TEDI GUIDELINES

DRUG CHECKING METHODOLOGY

2022

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TEDI
Trans European
Drug Information

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EXECUTIVE SUMMARY

The Trans-European Drug Information (TEDI) network is a network of organizations that analyze drugs and return the results to people planning to use those drugs, with the goal of reducing harm among people who use drugs.

TEDI consists of organizations across Europe with decades of collective experience providing drug checking, each working within the unique constraints of their audience and legal framework. Common to all of them is a vast amount of expertise in z targeted information to reduce harm among service users.

This document covers the techniques that are currently in use by drug checking services and explains their pros and cons for an audience that might be considering setting up a drug checking service in their own jurisdiction. A range of variables are considered including cost and the technical capabilities of each.

Guidance is given on overcoming legal challenges, a factor that most drug checking services have spent much time considering. Case studies are provided, describing the use of a variety of techniques in context, showing how the needs of service users are considered and how the legal framework is considered.

It is expected that readers will be able to use the document at an early stage in the setup of such a service to understand what equipment they might need and what considerations they need to make. The TEDI network encourages would-be drug checkers to contact it with questions and for more specific guidance.

INTRODUCTION TO THIS DOCUMENT AND TEDI

The Trans-European Drug Information network (TEDI) was formed around 2011 to foster the exchange of analytical data among drug checking countries and organizations. It now represents 20 fieldwork drug checking services from 13 different European countries (Austria, Belgium, France, Germany, Italy, Luxembourg, Portugal, Slovenia, Spain, Switzerland, the Netherlands, Finland and the United Kingdom).

TEDI provides a unique perspective on the European recreational drug market, when compared to classic national and European monitoring systems. It acts as a sentinel, submitting data biannually to the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) as well as on-demand for the evaluation of a specific trend.

TEDI's main goal is to optimize public health, prevention, and harm reduction intervention strategies/programs. To this end, several guidelines were developed when the project was funded by the Health Program of the European Union from 2011 to 2013. In these years, TEDI set standards for various methods and processes related to drug checking by supporting institutions interested in launching a drug checking service and helping reduce legal and technical uncertainties.

This effort led to the publication of the **Guidelines for drug checking methodology** that discussed various techniques being used by drug checking services in an attempt to standardize testing protocols, making the results comparable for the future.

Ten years have passed since then. During this time, new technologies have been developed, new settings have been explored (e.g., drug consumption rooms), and challenges have emerged such as high-dose MDMA pills or adulteration with fentanyl derivatives in some parts of the world. For these reasons, we decided to revise and extend the first set of guidelines.

1. WEDINOS — United Kingdom
2. The Loop — United Kingdom
3. Jellinek — Netherlands
4. Drugs Information and Monitoring System (DIMS) — Netherlands
5. Modus Vivendi — Belgium
6. Analyse ton Prod. — France
7. Checkin — Portugal
8. Ailaket — Spain
9. Kosmicare — Portugal
10. Energy Control — Spain
11. NTV Neutravel proj. — Italy
12. Borgorete — Italy
13. Saferparty Streetwork — Switzerland
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15. Drogenarbeit Z6 — Austria
16. Checkit! — Austria
17. PIPAPO — Luxembourg
18. Legal High Inhalts Stoffe — Germany
19. Drug Checking Berlin — Germany
20. A-Clinic Foundation — Finland

TEDI
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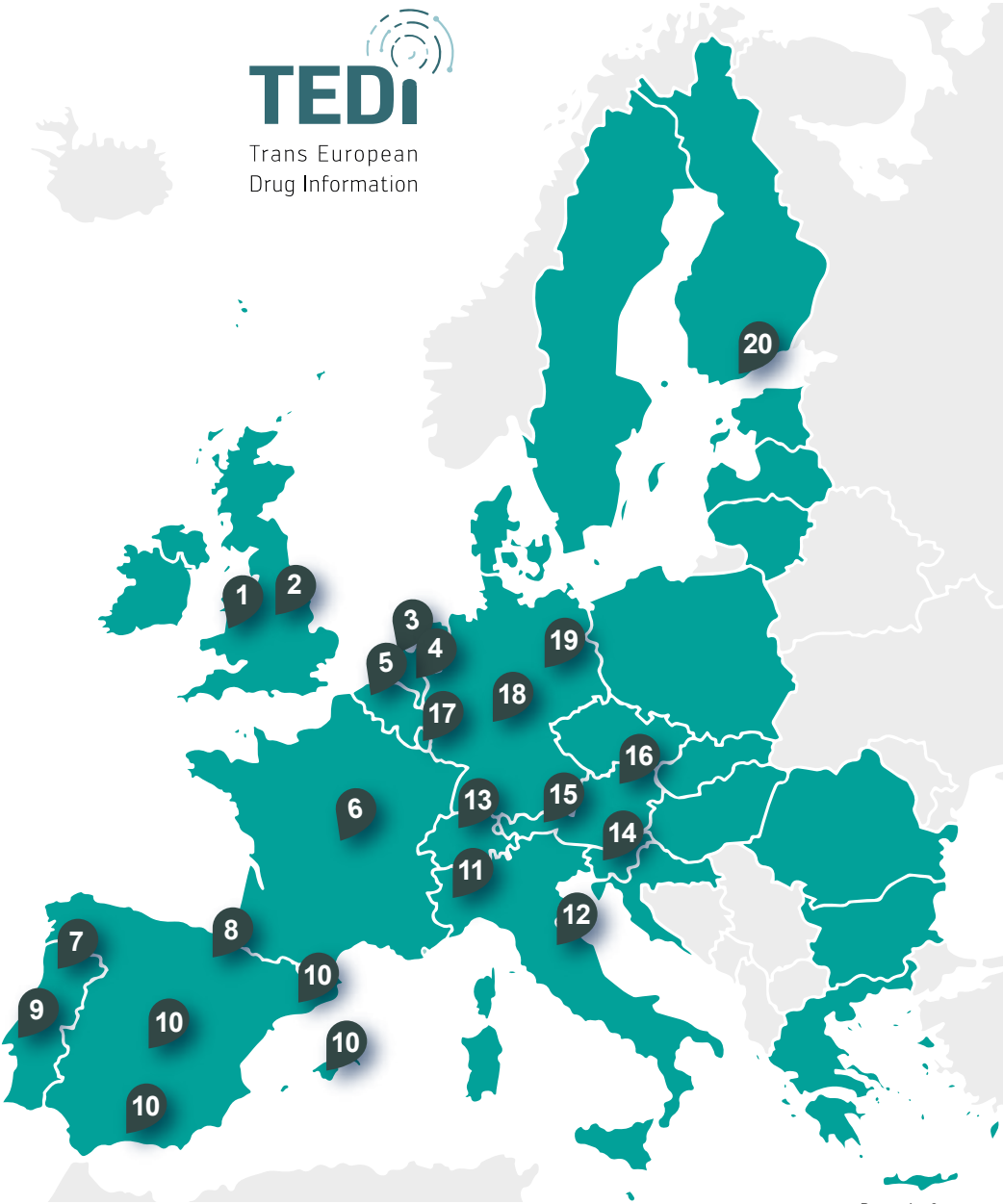


HOW IS “DRUG CHECKING” DEFINED?

Over the past 20 years the term “Drug Checking” has evolved from European English to refer to a specific type of service, different from the literal translation “to examine a drug to examine its quality or detect the presence of drugs”. This is similar to the use of the phrase “drug testing” in the USA to refer almost exclusively to the analysis of human samples to detect the consumption of drugs.

A Drug Checking service is one which focuses on public health and harm reduction for members of the public, by analyzing drugs to detect their contents and returning the results of each analysis to service users with the intention of helping the user reduce risk exposure without judgement of their decision to consume drugs.

In order to allow this focus on public health, a drug checking service uses the results of the analysis to contextualize the risks faced by the service user, including discussing interactions between substances that have been detected and explaining any quantitative results. The service must involve an exchange of information between the service user and the drug checking service, to obtain information which is specific to that service user, and this information must be used to tailor the advice given, embedded within a harm reduction consultation of some sort.

To summarize, a drug checking service must:

- Have an explicit aim of reducing harm;
- Collect and analyse samples directly from the public;
- Return the analysis results to the service user directly;
- Involve an exchange of information between the service user and the drug checking service;
- Give information about risk to the service user directly, tailored to the specific analysis result and the information received from the service user.

Market monitoring services may or may not analyse drugs for public health purposes but this is distinct from Drug Checking services because they do not return results to service users directly and do not engage in harm reduction consultations with service users directly.

Most Drug Checking services do serve a market monitoring function and the techniques in this document are valuable for organizations considering market monitoring as well.

Analysis of human samples for the presence of drugs is not Drug Checking and analysis of seized samples is not Drug Checking, even if this information is later used for public health purposes. Drug Checking services do not analyze samples to use as evidence for prosecutions of people who use drugs. Trust is essential in engaging people who use drugs and these activities can significantly undermine trust in Drug Checking services.

THE PURPOSE OF THIS DOCUMENT AND HOW IT WAS CONSTRUCTED

The guidelines are primarily meant to help organizations navigate the many intricacies of setting up a drug checking service. Based on the experience of TEDI members, we have sought to highlight the limitations and benefits of each commonly used technique, the settings they have been used in and how they have worked. Discussion of the forces working against drug checking and how to overcome them is also offered. Each section has been contributed to by the members with the most expertise on that technique, has been peer reviewed by other TEDI members and, in some cases, we have reached out to groups outside Europe to give additional perspectives.

Drug checking is not easy, and our learning is continuous and full of challenges in opaque and changing drug markets. Yet, over the years, we were able to draw general principles from our experiences:

- All drug checking technologies have their limitations, even the most advanced ones. One way to address a technology's limitations is to combine it with one or more other technologies. However, there is no single "right" combination of technologies, neither in general, nor in a particular setting. Many factors other than technical ones come into play when choosing a model of drug checking such as alliances with universities, the profile of the targeted users, budget or the legal framework of each country. Technology is a means to an end, not an end in and of itself. Consequently, a thorough needs assessment is required prior to choosing a model of drug checking and/or combination of techniques. Questions that can inform such assessment and help guide decision-making will be presented later in this document.

- Out of necessity, TEDI members have usually adopted a pragmatic approach. This is to think less in terms of what, in an ideal scenario, should be done; but more in terms of what, in a specific case, can be done.

