

Evaluation of Three Catheter Maintenance Schedules on Patency of Jugular Vein Catheters in CD Rats

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Abstract

Surgical placement of jugular vein catheters (JVCs) in rats is a common procedure to allow central venous access in conscious animals. Recommendations for catheter maintenance in rats, such as frequency of catheter flushing and types of lock solution used, are variable between institutions and generally based on limited scientific evidence. We conducted a study investigating the optimum maintenance schedule for rats with JVCs. Sixty male Crl:CD(SD) rats weighing 225-250g were used; 30 with polyurethane (PU) JVC catheters and 30 with PU-silastic (Blended) JVC catheters originating from two different Charles River commercial barrier surgical facilities. Animals were randomly assigned to one of 6 groups (n=10) based on surgical facility of origin, catheter material, and maintenance frequency (i.e. catheter flushing every 3 (Q3days), 5 (Q5days) or 7 (Q7days) days after surgery). The day of surgery was considered day 0. Catheters were considered patent if blood was successfully withdrawn. Treatment consisted of weighing each animal, aspiration of the lock solution (50% heparinized dextrose) and blood, followed by flushing with physiologic saline and replacement of lock solution. Catheter patency rates for treatment groups were 100% on the first assessment for day 3 (Q3day) and day 5 (Q5day) and 80% for day 7 (Q7day). At day 14, 60% of Q7day catheters remained patent and at day 15, 65% of Q5day catheters remained patent. Thirty percent of Q3day catheters remained patent at day 15. At the conclusion of the study, day 21 (Q7day) and day 20 (Q5day), 35% and 55% of the catheters remained patent, respectively. Fifteen percent of Q3day catheters remained patent on day 21. No significant difference in patency rates between catheter types (blended vs. PU) were found for the Q5day and Q7day treatment groups ($p > 0.966$). For the Q3day treatment group, PU catheter performance was significantly improved ($p = 0.007$) compared to the blended catheter. In summary, patency rates were greater than 80% for each treatment group for the first sampling day (i.e. days 3, 5 or 7), and 60% or greater on the next sampling day (i.e. days 6, 10 or 14). Longer term patency rates were greatest for catheters flushed every 5 or 7 days.

Introduction

Pharmacokinetic studies in rats are efficiently and humanely performed using chronic surgically implanted catheters that allow repeated blood sampling from a single animal. The amount of time a catheter remains patent determines the practical limits on the useful life of a catheter. Patency life of catheters is affected by many factors including growth of the animal and resulting positional change of the catheter tip over time, sepsis, flushing regimen, catheter material, and type of locking solution. Recommendations for catheter maintenance in rats, such as selection of locking solution and frequency of catheter flushing, are variable between institutions, often extrapolated from other species, and generally based on limited scientific data. This study was designed to compare patency rates of two common commercially available catheter materials, polyurethane (PU) and PU-silastic (blended) catheters, surgically implanted in the jugular vein of CD rats maintained at three different flushing frequencies.

Materials and Methods

Animals

Sixty CD rats (Crl:CD(SD)) weighing 225-250 grams were used; 30 each from commercial barrier production facilities in Raleigh, NC and Kingston, NY. Following placement of jugular vein catheters (JVCs), rats were transported in divided filtered (Sew Easy™) shipping containers to the Charles River facility in Wilmington, MA for the remainder of the study. In Wilmington, rats were housed singly in filter top polycarbonate microisolation cages and maintained at 21 +/- 2°C with a relative humidity of 30-70% and a 12:12 hour light:dark cycle. Commercially produced, sterilized feed, bedding and water were provided ad libitum. All conditions of animal care and use were approved by the Charles River IACUC and performed within AAALAC, International accredited facilities. Animals were of a VAF/Plus® health status.

Surgical Procedure

The rats were anesthetized with ketamine (43 mg/kg BW) and xylazine (8.7 mg/kg BW) administered intraperitoneally and provided buprenorphine (0.02 mg/kg) subcutaneously.

The skin overlying the scapula and over the right jugular vein were shaved and skin aseptically prepared. A 1-1.5 cm cranial-caudal incision, followed by blunt dissection was performed to expose the jugular vein, which was then catheterized using either a PU or blended catheter. After fixation of the catheter, it was flushed with sterile saline to verify patency. The distal end of the catheter was then tunneled subcutaneously to the dorsal scapular region where it was exteriorized. Catheter patency was verified again. The catheter was then locked with 50% heparinized dextrose solution. The exteriorized end of the catheter was sealed with a stainless steel plug. The skin incision was then closed with wound clips.

