

03. APPLIED SCIENCES GROUP

We champion innovation, adopt a progressive mindset and develop new capabilities to deliver faster and better solutions.



INNOVATIVE &
PROGRESSIVE

KNOWLEDGE AND INNOVATION

We harness scientific knowledge to bring about greater innovation in our work.

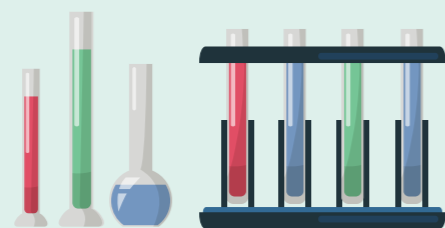
RESPONSIVE ANALYTICAL SUPPORT TO DETECT NITROSAMINE IMPURITY IN ARB PRODUCTS

In April 2021, HSA was alerted by overseas regulatory counterparts to the potential contamination of azidomethyl-biphenyl-tetrazole (AZBT) in angiotensin II receptor blocker (ARB) products. As there were no standard test methods for such analysis available internationally, we swiftly developed our own testing methodologies.

With strong commitment from our team, we successfully developed a Liquid Chromatography Q-Exactive Hybrid Orbitrap Mass Spectrometer (LC-HRMS) method in two weeks, to determine the amount of AZBT in ARB products. Our responsive analytical support enabled our colleagues in the Health Products Regulation Group to take timely and appropriate regulatory actions to safeguard public health.



A total of **38** ARB products

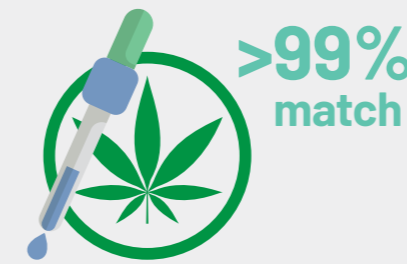


marketed locally in Singapore were analysed using our in-house developed testing methodology

DNA-BASED IDENTIFICATION OF CANNABIS

Traditional cannabis identification largely relies on a combination of physical examination and chemical analysis. To complement existing methods particularly for highly fragmented cannabis samples, we developed an innovative DNA testing method for forensic samples suspected to contain cannabis plant material.

With our new DNA testing method, we were able to obtain a



to known cannabis references from samples tested



EXAMINATION OF DIGITAL-FORMAT DOCUMENTS

In today's world where digital technology is used widely, it is increasingly common that documents for examination are often available only as soft copies. The limitation of examining soft copies is that some handwriting features such as pen pressure cannot be determined.

However, digital files can contain traces of crucial information, such as authorship, and whether data has been manipulated.

Recognising the benefits of such examination techniques, we initiated a multidisciplinary approach incorporating digital evidence analysis in handwriting examination as part of our standard practice. This additional information identifying the subject and associated alteration activity will be beneficial for the court.

ENHANCING THE INTERPRETATION AND ANALYSIS OF BLOODSTAIN PATTERN THROUGH RESEARCH

Bloodstain pattern analysis aims to provide information on the deposition of blood at a crime scene by studying the number, shape, size and distribution of bloodstains.

The key to effective bloodstain pattern analysis lies in the classification of bloodstain patterns and understanding how the blood was deposited. In our efforts to develop an established classification criterion, we successfully constructed a device to study the characteristics of downward cast-off and cessation bloodstain patterns, as well as the formation and deposition of blood droplets.

Through the subsequent application of statistical methods, we were able to obtain and publish qualitative insights to enhance our interpretation of bloodstain patterns at crime scenes.



ENHANCING OUR EFFICIENCY

We continue to enhance our efficiency through the improvement and refinement of existing techniques.

AUTOMATED URINE BOTTLE UNSEALING DEVICE



Annually, we receive approximately



20,000 to 22,000
urine samples in sealed plastic bottles for testing of controlled drugs

Old Method

We needed to manually open the water resistant tamper-proof seal on these urine samples using a cutter, which was both labour intensive and posed a risk for injuries.



New Method

Working with a commercial company, a custom device was built to automate the unsealing of urine samples. The portable device is made up of a bottle feeder, a conveyor belt, an attached blade and a collection tray.



v.s

Efficiencies Achieved

With this automated device, we can now unseal 90 urine bottles in around 5 minutes, as compared to 20 minutes by hand previously. This has increased our efficiency and more importantly, reduced the risk of injuries when handling the biohazardous specimens.