- In that respect, the present guidelines bear testimony to the resourcefulness and willpow er that drug checking services have displayed throughout the years to deal with the limited budget they often work with, the restrictive political and legal contexts they often operate in, and the shocks in the drug market they have witnessed. Even in difficult and dire circumstances, members of the TEDI network have been able to achieve the goals they have set for themselves in terms of harm reduction and monitoring. In other words, one need not wait to be granted a large budget or for drug checking to be legalized to set-up a drug checking service. However, it is not the case that anything goes. Because of the high stakes in terms of public health and of the forces working against drug checking, there's no margin for error, and even less for amateurism. Bad press can have very detrimental effects on harm reduction services, which still often lack recognition from authorities.

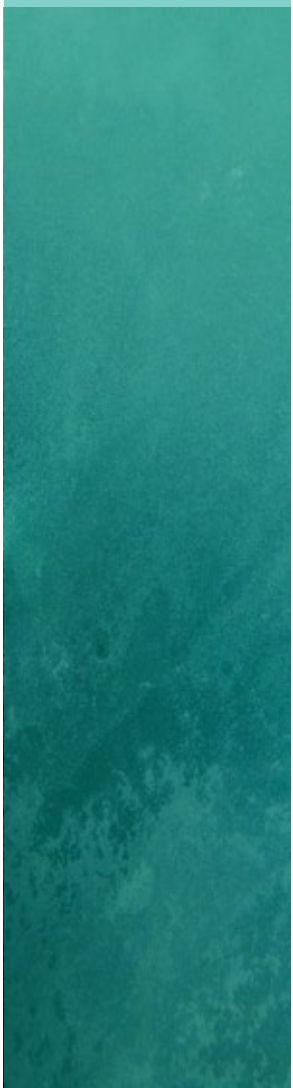
- If pragmatism is key, the fact remains that the highest standards of professional conduct possible must be upheld at all times. Professionalism includes, among other things, the recruitment of qualified personnel even when manufacturers of equipment say otherwise. Indeed, recruiting unqualified personnel increases the risks of false positives (i.e., results which incorrectly indicate the presence of a substance) and, even more damaging for public health, false negatives (i.e., results which incorrectly fails to detect the presence of a substance). With unqualified personnel, an

organization also restricts its ability to adapt to the ever-changing nature of drug markets.

- We are not starting from a blank state. There is now growing evidence on drug checking technologies, processes, and effectiveness on which an organization operating a drug checking service can and should build on. It is worth noting that this literature includes publications from the TEDI network (e.g., Brunt, Nagy, Bücheli, Martins, Ugarte, Beduwe, & Ventura Vilamala, 2015; see also the forthcoming Special Issue of Drugs and Alcohol Today on drug checking led by a TEDI collective). Besides being evidence-based, drug checking also needs to be evidence-producing: interventions should thoroughly be monitored and evaluated. Only in this way can drug checking services hope to learn, adapt to changing circumstances, reach their objectives, and establish credibility among decision makers.

- Collaboration is particularly important for drug checking services whose legal status often remains unclear or unstable, and should be established with different stakeholders, not only with other drug checking or harm reduction services, but also with public institutions, politicians, people who use drugs, etc.

In the following pages, we first present questions to consider when setting up a drug checking service. Answering these questions will help you identify the key requirements needed to achieve your goals. Before detailing the strengths and limitations of the most common analytical techniques, we then turn to a discussion of legal considerations. Finally, after a brief description of settings for drug checking types, we proceed with a (non-exhaustive) list of case studies. These case studies are meant to be indicative of the different scenarios in which TEDI members are operating.



WHAT TO THINK ABOUT WHEN CHOOSING A TECHNIQUE

Each organization within the TEDI network is unique in terms of background, funding, service structure, techniques applied. However, they share common objectives such as reducing risks and preventing harms caused using substances, mixtures of substances or harmful patterns of use. By providing the client with objective information about the composition and risks of the substance, informed decision-making about how to reduce risk is facilitated.

The chemical analysis of psychoactive substances along with the risk-focused interpretation of the result contribute significantly to the risk identification and the probability that someone will engage with the service. Accordingly, the careful selection of analytical methods as well as in-depth pharmacy knowledge and knowledge of the evidence base is essential.

Whether a priority or not, all drug checking services monitor the local drug market. Some of them already contribute to monitoring or early warning systems at the national, European, or global level. It is important for the service to be up to date on new trends on the market to adapt analytical methods and healthcare approaches accordingly.

Evidently, the variety among drug checking services is huge with many possible models. With a growing number of analytical techniques entering the market, choosing one or a combination of some can be difficult. All of them have advantages and disadvantages and factors other than analytical ones may influence the decision. It is worth noting that there are no drug checking services in operation which only use one single analytical method – even the best method benefits from being combined with others.

VARIABLES TO CONSIDER WHEN IMPLEMENTING A DRUG CHECKING SERVICE

Before we address advantages and limitations of single analytical techniques in detail, we invite the reader to take a broader perspective and begin by identifying the requirements that will help you achieve your stated goals. Specifically, we begin by identifying what data we want from a drug checking service for our purposes, e.g., how quickly do we need the analysis results and how comprehensive do they need to be? What information do we need from the users for interpretation?

To achieve this we have provided a range of points to consider when implementing a drug checking service and hope that our experiences and insights will guide the reader in the process setting up a drug checking service. Wherever applicable, we have included a reference to the respective category of the table “specification of methods” in the next section.

QUESTION	RESPONSE AND EXPLANATION	WHAT TO CONSIDER
HOW LONG WILL THE SERVICE USERS WAIT TO GET THEIR RESULT?	Some settings require faster results than others (e.g. drug consumption room or music events) as you generally want to give service users a realistic option to wait for their result before consuming. Besides a short analysis time, fast communication of results may also require a high sample throughput in case of a high demand. Fast results might be less important for monitoring purposes and depend on the requirements of the regional, national or international (early warning) system.	1. A short waiting time for the analysis result 2. Efficient workflow and communication between staff members (lab <-> psychosocial) 3. Samples per hour - Techniques allowing a high sample throughput 4. Portability - Portable techniques for on-site analysis 5. Regional / national / international early warning or alert system contributions
WHAT INFORMATION ABOUT THE SUBSTANCE DO WE NEED FROM THE SERVICE USER?	For individual harm reduction based on the analysis result, some information is necessary, e.g.: 1. What the substance was purchased as 2. If the substance was already consumed and if so, how much; which route of administration In case a very harmful substance / substance mixture is identified, it might be important to acquire more information to better assess the required actions, such as information about the origin and background of the sample. This information is essential to determine the scope of any alert issued (regional or national)	1. Questionnaire, or other assessment of necessary information 2. Trained (psychosocial) staff that work with clients and build trust 3. Data storage / database system 4. Data analysis expertise / knowledge 5. Establish an alert protocol / SOP
WHAT INFORMATION FROM AND ABOUT THE SERVICE USER IS BENEFICIAL?	Questionnaires are useful to start a conversation with users and explore their contexts and motivations for substance use, allowing for a personalized approach on harm reduction delivery. Having more information about drug use trends as well as about the origin of the samples allows you to keep updated on market trends and to adapt your service and/or methods accordingly. Effective monitoring of the market requires the collection of some data like source of supply, price, route of administration, pictures of the substance etc. To characterize your target group, you may want to gather some anonymized information about the individual client (age, gender, patterns of use etc.)	1. Questionnaire / Assessment of necessary information 2. Trained (psychosocial) staff that works with clients and builds trust 3. Data storage / database system 4. Data analysis expertise / knowledge

WHICH TYPE OF **ANALYSIS RESULTS** DO WE NEED?

QUESTION	RESPONSE AND EXPLANATION	WHAT TO CONSIDER
DO WE NEED TO DETECT AND IDENTIFY ALL PHARMACOLOGICALLY RELEVANT CONSTITUENTS?	Detection of all *pharmacologically relevant* constituents is necessary. Inert agents like tablet binders do not need to be detected or identified but active cutting agents do need to be at least detected (ideally identified) as they can cause harm (e.g. levamisole). This is especially relevant for substances active in very low concentrations (e.g. synthetic opioids). In some settings it may be beneficial to prioritize throughput over identification of all pharmacologically relevant constituents, provided they are detected. Effective risk-reduction information can still be delivered to a service user if the analysis result initially contains an unknown component. Although the ability to identify new components may be reduced by this approach, effective risk-reduction information can still be delivered to a service user when they are told "there is an unknown component present, and this means the risk is far higher than normal". This approach does not work if unidentified risks exist in all samples. It is important that the health intervention is clear about these limitations if they exist. For monitoring purposes: a complete identification (including by-products or pharmacologically inactive substances) can be unnecessary depending on your focus of monitoring. For example, it might be sufficient to detect and identify major natural and synthetic cannabinoids for cannabis, but not all phytochemicals.	1. Techniques with low detection limits especially when highly potent substances (may) appear 2. Detection of all components - Inclusion of separation techniques or other techniques with high discrimination power to handle substance mixtures 3. Identification of unknown - Expertise to interpret and categorize the analysis results 4. Adaptability to market changes - Updated knowledge on drug markets. Be prepared to adapt your analytical methods 5. Obtaining reference samples / access to analytical databases

QUESTION	RESPONSE AND EXPLANATION	WHAT TO CONSIDER
DO WE NEED TO QUANTIFY ALL THE CONSTITUENTS?	Depends on the substance and your target group. **Quantification** is important when the amount of drug present in samples varies a lot. Examples include tablets or powders where it is common for huge amounts of inert bulking agent to be added. (Amphetamine powder and MDMA tablets both have 30-90% bulking agent). Quantification is a precise science and requires care and skill that mean it takes *much* more time to process each sample. Quantification is generally useful for psychoactive substances and adulterants, where dosing is up to the client (e.g. lines). In some cases, such as levamisole, it is also important to quantify the adulterants because their toxicity depends on the dose taken. For accurate quantification of substances that are difficult and risky to dose (highly potent; low therapeutic range), it is essential to ensure that the sample is homogeneous and representative. For monitoring purposes, it depends on your focus of monitoring which substances or adulterants you want to monitor. The ones you monitor are important to quantify.	1. Quantitative determination Techniques that allow quantification 2. Obtaining relevant reference samples / access to analytical databases 3. Accurate methods to prepare samples before they are analyzed
IS THE DIFFERENTIATION OF STEREOISOMERS NECESSARY?	This is highly technical and usually not done. In case stereoisomers with very different potency appear on the market, differentiation (and quantification) might be important for harm reduction (e.g. ketamine and methamphetamine). This could be of importance when and the difference in effect is relevant for the consumer's health (risk of overdose). Whether differentiation of stereoisomers is important for monitoring depends on your specific aim.	1. Determination between isomers - Techniques that allow for differentiation of isomers

ANALYTICAL PARAMETERS TO CONSIDER

There are a wide range of technical parameters that can be considered with any analytical method used in drug checking.

