

Overview

- Fentanyl and its potent analogs pose a major health risk to communities in the US as fentanyl-related overdose deaths increase annually
- The number and variety of fentanyl analogs in the drug supply have led to widespread emergency scheduling of "fentanyl-related substances"¹
- The bulk of illicit fentanyl, fentanyl analogs, and fentanyl precursors enter the US through mail services, though recent policy changes have sought to stall the supply chain
- Early, rapid, and affordable detection of these compounds remains a priority
- Paper spray-mass spectrometry (PS-MS) offers quick drug identification with limited sample preparation
- Pressure-sensitive adhesive (PSA) lined paper has been previously introduced as a sampling mechanism and PS-MS substrate²
 - PSA paper is commercially available and inexpensive
- This work expands the established PSA and PS-MS to detection of fentanyl-related compounds including in the presence of cutting agents

Methods

- A previously developed PS-MS method using PSA paper was applied to fentanyl, fentanyl analogs, and fentanyl precursors
- Seven common fentanyl analogs, precursors, and byproducts were selected for analysis
 - fentanyl, 4-ANPP, phenethyl-4-ANPP, valeryl-fentanyl, carfentanil, *p*-fluorofentanyl, and 4-FIBF
 - Compounds were spotted on surfaces and dried before recovery by PSA paper
- The recovery of analogs was assessed from four different surfaces, cardboard, shipping labels, packaging tape, and plastic
 - Surfaces were sampled by firmly pressing the adhesive to surface before lifting to recovery drug residues
- Analysis was conducted on an LTQ-XL Linear Ion Trap mass spectrometer in positive ion mode
 - Data collection was carried out for 0.7 minutes at +4.5kV
- Fentanyl-related compounds were analyzed in the presence of common cutting agents including caffeine, lidocaine, and diphenhydramine
- A cartridge that accommodates a full-sized PSA ticket ("no-cut cartridge") was compared to the standard cartridge used for the PSA and PS-MS method
 - Voltage increased to +5.0kV for no-cut cartridge



Figure 1. Thermo Fisher LTQ-XL Linear Ion Trap MS

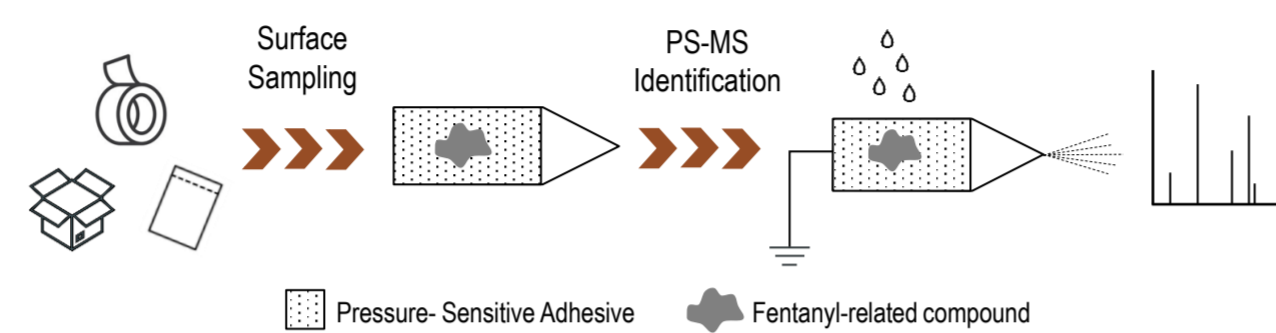
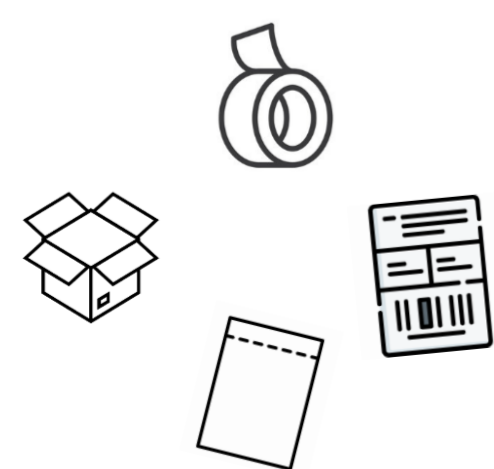


