

Background

- Electronic nicotine delivery systems (ENDS) have been known to host various toxic substances in their e-liquids, including heavy metals.
- Previous research in our lab has shown that closed-system (prefilled) ENDS leach these metals into their e-liquids.
- One device previously tested, a blu PLUS+ Tanks™ (Patent 9,986,762), showed elevated levels of lead.
- This pilot study utilized electrothermal atomic absorption spectroscopy (ETAAS) to identify the source of metals contamination (Table 1).

Table 1: Elements of interest and their possible sources in ENDS.

Metal	Possible Source
Lead (Pb)	Currently Unknown
Nickel (Ni)	Heating Coil
Chromium (Cr)	Heating Coil
Cadmium (Cd)	Leaking Battery

Results

- Nickel, chromium, and cadmium were not found in quantifiable amounts from any part.
- Lead was quantifiable from only one part, the battery connector (D5, boxed in red).
- Figure 1 shows the increase in lead leached (ppb in 10 mL) into PG/VG over time by D5.
- Concentration increased from Time 0 to 1 Month, then leveled off through 6 Months.

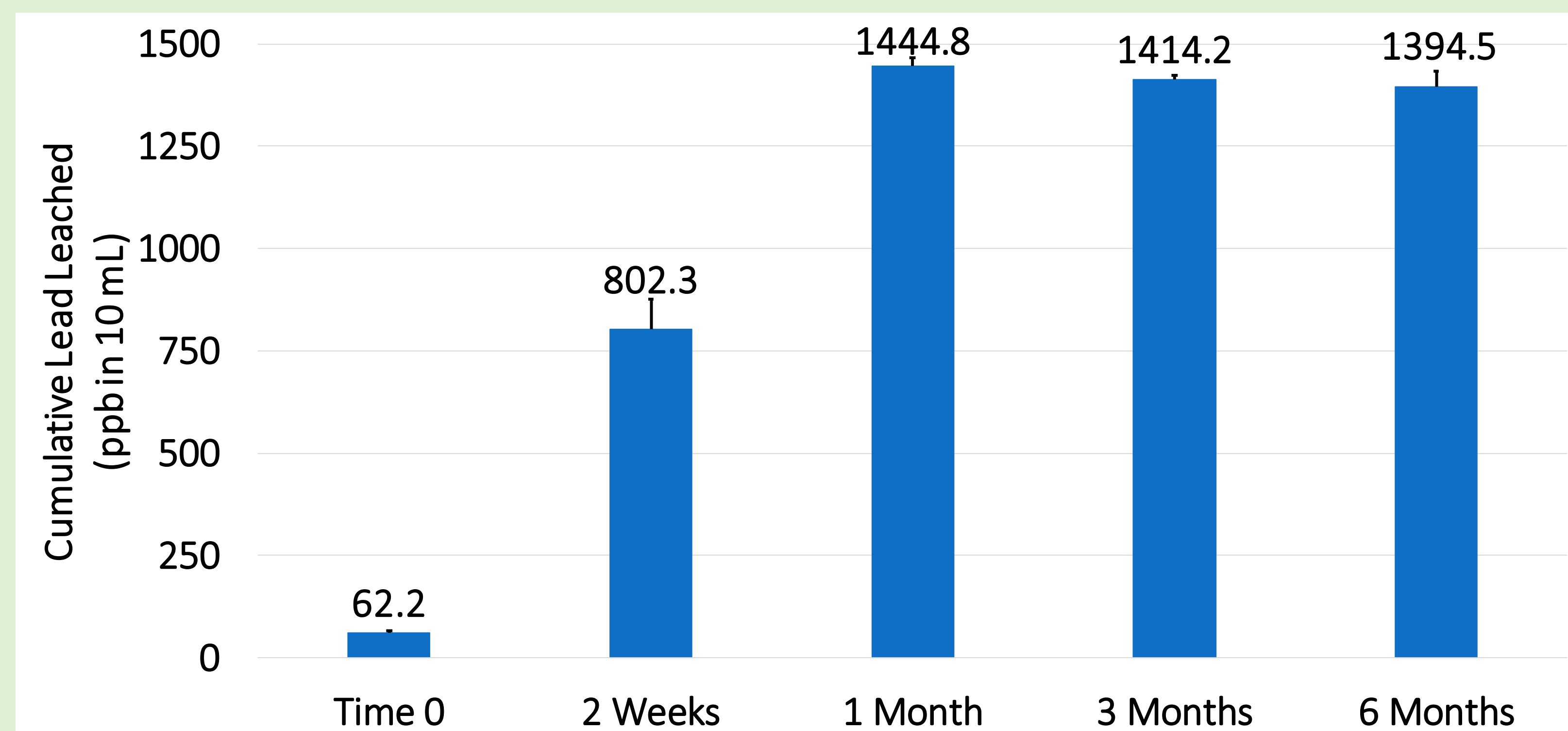
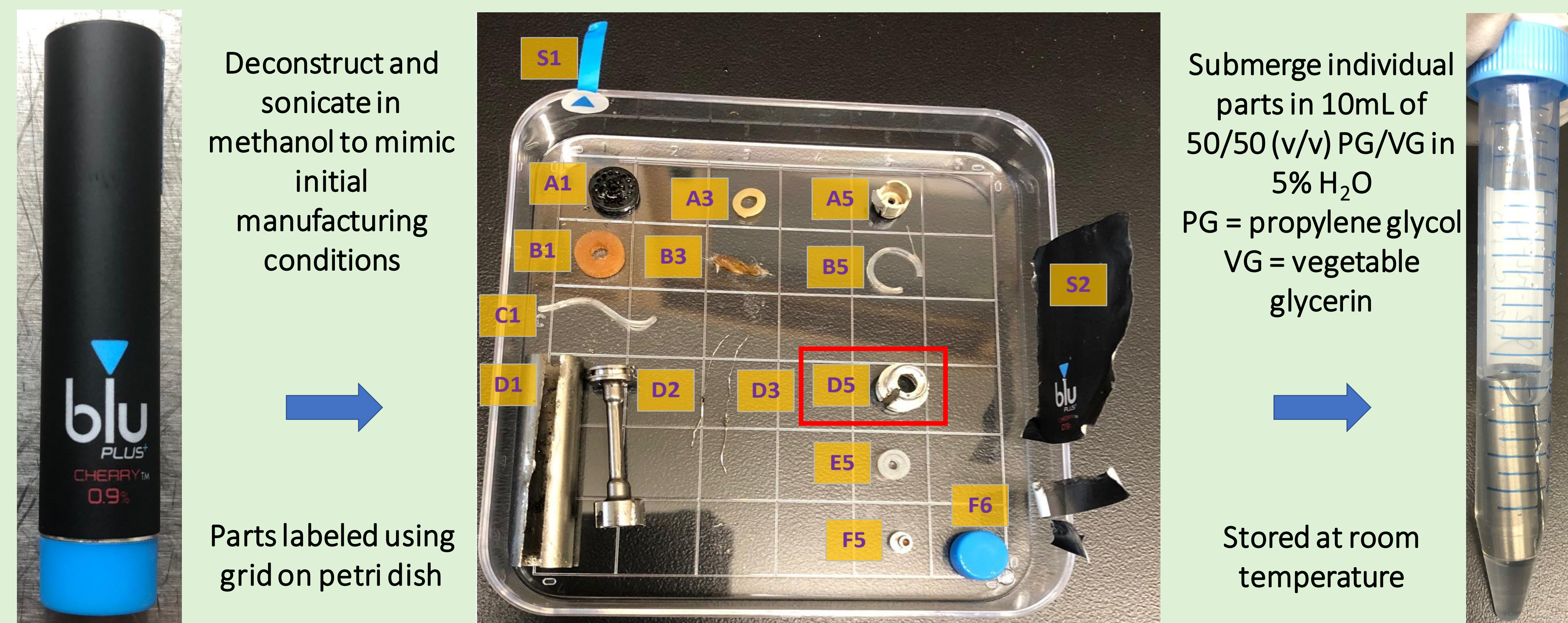


