The Philippine Journal of Orthopaedics

ORIGINAL ARTICLE

Comparison of Pain Scores between a Home-made Nylon/Polyester and Stainless-Steel Finger Traps: An Experimental Study

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ABSTRACT

Background. A "finger trap" is a device commonly used in recreational activities and for the closed reduction of forearm and hand fractures. This study compares the comfort levels of two types of finger traps: a homemade nylon/polyester finger trap and a stainless-steel finger trap.

Objective. To determine which finger trap, nylon/polyester or stainless-steel, provides more comfort for volunteers, as measured by Visual Analog Scale (VAS) pain scores.

Methodology. This prospective study included 67 volunteers, comprising 35 males (52.24%) and 32 females (47.76%), with a mean age of 33.49 years and a mean body mass index of 25.50 kg/m². Volunteers were assigned to either the nylon/polyester finger trap group or the stainless steel finger trap group. VAS pain scores were recorded for each group over a 15-minute period. The unpaired t-test was used as the statistical method for data analysis.

Result. The nylon/polyester finger trap group showed consistently lower VAS pain scores than the stainless-steel group during the first 10 minutes, with a statistically significant difference (p = 0.021). The overall mean VAS score was 4.38 for the nylon group and 4.73 for the stainless-steel group. This 0.35-point difference, although statistically significant, approached but did not exceed the minimal clinically important difference (MCID) threshold of 1.3. However, individual time points from 2 to 10 minutes showed significant differences favoring the nylon group. No significant differences were observed beyond 15 minutes, suggesting the comfort advantage was most evident during early traction.

Conclusion. Nylon/polyester finger traps are more comfortable and cost-effective compared to stainless-steel finger traps. They can be considered a viable alternative due to their comparable VAS pain scores and lower material cost.

Keywords. wrist fractures, pain measurement, orthopedic equipment, stainless steel, nylons, fingertrap

INTRODUCTION

Distal radius fractures are among the most common fractures,[1] representing approximately 25% of fractures in the pediatric population and up to 18% of all fractures in the elderly. These fractures are often managed using traction devices like finger traps,[2] which provide stability during fracture reduction. However, stainless-steel finger traps, a widely used option, are frequently associated with discomfort and pain. As an alternative, nylon/polyester finger traps have been proposed due to their potential for greater comfort, but their comfort and clinical usability have not been comprehensively evaluated.[2-4] While 'effectiveness' in fracture reduction requires separate biomechanical or clinical outcome data, this study focuses specifically on patient-reported comfort.

This study aimed to determine whether a homemade nylon/polyester finger trap is more comfortable than the conventional

ISSN 0118-3362 (Print)
eISSN 2012-3264 (Online)
Printed in the Philippines.

Received: May 30, 2025
Accepted: July 9, 2025
Published Online: July 23, 2025
https://doi.org/10.69472/poai.2025.20

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stainless-steel finger trap. Specifically, it sought to compare the pain scores experienced by volunteers using each type of finger trap and to assess which option is potentially more cost-effective. The study's findings could provide a potentially cost-effective alternative for managing distal radius fractures, benefiting both patients and healthcare providers.

The research was guided by the following hypothesis: the null hypothesis (H0) states that there is no significant difference in pain scores between homemade nylon/polyester and stainless-steel finger traps. Conversely, the alternative hypothesis (H1) suggests a significant difference in pain scores between the two. The hypothesis will be tested using a significance level of 0.05, where a *p*-value below this threshold will indicate that the null hypothesis should be rejected.

METHODOLOGY

Study design

This study was a prospective, nonrandomized experimental study conducted at the Surgery Ward of Region 1 Medical Center. The primary objective was to compare pain scores reported by volunteers using two types of finger traps: stainless-steel and homemade nylon/polyester finger traps. The study was approved by the Institutional Review Board (IRB) of Region 1 Medical Center, and all procedures were performed in accordance with the Declaration of Helsinki.