Catheter Patency Assessment

Thirty rats with each catheter type were randomly assigned to one of three maintenance schedules (n=10 animals per catheter material and maintenance schedule) and patency assessed every 3 (Q3day), 5 (Q5day) or 7 (Q7day) days post catheter implantation. The day of the surgery was considered day 0. Each animal was manually restrained, the catheter plug was removed, and the lock solution aspirated using a 23 gauge blunt needle attached to a 1 ml syringe. If aspiration was unsuccessful, an attempt was made to inject up to 0.5 ml of 0.9% saline in the catheter, followed by aspiration. After successful aspiration, catheters were flushed with up to 0.04 ml of saline, followed by up to 0.04 ml of lock solution (based on volume of catheter) and the catheter plug replaced. Animals with non-patent catheters were removed from the study.

Catheter Patency Classifications:

Fully Patent: Successful withdrawal on the first attempt.

Patent: Successful withdrawal after infusion (flushing) with saline.

Non-Patent: Unsuccessful withdrawal with and without attempted infusion of saline.

Statistical Analysis

Patency rates of PU and blended catheters were assessed using the student's t-Test using Excel 2003 (Microsoft Corp., Redmond, WA), with significance being associated with a $p < 0.05$.

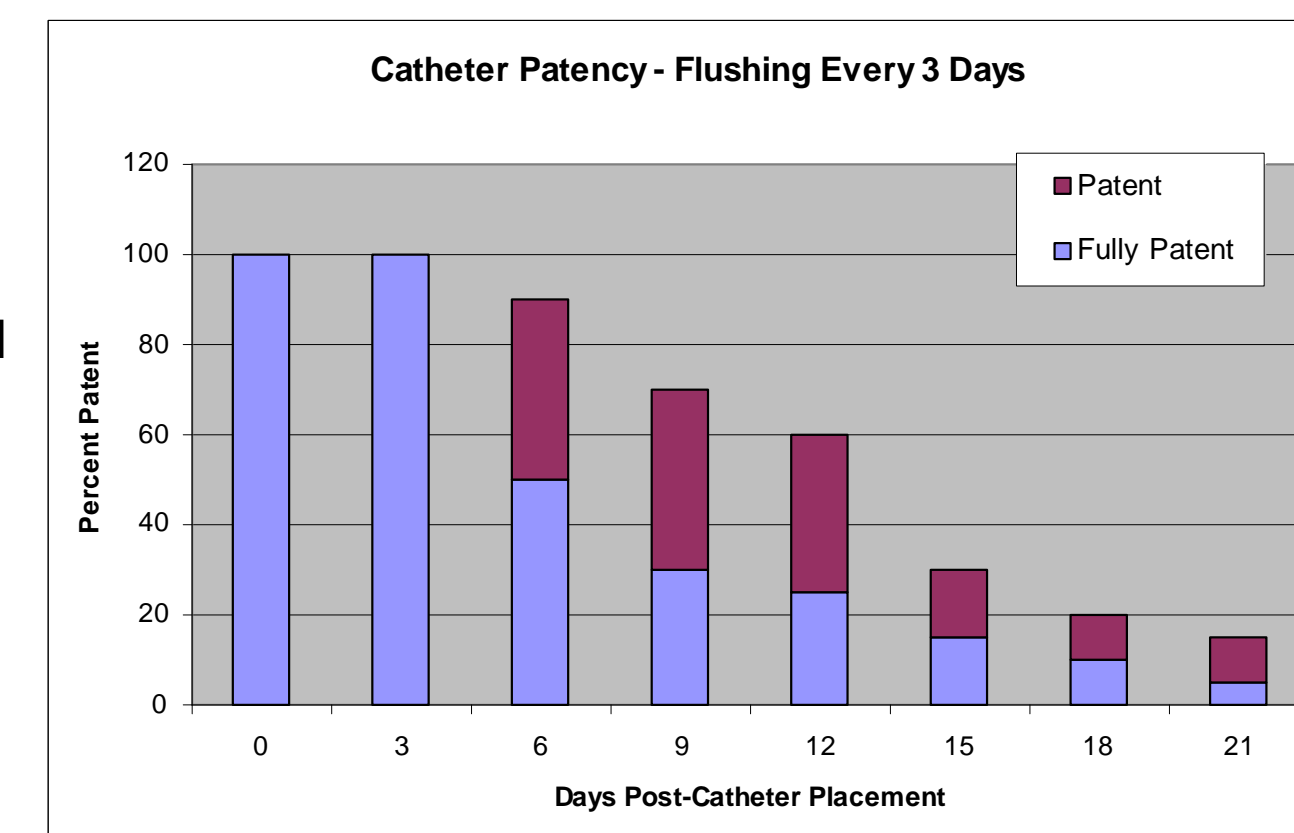


Figure 1. Percent of patent and fully patent JVC catheters with locking solution replaced every 3 days for 21 days. Data represents PU (n = 10) and blended catheters (n = 10), total catheterized animals assessed, n = 20.

