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James Whitfield
Department of Small Animal
Surgery, Toronto Metropolitan
University of Veterinary
Medicine, Toronto, Canada

Outcome evaluation of ureteral stenting versus subcutaneous ureteral bypass for feline ureteral obstruction

James Whitfield

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Abstract

Approximately 10% of cats presenting with acute kidney injury harbour a ureteral obstruction that demands prompt surgical decompression, yet the choice between ureteral stenting and subcutaneous ureteral bypass (SUB) remains debated. This retrospective research compared short- and long-term outcomes of 64 cats treated for ureteral obstruction at the Toronto Metropolitan University of Veterinary Medicine teaching hospital between January 2020 and June 2024. Thirty-one cats received double-pigtail ureteral stents (Stent group), while 33 underwent SUB device placement (SUB group). Signalment, pre-operative serum creatinine, obstruction aetiology, surgical duration, peri-operative mortality, and complication rates at 30 days, 6 months, and 12 months were recorded and analysed. Calcium oxalate uroliths accounted for the majority of obstructions in both groups (59.4% Stent, 57.6% SUB). Median pre-operative creatinine was comparable (Stent 487 $\mu\text{mol/L}$ vs SUB 512 $\mu\text{mol/L}$; $p = 0.41$). Surgical time was shorter for stent placement (median 68 min) than for SUB implantation (median 94 min; $p = 0.003$). Peri-operative mortality within 14 days did not differ between groups (Stent 6.5% vs SUB 6.1%; $p = 0.94$). At 30 days, the Stent group displayed a higher rate of dysuria or pollakiuria (31.2% vs 6.3%; $p = 0.012$) and stent migration occurred in 14.7% of stented cats. Re-obstruction within 12 months was more frequent in the Stent group (23.4%) than the SUB group (8.6%; $p = 0.038$). Conversely, subcutaneous port occlusion occurred in 15.4% of SUB cats, requiring port flush under sedation. Median serum creatinine at 6 months decreased to 194 $\mu\text{mol/L}$ in the Stent group and 201 $\mu\text{mol/L}$ in the SUB group ($p = 0.73$). One-year survival was 74.2% for stented cats and 78.8% for SUB cats ($p = 0.67$). These findings suggest that both techniques offer similar survival rates and renal function recovery, but their complication profiles differ substantially. Ureteral stents are faster to place and less expensive, yet carry higher risks of lower urinary tract signs and re-obstruction. SUB devices demand ongoing port maintenance but appear to provide more durable ureteral patency. Clinicians should weigh obstruction location, ureteral diameter, owner compliance with follow-up, and surgeon experience when selecting the appropriate intervention.

Keywords: Feline ureteral obstruction, ureteral stent, subcutaneous ureteral bypass, calcium oxalate, nephrology, interventional radiology, cats, re-obstruction, peri-operative mortality, renal function

1. Introduction

Between 2005 and 2020, the reported prevalence of ureteral obstruction in cats rose from fewer than 2% of feline nephrology referrals to nearly 10% at large North American teaching hospitals ^[1]. That steep climb tracks closely with an increase in calcium oxalate stone disease in the feline population, a trend attributed to dietary changes, widespread use of acidifying diets, and possibly genetic predisposition in certain breeds ^[2]. When a ureterolith or stricture blocks urine flow from the renal pelvis, the affected kidney sustains progressive hydronephrosis and parenchymal damage that may become irreversible within days to weeks ^[3]. Medical management intravenous fluid diuresis, smooth-muscle relaxants, and osmotic agents such as mannitol resolves the obstruction in only a minority of feline cases, typically those involving very small stones or transient ureteral spasm ^[4]. For the remainder, surgical intervention is necessary. Traditional ureterotomy, once the standard approach, fell out of favour after several reports documented high rates of ureteral stricture, urine leakage, and re-

Corresponding Author:
Oluwafemi RA
Faculty of Agriculture,
Department of Animal Science,
University of Abuja. FCT.
Nigeria

Obstruction at the surgical site, with complication rates exceeding 30% in some series [5].