SEMI-AUTOMATED TOOL FOR QUALITY CONTROL DATA MONITORING

To ensure our laboratory processes adhere to the highest standards, we regularly monitor quality control (QC) standards and data. To improve our efficiency, we developed a semi-automated tool to analyse QC data trends and quickly address potential issues before they arise.

At the 2021 Annual European Network of Forensic Science Institute (ENFSI) DNA Expert Working Group Meeting, we shared our practices and methods with other international laboratories that were also gearing towards monitoring their QC data.

AUTOMATED PROFICIENCY TEST SYSTEM

As part of our continual efforts to enhance productivity, we upgraded our manual proficiency test (PT) system into an automated one in 2021. This new e-PT system allows authorised users to create the annual PT masterplan and route for approval with tracked changes, among other functions.

The initiative has enhanced work productivity through effective management of PTs and upkeeping of stringent quality standards, in accordance with ISO/IEC 17025:2017 requirements.



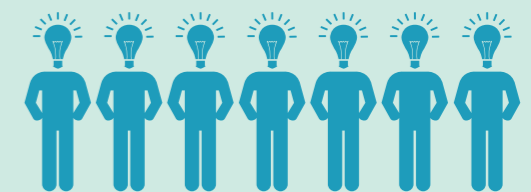
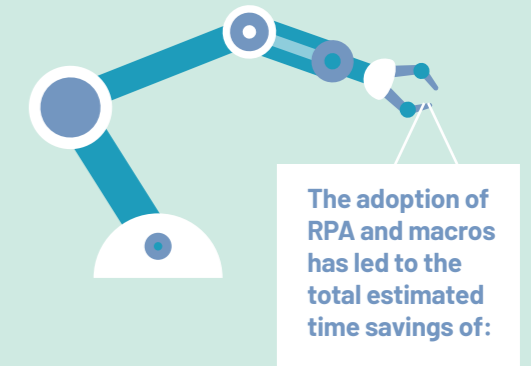
AUTOMATING PROCESSES FOR ILLICIT DRUGS ANALYSIS

We turned to Robotic Process Automation (RPA) to assist us in the daily autotuning process of all our Gas Chromatography - Mass Spectrometers (GC-MS) in the laboratory. The use of RPA has enhanced our work efficiency and prevents oversight which can occur during manual verification.

Additionally, to enhance users' experience when using the GC-MS, we have also implemented macros that allow users to:

- Automate library matching of sample peaks to databases to enhance efficiency of result interpretation
- Directly display method information on instrumental printouts for traceability
- Process data from instrument runs and generate PDF printouts of results for interfacing to the Laboratory Information Management System
- Extract ion chromatograms to look for trace amounts of commonly searched drugs

As a result, it eliminates the need for manual documentation, thereby reducing human errors and improving process productivity.



84 man-days/year

OUR LOCAL COLLABORATIONS

We continue to actively collaborate with our local partners on various projects.

ASSESSING THE QUALITY AND SAFETY OF COSMETIC PRODUCTS

To assess the quality and safety of cosmetic products sold in Singapore, we assisted the Consumer Association of Singapore (CASE) to conduct a heavy metals (lead and cadmium) consumer survey on 30 popular lipsticks sold in physical and e-commerce platforms in May 2021.

The results of the survey revealed that the levels of toxic metals in most of the lipsticks sold were generally within regulatory limits, and CASE issued a statement on the findings.



PATTERNS OF CHANGES IN HANDWRITING PRECEDING SEVERE CAR-T CELL RELATED NEUROTOXICITY

Even as CAR-T cell therapy continues to advance for relapsed or refractory acute lymphoblastic leukaemia, there remains a major concern of CAR-T cell related neurotoxicity or CAR-T cell related encephalopathy syndrome (CRES) occurring in patients. Early recognition and management of such toxicities is key in minimising complications related to the therapy.

In August 2021, our document examiners collaborated with the NUH Department of Paediatrics in a project to help determine if changes in the patterns of handwriting in patients that preceded major seizure events could be a sign of more severe neurotoxicity.



DETECTING THE ABUSE OF EMERGING SYNTHETIC CANNABINOIDS

To boost the detection of designer drug abuse such as synthetic cannabinoids, we partnered with the NUS Pharmacy Department to develop a new testing approach in August 2021 that employs the concepts of drug metabolism and pharmacokinetics to identify unique urinary biomarkers of new and prevalent synthetic cannabinoids.