There is no single technique that optimizes every one of these technical parameters. It is up to the service operator to determine the techniques that will balance these parameters as effectively as possible for their specific service.

PORTABILITY

Portability is important for mobile services. Some equipment is too large, too fragile or needs to be allowed to settle for 24 hours before use, whereas other equipment can be used immediately.

ROBUSTNESS

Related to portability, some drug checking is performed in harsh environments with high humidity, temperature fluctuations or dust. Some instruments are designed only for use in a lab and therefore unsuitable for harsh conditions.

DETECTION OF ALL COMPONENTS

The most effective way to detect all components is to separate the mixture physically first, then analyze each fraction. This process takes time and uses consumable materials. Software discrimination can be used, but has limitations. Whereas detection of all components is essential, not every substance needs to be identified instantly.

LOW DETECTION LIMITS

High sensitivity for trace components is important for potent drugs but is reliant on good discrimination of different components, to prevent signal overlap hiding one component.

QUANTITATIVE DETERMINATION

Some techniques allow no or only rough estimates of quantitative composition.

SAMPLES PER HOUR

The sample throughput is extremely important for busy services, but is a trade-off against other important variables. Some techniques have a drying or processing stage that can be done while other samples are processed, allowing samples to be processed in parallel.

TIME TO RESULT

"Time to result" estimates the waiting time for the result from sample submission and involves sample preparation, analysis and interpretation. It is often related to sample throughput, except where samples can be run in parallel. This is important for any service where a service user may wait for a result to consume their substance. If the time to get the result is long, then they may not wait.

IDENTIFICATION OF UNKNOWNS

New substances are often discovered first by drug checking services. The ability to determine the identity of previously-unseen products is therefore valuable in understanding risk and for market monitoring. Some techniques need to be calibrated against known reference standards, others can simply compare to a software library of global detections. Techniques like colorimetric testing may never identify unknown components.

DISCRIMINATION BETWEEN ISOMERS

Different stereoisomers (forms) of a drug may have slightly different potency and effects. It is uncommon for this to be a significant concern in managing risk, but can be considered for more advanced services

ADAPTABILITY TO MARKET CHANGES

As legislation around drugs changes, the drugs market changes too. This means that new drugs can appear, in new forms. A drug checking service needs to be able to adapt its protocols and methods to account for this. The extent of adaptability varies between drug checking techniques.

COSTS

A non-technical parameter, but one which is considered by almost any service. Costs for drug checking equipment range from 100 EUR up to 1 000 000 EUR depending on what level of compromise is acceptable on the other parameters. Staffing costs add on top of this and need to be considered in order to determine the overall viability of the service. Using under-qualified staff to operate even simple lab equipment greatly increases the chance that mistakes will be made in interpreting results.

TEDI Trans European Drug Information	TEST STRIPS ANTIBODY TEST STRIPS	REAGENT TESTING REAGENT TESTING	TLC TLC	UV UV SPECTROSCOPY	FTIR FTI RAM
PORTABILITY	⊕	⊕	⊕	⊕	⊕
ROBUSTNESS	⊕	⊕	⊕	⊕	⊕
DETECTION OF ALL COMPONENTS	⊖	⊖	⊖	⊖	⊖
LOW DETECTION LIMITS	⊕	≈	⊖	≈	⊖
QUANTITATIVE DETERMINATION	⊖	⊖	≈	⊕	≈
SAMPLES PER HOUR	⊕ 90	⊕ 40	⊕ 30	≈ 15	⊕ 3
IDENTIFICATION OF UNKNOWNS	⊖	⊖	⊖	⊖	≈
DISCRIMINATION BETWEEN ISOMERS	⊖	⊖	≈	⊖	≈
ADAPTABILITY TO MARKET CHANGES	⊖	≈	⊕	⊖	⊕
COSTS	€	€	€€	€€	€€

LEGEND

- € Less than 500 €
- €€ 500 - 5000 €
- €€€ 10000 - 50000 €
- €€€€ 50000 -100000 €
- €€€€€ 200000 - 300000 €
- €€€€€€ + 500000 €
- ⊕ Possible
- ⊖ Not possible
- ≈ Possible under specific conditions

RAMAN IR/ MAN	HPLC-UV (U)HPLC-UV	HPLC-MS (U)HPLC-MS	GC-MS GC-MS	DIRECT MS DIRECT MS	LC-HRMS LC-HRMS
⊕	≈	≈	⊖	≈	⊖
⊕	⊕	≈	⊕	≈	⊖
⊖	≈	≈	≈	≈	≈
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LEGAL CONSIDERATIONS

Before planning a drug checking project or intervention, the local legal framework must be considered. Some models of drug checking may be permitted and others outright forbidden, but even when permitted, most services need unique specializations to appease authorities.

The legal framework must be considered in relation to the setting and the actions taken to analyze the sample (for instance: transporting the sample to a lab).

Consider seeking legal advice on all of these points.

IS DRUG CHECKING EXPLICITLY FORBIDDEN BY THE LAW?

Drug checking can be explicitly forbidden by the law or allowed only by a specific license. Check the entities that can perform drug tests and the requirements to get a license (for instance: monitoring or research are often acceptable and for this purpose you can often carry a small quantity of drugs.)

HOW IS A DRUG DEFINED IN THE LEGISLATION?

Is it possible to claim that what you have is not "a drug" until analysis confirms this? Or is the form, color, or smell enough to cause it to be covered by the law?

CAN YOU HANDLE/TOUCH THE SAMPLES?

Some jurisdictions don't explicitly forbid drug consumption or drug checking, but restrict adjacent activity, like holding the sample or giving it back to a person. Pay attention both to the criminal law but also to civil laws and check the conduct that is and isn't allowed (for instance: if you are not allowed to give back any of the sample).

Don't forget that technology can help you in facing this kind of barrier (see the case study of Italy) and build your drug checking service. Starting a drug checking project or intervention in a "grey area" can allow you to collect data and demonstrate the service is effective.

WHAT ADVICE CAN YOU GIVE?

Some jurisdictions make it a crime to "facilitate" or assist a crime and giving instructions about how to safely prepare drugs might be considered to fall under these rules. Check that the language you are using is acceptable under criminal law, but also consider civil liability and whether you could be sued if a service user considered that you gave them dangerous advice.

CAN YOU TRANSPORT THE SAMPLES?

Drug transportation is often treated differently, even if you have authorization to possess drugs.

Generally, drug transportation can happen only by a specific authorization from an institution. Check the requirements to transport a sample (register, specific package with a specific alert etc.) and check if you are allowed to transport a small amount of an illicit drug (For instance: less than an active dose).

DOES THE LAW SPECIFY A MINIMUM QUANTITY/PURITY TO DEFINE A SAMPLE AS A DRUG, OR TO BE CONSIDERED DRUG POSSESSION?

Often a sample must have some characteristics like

a minimum weight and/or a minimum level of purity before it is considered a drug. Lab analysis can often work with much less than an active dose of the drug.

CAN YOU RECEIVE SAMPLES BY POST? IF YES, WHAT ARE THE REQUIREMENTS?

Not everything can be sent by post: alcohol delivery is regulated, as well as generally sending drugs is prohibited (customs agencies works also on this, by checking mail and packages). Some products must respect certain rules to be sent (for instance: chemicals and dangerous products must be highlighted and properly enveloped).

DO YOU NEED AN AUTHORIZATION TO MANAGE A SERVICE FOR PEOPLE WHO USE DRUGS?

Check if you need a licence to start a new service for people who use drugs (for instance: opioid substitution therapy must be authorized and sometimes even HIV testing, too).

DO YOU NEED TO REPORT OR REGISTER THE NAMES OF THE PEOPLE USING A DRUG SERVICE?

Drug checking is a low threshold and a harm reduction service. The privacy of the user must be guaranteed. Some services for people who use drugs require data of users (For instance: OST generally requires the service to register you as a patient). A drug checking intervention might not be possible if you are forced to report the names of the people attending.

IS DRUG USE OR POSSESSION A CRIME? CAN YOU USE PROFESSIONAL PRIVILEGE TO AVOID REPORTING?

When planning your drug checking project or intervention pay attention to what is defined as a crime and if you are obliged to report to authorities or you can use professional secrecy laws to avoid reporting service users.

CAN YOU ACCEPT SAMPLES FOR DESTRUCTION?

Plan a strategy in case the person wants to discard the sample after receiving the result. Check if you can keep that sample locally and what to do in case you cannot. You may be able to use “drug destruction gel” to ensure you are not possessing a drug.

CAN YOU OBTAIN REFERENCE STANDARDS?

Some techniques used for drug checking require an analytical standard. A standard is a sample of a pure substance with known identity which can be compared to user-submitted samples to have total confidence in the result.

Generally, lab use of controlled substances is subject to strict regulation and requires special authorizations by the government, national health authorities or others.

ARE MINORS ALLOWED TO USE THE SERVICE WITHOUT PARENTAL AUTHORIZATION?

In some countries minors are not allowed to be provided with a health service without parental consent. Check the legislation carefully about the rights and duty of minors and the duties of professionals when dealing with a minor (for instance: reporting to parents or asking their consent before providing the person with a service).

DO YOU HAVE SAFEGUARDING OBLIGATIONS IF YOU BELIEVE A PERSON IS IN DANGER?

Most health services have an obligation to act if they believe a person is in immediate danger, for example they disclose that they are being abused during the advice session. This is particularly relevant to minors. Ensure that you have a protocol for this situation.

DESCRIPTION OF SETTINGS FOR DRUG CHECKING SERVICE TYPES

t's crucial to examine the setting or settings the service will operate in before deciding the methodology because the setting affects the needs of the service.