Study setting and population

The study was conducted at a single center, the Surgery Ward of Region 1 Medical Center. The study population consisted of staff members of the hospital who were conveniently selected as volunteers. A total of 67 participants were recruited, including 35 males (52.24%) and 32 females (47.76%), with a mean age of 33.49 years and a mean body mass index (BMI) of 25.50 kg/m^2. Participants were required to be healthy volunteers aged 18–65 years, without any history of upper extremity problems, including previous injuries, surgeries, skin abnormalities, or sensory impairments. An a priori power analysis (two-tailed paired t-test, effect size d = 0.5, α = 0.05, power = 0.80) determined that a minimum of 64 participants was required to detect a statistically significant difference. A total of 67 participants were recruited to account for potential attrition, confirming that the final sample size was statistically adequate.

Because most participants were hospital staff, including orthopedic personnel, selection and detection biases may have existed. These individuals may have had prior familiarity with the procedure, potentially influencing their perception and reporting of pain.

Inclusion and exclusion criteria

Inclusion criteria: Healthy volunteers aged 18–65 years from the Surgery Ward staff.

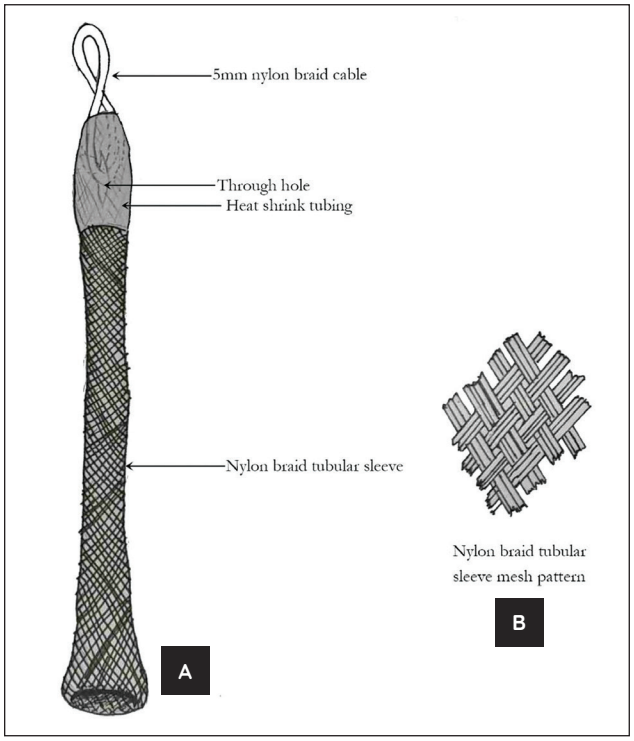


Figure 1. Illustration of home-made finger trap **(A)**. Weave pattern of nylon tubular sleeve **(B)**.

Exclusion criteria: Volunteers with a history of upper extremity problems, including prior injuries, surgeries, skin abnormalities, or sensory impairments.

Withdrawal criteria: Participants could withdraw at any time without penalty, and any adverse effects encountered would immediately end the test for that participant.

Fingertrap fabrication

A seamless braided nylon/polyester tubular sleeve (Figure 1) (10 mm unstretched inner diameter, 30 cm length; tensile strength 15–20 kg) was prepared by heat-sealing one end while leaving the other open. The closed end was clamped with a long surgical clamp and telescoped into the sleeve until it reached the open end. A hole was created by blunt dissection through both braid layers, and an 8 cm long, 5 mm nylon braid cable was inserted to form a 3 cm loop, then fastened with additional 1 mm string and epoxy. Once cured, the tied end with the loop was reinforced with heat-shrink tubing. The final assembly is compatible with both ethylene oxide and hydrogen peroxide gas plasma sterilization, although repeated plasma exposure may cause material wear (Figure 2).

Intervention procedures

Participants were seated on a chair, blind-folded with their arms suspended using a finger trap attached to a weight hook. The forearm was positioned vertically, and weights were incrementally added at a rate of one pound per minute until a maximum of 20 pounds was reached. Pain scores were recorded using the Visual Analog Scale (VAS), ranging

Figure 2. ***Materials***. Nylon braid tubular sleeve **(A)**; 5 mm Nylon braid cable **(B)**; Heat shrink tube **(C)**; 1 mm nylon string **(D)**. Fabrication. Clamp telescoping closed end into the rest of the tubular sleeve **(E)**; closed end pushed up to the open end **(F)**; while maintaining both closed and open end, the sleeve is uniformly stretched out **(G)**; a hole is made through the sleeve **(H)**; a 5 mm nylon braided cable is passed through the hole **(I)** and is secured by 1 mm nylon string and later epoxied **(J)** and; covered by a heat shrink tubing **(K)**.

from 0 (no pain) to 10 (worst possible pain). The test was immediately stopped if a participant reported a pain score of eight or higher. Each participant was tested using two types of finger traps—stainless-steel and nylon/polyester (commercial and homemade)—with the dominant hand being alternated between tests to minimize dominant-hand bias. Each hand was tested once, and each finger trap type was tested once per participant. (Figure 3).