Figure 2. Basic diagram of paper spray-mass spectrometry

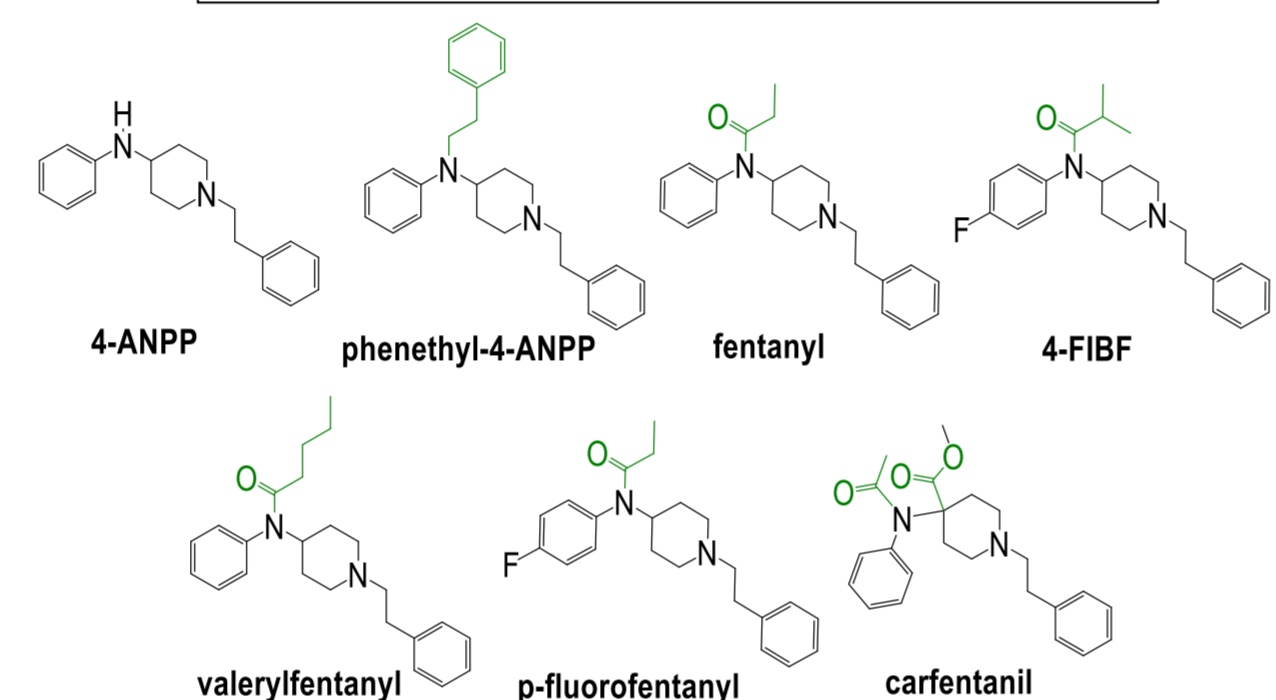


Figure 3. Fentanyl-related compounds sampled with PSA and PS-MS method