AT A MUSIC EVENT

This can include both multi-day music festivals as well as one-night events which may be unlicensed. Samples from music events are typically analyzed on-demand to deliver results to service users as soon as possible after submission.

Some music event services increase focus on speed of testing and with limited budgets, this means that they may reduce accuracy slightly (to an extent which still allows key information to be conveyed to the service user).

FIXED LOCATION

Drop-in centers are testing services run from fixed city locations. They are open on a regular basis for people to submit samples and typically return results 3-7 days after sample submission. They require a degree of planning from service users but can be accessed by all demographics.

PRIVATE LABORATORIES

This type of service describes non-public testing services which test samples for monitoring purposes. They do not accept direct submissions from the public and typically gather samples directly from police or hospital services, or through the use of “test purchases” from novel psychoactive substance (NPS) vendors.

SAFER INJECTION FACILITIES

Also known as “Overdose Prevention Centres”, these are medical facilities which provide clean injecting equipment and drug administration booths. They are constantly monitored by healthcare staff who can intervene immediately in the event of an overdose and provide a valuable opportunity to engage some of the most vulnerable people who use drugs.

Most samples are heroin and cocaine. Due to the high cost of these drugs compared to the budget of the users it is common to only test the residue on consumption equipment after the drugs have been consumed.

TEMPORARY CITY LABORATORIES (“POP-UP” LABS)

Pop-up testing facilities are temporarily located services which operate in city areas in an attempt to engage with all demographics. They offer significant flexibility compared to fixed drop-in centers.

Pop-up labs can face the same challenges as labs at music events as equipment must be semiportable.


18
HARMFUL
18
NOT FOR SALE
NOT FOR HUMAN CONSUMPTION
HEMICAL POWDER
HOOTER
RESEARCH CHEMICAL POWDER
18
NOT FOR HUMAN CONSUMPTION
BK-2

TECHNICAL INFORMATION ABOUT THE TESTING TECHNIQUES

This section contains detailed technical information about each technique used by TEDI members, including specific information about using the technique in the context of drug checking, the expertise required, the equipment required and a range of other considerations that prospective users might need to think about.

LIST OF TECHNIQUES IN THE DOCUMENT

- TLC
- Fourier-Transform Infrared (FTIR)
- UV spectroscopy
- Raman Spectroscopy
- Introduction to Chromatographic Separation
- Introduction to detection methods
- (U)HPLC-DAD-MS
- GC-MS

THIN-LAYER CHROMATOGRAPHY (TLC)

is a technique that allows the separation of the different compounds present in a sample.

The different compounds can then be identified by comparison of their spot migration with the one of an analytical standard of the substance, or a previously compared substance like caffeine. TLC is performed using diluted samples, requiring less than 15 mg of a sample.

TLC is extremely cheap to implement, requiring common materials that can be found in most laboratories or easily acquired, and can be upgraded over time, either by increasing the library of reference standards or linking it with other techniques (colorimetric reagents, UV spectrophotometry, FTIR).

PROS AND CONS OF THE TECHNIQUE

Pros

- Low cost (~1-3€/sample; initial cost of 500€ - 2000€ in non-consumables, that can also be found in most laboratories)
- Easy to implement
- Usable as an on-site technique
- Can be linked to other techniques
- Highly portable
- Adaptable to adverse conditions
- Low sample preparation
- Analysis done in parallel batches
- Allows the separation of different compounds present in a sample
- Adaptable to allow separation of a wide range of mixtures

Cons

- Requires analytical standards
- Requires consumables
- Very difficult to get quantitative information
- Hard to analyze complex mixtures (eg. plant material)
- Doesn't detect some drugs in low concentrations (LOD~ >20ug/mL)
- Doesn't distinguish isomers
- Not suitable for identification of novel psychoactive substances
- Medium amount of sample needed (5-20 mg)
- Medium time to set all equipment in the workspace up before testing (1 hour)
- Variable time for result (~ 2 hours in a busy setting)
- Flammable solvents are used

LIMITATIONS OF THE TECHNIQUE AND MANAGING THE LIMITATIONS

Given that TLC depends on the comparison of the sample against standards, your technique is only as good as your library. Using TLC for drug checking requires an up-to-date library of standards and must change with the drug market.

It is extremely useful to have a back-up laboratory with more sensitive techniques to identify unknown substances. This also allows you to use samples that were fully analyzed by GC-MS or other high reliability technique to make new analytical standards for TLC.

Given that samples must be diluted to be applied on the plate, their detection depends on their solubility on the solvent of choice. This makes most binders and excipients undetectable, which is helpful when analyzing pills, but can also mean some insoluble substances are not detectable.

Another issue is that complex mixtures can be hard to identify as there are too many unknowns to reliably separate (eg. plant material). Similarly, adulterants in low concentrations can go undetected in TLC, which can be problematic for extremely powerful substances (like fentanyl). Additional techniques, such as colorimetric reagents, are useful.

BEST-CASE SCENARIO FOR THIS TECHNIQUE

This technique is very versatile and can be implemented in different environments, from festival grounds to a permanent drop-in center. However, it is necessary to ensure a ventilated place, with temperature under 25 *C and a flat surface for the elution chambers for best results. Refrigeration is useful to store the analytical standards (and colorimetric reagents, if used).

MINIMUM EQUIPMENT REQUIRED

- Elution chambers
- TLC plates
- Capillary tubes
- Eppendorf tubes
- Solvents for sample dilution (methanol)
- Solvents for elution (methanol, acetone, ammonia)
- UV light (254/365 nm), if using fluorescent TLC plates

ADDITIONAL EQUIPMENT AVAILABLE ON A HIGHER BUDGET

- Colourimetric reagent tests for improved identification ability and sensitivity
- Increase the number of reference standards available
- Larger range of eluent solvents/systems
- Complement TLC with a quantitative method such as UV spectroscopy
- A secondary method such as GC-MS is useful in case of unknown compounds.
  - This could be offered by a university that agrees to test a small fraction of samples, if it is legal to send the samples to that lab.

QUALIFICATIONS REQUIRED TO CORRECTLY INTERPRET THIS DATA

TLC requires a chemist or pharmacist. Un-qualified operators can use the equipment but will require significant training.

For analyzing the results, it is essential to have knowledge on the drug market, patterns of adulteration and technique limitations.

Technical Specifications

FOURIER-TRANSFORM INFRARED (FTIR)

FTIR shines different colors of light at a sample and measures the absorbance of each color. Different molecules absorb different amounts of each color and this allows a unique fingerprint to be measured for each molecule.

FTIR is typically run on a solid sample and requires little preparation but cannot measure purity of the components it detects.

FTIR reports a numerical *confidence* value to indicate the statistical confidence of any detections it makes. A skilled operator uses this number and the visual appearance of the spectrum to understand the need for additional analysis.

PROS AND CONS OF THE TECHNIQUE

Pros

- No sample preparation required
- Fast (2-3 minutes per sample)
- No calibration standards required
- Good for distinguishing positional isomers (eg 3-MMC vs 4-MMC)
- Medium cost (18000 EUR)
- Portable (5-10kg, 400mm x 300mm)
- Fast setup time (10-20 minutes)
- No consumables

Cons

- No physical separation of mixtures
- Limit of detection is quite high, so trace components are not detectable (3-20% depending on substance mixture)
- Reliant on a reference library of samples measured by other organizations
  - Liable to give false positives if an unknown sample is measured, needs an experienced operator to review these.
- Unable to test blotter or plant material
- Medium amount of sample needed (2-10mg plus whatever is needed to overcome static in any intermediate transport container)
- Unable to test diluted solutions (such as LSD or vape liquid)
- Limit of detection makes analysis of potent pharmaceuticals difficult (eg 1% alprazolam in a Xanax tablet)

LIMITATIONS OF THE TECHNIQUE AND MANAGING THE LIMITATIONS

FTIR does not physically separate components in mixtures. Signals from each component overlap and these must be disentangled. Computer software can algorithmically separate a single data stream into separate compounds, and this is accurate for mixtures with a small number of components.

If a mixture contains many components (three or more), or a component is below the limit of detection then the software will struggle to automatically separate the data and therefore will give a false negative. A skilled operator may still be able to detect a specific compound that they are looking for (this is done in Canada for fentanyl) but this is done one-by-one.

Particularly complex mixed data may cause the software to report a false positive for a compound, particularly tending to "detect" analogues of compounds that are present.

While the ability to use a library of past detections (provided by other organizations) is a huge strength because it eliminates reliance on calibration standards, it can encourage a false confidence about the capability of the instrument. If a novel compound is encountered and is not in the library then the instrument will report a low confidence in the measurement. A skilled operator must consider this number and use what they know about drug markets and infrared spectroscopy to determine whether further analysis is needed.

BEST-CASE SCENARIO FOR THIS TECHNIQUE

FTIR lends itself well to situations where fast, effective analysis is important. Coupled with its size, it is very useful in portable settings such as music events and other mobile drug checking services.

FTIR should be used with other analysis methods to improve its ability to identify substances below the limit of detection. Reagent tests are extremely useful as they can be used to easily flag false negatives with MDMA or 2C-B mixed with large amounts of tablet binder.

Thin Layer Chromatography (TLC) is extremely valuable to use as a second factor where analysis confidence is low. This is because of its ability to inexpensively show the number of components in a mixture.

MINIMUM EQUIPMENT REQUIRED

- FTIR instrument with ATR attachment
- Laptop or computer
- Equipment to crush pills
- Isopropanol and water for cleaning
- Free libraries provided by other drug checking services

ADDITIONAL EQUIPMENT AVAILABLE ON A HIGHER BUDGET

- Reagent tests to detect substances under the limit of detection
- Immunoassay test strips to detect substances under the limit of detection
- Solvents and filter setup to separate binders from active components, therefore concentrating them to a higher % above the limit of detection.

Shimadzu instruments are much cheaper than bruker and the software is more stable but there is a reduced ability to detect two or more components due to usability issues with the software. The physical design of the Shimadzu IRSpirit sample stage makes it harder to clean powdered samples.

Bruker instruments are the most expensive (50% more than Shimadzu instruments) and do not offer better analysis, but do offer improved usability. The software is less stable and crashes occasionally.

QUALIFICATIONS REQUIRED TO CORRECTLY INTERPRET THIS DATA

A skilled operator is essential because the automatic matching features will report false positives and negatives from time to time. The operator should have a functional understanding of both infrared spectroscopy and drug markets as the software will attempt to provide a match from its library in all situations.