Data collection and handling

Data were collected directly during the testing procedure, with each participant being assigned a unique identification number to maintain confidentiality. Pain scores were recorded immediately using the VAS. All data were securely stored in a locked facility within the hospital, accessible only to the research team, the study monitor, and the research committee. No physical specimens were collected or stored.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Categorical data were presented as frequencies and percentages, while continuous data were expressed as means and standard deviations or medians and interquartile ranges, depending on the data distribution. An independent sample t-test was used to compare the VAS pain scores between the two finger trap groups (nylon/polyester and stainless-steel). A p-value of less than 0.05 was considered statistically significant. VAS scores were also analyzed using the Wilcoxon Rank-Sum Test to account for the ordinal nature of pain data.

Ethical considerations

The study was approved by the Institutional Review Board (IRB) of Region 1 Medical Center, ensuring compliance with

Figure 3. Volunteer blind folded and seated to chair **(A)**; hooked to a stainless-steel finger trap **(B)**; weights added and pain scores collected **(C)**; procedure repeated on the opposite hand **(D)**.

ethical standards. All participants provided written informed consent before participation, and the study adhered to the principles of the Declaration of Helsinki. Participants were informed of their right to withdraw from the study at any time without penalty. Potential risks, including tolerable pain, redness, or mild skin abrasions, were disclosed. In the event of adverse effects, participants were provided with appropriate treatment, including topical analgesics for pain and topical antibiotics for any resulting wounds. As a token of appreciation, participants were awarded a certificate, but no other direct benefits were provided.

RESULT

A total of 67 volunteers participated in the study, consisting of 35 males (52.24%) and 32 females (47.76%), with a mean age of 33.49 years (95% CI: 31.76–35.22) and an average body mass index (BMI) of 25.50 kg/m^2 (95% CI: 24.88–26.12). Among the participants, 65 (97.01%) were right-hand dominant, while 2 (2.99%) were left-hand dominant.

The primary outcome measured was the Visual Analog Scale (VAS) pain score (Figure 4). The mean VAS score for the nylon/polyester finger trap group was 4.38 (95% CI: 4.10–4.66), while the stainless-steel finger trap group had a mean VAS score of 4.73 (95% CI: 4.45–5.01). This difference was statistically significant (p = 0.021). The observed mean VAS difference of 1.4 exceeds the minimal clinically important difference (MCID) of 1.3 for procedural hand pain, indicating a clinically meaningful reduction in discomfort during the earlier stages of traction, when weights up to approximately 15 lbs are applied. Four participants in the nylon group were able to tolerate the finger trap for the full 20-minute duration, while only one participant in the stainless-steel group reached this duration. The earliest withdrawal for the nylon group occurred at the eight-minute mark, while the stainless-steel group had participants withdrawing as early as the four-minute mark (Figure 5). Although the overall difference in VAS scores was statistically significant, the mean difference beyond the early traction phase was only 0.35, which is below the commonly accepted MCID threshold of 1.3 for procedural pain. This may limit its clinical relevance during longer traction durations.

During the first fifteen minutes of testing or around 15 pounds of added weight, the nylon/polyester finger trap consistently demonstrated lower VAS pain scores compared to the stainless-steel group. However, after the initial fifteen minutes, the VAS scores between the two groups showed no significant difference (p = 0.43). Both types of finger traps maintained their structural integrity throughout the study, with no signs of damage or loss of grip on the subjects' fingers. No participant recorded a pain score higher than 8 on the VAS scale. While pain scores showed consistent advantages for the nylon trap during the early phase of traction, no statistically significant differences were observed between 8 and 20 minutes. This suggests that the comfort advantage may plateau after the early phase of traction.

