; a four-step model for carrying out change. The PDCA cycle is repeated routinely for continuous improvement. For this CQI project using Tego connectors, each patient had new connectors placed on Friday of each week. For those patients receiving dialysis more than three treatments a week, the connectors were also replaced on Monday. The authors initially planned to change the connectors prior to the third run for each patient (manufacturer recommendation to change weekly or every three runs), but this proved difficult to track easily. It was then determined to change the connectors on set days of the week.

Do

The connector easily luer-locked onto the catheter hubs and were changed in a sterile setting prior to a run. Accessing the catheter through the connector was done after cleansing of the connector end per hospital protocol for accessing CVCs using two alcohol wipes for 10 seconds each and allowing the end to dry prior to connecting the syringes. Waste was withdrawn followed by flush and then connection to the machine tubing. The machine tubing locked snugly into place for the treatment. Between treatments, the lines were locked with heparin in the usual fashion and labeled with a "High Dose Heparin – Do Not Flush" sticker.

Staff quickly established a comfort level with the connectors, and the ease of use was evident to patients and their families. Patients and their families especially liked not having to wear masks for connections except on the days the Tego connectors were changed.

Check

The incidence rate ratio for BSIs was 0.62, suggesting a substantial reduction of more than one-third in the BSI rate using the Tego connector as compared to historical data from 2001 through September 2005 using dead-end connectors. However, the confidence interval for the incidence rate ratio was wide (0.3, 1.3) due to the high degree of variability in rates over that historical period. The decision to switch to Tego connectors was motivated by infection rates observed during the first three quarters of 2005. Restricting the comparison to the more recent historical window, the incidence rate ratio for the post-Tego versus pre-Tego comparison drops to 0.36, or a nearly two-thirds reduction in rate, with a narrower confidence interval of 0.2, 0.8.

Act

Due to the successful reduction of catheter infections in this cohort of patients, it was determined to continue to use Tego connectors. The authors anticipate continued success. They have now expanded the project

and begun a PDCA cycle using Tego connectors on hospitalized patients who have hemodialysis (HD) lines in place.

Discussion

For the calendar year 2005, 13 patients were on chronic dialysis in an outpatient capacity. In this time, there were 19 line infections. In the 77.8 months represented in this period, one patient had six separate infections, two patients had three infections each, two patients had two infections, two patients had one infection each, and five patients had no infections.

For the calendar year 2006, 19 patients were on chronic HD in an outpatient capacity. In the 78.4 months of dialysis therapy represented in this time period, there were seven line infections. Of the total 19 patients, 15 had no infection.

For the calendar year 2007, there were 18 patients on chronic HD in an outpatient capacity. In the 144.4 months of dialysis therapy represented in this time period, there were 14 line infections. Of the total 18 patients, 10 had no infection.

Although the patient population varies as patients change modality, the pre-Tego and post-Tego groups had similar ages (range = 2.8 years to 19.2 years; average = 10.3 years), and patients with co-morbid conditions remained relatively constant. A fair amount of variability continues to be seen in the number of infections. Tego connectors are now placed on all newly placed HD lines in the operating room to help with potential contamination in the immediate postoperative period. In addition, the use of Tego connectors has made it comfortable for emergency department staff to draw cultures if needed from the catheter since it can be done through the connector.

Conclusion

In the authors' center, children are dialyzed through CVCs due to failure and/or exhaustion of permanent vascular access, small patient size, and inability to initiate or continue peritoneal dialysis. Pediatric patients on HD are more likely to require CVCs for temporary or permanent vascular access. Although technical improvements in vascular access surgery may allow AV fistulas or grafts in some patients, CVCs will remain a necessary mode of vascular access in many children, especially the very young. Therefore, further research needs to be done to devise methods to prevent infections and malfunction of these catheters (Neu, Ho, McDonald, & Warady, 2002). Use of Tego connectors has been a successful method for the authors' program and could be considered by other programs facing high BSI rates.

References

Fadrowski, J.J., Hwang, W., Neu, A.M., Fivush, B.A., & Furth, S.L. (2009). Patterns of use of vascular catheters for hemodialysis in children in the United States. *American Journal of Kidney Disease, 53*(1), 91-98.

North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS). (2008). *NAPRTCS 2008 annual report.* Retrieved from https://web.emmes.com/study/ped/annlrept/Annual%20Report%20-2008.pdf

Neu, M., Ho, P., McDonald, R., & Warady, B. (2002). Chronic dialysis in children and adolescents. The 2001 NAPRTCS annual report. *Pediatric Nephrology, 17*(8), 656-663.

Ramage, I., Bailie, A., Tyerman, K., McColl, J., Pollard, S., & Fitzpatrick, M. (2005). Vascular access survival in children and young adults receiving long-term hemodialysis. *American Journal of Kidney Disease, 45*(4), 708-715.

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