Someone with no understanding of drug markets may be happy to accept the suggestion of toothpaste detected in a substance when in fact the instrument is simply providing a close match for unrefined calcium carbonate. Even qualified scientists untrained on the intricacies of using FTIR for drug checking can be misled by such quirks.

Furthermore, chemical understanding of infrared spectroscopy makes it much easier for the operator to understand the limitations of the technique and therefore understand when further analysis is required (false negatives).

COMPLEMENTARY TECHNIQUES REQUIRED TO BRING DATA TO MARKET MONITORING STANDARD

FTIR alone is prone to missing components due to its relatively high limit of detection. This makes it challenging to get data that is of a compatible quality with data collected using separative techniques. This is compounded by the typical context of use for FTIR, where net reduction of harm (therefore rapid analysis of samples) is typically the priority over extreme precision.

If FTIR data is to be combined with other European data then it needs to be combined with a separative technique for complex samples. Some organizations withhold samples and send them for lab analysis, while others combine with TLC to check for the presence of additional components.

UV SPECTROSCOPY

is a quantification method. It is not suitable as the sole method for qualitative identification but can be used to act as a sense check for other methods.

PROS AND CONS OF THE TECHNIQUE

Pros

- Inexpensive (3000 EUR-15000€)
- Fast (3 minutes per sample)
- Accurate
- Portable (2kg, 30x40cm)

Cons

- As with all quantitative techniques, UV needs a stable surface for weighing
- Careful weighing and sample preparation required
- Requires occasional calibration with a reference standard
- Mainly suitable for MDMA, 2C-B
- Not suitable for heroin, cocaine, amphetamine (samples usually suspected adulterated)
- Requires flammable solvents

LIMITATIONS OF THE TECHNIQUE AND MANAGING THE LIMITATIONS

The limitations of UV spectroscopy mean it is unsuitable for analyzing certain drugs. There is no way around this, but its low cost still makes it a valuable addition to the lab. As with any quantitative technique, care must be taken when weighing and diluting samples.

UV analysis cannot analyze trace quantities of substances.

BEST-CASE SCENARIO FOR THIS TECHNIQUE

UV is ideal as a secondary technique in a lab which needs a low-cost method to increase quantification capacity. Or increase specificity of TLC.

MINIMUM EQUIPMENT REQUIRED

- UV spectrometer
- Quartz measurement cuvettes
- Liquid handling equipment
- Suitable solvents (methanol)
- Accurate weighing balance (0.001g) on stable surface

ADDITIONAL EQUIPMENT AVAILABLE ON A HIGHER BUDGET

- Autopipettes to speed up sample processing
- Anti-vibration platform for weighing in unstable environments

UV spectroscopy is a simple and well-established low-cost technique. There are few improvements to be bought outside of additional techniques that address the limitations of the technique.

QUALIFICATIONS REQUIRED TO CORRECTLY INTERPRET THIS DATA

The limited scope of UV spectroscopy means that there is very little interpretation required. A technical, competent person with good manual dexterity can be trained to carry out the procedure in a few hours.

COMPLEMENTARY TECHNIQUES REQUIRED TO BRING DATA TO MARKET MONITORING STANDARD

UV data is fully compatible with other quantitative data but must be combined with other techniques to allow whole-of-market monitoring which covers drugs that UV cannot.

Technical Specifications

RAMAN SPECTROSCOPY

is commonly used in chemistry to provide a structural fingerprint by which molecules can be identified. Sample preparation is generally minimal or unnecessary, allowing for the non-destructive *in situ* analysis of tablets, powders and liquids.

These features are particularly important for the speed of analysis, prevention of sample contamination and preservation of evidential material. Moreover, the analysis can be performed through the drug-container, avoiding any contact with the operator.

The instrument compares the measured spectrum with spectra contained in its libraries and returns spectra of the matching substances along with the confidence in the match.

PROS AND CONS OF THE TECHNIQUE

Pros

- No need to handle or even open the sample container
- No sample consumed
- Some measurement of mixtures (cutting agents included)
- Limited training needed
- Fast analysis (60 seconds)
- Comprehensive libraries available to buy
- Possibility to extrapolate the spectra from the tools for PC processing
- Portable (handheld)

Cons

- No physical separation of samples
- Disturbances (pill coating, dark samples and fluorescent substances may cause issues)
- Library-based (substances that are not present in the libraries have to be identified using Mass Spectrometry)
- High limit of detection
- More expensive than FTIR for similar quality of results
- Very limited quantitative analysis with current technology

LIMITATIONS OF THE TECHNIQUE AND MANAGING THE LIMITATIONS

Raman spectroscopy does not physically separate samples into their constituents. It has a high limit of detection and struggles with components under 10% concentration. The main advantage of Raman (not having to touch the sample) means that further processing of the sample is likely to be hard, so the only option is to try to arrange transport to an external lab.

BEST-CASE SCENARIO FOR THIS TECHNIQUE

This technique is not influenced by environmental variables and is suitable for all common scenarios (including cold outdoor events with high humidity and wind). The high cost of Raman compared to FTIR means it is likely that Raman will be chosen in situations where it is important to test through the sample container.

MINIMUM EQUIPMENT REQUIRED

Battery charger and appropriate power source

ADDITIONAL EQUIPMENT AVAILABLE ON A HIGHER BUDGET

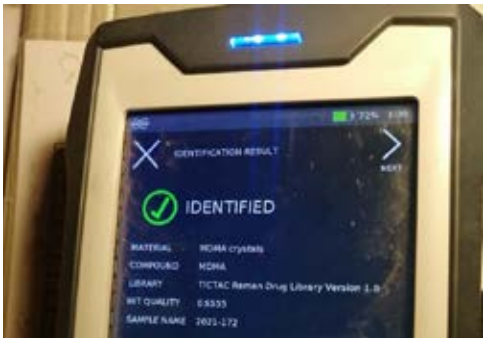
The TruNarc analyzer (ThermoFisher Scientific) used during the project BAONPS struggled to handle mixtures and samples with IR fluorescence.

With the Bruker Bravo instrument Neutravel have improved analysis on fluorescent substances considerably. Neutravel now work with the “Bruker Tictac” libraries which have significant ongoing costs but are better than the ThermoFisher ones.

Colorimetric reagents can be used to face the sensitivity limitations of Raman.

QUALIFICATIONS REQUIRED TO CORRECTLY INTERPRET THIS DATA

Qualitative analysis by Raman doesn’t require skilled personnel. The basic interface is easily understandable to everyone.



FUTURE DEVELOPMENT OF THE TECHNIQUE

Using Multivariate Curve Resolution - Alternating Least Squares (MCR-ALS), it is possible to decompose spectra of mixtures obtaining the spectra of each component, and to build a calibration curve for each compound of interest, provided that known-concentration standards are available. A free, open-source application on “R” is being developed, which would simplify the chemometric approach of the analysis, making MCR-ALS algorithms more user-friendly.

Similar techniques with FTIR have shown to struggle in many situations and this may therefore not be suitable for drug checking, where the range of possible chemicals that could be found is extreme.

COMPLEMENTARY TECHNIQUES REQUIRED TO BRING DATA TO MARKET MONITORING STANDARD

The high limit of detection with Raman means it is incompatible with data from other methods when used alone. Samples which do not have a high confidence score must be sent for further analysis, but samples with a high analytical confidence and one component can be reported directly.

INTRODUCTION TO CHROMATOGRAPHIC SEPARATION

Many traditional lab analysis methods combine a separation technique (chromatography) with a s much more accurate but takes time, space and cost.

Chromatography is a separation technique that works by forcing a sample along a tube containing a special material, which causes different molecules to come out at different times according to their chemical properties.

The following technologies use chromatographic separation in combination with a detection method.

INTRODUCTION TO DETECTION METHODS

The most well known detection method is “mass spectrometry” (MS) which literally measures the mass of each molecule that comes out of the separator. Masses are reasonably unique to each molecule and as a result this gives very high ability to identify a specific molecule. Due to the specifics of how the technique works, it is hard to use MS to quantify the relative amounts of each molecule in a mixture. MS tends to be less robust than other detectors and have lots of requirements.

Diode array detection (DAD) (aka photodiode detection array (PDA)) technology works by shining light through the parts of the sample as it exits the separator and measuring the absorbance. It is extremely robust and able to quantify amounts of substances in a mixture, but has less ability to identify unusual samples.

While diode array detectors (DAD) focus on lower acquisition costs and the possibility of an exact quantitative determination of the ingredients, coupling with mass spectroscopy offers an exact identification of more

complex molecules. The joint use of the latter two methods represents an almost ideal combination for use in mobile settings due to the complementary information obtained. However, the disadvantages are the high cost of apparatus, complex and sometimes costly maintenance work and high expertise requirements for operation and interpretation.

Although the acquisition costs for new mass spectrometers are very high, cheap devices suitable for mobile use are often available on the secondary market. The price for secondhand MS is even often far below that of instruments such as FT-IR or RAMAN spectrometers.

The statement that mass spectrometric methods in particular are unsuitable for mobile analysis (Harper, et al., 2017) has also proven to be incorrect using checkit! as an example (Mayer, et al., 2017). However, using these techniques in mobile settings is harder than in stationary settings and requires good expertise.

(U)HPLC-DAD-MS

(Ultra) High Performance Liquid Chromatography (HPLC) does chromatographic separation at very high pressure, with the sample dissolved in liquid and is a versatile method for the analysis of psychoactive substances, especially in complex mixtures such as those often found in recreational drugs. (Kapp, 2006) Combining UHPLC with DAD and MS detection gives unparalleled ability to detect, identify and quantify substances.

The advantages of this method are the broad spectrum of measurable substances, the ability to easily separate components of mixtures and the high adaptability to changes on the substance market.

Furthermore, the separation method can be combined with various detection options which focus on ability to identify unknowns or focus on ability to quantify.