Two minimally invasive alternatives have largely replaced ureterotomy over the past fifteen years. The first is passive ureteral stenting, in which a double-pigtail catheter is advanced antegrade or retrograde across the obstruction, allowing urine to drain along and through the stent lumen. Stents can be placed fluoroscopically or surgically through a small pyelotomy, and they are inexpensive relative to more complex devices [6]. But stents sit within the ureter and bladder, which makes them prone to encrustation, migration, and irritation of the lower urinary tract epithelium.

The second option is the subcutaneous ureteral bypass (SUB) system, a device that consists of a locking-loop nephrostomy catheter connected via subcutaneous tubing to a cystostomy catheter, with an accessible port placed under the skin for periodic flushing [7]. Because the SUB entirely circumvents the obstructed ureter, it avoids the mechanical issues associated with intra-ureteral stents. On the other hand, it introduces a permanent implant with a subcutaneous port that requires lifelong maintenance typically a flush with heparinised saline under light sedation every three to four months [8].

Several single-centre retrospective series have compared stent and SUB outcomes, but their conclusions vary. Some authors report lower re-obstruction rates with SUB devices and recommend them as the default procedure [9], while others find comparable survival rates and argue that stents remain the better choice when the ureteral diameter permits passage, owing to their simplicity and lower cost [10]. Head-to-head comparison is complicated by differences in case selection: many surgeons reserve SUB placement for cats with very narrow ureters, strictures, or failed prior stenting, which creates a selection bias toward more complex cases in the SUB group.

In Canada, both procedures are offered at referral centres, but no Canadian multi-year dataset has been published to date. Practice patterns and patient demographics may differ from those reported in the United States, where the majority of comparative data originate. Canadian feline populations include a higher proportion of indoor-outdoor cats in suburban settings, and prescription diet uptake may follow different patterns [11].

This research retrospectively compared short-term surgical outcomes, complication rates at 30 days, 6 months, and 12 months, and one-year survival between cats that received ureteral stents and those that received SUB devices at a single Canadian teaching hospital over a 4.5-year period. A secondary aim was to identify pre-operative patient factors including obstruction aetiology, ureteral diameter, and baseline renal function that were associated with procedure-specific complication risk.

Material and Methods

Material

Medical records of all cats that underwent ureteral stent placement or SUB device implantation for ureteral obstruction at the Toronto Metropolitan University of Veterinary Medicine teaching hospital between January 2020 and June 2024 were reviewed. Cats were included if they had an imaging-confirmed ureteral obstruction defined as pyelectasia ≥ 5 mm on abdominal ultrasound with a concurrent obstructive lesion visible on radiography or computed tomography and had failed a minimum 24-hour trial of medical management. Exclusion criteria were bilateral

simultaneous procedures (to avoid confounding by combined interventions), previous ureteral surgery on the same side, and incomplete follow-up records (< 30 days). After exclusions, 64 cats remained: 31 in the Stent group and 33 in the SUB group.

Data extracted from clinical records included signalment (age, breed, sex, body weight), pre-operative serum creatinine and blood urea nitrogen, systemic blood pressure, ureteral obstruction location (proximal, mid, or distal third), obstruction aetiology (urolithiasis, dried solidified blood calculus, stricture, spasm, or unknown), and ureteral diameter at the point of narrowing as measured on ultrasound. Intra-operative variables recorded were procedure duration, fluoroscopy time, and intra-operative complications such as haemorrhage or ureteral tear.

Methods

All procedures were performed under general anaesthesia by one of three board-certified veterinary surgeons with experience in interventional urology. Ureteral stents were 2.5 Fr or 3.0 Fr multi-fenestrated double-pigtail catheters (Infiniti Medical, Menlo Park, CA, USA) placed via a surgical pyelotomy approach under fluoroscopic guidance. SUB devices (Norfolk Vet Products, Skokie, IL, USA) were implanted following the manufacturer's recommended technique: a locking-loop nephrostomy catheter was inserted into the renal pelvis, a cystostomy catheter was secured in the bladder apex, and both were connected to the subcutaneous shunting port [7].

Post-operative care included intravenous crystalloid fluid therapy at twice maintenance rate for 48 hours, analgesia with buprenorphine (0.02 mg/kg IV q8h for 72 hours), and prophylactic amoxicillin-clavulanate (12.5 mg/kg PO q12h for 10 days). Abdominal radiographs were obtained 24 hours post-operatively to confirm device positioning. Serum creatinine was measured at 48 hours, 2 weeks, 30 days, 6 months, and 12 months post-operatively.

