The arteriovenous fistula remains the preferred type of vascular access because of its higher patency and lower infection rates (1). Cannulation of the fistula remains a challenge for patients, caregivers, and nurses, often resulting in increased pain, stress, and vessel injury. The use of rotating puncture sites along the entire length of the fistula, or rope-ladder cannulation (RLC), was intended to heal the site and prevent hematoma, stenosis, infection, and pseudoaneurysm. Constant site needling or buttonhole cannulation (BHC) was introduced in the 1970s to address cannulation of short fistula segments (2). The technique is based on repeated sharp needle insertion into the same site, preferably by a single cannulator, at the same angle over the course of six to nine hemodialysis sessions. This produces a scar tissue tract across the vein wall, which can subsequently be cannulated with blunt needles.

The initial observational studies of BHC, many of which were retrospective, reported lower rates of hematoma and infiltration injury, less needling time (2,3), and, importantly, less pain (3–7). BHC was adopted by many home dialysis programs for its ease of cannulation and decreased training time, as well as in-center units, with support from the National Kidney Foundation’s guidelines on vascular access (1) and promotion as the preferred type of cannulation by the United Kingdom Renal Association (8).

The recent reporting of increased infection rates (4,6,9–11) with the use of BHC and debate as to its benefit in reducing pain (9,11–14) and improving patency (15) has tempered its use in many units and calls into question whether BHC should be used at all. Before addressing this question, it is important to review the complete body of evidence, the study population (particularly differentiating home or in-center patients), outcomes, follow-up, and the specifics of the buttonhole technique. Recent systematic reviews of both home and in-center dialysis (16) and intensive dialysis (17), as well as a narrative review (18), highlight the concerns regarding observational and crossover study designs, short follow-up, operator dependency, and differences in the BHC technique. These reviews highlight the ongoing uncertainty surrounding the benefits and risks of BHC (14,19).

In this issue of CJASN, Muir et al. (20) report on a retrospective, single-center experience comparing BHC to RLC in a home hemodialysis population, accompanied by a systematic review of the related literature. The study reports a significant 3-fold increase in total fistula-related infections/1000 fistula-days in the BHC cohort (0.39 events) compared with the RLC cohort (0.10 events), with little change in the effect size after adjustment for differences in populations. The rate of systemic fistula infections is more difficult to interpret because event rates were low and results were not reported as per 1000 fistula-days, with different reporting periods: 2003 to mid-2004 for RLC and 2004–2009 for BHC. In addition, interpretation of the rate of fistula loss and need for surgical intervention is hampered by the exclusion of radiologic interventions that represent the majority of interventions in patients with fistula and have been significantly associated with fistula patency outcomes (21). The utilization-related outcomes were as follows: Training time and ongoing support encounters were significantly higher with BHC (median, 46 days [interquartile range, 37–60 days] versus 37 days [interquartile range, 25–58 days] in the RLC and 1 encounter per 13.2 fistula-days versus 1 encounter per 19 fistula-days for RLC). These results, however, cannot be generalized because each facility will develop its own proficiency with training, patient selection, and technique, which may lead to different results than those reported by Muir et al. (20) in their single-center experience.

As the authors point out, the accompanying systematic review is limited by a small number of studies with relatively short follow-up. However, they also report an approximate 3-fold increase in systemic infection risk with BHC compared with RLC in pooled analyses across various study designs, the most reliable of which is based on randomized controlled trials, with a pooled relative risk of 3.34 (95% confidence interval [95% CI], 0.91 to 12.20; $I^2=15\%$). The concordance between this pooled estimate and the authors’ local experience seems to reassure that the measured effect is accurate, and the $I^2$ statistic suggests little heterogeneity in this body of evidence. It is, however, likely that this analysis (which included only four small studies) was not adequately powered to detect heterogeneity. The relative risk reported in these trials ranged between 1.00 (95% CI, 0.14 to 6.90) (i.e., no increased risk of infection with BHC) to 25.00 (95% CI, 1.51 to 414.12) (i.e., significant risk of infection with BHC), indicating that an unexplained clinical heterogeneity probably exists. This marked variability in infection risk across studies is likely to be attributed to unmeasured variables in the use of BHC and RLC.