PROS AND CONS OF THE TECHNIQUE

Pros

- High specificity
- High sensitivity (ng/ml range)
- Quantitative analysis
- High throughput is possible (setup/ method dependent)
- Fully automated operation possible
- Identification of new emerging substances
- Discrimination between isomers (4-MMC, 3-MMC, 2-MMC, LSD, iso-LSD etc.)
- Adaptability to market changes
- Modular design (adaptable to the needs of the service)

Cons

- High maintenance costs
- High acquisition costs (50 000 - 120 000 EUR for new equipment)
- High technical complexity/demands
- Requires a lot of technical expertise
- Start-up time 1-2 hours before the analysis (mobile drug checking)
- Continuous, stable power supply needed (older systems)
- Reference standards are necessary for quantitation
- Technical infrastructure for preparation of solvents is mandatory
- Requires flammable solvents

LIMITATIONS OF THE TECHNIQUE AND MANAGING THE LIMITATIONS

- Limitations of HPLC-DAD-MS are less about the quality of the results (which are extremely good) and more about external factors such as expertise required, non-portability and cost.
- New equipment is extremely expensive, approaching 100 000 EUR.
- Old equipment can be extremely affordable but tends to be very large and requires expertise to know what to buy
- Benchtop mass spectrometers can be transported to the site of the event, but not all of them are fit for on-site use. Single quad MS have less technical demands (quality of vacuum and gas supply) and can therefore be used on-site.
- Differentiation between isomers is not always possible with HPLC-MS alone. Possible solution: combination with DAD or another complementary technique e.g. FTIR

LIMITATIONS OF USING HPLC-DAD WITHOUT MS

- DAD requires analytical standards of drugs for qualitative and quantitative analysis. In most of cases it's mandatory to have legal permissions or a license to purchase analytical standards of scheduled substances
- Identification is only possible in combination with measuring of retention times of HPLC and comparison of the full DAD spectrum with that of a standard
- In cases of "unknown" compounds a complementary technique such as HPLC-MS, GC/MS or NMR is needed

BEST-CASE SCENARIO FOR THIS TECHNIQUE

HPLC-DAD must be considered primarily a laboratory- bound technique. Nevertheless it's possible to use it as an on-site technique with the right support, but this is suited to an advanced drug checking project.

MINIMUM EQUIPMENT REQUIRED

- HPLC instrument coupled to DAD and/or MS
- Computer
- Analytical balance
- Ultrasonic bath
- Handling equipment
- HPLC consumables
- Volatile solvents
- Reference standards (in all cases)

QUALIFICATIONS REQUIRED TO CORRECTLY INTERPRET THIS DATA

A skilled operator is required to interpret and manage chromatograms and DAD MS-spectrum data as well as a chemical understanding of the compound's behavior under this technique.

Only qualified and experienced individuals with proper laboratory equipment should perform these analyses and basic maintenance.

COMPLEMENTARY TECHNIQUES REQUIRED TO BRING DATA TO MARKET MONITORING STANDARD

Chromatography-based techniques are generally fully compatible with other data sources and do not require additional work.

TECHNICAL SPECIFICATIONS

GAS CHROMATOGRAPHY

differs from HPLC as it relies on heating up the sample and pushing it through the tube with high pressure gas. Different molecules pass through at different speeds, allowing their mass to be measured separately.

GC/MS is considered a gold standard in forensic drug analysis. Availability and updated different mass spectrum libraries, scientific data and information shared by Early Warning Systems let you identify most New (and emerging) Psychoactive Substances.

There are widely recommended methods for identification and quantification suitable for GCMS.

PROS AND CONS OF THE TECHNIQUE

Pros

- Separating mixtures
- Small amount of sample is required
- High specificity
- High sensitivity (ng/ml range)
- Quantitative analysis
- Fully automated operation possible for expensive systems
- Identification of new substances
- Discrimination between positional Isomers (4-MMC, 3-MMC, 2-MMC etc.)
- Adaptability to market changes
- Fast analysis results
- Validated methods are freely available

Cons

- High maintenance costs
- High acquisition costs (50 000 -120 000 EUR for new equipment)
- Not suited to portable use
- High technical complexity/demands
- Requires technical expertise
- Continuous, stable power supply
- Continuous gas supply (helium gas cylinder)
- Laboratory conditions (ventilation and room cooling)
- Reference standards for quantification necessary
- Technical infrastructure for preparation of solvents is mandatory
- Flammable solvents

LIMITATIONS OF THE TECHNIQUE AND MANAGING THE LIMITATIONS

- Continuous gas and power supply and suitable instrument conditions requires a laboratory adapted to its needs
- Only substances soluble on volatile solvents (such as Methanol) are accessible to GC/MS analysis.
- Some chemicals are destroyed as they pass through the hot chromatography system (LSD, GHB, NBOx family). These cannot be analyzed well
- In case of performing quantitative analysis, purchasing reference standards of illicit drugs requires legal permissions.

BEST-CASE SCENARIO FOR THIS TECHNIQUE

GC/MS must be considered primarily a laboratory- bound technique. All settings to run this technique should allow the lab to be a traditional laboratory.

MINIMUM EQUIPMENT REQUIRED

- GC-MS instruments
- Rotary vacuum pump
- Computer
- Inert gas supply (e.g. Helium)
- Analytical balance
- Ultrasonic bath
- Sample handling equipment
- GC-MS consumables (solvents)
- Reference standards (if quantifying samples)

ADDITIONAL EQUIPMENT AVAILABLE ON A HIGHER BUDGET

Another technique would be required in case of identification and/or quantification of thermally unstable compounds, such as LC/MS

QUALIFICATIONS REQUIRED TO CORRECTLY INTERPRET THIS DATA

A skilled operator is required to interpret and manage chromatograms and spectral data. A chemical understanding of the behavior of different compounds under GC/MS is also necessary.

Only qualified and experienced individuals with proper laboratory equipment should perform these analyses and basic maintenance.

COMPLEMENTARY TECHNIQUES REQUIRED TO BRING DATA TO MARKET MONITORING STANDARD

Chromatography-based techniques are generally fully compatible with other data sources and do not require supplementation.

TECHNOLOGIES CURRENTLY UNEXPLORED BY DRUG CHECKING ORGANIZATIONS

Some modern instruments may use unusual methods of taking a sample (such as blasting with a tiny laser pulse) in order to reduce the amount of sample preparation and/or speed up the process. These are not widely used by drug checking organizations and are likely to require significant budget and expertise as they become available.
These techniques won't be discussed in this document. These include

- Direct analysis in real time (DART) sampling
- Matrix-assisted laser desorption/ionization (MALDI)
- Paper-spray sampling (PS-MS)

TECHNICAL SPECIFICATIONS

CASE STUDIES

These case studies have been taken from services offered in different settings. They try to represent the different scenarios which TEDI drug checking services are operating in. The case studies are intended to give information about how real-world services operate, but they are not the only way to run a drug checking service

CASE STUDIES IN THIS DOCUMENT

- Running a service in an extremely legal restrictive environment
- High-tech setup in a party setting
- Fast sample analysis at a music festival, using FTIR
- FTIR in a low threshold service
- Low-cost TLC + UV in a festival and rave parties
- Drug Checking in a drug consumption room

RUNNING A SERVICE IN AN EXTREMELY RESTRICTIVE LEGAL ENVIRONMENT (ITALY)

NEUTRAVEL project operates in Italy, mainly in the Piedmont Region, in party settings such as unlicensed raves, clubs and electronic music festivals. Drug checking is not explicitly forbidden by the national law, but the possession of a substance is not allowed and to give a drug back to a person can be considered a crime. For these reasons, it is better not to touch the samples in drug checking activities. Neutravel has been running the service since 2016.

In Italy drug checking (DC) has been a challenge since the late 90's, when the Drop-In project (now Lab57 Alchemica) started to perform it in party settings with colorimetric reagents and tried to connect with the National Health Service (NHS) system. DC was never formally allowed because possessing the sample or giving the sample back to the user is illegal.

In 2010 there was another attempt to organize a DC service, based on sample collection, in Rome (Nautilus project). The project was not authorized since in Italy it is not possible to transport drugs, without an authorization from institutions. From 2006 to 2014 there was a very repressive policy on drugs in Italy but DC was carried out informally by autonomous organizations throughout the years.

Neutravel project (NTV) is a partnership between an NGO and an NHS agency. In 2014 NTV decided to try to perform DC once again. Before applying, NTV obtained legal advice on the framework that created concerns around DC: it was not specifically forbidden to analyze drugs, but workers should avoid touching the sample

and avoid transporting something proven to be a drug. The regional addiction department agreed because NPS were a growing concern for public health (as EMCDDA and national alerts were showing).

Then, NTV networked with the Regional Antidoping Center and planned DC interventions in party settings, by using Raman spectroscopy that allowed workers to analyze samples without touching them.

When results were inconclusive the sample could be brought in lab to be processed with GC-MS because if a scientific instrument doesn't identify a scheduled drug, there is no proof you are transporting an illicit substance. Furthermore, the sample can contain something dangerous, like a very new NPS. This means the need to protect public health and inform institutions about a danger take priority.

The Raman technique has some limitations, like the inability to detect a drug under 5-10% concentration. This turned out to be useful for the Italian situation, since it meant it was possible to transport more samples in the lab for detailed quantitative analysis.

After 18 months, the project proved DC was a useful tool to monitor the market and funding was received to continue the service, as well as for DC projects elsewhere in Italy. The biggest result for institutions and policy

makers was that people discarded the substance when the result was something unknown or not expected. In the Piedmont region a law was created inserting drug checking as a "basic level of assistance" for people who use drugs alongside things like blood analysis.

The lesson learned is that the possibility of success increases if you work with health authorities and you have a professional relationship with relevant stakeholders (toxicological labs), officers & policy makers. By liaising with them and listening to and understanding their needs, paying attention to the legal framework and use technology innovation to go beyond law restrictions it was possible to justify the action with theory and data.

Then, it is necessary to analyze the political situation and take advantage of the so-called "political window". Projects can still be approved even if they have been denied in the past, since policy makers and people in institutions change. Finally, don't wait for a top-down action, but create the conditions for a (scientific) bottom-up approach.

HIGH-TECH SETUP IN A PARTY SETTING

CHECKIT! is providing mobile drug checking at festivals, clubs and rave parties since 1997 in Vienna. As a scientific cooperation project of the Vienna addiction services and the Medical University of Vienna, checkit! has access to state-of-the-art analytical equipment as well as highly trained staff for both the analytical-toxicological and the psychosocial field. checkit! is funded by the City of Vienna and the Federal Ministry of Social Affairs, Health, Care and Consumer Protection.