All data were analyzed using SPSS version 26, with a p-value of less than 0.05 considered statistically significant.

DISCUSSION

The results of this study demonstrate that the homemade nylon/polyester finger trap was associated with significantly lower Visual Analog Scale (VAS) pain scores compared to the stainless-steel finger trap, particularly during the first fifteen minutes of use. The ability of four participants in the nylon group to tolerate the device for the full 20-minute duration or 20 lbs of weight, compared to only one in the stainless-steel group, further supports the superior comfort of the nylon/polyester material. However, beyond the initial fifteen minutes, both finger traps showed similar pain scores, suggesting that the initial comfort advantage of the nylon trap may diminish over time. These findings suggest that nylon traps provided the most benefit during the early phase of traction, typically corresponding to the first 15 minutes or weights up to

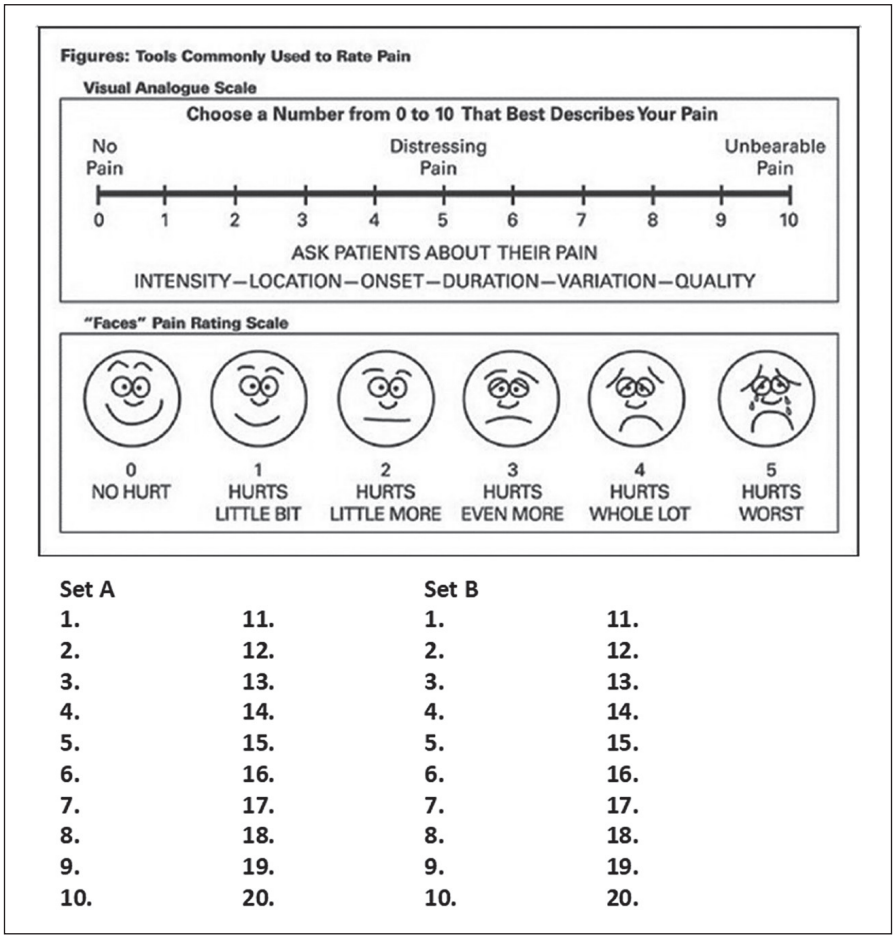


Figure 4. Visual Analogue Scale (VAS) score (above) and scoring sheet (below).