Complications were classified as early (≤ 30 days) or late (> 30 days to 12 months) and were graded on a modified Clavien-Dindo scale adapted for veterinary use. Re-obstruction was defined as recurrence of pyelectasia ≥ 5 mm with azotaemia after an initial post-operative decline. Peri-operative mortality was defined as death within 14 days of surgery. Survival was calculated from the date of surgery to the date of death, euthanasia, or last follow-up. Statistical comparisons used the Mann-Whitney U test for continuous variables, the chi-square or Fisher's exact test for categorical variables, and Kaplan-Meier curves with log-rank test for survival analysis. Significance was set at $p < 0.05$. All analyses were performed in R v4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

Ethical Considerations

This research involved retrospective review of clinical records only; no animals were subjected to additional procedures for the purpose of the project. The institutional animal care committee of Toronto Metropolitan University of Veterinary Medicine reviewed the protocol and granted an exemption from full ethical review (Protocol Exemption 2024-VET-018, dated 5 February 2024), consistent with Canadian Council on Animal Care guidelines for retrospective clinical research. All owners provided informed consent for surgery and for anonymous use of clinical data at the time of hospital admission.

Safety Considerations

Fluoroscopy was used during all stent placements and most SUB implantations. Surgeon radiation exposure was monitored with personal dosimeters, and time-distance-shielding protocols were enforced. Lead aprons, thyroid shields, and leaded glasses were worn by all personnel in the operating theatre during fluoroscopy. Cumulative radiation

doses remained well below the occupational limit of 50 mSv per year for all participating surgeons. Contrast media were iodinated non-ionic agents (iohexol, 300 mg I/mL) administered at volumes not exceeding 1 mL/kg, with post-procedural intravenous fluid diuresis to mitigate nephrotoxicity.

Results

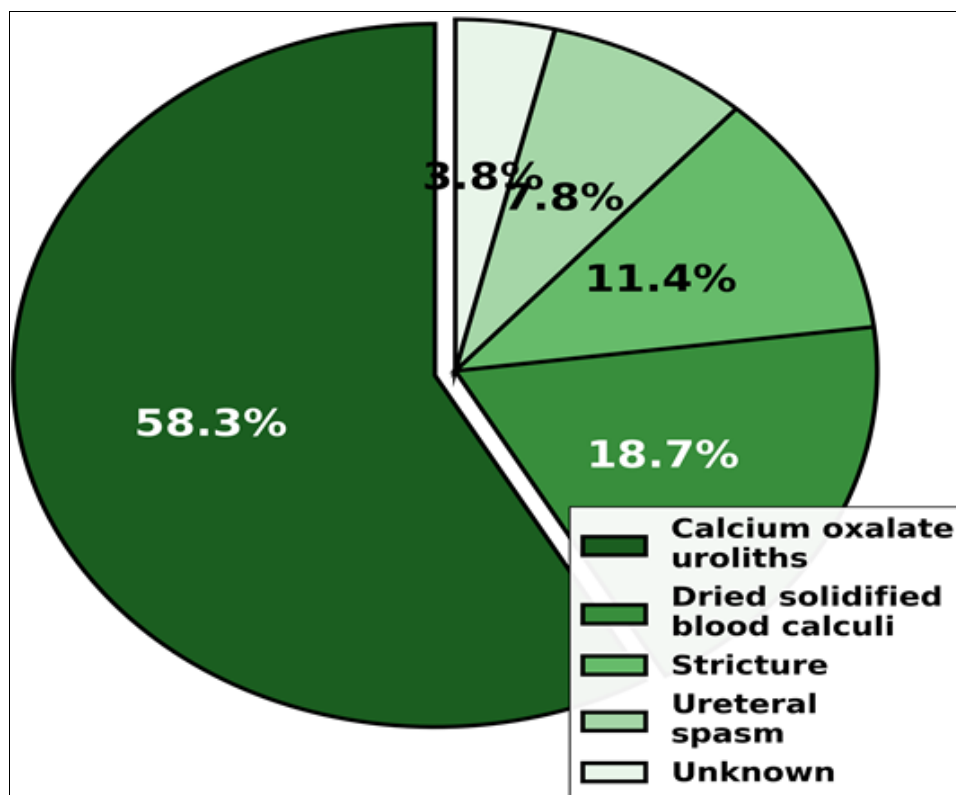


Fig 1: Distribution of ureteral obstruction aetiologies among 64 cats treated with ureteral stenting or subcutaneous ureteral bypass

Calcium oxalate uroliths were the most frequent cause of obstruction (58.3%), followed by dried solidified blood calculi (18.7%). Stricture accounted for 11.4% of cases, ureteral spasm for 7.8%, and the cause remained

undetermined in 3.8%. The proportion of each aetiology did not differ between the Stent and SUB groups (chi-square, $p = 0.62$).