For mobile drug checking at dance music events, an analytical system was established providing fast, selective and sensitive screening for a wide range of pharmacologically active substances on-site. The mobile system consists of four nearly identical ultra high performance liquid chromatography diode array detection (UHPLC-DAD) systems operated in parallel, allowing for detection of active substances in the microgram range. One of these UHPLCs is coupled with a robust mass spectrometer for complex mixtures, highly potent substances in low concentrations (ng-range) and for confirmation of identity. In addition, prescreening of all submitted samples is performed on a portable fourier transform infrared (FTIR) spectroscopy during sample preparation.

In total, the minimum time from sample submission by service users to result communication by psychosocial staff is approximately 15 minutes with this approach.

BEFORE THE EVENT:

A few days before the event, all necessary equipment including the laboratory van and the installed infrastructure (vacuum pumps, nitrogen generator, etc.) undergoes a system suitability test to ensure proper function.

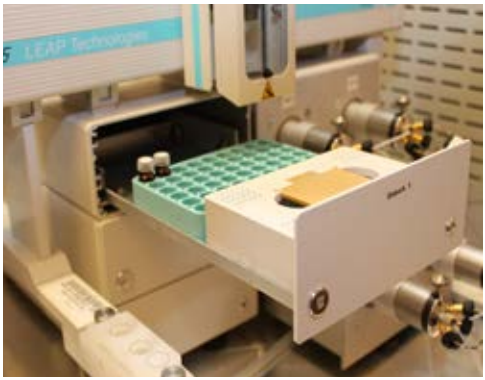
For the quantification of the most prevalent substances, a calibration curve covering the measurement range is established and checked against quality control samples in the expected range for each of the calibrated substances. On the day of the festival, the equipment is loaded into the laboratory van and driven to the festival site.

AT THE EVENT:

Approximately two hours before the actual drug checking takes place, the psychosocial and the laboratory staff arrive at the venue and install the required equipment, a tent for sample submission, and the information & counselling area. Once the drug checking process starts, service users hand over a small sample (5-10 mg) of the substance to be analyzed and are asked for some anonymous information about the substance sample.

In the laboratory van, the main proportion of the sample is weighed and dissolved then automatically diluted and injected into the system. The remaining proportion of the sample is simultaneously subjected to FTIR analysis. Substances are identified based on retention time and UV- and FTIR-spectra. For more complex samples, MS-spectra are also acquired and matched against database entries.

Once the substance(s) contained are identified and quantified, results are categorized and uploaded to an in-house database, printed and handed over to psychosocial staff onsite, which then communicates it to the clients. During a typical event, approximately 100 samples are submitted and analyzed.



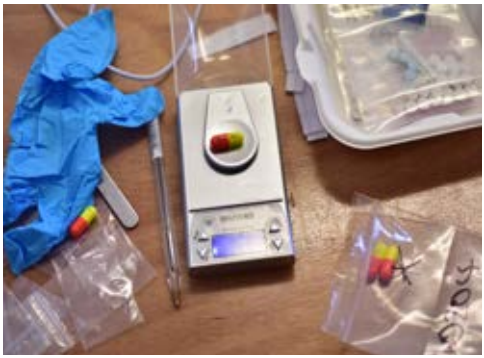
Checkit!

AFTER THE EVENT:

All the equipment is returned to the stationary lab and reinstalled to be ready for the analysis of samples submitted during stationary drug checking. Substances that could not be identified during the on-site analysis, are analyzed using advanced techniques (not discussed in this document) a few days after the event at the stationary lab. Service users that initially received an inconclusive result on-site are notified about the updated results by psychosocial staff members.

FAST SAMPLE ANALYSIS AT A MUSIC FESTIVAL, USING FTIR

THE LOOP operates in the UK, where the government is resistant to drug checking and it is still illegal to possess a drug, even for drug checking. The law does allow possession if you are “supervised” by a police officer or if the drugs are possessed in the process of destroying them. Initially with limited funding for equipment and buildings, but lots of volunteers, The Loop has been running a festival testing service since 2016.



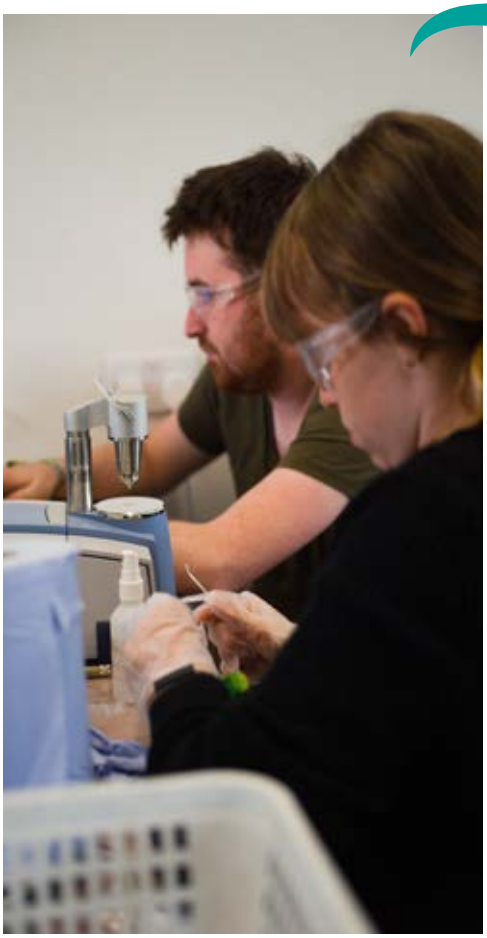
If 1000 people are taking drugs and the priority is giving the most perfect information without consideration for other parameters, it may be possible to give a test result and some advice to 100 people.

Because mistaken identity of the drug is not the only cause of harm, the ability to discuss drugs with a professional has a significant benefit, therefore even simple information about the sample encourages people to use this mandatory part of the service. While it is fantastic that 100 people got advice in the example above, 900 received nothing.

If the priority is instead to give the greatest net reduction in harm, by giving “good enough” information that is enough to warn about the major harms, it could be possible to contact all 1000 people who need the service. Therefore, there is a significant advantage to using a faster technique. Even if some service users are told “the drug presented is not one of the common drugs, but we do not know what it is” they can still act on this information.

FESTIVAL SETTINGS ARE CHARACTERISED BY:

- Harsh conditions (dust, heat, humidity, vibrations)
- High demand for the service, potentially hundreds of samples per day
- Extremely fast turnaround required as some service users are unwilling to wait over 2 hours before consuming
- Requirement for portability as vehicle access may be restricted
- Limited space
- For The Loop's service, members of the public deposit into a secure safe inside a tent. The safe is regularly transported to the lab by a registered person (security or police).
    - There is no public access to the lab.



FTIR

FESTIVAL CHALLENGES

FTIR handles these festival challenges happily, but its real advantage is in its speed of processing. The Loop is able to analyze 60 samples per hour with two FTIR instruments in real conditions. Many of these results are good enough to return directly to the service user, and any additional analysis required can be run in parallel to ensure that the speed of results is maintained. Techniques which take longer to analyze can be preserved for samples which FTIR cannot handle.

The Loop uses reagent testing as a second qualitative factor to support FTIR.

Quantitative results are only given for MDMA tablets. These are measured using UV spectroscopy or “Mass Loss Analysis” (extraction and weighing of MDMA from a whole tablet).

Very large numbers of volunteer chemists are used to run all the techniques in parallel. The Loop has found it easy to recruit talented, enthusiastic volunteer chemists and healthcare workers, with over 500 volunteers trained as of 2021.

WE ARE THE LOOP

FTIR IN A LOW THRESHOLD SERVICE

FTIR

DESCRIPTION OF THE SETTING

Addressing the lack of a clear definition, Islam, Topp, Conigrave and Day (2013) have proposed that the term 'low threshold' should only be used to designate facilities offering services to hard-to-reach drug users, without imposing abstinence as a precondition to service use, and with the aim of reducing other barriers (than abstinence) to access.

Yet, low threshold services vary from country to country (Edland-Gryt & Skatvedt, 2013). In Belgium, the notion is used as an umbrella term for different services such as shelters, health service, administrative and social services, needle exchange programs, street outreach, and, occasionally, safe consumption rooms. These services are typically offered to vulnerable (e.g., homeless) adults who suffer from poor physical and/or mental health and exhibit problematic use of illicit drugs. In early 2019, *MODUS VIVENDI ASBL* opened a third drug checking point, extending its coverage to low threshold services located in the Brussels Region. In this section, we share our experience in the hope others will learn from our trials and errors.

PREPARATION

We believe three elements played a critical role in us getting the funding for the project. First, thanks to more than twenty years' experience in drug checking, we could emphasize our expertise and the fact that we already had regulatory approvals, e.g., transport authorization from the relevant Federal Agency. Second, we had a history of successful partnerships with low threshold services in the Brussels Region. Third, we proposed to use a technology that seemed adapted to the target audience, namely a Fourier -transform infrared (FTIR) spectrometer (see below).

PLANNING

Despite the federal approvals in our possession, we soon realized it was also important to get approval at the local level, something that proved more energy and time consuming for some municipalities than for others. Here are things we have put in place to smooth coordination and communication with the partner low threshold services:

- presenting the project to the partner's team, settling a partnership agreement (which should include at the minimum the aim of the agreement, its duration and the modalities of its renewal, general principles, data protection policy, and when and how the agreement can be terminated),
- appointment of a contact person at the partner organization who should be trained in counselling, presentation of the project to the users before the project starts (to establish a relationship of trust with this audience, we organized four presentations),
- creation and distribution of flyers and posters containing the schedules of the drug checking service,
- and a regular meeting with the partner's team to monitor the project (we organize one every three months).

OPERATION

Due consideration should be given to the timing and frequency of service provision. In our experience, one should try to run a drug checking service in the afternoon or early evening. In the morning, users usually visit low threshold services to carry out administrative procedures or to rest. Also, the timing of the drug checking service should be matched with the time of the month when users receive their social welfare.

When operating a drug checking point in a low threshold service, setting up the space is of utmost importance. Ideally, two desks should be provided by the partner organization, one for counselling, one for testing. The desks should be located in a remote sealed area to ensure anonymity of the service, which is a guiding principle of drug checking.