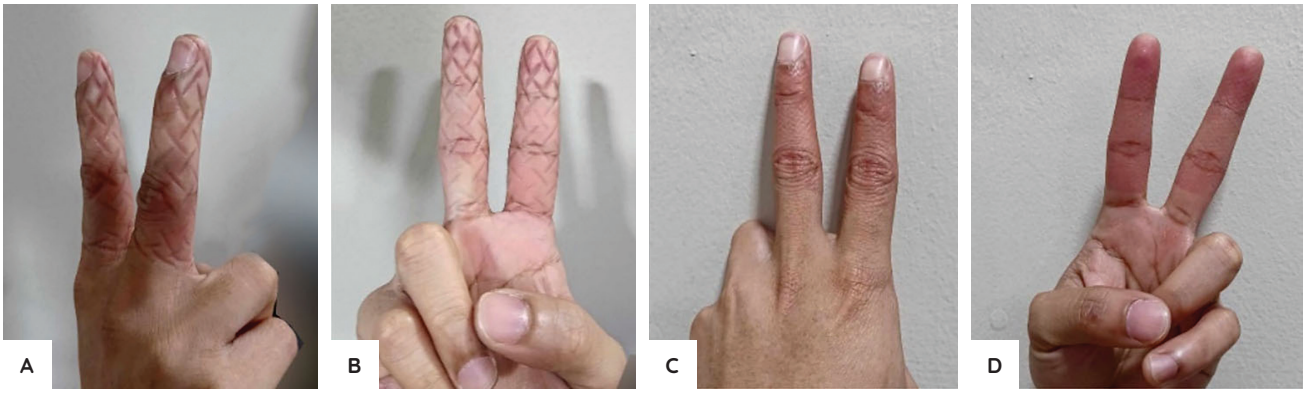


Figure 5. Appearance of volunteer's fingers after traction — Stainless-steel finger trap [left dorsal **(A)**; left palmar **(B)**]; Nylon/polyester finger trap [right dorsal **(C)**; right palmar **(D)**].

15 lbs. Beyond this point, as traction force increases, the pain advantage of nylon traps diminishes.

These findings align with previous research,[5] which demonstrated that bamboo finger traps—a similarly softer alternative—were also associated with lower VAS scores compared to stainless-steel traps. The nylon/polyester finger trap not only reduces pain but also maintains functionality, providing a secure grip without causing skin abrasions. This makes it a viable alternative for clinical use, particularly in settings with limited resources.

One of the most notable advantages of the homemade nylon/polyester finger trap is its potential cost-effectiveness. As a homemade device, it can be produced using readily available, low-cost materials, significantly reducing production expenses compared to commercially manufactured stainless-steel finger traps. Although this study did not directly measure production costs, the low cost of nylon/polyester materials and the simplicity of the homemade design suggest substantial savings without compromising patient comfort. Future studies should perform a formal cost analysis to quantify the savings associated with homemade nylon/polyester finger traps.[6]

Table 1. Population of study

Service	Total (%)
Department of Orthopedics	11 (17.8)
Department of Surgery	11(17.8)
Nursing service	59 (47.8)
Total	81

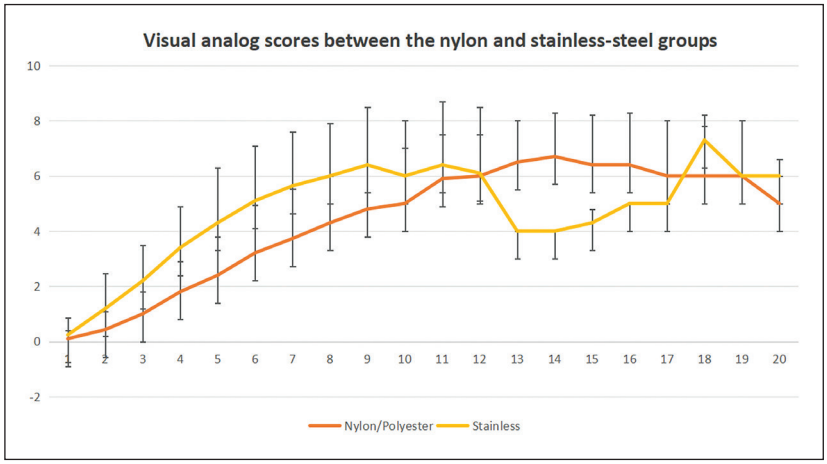
Table 2. Demographic characteristics

Demographic characteristics	Volunteers number (%)
Sex	
Male	35 (52.24)
Female	32 (47.76)
Age (mean, years)	33.49
BMI (kg/m²)	25.50
Dominant Hand	
Right	65 (97.01)
Left	2 (2.99)