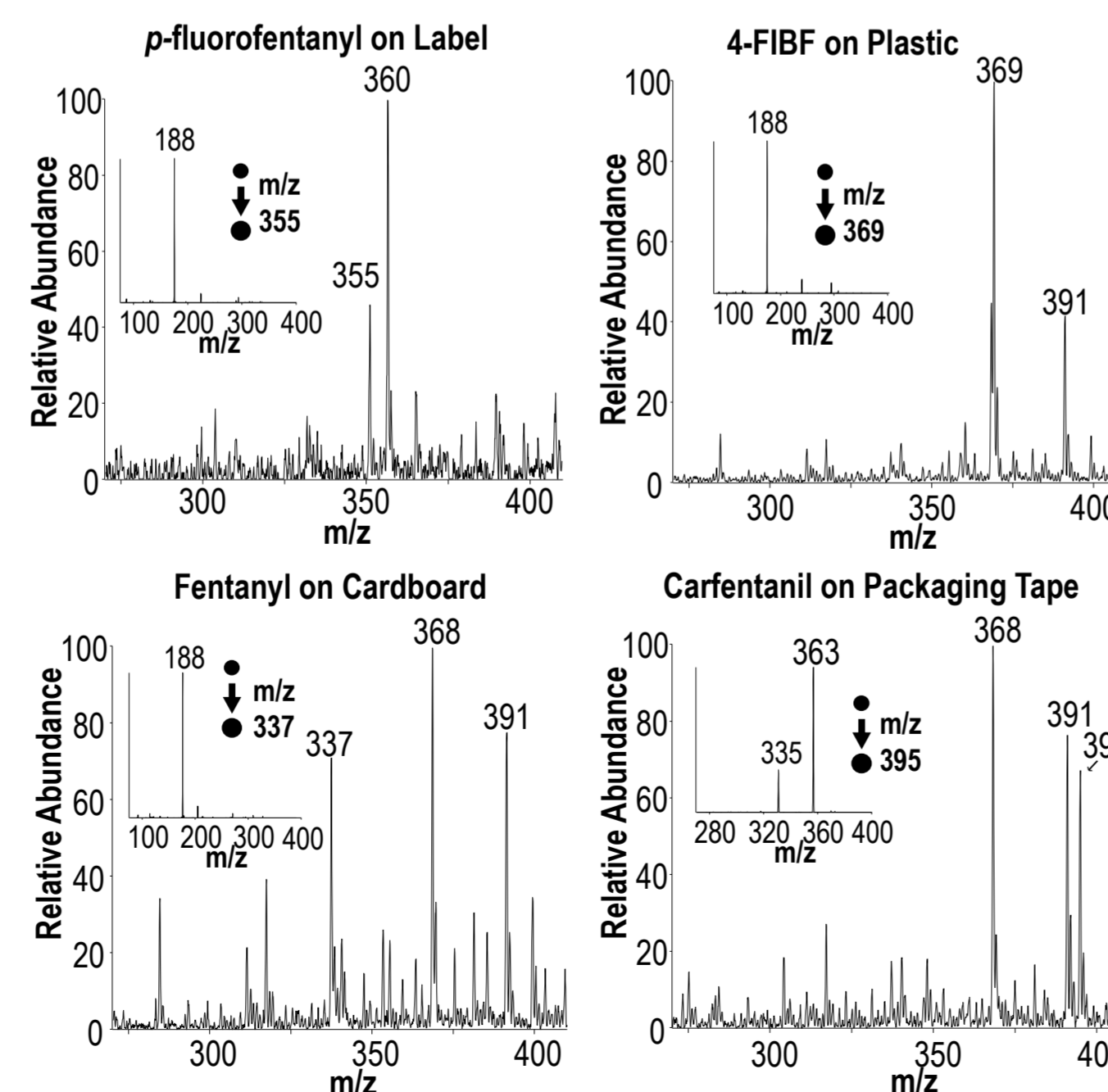


Figure 4. Full MS and MS/MS spectra for fentanyl analogs on parcel-related surfaces