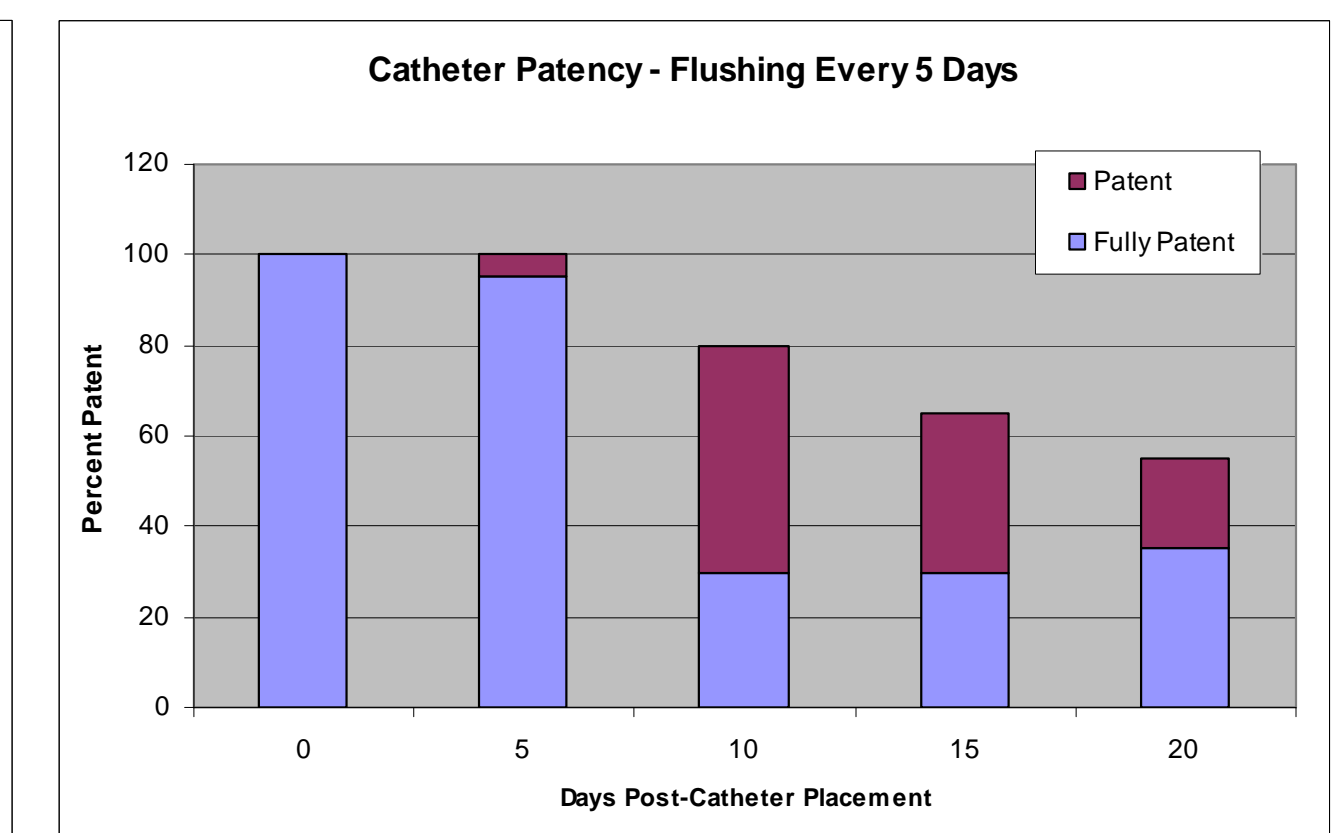


Figure 2. Percent of patent and fully patent JVC catheters with locking solution replaced every 5 days for 20 days. Data represents PU (n = 10) and blended catheters (n = 10), total catheterized animals assessed, n = 20.

Results

Comparison of Catheter Patency Rates

Catheter patency rates, as defined as fully patent and patent catheters, were 100% on the first day of assessment for day 3 (Q3day) and day 5 (Q5day), and 80% on day 7 (Q7day). For catheters flushed every 3 and 5 days, the patency rate was 90% on day 6 (Q3day) and 80% on day 10 (Q5day). Patency rate for Q7day flushing was 60% on the second sampling (day 14). At the third sampling, patency rates were 70% on day 9 (Q3day), 65% on day 15 (Q5day), and 35% on day 21 (Q7day). Catheters flushed every 5 days showed the greatest patency rate of 55% on day 20; whereas patency rates were 35% on day 21 (Q7day) and 15% on day 21 (Q3day).