This privacy principle also has implications for data sharing. The drug checking service may only share summarized data with the low threshold service. If raw data is shared then obfuscation techniques like age categories can be used to prevent identification of individual service users.

APPROPRIATE METHODS FOR THIS SETTING

Modus Vivendi asbl uses fentanyl strips, reagent testing and, occasionally, thin layer chromatography (TLC) as qualitative factors to support FTIR. FTIR meets the needs of the audience of low threshold services better than the other methods. This audience distinguishes itself from other audiences we work with (e.g., partygoers with a recreational drug use) in at least two ways.

- First, service users usually cannot or do not want to postpone use until we get the results of a more advanced and quantitative analysis, which would be conducted in a partner lab and can take days or weeks to perform.
- Second, service users usually want the product to be returned and are reluctant to use the service if the sample will be sacrificed.

Because FTIR analysis is more precise than reagent testing, is faster than TLC or GCMS, and, unlike the others, is a non-destructive method, we believe, like Tupper, McCrae, Garber, Lysyshyn and Wood (2018), that FTIR can motivate this audience to get their products tested in larger numbers. FTIR has its limits that should be reckoned with though and these are considered during the operation of the service. (See the section on FTIR).

LOW-COST TLC + UV IN A FESTIVAL AND RAVE PARTIES

The general description of this case study was developed by Kosmicare (Portugal). Energy Control (Spain) contributed to the description of the worst-case scenarios.

The rate of samples submitted for analysis for an in situ (e.g. large scale music festival) drug checking intervention is usually much higher than for fixed drug checking services. Methods must be extremely portable for event settings, which may only be active for a single day.

Thin layer chromatography (TLC) uses a small silica sheet to separate different substances. The substances separate according to their chemical structure, so it is possible to identify substances and mixtures using the technique. There are no large pieces of equipment, so it is one of the most portable and lowest cost methods.

Multiple TLC tests can be run in parallel, so even though it takes an hour for a single result, many samples can be run in a day if there are enough staff and desks.

TLC has been used for decades for detection and identification of psychoactive drugs and literature on its performance and reliability is vast. The use of TLC in conjunction with the spraying of colorimetric reagents over the plates can improve performance further.

Recent trends on the drugs market such as the circulation of high dose MDMA pills (>200 mg) reinforce the need to also provide quantitative results for proper harm reduction advice. UV spectrophotometry is used for this, and additional qualitative confirmation. UV isn't hard to implement, has a low-medium cost and in combination with a separatory method (such as TLC) provides reliable and fast results.

PRACTICAL IMPLEMENTATION

Kosmicare (Portugal), in collaboration with **Energy Control (Spain)** and peers from other harm reduction organizations, provided an integrated drug checking service in a psychedelic music festival in Portugal, combining colorimetric reagents, TLC and UV spectrophotometry.

Sample collection was done near the main stage of the festival in a private space. The samples were brought into the lab with around 15 mg collected for qualitative analysis and 40 mg for qualitative + quantitative analysis. Samples were collected from the user in separate Eppendorf tubes. The user received a ticket with a number for each sample and was asked to return later to receive the results.

Sample collection was from 14:00 to 01:00 and testing started at 19:00, sometimes going until 05:00 in the morning. The high temperatures during the day made it impossible to test earlier. The laboratory was set up in a construction container (10 x 2,5 meters) with air conditioning keeping the temperature below 25ºC.

Once inside the laboratory the sample is registered and the tubes are analyzed at their respective workstations (see Fig. 1). The lab coordinator ensures the workflow runs smoothly and reviews the analysis. Results were confirmed by at least two people, recorded in an Excel file and also posted on a board inside the lab, which healthcare advisers delivering the results could consult.

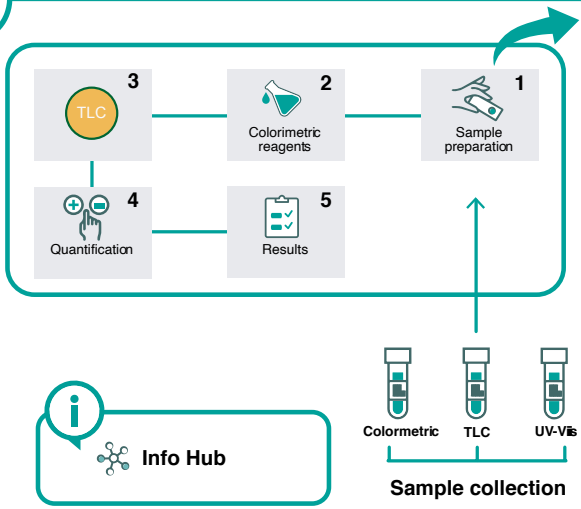


Fig.1

Figure 1. Set up of the laboratory inside a construction container. A team of eight people with backgrounds in drug checking and harm reduction worked in the labs.

Another six members of the drug checking team were trained to collect samples and to deliver testing results to users, together with a brief intervention focused on their individual needs and test results.

In case there were very specific results or substances found, a team member who had more knowledge about them could give a briefing to the person delivering the results or even talk directly with the user.

TECHNICAL DETAILS

Colorimetric reagents are used as an initial screening and also on top of the TLC plates, as confirmation. UV spectroscopy allows quantification of MDMA and some others but not cocaine.

This is a combination of the least expensive techniques on the market paired with a competent team is able to provide a highly effective drug checking service with excellent capability to detect any substances of concern. For a large festival in extremely harsh conditions (dust, 40*C heat and continuous loud music) this shows that big budgets are not essential to run a drug checking service.

KOSMICARE

ENERGY CONTROL

DRUG CHECKING IN A DRUG CONSUMPTION ROOM

EXPERIENCES FROM ZURICH

From 2018 to 2019, a pilot project for the implementation of a drug checking service was launched in two drug consumption rooms (DCRs) in the cities of Basel and Zurich. The project was combined with scientific research. This evaluation study focused on the following points:

- Impact of the analysis information on the user's knowledge
- Impact of counselling on users
- Impact of drug checking on the daily operation in a drug consumption room
- Attitude (need, acceptance, participation) of users towards drug checking
- Variations between the results from the DCR to the results from a service for recreational users (purity, adulterants etc.)

The responses from the users were collected through questionnaire interviews. A total of 100 people took part in the pilot project. During the process (follow up interviews), a relatively high drop-out rate was observed. In the final survey, only about one third of all study participants took part. Accordingly, the significance of the study results is rather low.

Overall, a positive effect on the level of user's knowledge was observed. Those questioned also stated after the consultation that they would respect safer use recommendations more often while consuming. The participants rated the possibility of using drug checking in a DCR positively in general. The majority of the employees did not notice any negative impact of drug checking on the daily business.

Out of the 100 samples tested, 59 contained cocaine and 41 heroin. Almost every heroin sample contained paracetamol and caffeine as cutting agents (39 out of 41). The cocaine samples contained different cutting agents such as caffeine (n=6), levamisole (n=7), phenacetin (n=3) or lidocaine (n=2).

The analysis was carried out in the forensic lab in Basel and was performed with HPLC/GC-MS. Users had to wait about 1 week until they got their result. The cooperation between a laboratory that usually focuses on law enforcement and harm reduction services was seen as a positive example of a constructive cooperation.

Following the study, the city of Zurich attempted to integrate a drug checking service firmly into the routine of their DCR: Four times a year, drug users were to be given the opportunity to have substances tested and to receive counselling. The demand for that service was generally low and decreasing from month to month. We assume the following reasons for the low interest:

- Visitors to the DCR often think “from one consumption to another”. Giving away 30mg of a substance like heroin or cocaine is a high financial hurdle for many of them.
- Some suffer from cognitive impairments due to long-term consumption and have difficulties processing information.
- Personality disorders, which occur significantly more frequently in this target group, could lead to information being given less faith.
- Visitors often doubted the quality of information given by the staff. Building trust is a continuous process.
- The waiting time between submission and notification of results is too long. Many visitors of DCR are not able to wait a week before using the substance or to keep follow-up appointments.

The implementation of a Drug Checking service in a DCR has shown to be difficult. A possible solution could be the use of test methods that provide faster results and may require less sample material. In no case, however, should this be done with a risk of a low-quality test result. Especially the high number of heroin samples in the pilot study indicates the danger of increased contact with highly potent synthetic opioids.

DATA COLLECTED BY THE TEDI NETWORK

TEDI
Trans European Drug Information

A template .CSV file is available for organisations who would like to make their data compatible with TEDI members.
Mandatory information is marked with *

Date (yyyy-mm-dd)*	
Organisation	The name of the organisation collecting the data
Sample UID*	A unique ID value for the sample which will never be re-used for more than one sample
Country*	The country of data collection
City*	The city where the sample was collected from. If this is not available, the city that the sample was tested in should be given.
Geography/Context (where sample was purchased)	A list of geographic contexts from which a sample could originate. E.g. “A music festival”, “a street”,
Relationship with provider	A list of options, such as “a friend”, “a stranger”, “online”. This is more important than the geographic context.
Sold-As*	What the substance was said to be when it was bought or given to the service user
Alias (optional)	A slang name that the service user used (if any)
Sample used prior to test	Whether the sample was consumed by the service user or a close friend before submitting for testing
Sample Form*	A fixed list of options (tablet, powder, liquid etc)
Colour	
Logo	(Tablets/blotter, not powders etc)
Width (mm)	(Tablets/blotter, not powders etc)
Thickness (mm)	(Tablets/blotter, not powders etc)
Height (mm)	(Tablets/blotter, not powders etc)
Weight (mg)	(Tablets/blotter, not powders etc)
Price per unit (EUR)	
Gender	
Age	
Test Method*	The analytical method used to obtain the result (if multiple methods used, enter most sophisticated)
Service Type*	The context of the service e.g. “music event” or “safer consumption facility”
Substance-1*	The identity of the first substance detected
Subst1-Quant	The numerical value of the quantification (if quantified). Excludes units, numerical data only
Subst1-Unit*	The units of the quantification (if quantified)
Substance-9	There are 9 columns in total, to allow detection of mixtures. For simplicity, 2-8 are not shown in this document
Subst9-Quant	
Subst9-Unit	

The template shown here is used by the TEDI network to facilitate sharing and comparison of data between the partner organizations. The compatibility of the different data sources is particularly important to the ability of the TEDI network to share data with the EMCDDA. The TEDI network would like to acknowledge the EMCDDA for their support, motivation and trust.

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