Results

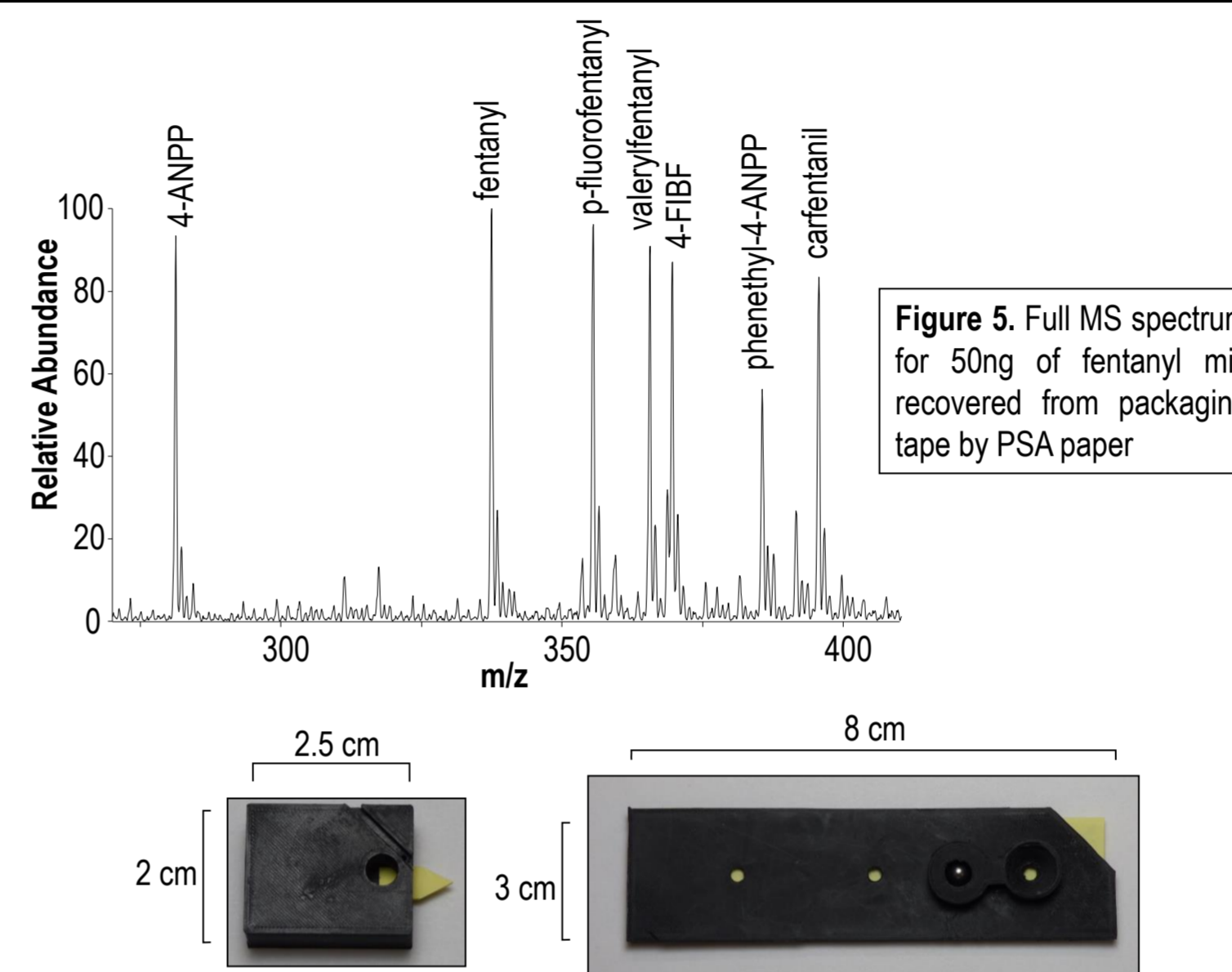


Figure 5. Full MS spectrum for 50ng of fentanyl mix recovered from packaging tape by PSA paper