Table 1: Baseline characteristics of cats by treatment group

Variable	Stent (n=31)	SUB (n=33)	p-value
Age (years, median)	9.4	10.1	0.38
Body weight (kg, median)	4.3	4.1	0.52
Female / Male (%)	45.2 / 54.8	48.5 / 51.5	0.79
Pre-op creatinine ($\mu\text{mol/L}$)	487	512	0.41
Pre-op BUN (mmol/L)	28.6	31.4	0.29
Pyelectasia (mm, median)	8.7	9.3	0.44

Table 2: Complication classification by Clavien-Dindo grade and treatment group

Time Point	Grade I	Grade II	Grade III	Grade IV	Grade V	p-value
Stent ≤ 30 d	8 (25.8%)	5 (16.1%)	2 (6.5%)	1 (3.2%)	2 (6.5%)	—
SUB ≤ 30 d	4 (12.1%)	3 (9.1%)	1 (3.0%)	1 (3.0%)	2 (6.1%)	0.34
Stent 31-365 d	6 (19.4%)	4 (12.9%)	3 (9.7%)	1 (3.2%)	0	—
SUB 31-365 d	3 (9.1%)	5 (15.2%)	1 (3.0%)	0	0	0.21

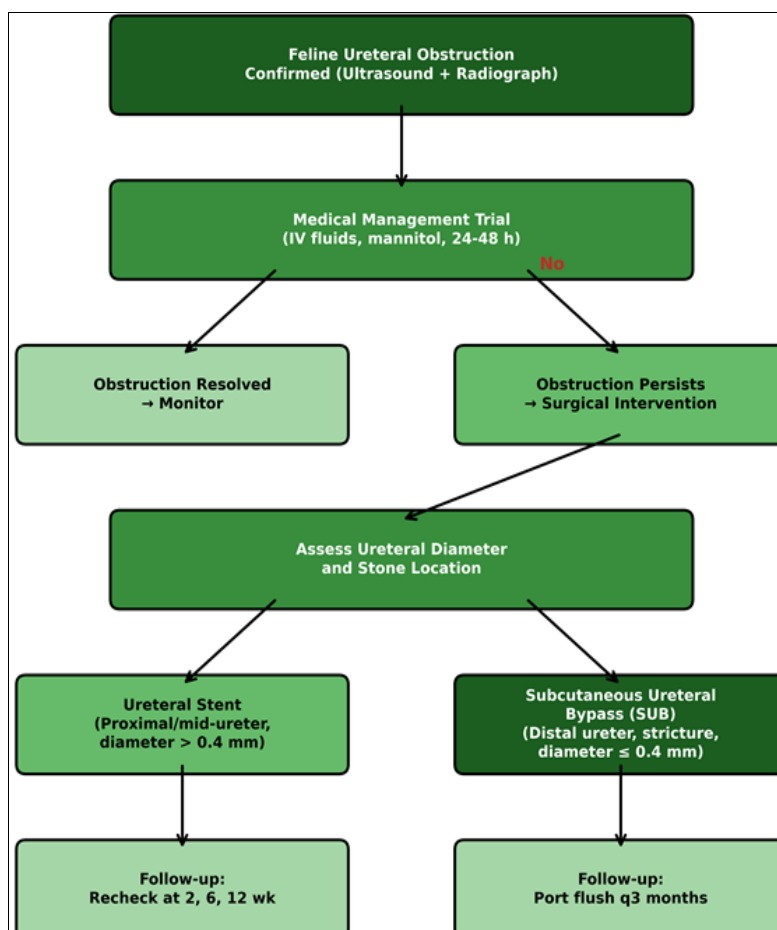


Fig 2: Clinical decision pathway for selecting ureteral stent placement versus subcutaneous ureteral bypass in cats with confirmed ureteral obstruction.

