Medical Xpress

RaDPi-U: Fast and convenient drug screening with urine samples

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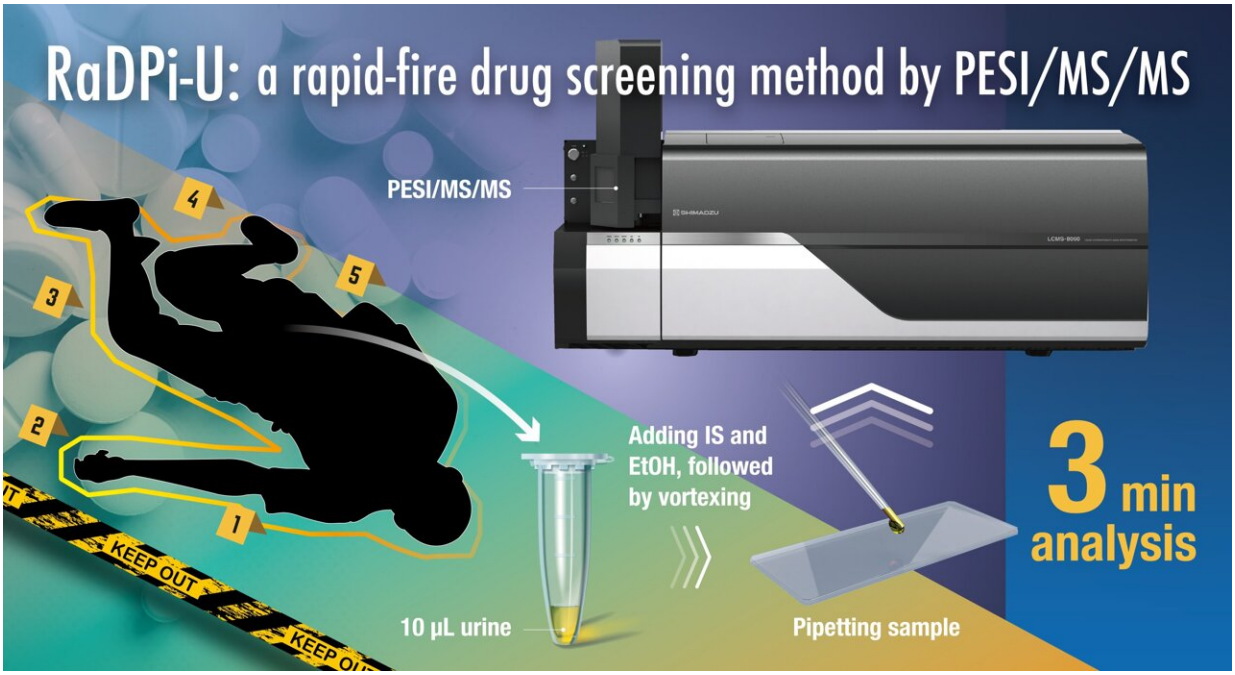

The RaDPi-U technique is extremely simple to perform and produces reliable drug screening results in less than three minutes. With many advantages compared to conventional screening methods, it is poised to become a powerful tool for forensic investigators. Credit: Dr. Issey Takahashi / Nagoya University

Drugs, both legal and illegal, cause millions of cases of severe intoxication every year, leading to health complications and even fatalities. Often, they are also implicated in violent and sexual

harassment crimes, as well as accidents.

Obtaining detailed information about the drugs consumed by a criminal or victim is often challenging. Forensic professionals rely on drug screening techniques performed on biological samples, such as blood or saliva, to gather crucial evidence.

Today, various types of practical drug screening methods exist, each with their own unique advantages and drawbacks. For example, immunological drug screening tests can provide results quickly, but are limited to very specific drugs and often show false positives.

In contrast, techniques based on mass spectrometry (MS), which analyze the mass-to-charge ratio of captured ions, tend to be more accurate. However, conventional MS approaches require careful sample preparation steps, which makes them somewhat tedious and difficult to use for non-experts.

Against this background, a research team from Japan has developed a promising drug screening technique dubbed "RaDPi-U" that can rapidly detect the presence of 40 forensically relevant drugs from urine samples. Their study, detailing the performance of their approach in preliminary tests, was published in the journal *Analytical and Bioanalytical Chemistry*.

Members of this research team included Professor Kei Zaitsu from Kindai University, Dr. Kazuaki Hisatsune of the Forensic Science Laboratory at Aichi Prefectural Police Headquarters, and others.

The proposed technique is based on a combination of probe electrospray ionization and tandem mass spectrometry (PESI-MS/MS). Simply put, PESI involves capturing molecules to be analyzed using a thin metal probe, which induces a strong electric field that ionizes compounds

adsorbed onto the surface of the probe.

These captured molecules, or "analytes," are transferred to a series of mass spectrometers, which determine the mass-to-charge ratio and additional structural information to determine the concentration of specific compounds (drugs).

The procedure for RaDPi-U is extremely simple, requiring only a few steps. First, 10 microliters of urine are collected from the screened individual and mixed with a substance predetermined as an internal standard, and ethanol.

Then, after thoroughly mixing the sample using a vortex mixer (pre-treatment: 1.5 minutes), the same is pipetted and laid onto a sample plate for PESI. Finally, the plate is set into the PESI-MS/MS (analysis time: 1.5 minutes), which produces results in less than three minutes and automatically reports them using a built-in software.

The researchers carefully investigated the reliability and accuracy of the results for multiple concentrations of each of the 40 screened drugs. Compared to established methods, the proposed technique exhibited an equal or better lower limit of detection for all drugs, meaning that it can detect drug concentrations as minuscule as fractions of a nanogram per microliter for several compounds.

Moreover, the measurements were highly repeatable, demonstrating the reliability of RaDPi-U. This was further proved through tests with postmortem urine samples. To top things off, this method requires only one single substance as an internal standard rather than a specific compound for each screened drug, which means setting up the device is straightforward.

Overall, the team has high hopes that RaDPi-U will prove to be a

powerful tool for forensic departments everywhere. "Our method boasts simplicity and user-friendliness, enabling even non-professionals to conduct drug analysis with ease," remarks Prof. Zaitsu.

"In essence, our research streamlines drug analysis to unprecedented levels, thereby fostering long-term efforts to curb drug-related crimes." He also notes that RaDPi-U has potential not only in forensic fields but also in tasks related to clinical toxicology.

Additional efforts are already underway to make the proposed method even more useful. "While this study is preliminary and the number of currently detectable drugs is limited to 40, we are actively expanding the range of targeted substances, aiming to enhance both the speed and scope of detection," comments Dr. Hisatsune.

The researchers are also developing a similar method for blood samples, called RaDPi-B, which will be essential when urine samples are unavailable or in case of drugs for which urine-based testing is not applicable.

More information: Kazuaki Hisatsune et al, Development of a rapid-fire drug screening method by probe electrospray ionization tandem mass spectrometry for human urine (RaDPi-U), *Analytical and Bioanalytical Chemistry* (2024). DOI: 10.1007/s00216-024-05215-x

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