Figure 6. Standard (left) and no-cut cartridges (right) for PSA and PS-MS

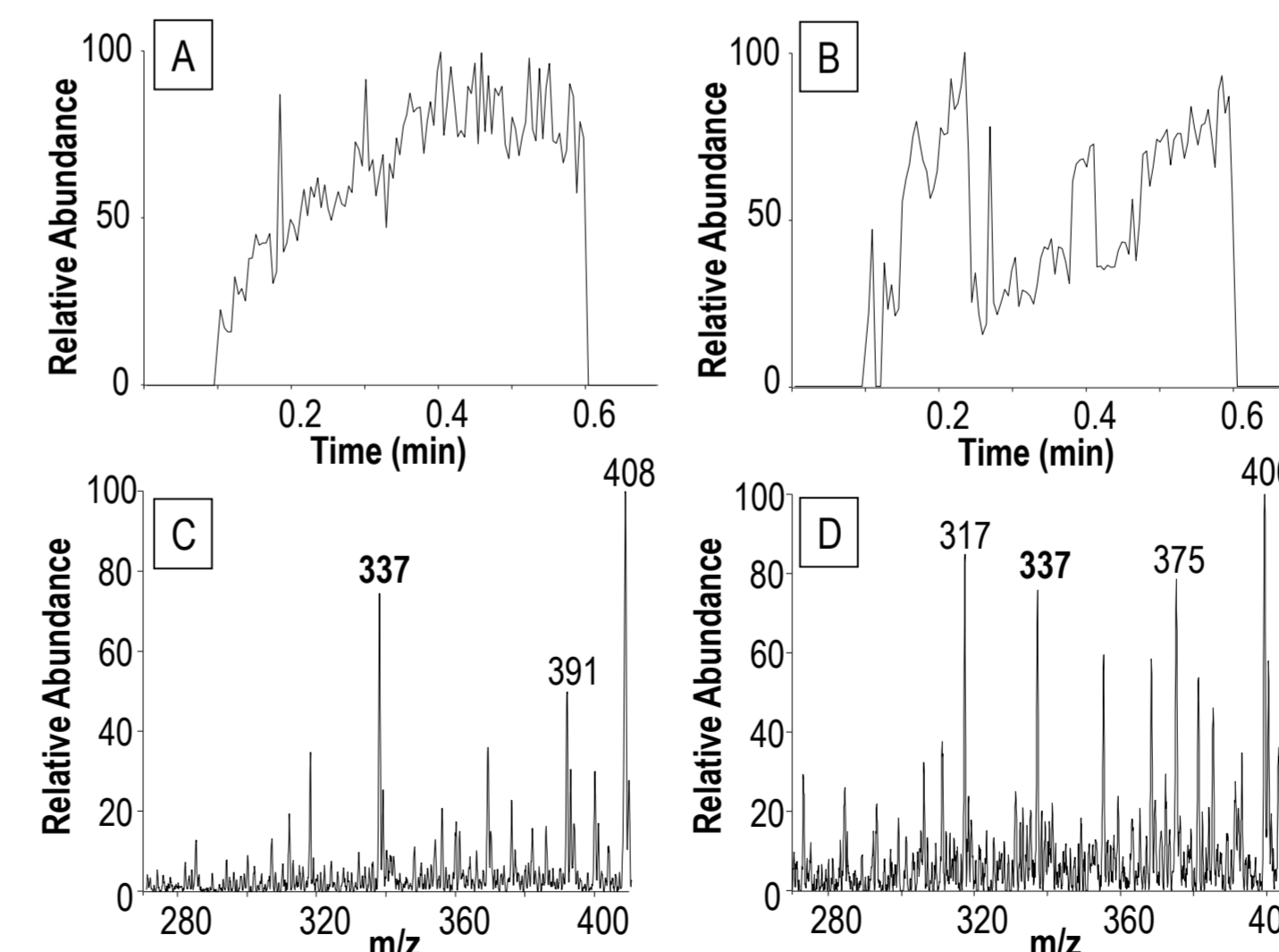


Figure 7. Comparison between standard and cut-free cartridges for the recovery of 100 ng fentanyl from a plastic surface. A) chromatogram (TIC) for standard cartridge B) chromatogram (TIC) for cut-free cartridge, C) Full MS spectrum for standard cartridge, D) Full MS spectrum for cut-free cartridge.

Results (cont.)