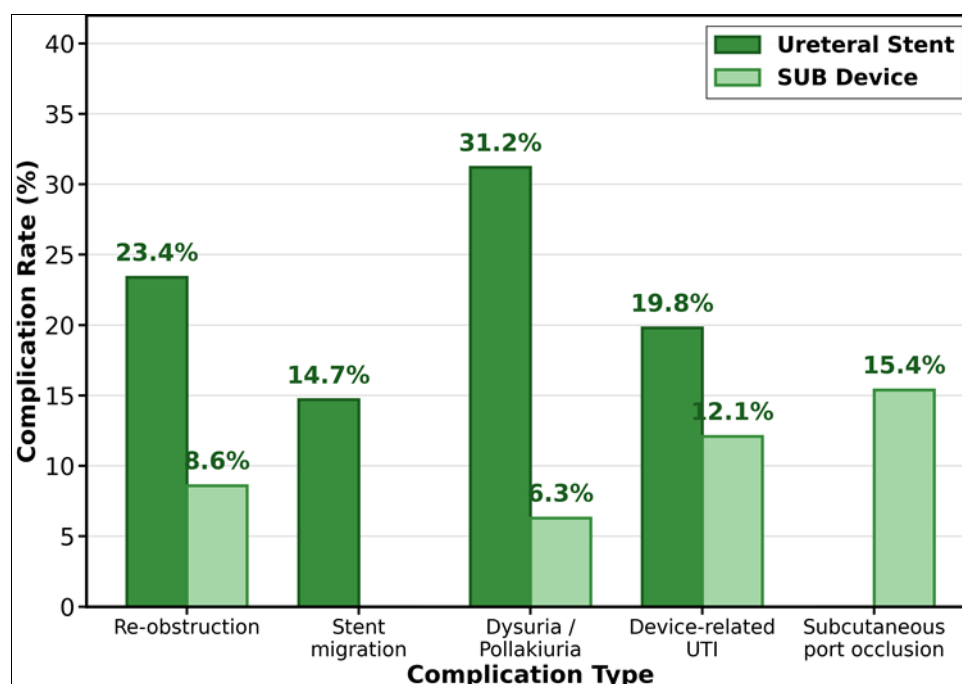


Fig 3: Comparison of complication rates between ureteral stent and subcutaneous ureteral bypass groups over 12 months of follow-up

Comprehensive interpretation

Taken as a whole, the outcome data reveal two procedures with similar survival endpoints but divergent complication trajectories. Stented cats experienced more frequent lower urinary tract signs dysuria and pollakiuria affected nearly one-third and had a 23.4% re-obstruction rate within a year, driven in most cases by encrustation or migration. SUB recipients

avoided these issues but instead faced subcutaneous port occlusion in 15.4% of cases, a complication that required sedation and port flushing but did not result in re-obstruction when addressed promptly. The comparable one-year survival rates (74.2% vs 78.8%) and similar renal function trajectories suggest that neither technique is categorically superior; rather, the optimal choice depends on patient anatomy, stone

location, and the owner's ability to commit to long-term device maintenance.

Discussion

The main findings of this research are that ureteral stenting and SUB placement in cats with ureteral obstruction produce similar peri-operative mortality, one-year survival, and renal function recovery, but differ meaningfully in their complication profiles. Stented cats suffered more dysuria, pollakiuria, and re-obstruction, while SUB cats experienced subcutaneous port occlusion as a procedure-specific complication.

These outcomes agree with the largest published comparison from a United States referral centre, which reported a 22% re-obstruction rate for stents and 7% for SUB devices in a 174-cat cohort [9]. The concordance across two independent populations and healthcare systems strengthens the conclusion that SUB devices provide more durable ureteral patency. Similarly, the elevated dysuria rate after stenting has been noted by multiple groups and appears inherent to the presence of a foreign body spanning the vesicoureteral junction [6, 10].