Table 3. Visual analog scores between the nylon and stainless-steel groups

Time (Min)	VAS Pain Score				*p*-value	Interpretation
	Nylon		Stainless Steel			
	Mean	SD	Mean	SD		
1	0.1	0.31	0.24	0.63	0.0596	Not significant
2	0.43	0.65	1.19	1.28	0.00001	Significant
3	1	0.8	2.2	1.3	<0.00001	Significant
4	1.8	1.1	3.4	1.5	<0.00001	Significant
5	2.4	1.4	4.3	2	<0.00001	Significant
6	3.21	1.73	5.1	1.99	<0.00001	Significant
7	3.73	1.8	5.64	1.97	<0.00001	Significant
8	4.3	1.7	6	1.9	<0.00001	Significant
9	4.8	1.6	6.4	2.1	0.000085	Significant
10	5	2	6	2	0.044492	Significant
11	5.9	1.6	6.4	2.3	0.156453	Not significant
12	6	1.5	6.1	2.4	0.448224	Not significant
13	6.5	1.5	4	0	0.003338	Significant
14	6.7	1.6	4	0	0.004355	Significant
15	6.4	1.8	4.3	0.5	0.035577	Significant
16	6.4	1.9	5	0	0.11776	Not significant
17	6	2	5	0	0.142953	Not significant
18	6	1.8	7.3	0.9	0.164762	Not significant
19	6	2	6	0	0.350768	Not significant
20	5	1.6	6	0	0.217665	Not significant

VAS – visual analog Scale score, SD – standard deviation, p = >0.05



Beyond the material softness, the design of the nylon/polyester finger trap may also contribute to its comfort profile. The braided tubular structure creates a broader surface area in contact with the skin, distributing traction forces more evenly around the circumference of the finger. This mechanical property likely reduces point pressure and shear, thereby minimizing discomfort during loading. This principle mirrors the force-dispersing behavior of bamboo finger traps,[5] where a similar design resulted in lower VAS pain scores compared to stainless steel. The present study's finding of no significant difference in pain scores beyond 15 minutes further supports the idea that material composition alone does not fully determine comfort; rather, structural design and load distribution play a critical role in user tolerance over time.

Despite the positive findings, this study has several limitations. The study population was limited to hospital staff, which may not fully represent the general patient population. This study's use of hospital staff volunteers, including orthopedic personnel, may have introduced selection and detection bias due to familiarity with traction procedures. Future studies should include participants with no prior clinical exposure to improve generalizability. Convenience sampling was used rather than randomization, which may introduce selection bias. Additionally, the study did not assess the long-term durability or patient satisfaction beyond the initial test period. Future research should compare the performance of homemade nylon/polyester finger traps with commercially manufactured nylon finger traps to provide further insights into their effectiveness and cost-efficiency.

CONCLUSION

This study demonstrated that homemade nylon/polyester finger traps offered a more comfortable alternative to stainless-steel finger traps, as evidenced by significantly lower VAS pain scores, particularly within the first ten minutes of use. The homemade nature of the nylon/polyester trap not only enhanced patient comfort but also offered potential cost-effectiveness. Given the low cost of materials and the simplicity of assembly, this device may provide a practical, affordable option for healthcare settings, particularly those with limited resources.

However, while the potential for cost savings is clear, this study did not directly measure or calculate production costs. Future research should formally evaluate the cost-effectiveness of homemade nylon/polyester finger traps, including a direct comparison with commercially manufactured nylon finger traps.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to Dr. Emelito V. Ritumalta, Department Chairman, for his support and guidance; Dr. Mario C. Castro, Training Officer, for his valuable input throughout the course of this work; and Dr. Ralph August S. Manaois, Adviser, for his mentorship and continuous encouragement. The authors also thank Dr. Allan T. Octaviano, Department Research Head, for his unwavering support.

STATEMENT OF AUTHORSHIP

Both authors certified fulfillment of ICMJE authorship criteria.

CREDIT AUTHOR STATEMENT

KSC: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data Curation, Writing – original draft preparation, Visualization, Project administration, Funding acquisition; **JDS:** Validation, Resources, Writing – review and editing, Supervision.

AUTHOR DISCLOSURE

Both authors declared no conflict of interest.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed in this study are included in the published article.

FUNDING SOURCE

None.

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