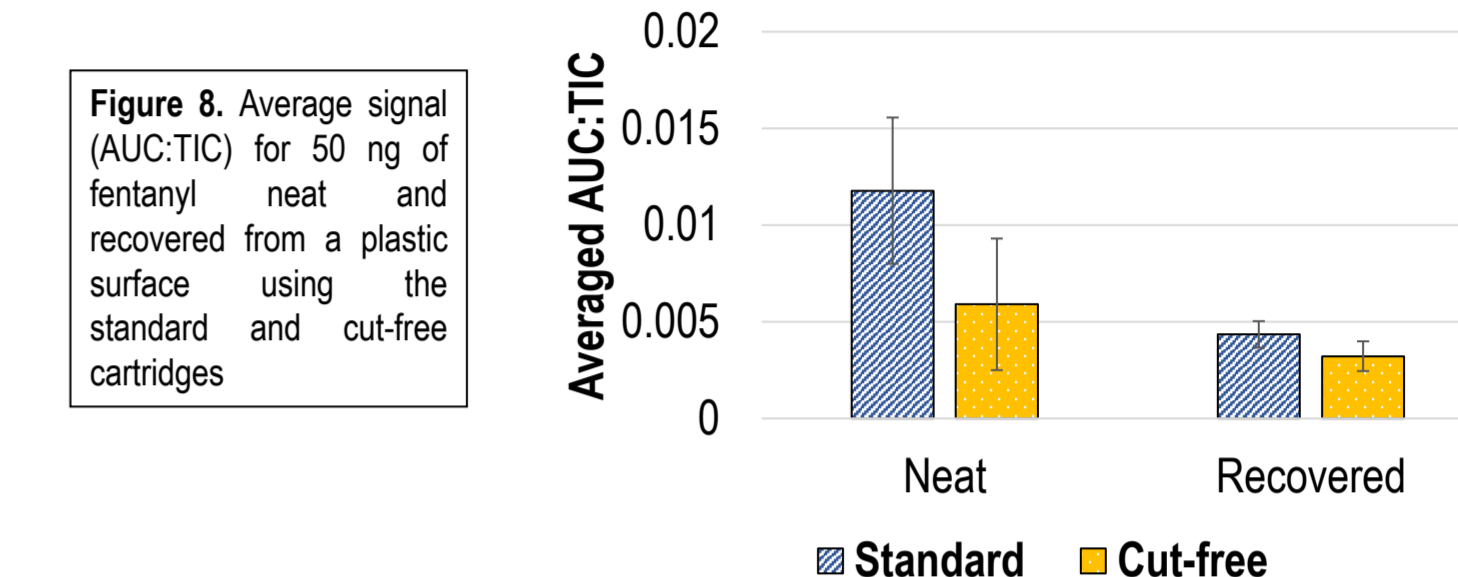


Figure 8. Average signal (AUC:TIC) for 50 ng of fentanyl neat and recovered from a plastic surface using the standard and cut-free cartridges

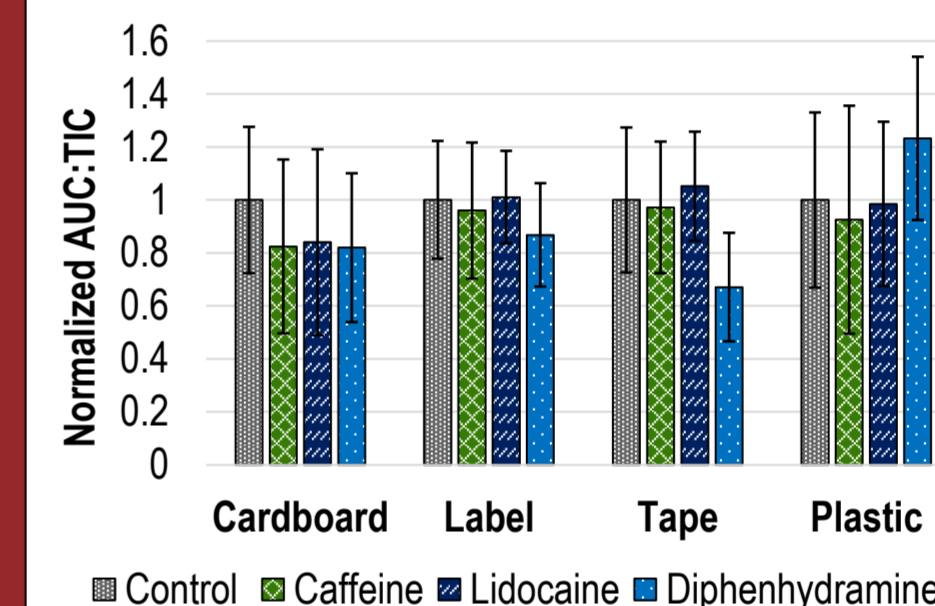


Figure 9. Normalized fentanyl signal in the presence of caffeine, lidocaine, and diphenhydramine for recovery from cardboard, shipping label, packaging tape, and plastic by PSA paper.

Conclusions

- The PSA and PS-MS method is expanded to the recovery and detection of seven fentanyl-related compounds
- Recovery of analogs from 4 common use shipping surfaces was demonstrated at 100ng. Smooth and less porous surfaces allowed for recovery at 50 ng
- An evaluation of cartridge allowing for analysis of a full-sized PSA ticket was conducted
- Despite generally poorer performance of the "no-cut" cartridge compared to the standard cartridge, the recovery and detection of fentanyl from a plastic surface was reported
- The impact of noncontrolled cutting agents on PS-MS analysis of fentanyl analogs was assessed, with no significant impact of cutting agent on analyte signal being reported
- Overall, this method offers for a quick, and affordable means of fentanyl screening

References

- DEA. Drug Scheduling. Administration, D. E., Ed.; July 10, 2018.
- Nguyen, C. B.; Wichert, W. R. A.; Carmany, D. O.; McBride, E. M.; Mach, P. M.; Dhummakupt, E. S.; Glaros, T.; Manicke, N. E. Pressure-Sensitive Adhesive Combined with Paper Spray Mass Spectrometry for Low-Cost Collection and Analysis of Drug Residues. *Analytical Chemistry* 2021.

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