The study by Muir et al. (20) is representative of the literature on cannulation techniques. It describes a
single-center experience, with limited external generalizability and suboptimal reporting of the technical aspects of the BHC intervention itself. Determinants of infection risk include buttonhole site care protocols, scab removal techniques, cannulation technique and skill, the use of sharp needles versus polycarbonate pegs, fistula vintage, prior surgical or angiographic procedures, follow-up time, overall vigilance with antiseptic technique and monitoring for early signs of infection, and several other patient and dialysis facility characteristics. Illustrative examples of the effects of BHC technique include the association between infection risks and the number of sharp-needle cannulations required to create the tract (14), as well as the use of prophylactic antibiotic cream at the site of BHC to reduce infection risk (22). Another clear example of differences in technique is the use of devices to aid in development of the fibrous tract. The BioHole peg is a recently introduced adjunct to the BHC technique. This polycarbonate peg replaces sharp needle cannulation during the establishment of buttonholes. The peg remains in place between dialysis sessions and allows a tissue tunnel tract to form within approximately 14 days. Interestingly, no episodes of bacteremia have been reported in one study with up to a year’s follow-up (14) or in two studies with 3 or fewer months’ follow-up (23,24). Of note, all patients in these studies had established buttonhole tracts within 14 days. Despite promising preliminary results, further studies that consider costs and training times are warranted.

All of the determinants of infection risk have not been fully elucidated, yet if identified, they could lead to significantly different rates of infection and other complications with BHC. Variation in these many practices may explain the inconsistent results in the current literature, which are driving the ongoing controversy regarding the use of BHC. Two recent editorials on this topic took opposing sides based on reviews of two separate studies (25,26), highlighting the need to examine all components of a cannulation program.

So where should we stand on use of buttonhole cannulation? Despite the above limitations, the results of Muir and colleagues’ observational study and systematic review (20) demonstrate a concordant signal of up to a 3-fold greater risk of infection with the use of BHC. The results are consistent with those of other trials reporting infection rates (9,11,22). It is important to note that these rates of infection (0.39 event/1000 fistula-days) are similar to those reported for well managed catheters (27), potentially negating the primary benefit of the fistula.

Are we trading off improvement in cannulation injury, improved patency, and perhaps a decrease in training time and pain for increased risks of infection? Or is it that we have to ensure that the BHC technique is standardized and rigorously described, with diligent follow-up procedures and standardized reporting of outcomes? Clearly this technique requires cannulators, whether patients, lay caregivers, or nurses, to be fully committed to aseptic and hygienic protocols, with meticulous and careful execution of needle insertion in both new and developed tracts. Units considering BHC must ensure intensive, rigorous, and continual training and education of nurses and self-cannulators to prevent infections and related complications. We specifically emphasize the need for retraining at specified intervals to ensure that proper technique is maintained. Many in-center units cannot meet these criteria, with rotating nurses with varying degrees of cannulation skills and awareness of the need for exacting technique. In addition, a structured program for monitoring, reporting and follow-up of outcomes related to cannulation must be in place to ensure timely identification of complications.

We have previously recommended that BHC be used only in selected patients undergoing home hemodialysis (17,28). Given the recent evidence included in the report by Muir et al. (20), we believe this cautious, individualized approach is still warranted with the inclusion of the above specifications for education, training, and monitoring. However, given the limitations in the current literature and the new opportunities suggested by more recent studies, larger and more rigorous trials evaluating specific aspects of the BHC technique in well-defined populations seem warranted.

Disclosures
None.

References


Published online ahead of print. Publication date available at www.cjasn.org.