PP – 16

Development of a rapid drug-screening method for serum samples using probe electrospray ionization tandem mass spectrometry

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Objective: Rapid identification of toxic compounds in poisoned patients contributes towards initiating the toxicological treatment plan. This study aimed to develop a rapid drug-screening method to assist the medical treatment of poisoning. Probe electrospray ionization (PESI), an ambient ionization technique, detects compounds from various biological samples either directly or after minor processing. We applied the PESI technique for rapid detection of drugs and poisons in serum samples.

Methods: Target compounds: Acetaminophen (APAP), salicylic acid (SA), paraquat (PQ), and glufosinate (GLUF). These compounds were added to the blank serum sample and spiked serum samples were diluted with ammonium formate (10 mM):ethanol (1:1 v/v) containing deuterium-labeled internal standards (IS) of each compound. The dilutions of APAP, PQ, SA, and GLUF were 1000, 20, 50, and 20 times, respectively. Only 10 µL of diluted samples were used per measurement. A tandem mass spectrometer coupled with PESI (PESI–MS/MS; Shimadzu, Kyoto, Japan) was used in the selected reaction monitoring mode for the analysis of these compounds. The measurement time was set at 30 s. APAP and PQ were analyzed in the positive mode, and SA and GLUF in the negative mode. Transitions of each compound were as follows: APAP, 152 > 110 (IS, 156 > 114); PQ, 186 > 171 (IS, 194 > 179); SA, 137 > 93 (IS, 141 > 97); and GLUF, 180 > 95 (IS, 183 > 98).

Results: All target compounds in the serum were detected within 5 minutes, which included the sample preparation time. The calibration curves ($1/x^2$) of APAP, PQ, SA, and GLUF in serum were linear over the range of 0.78–200 (r^2 = 0.994), 0.05–5 (r^2 = 0.995), 1–1000 (r^2 = 0.999), and 1–400 (r^2 = 0.996) µg/mL, respectively. The relative standard deviation (n = 6) for these calibrators was < 20%. In actual APAP intoxication cases, the quantitative values of APAP determined using PESI-MS/MS were almost identical to those using liquid chromatography (LC)–MS/MS.

Conclusion: PESI–MS/MS is a simple technique for the detection of selected toxic compounds in serum. The total analysis time, including pretreatment (only dilution) and data analysis, was < 10 minutes. The measurement range of the method for APAP, SA, PQ, and GLUF included their toxic range. These results suggest that PESI–MS/MS could be used for toxicological evaluation in clinical settings.