Comparison of Catheter Materials

Comparison of patency rates for the two catheter materials indicated that in for the Q3day treatment, the PU catheter patency rate was significantly greater than the blended catheter ($p = 0.007$). Differences in patency rates between the two catheter materials were not significant for the Q5day and Q7day treatment groups. Data not shown.

Conclusions

• For short term projects, when animals are used within 5 days after catheter placement, no flushing may be necessary as all catheters remained patent at day 5 for the Q5day group.

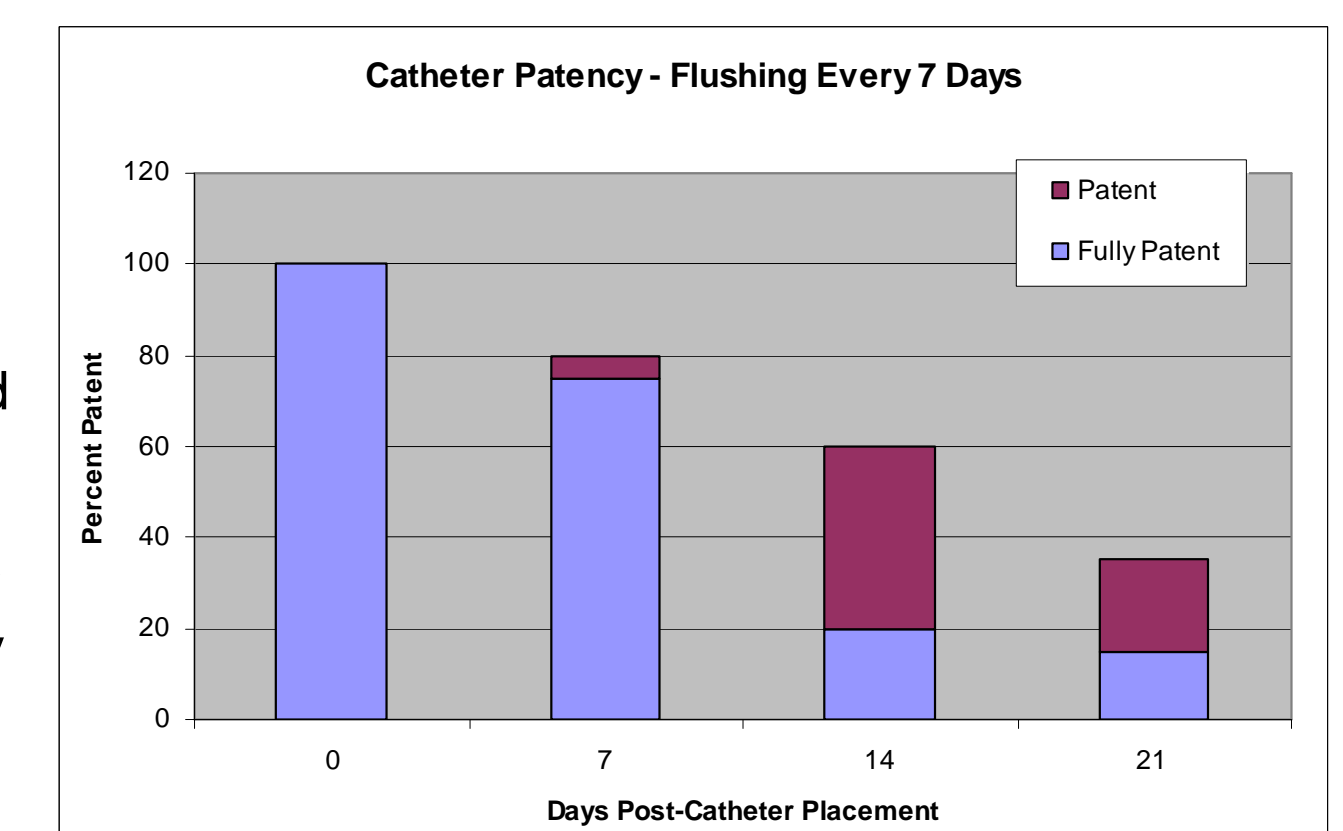


Figure 3. Percent of patent and fully patent JVC catheters with locking solution replaced every 7 days for 21 days. Data represents PU (n = 10) and blended catheters (n = 10), total catheterized animals assessed, n = 20.

• Flushing catheters every 5 days resulted in the highest patency rate at approximately 2 weeks after catheter placement (65% at day 15), as well as the highest patency rate approximately 3 weeks after catheter placement (55% at day 20). For projects requiring catheter patency for two to three weeks, flushing catheters every 5 days provided the greatest benefit.

• Catheter material, i.e. PU or blended PU-silastic, performed similarly and showed an inconsistent affect on patency rate across the three maintenance regimens.

Acknowledgement

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