Figure 1: Cumulative quantity of lead (ppb in 10 mL) leached from D5 at each sampling time. Error bars indicate positive and negative standard deviation for n = 3.

Methods



Deconstruct and sonicate in methanol to mimic initial manufacturing conditions

Parts labeled using grid on petri dish

Submerge individual parts in 10mL of 50/50 (v/v) PG/VG in 5% H₂O
 PG = propylene glycol
 VG = vegetable glycerin

Stored at room temperature

- 16 total parts consisting of metal (5 parts; D1-3,5; F5), rubber or a similar material (5 parts; A3, B5, C1, E5, F6), plastic (2 parts; A1,5), cotton-like fabric (2 parts; B1,3), and vinyl-like stickers (2 parts; S1-2)
- 1 mL aliquots were pipetted into individual 2 mL Eppendorf tubes at the following time points:
 - Time 0, 2 Weeks, 1 Month, 3 Months, 6 Months
- 1 mL of clean, unexposed 50/50 (v/v) PG/VG in 5% H₂O was used as a reference.

Discussion

Table 2: Statistics for data in Figure 1. Overall $p = 0.0040$; Significance threshold is $p < 0.05$.

Kruskal-Wallis Non-Parametric Test	Adjusted p Value
Time 0 vs 2 Weeks	0.9329
Time 0 vs 1 Month	0.0031
Time 0 vs 3 Months	0.0465
Time 0 vs 6 Months	0.0710

- Significance found at the 1 Month and 3 Months time points when compared to Time 0.
- $p = 0.0001$ for multiple comparisons test, excluding Time 0.
 - Only 2 Weeks vs 1 Month was statistically significant (adjusted $p = 0.0078$).

- More data is needed to further determine the significance between all time points.
- This data provides preliminary insight into the timeline of metal exposure.
- Consumers may be at less risk of metal exposure if closed-system products are purchased and used within 2 weeks of manufacture.

In the Future:

- Test multiple ENDS devices
 - Include heat and a battery
- Consider in future tests:
 - How dilute sample will become
 - Manufacture dates
 - More thorough cleaning procedure
- Investigate types of metals used in ENDS production

Acknowledgements

AMC-B, NJL, JH, and RJO have nothing to report.
 MLG received a research grant from Pfizer and is a member of the advisory board to Johnson & Johnson.

This work was carried out with the aid of a grant from the National Institutes of Health under Award Numbers P01 CA200512. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.