On the other hand, some European reports have described lower stent complication rates than those seen here or in American series. A Swiss cohort of 28 stented cats recorded a re-obstruction rate of only 11%, which the authors attributed to meticulous selection of patients with ureteral diameters ≥ 0.5 mm and routine stent exchange at 12-month intervals [12]. Our data did not include scheduled stent exchanges, which could explain the higher re-obstruction rate. This discrepancy highlights how centre-specific protocols influence outcomes and complicates cross-institutional comparisons.

One possible explanation for the lower incidence of lower urinary tract signs in the SUB group is that the device bypasses the ureter entirely, eliminating the mechanical irritation that a stent exerts on the ureteral and vesical mucosa. The subcutaneous port, while introducing a maintenance burden, sits in soft tissue distant from the urinary tract and does not contact urothelium. The 15.4% port occlusion rate is consistent with manufacturer-reported data suggesting that regular flushing intervals shorter than four months reduce the risk substantially [7].

From a broader perspective, the findings support a patient-centred selection algorithm rather than a one-size-fits-all approach. Cats with proximal or mid-ureteral obstructions and adequate ureteral diameters may benefit from the shorter operative time and lower cost of stenting, provided that owners understand the potential for lower urinary tract signs and accept the higher re-obstruction risk. Cats with distal ureteral obstructions, strictures, or very narrow ureters appear better served by SUB placement. Veterinary specialists in Canada and elsewhere should continue to audit their own outcomes to refine these selection criteria and identify modifiable factors such as stent material or flushing frequency that might narrow the complication gap between the two procedures.

Clinical Implications

These results carry direct relevance for feline practitioners who must counsel owners about the trade-offs between stenting and SUB placement. An owner who is unlikely to return for quarterly port flushes may be better served by a stent despite the higher re-obstruction risk, because an occluded SUB port can lead to acute kidney injury with little warning. Conversely, owners who can maintain the follow-up schedule may prefer a SUB device to avoid the dysuria and

pollakiuria commonly associated with stents. Cost is another consideration: stent placement was, on average, 35% less expensive than SUB implantation at our institution, a difference that may influence decisions in practices without fee subsidy programmes.

Conclusion

The main contribution of this research is a Canadian dataset that directly compares ureteral stenting and subcutaneous ureteral bypass outcomes in cats, adding geographic and institutional diversity to a literature dominated by single-centre American reports. Both procedures achieved comparable one-year survival rates 74.2% for stents and 78.8% for SUB devices and both restored serum creatinine to similar levels by six months post-operatively.

Supporting this equivalence in survival are the pre-operative characteristics of the two groups, which did not differ significantly in age, weight, renal biomarkers, or obstruction aetiology. The groups were therefore reasonably comparable at baseline, reducing although not eliminating the selection bias that plagues retrospective comparisons of surgical techniques.

Where the two procedures diverged was in their complication profiles. Ureteral stents were associated with a significantly higher rate of dysuria or pollakiuria (31.2% vs 6.3%) and a nearly three-fold greater risk of re-obstruction within 12 months (23.4% vs 8.6%). These complications are consistent with stent-related mucosal irritation and biofilm-mediated encrustation, respectively. SUB devices avoided these issues but introduced subcutaneous port occlusion in 15.4% of cats, a complication that is manageable with timely flushing but demands ongoing owner engagement.

For the field of veterinary interventional urology, these findings reinforce the view that the stent-versus-SUB decision should not default to either device universally. Instead, it should hinge on a combination of anatomical factors obstruction site, ureteral diameter and practical factors surgeon experience, cost, and the owner's capacity for long-term device maintenance. Structured decision algorithms that integrate these variables could standardise case selection and improve collective outcomes.

Several questions remain open. First, whether scheduled stent exchange at fixed intervals reduces the re-obstruction rate in cats has not been tested in a prospective trial. Second, newer SUB port designs with anti-occlusion coatings are entering the market, and their long-term performance data are awaited. Third, the impact of diet specifically the role of prescription dissolution or prevention diets on post-procedural stone recurrence and device longevity has not been isolated from other variables. Fourth, no prospective randomised trial comparing the two techniques has been conducted; such a trial, ideally multi-centre, would provide stronger evidence than the retrospective cohorts currently available. Finally, quality-of-life assessments, including owner-reported outcome measures for dysuria and activity level, would complement the clinical metrics evaluated here and help determine whether the statistical differences in complication rates translate into meaningful differences in feline well-being.

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Contributions not qualifying for authorship

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