Photo credit: NUS

PLAYING OUR PART IN THE COVID-19 PANDEMIC



In our continued fight against the pandemic, we worked closely with the Coroner's Court and the Singapore Police Force to safely transfer and handle deceased persons who were suspected to have or diagnosed with COVID-19.

In line with the roll out of the national COVID-19 vaccination programme, we also assisted with autopsy findings relevant to the investigation of deaths that occurred after COVID-19 vaccinations.

SHARING OUR EXPERTISE

To maximise the positive impact of our work, various knowledge sharing and exchange sessions were held both here and abroad.

APMP FOCUS GROUP ON FOOD SAFETY PROJECT ON MEASUREMENT CAPABILITIES FOR TOXIC ELEMENTS IN SEAFOOD

In May and June 2021, we partnered with the National Institute of Metrology (Thailand) and Government Laboratory (Hong Kong SAR, China) to organise a series of virtual training workshops under the Asia Pacific Metrology Programme (APMP). Joining as speakers and moderators were experts from HSA's Chemical Metrology Laboratory; Thailand Food and Drug Administration; National Measurement Institute, Australia; National Institute of Metrology, China; Government Laboratory, Hong Kong SAR, China; and Korea Research Institute of Standards and Science.

As part of the post-training activity, the organisers tested the measurement capabilities of participating institutes for toxic elements in a fish sample.

TRAINING SESSIONS FOR ENFORCEMENT OFFICERS

In November 2021, we held a virtual training session for Singapore Police Force officers on the preservation and submission of evidence, the laboratory processes, and the interpretation of results. We also shared about our new test services, namely Y-STR testing, mitochondrial testing, and age/ancestry prediction. These key learning points provided attendees with a better understanding of DNA evidence and the role that HSA plays in investigations.

In March 2022, we conducted an exhibit processing refresher training programme for Forensic Response Team (FORT) officers from the Central Narcotics Bureau. The programme was specifically tailored to their current work processes and needs, with a special focus on swabbing techniques in exhibit processing, exhibit integrity preservation and contamination prevention. Through this programme, both parties gained a better understanding of the mutual challenges faced, thereby facilitating better support for future casework.

PROVIDING OUR EXPERTISE TO THE HONG KONG LABORATORY ACCREDITATION SCHEME (HOKLAS)

In March 2022, our scientists from the Illicit Drugs Division and the Analytical Toxicology Division were invited as technical experts to assist in the online reassessment of the Hong Kong Government Laboratory under the HOKLAS.



SHARING OUR KNOWLEDGE AT THE ASIAN FORENSIC SCIENCES NETWORK (AFSN)

Gaining Insight on Secondary DNA Transfer

In recent years, a common question in court trials has been around the likelihood and frequency of secondary DNA transfers; whereby a person's DNA is transferred onto an object through an intermediate object or person.

During the AFSN DNA Workgroup meeting, we delivered a presentation on factors associated with such transfers. These findings would allow fellow scientists from the region to gain more insight on secondary transfers.

Workshop on Forensic Analysis of Paint

As part of the AFSN symposium, we conducted a workshop titled "Forensic Analysis of Paint Evidence". Our key objective was to share about common practices in forensic paint examination and the challenges in the interpretation of paint evidence.

Through our sharing, participants were equipped with the requisite knowledge on how to make an informed decision when selecting methods for paint examination.

Analysis of Explosives

Another session that we hosted at the AFSN symposium was on the challenges faced by regional forensic scientists in analysing explosives. We touched on the difficulties of analysis brought about by the sheer diversity of explosive types, as well as which techniques were the most suitable for analysing each explosive type.



BENCHMARKING OF MEASUREMENT CAPABILITIES

To ensure the reliability of our measurement results, we benchmark our measurement capabilities.

INTERNATIONAL AND REGIONAL COMPARATIVE STUDIES PARTICIPATED/CO-ORGANISED

International Comparisons Participated

Topic	Organising Metrology Institutes
Toxic elements in seafood	Government Laboratory (Hong Kong SAR, China)
Elements in rice	Korea Research Institute of Standards and Science (Republic of Korea); and National Metrology Institute of Japan (Japan)
Elements in yerba mate	Laboratorio Tecnológico del Uruguay (Uruguay)
Amino acids in human plasma	LGC Limited (United Kingdom)
Zearalenone in maize and anions in seawater	National Institute of Metrology (China)

International Study Co-organised

Topic	Co-organising Metrology Institute
Pilot study on HbA1c measurement	Health Sciences Authority (Singapore), Laboratoire national de métrologie et d'essais (France), Korean Research Institute of Standards and Science (Republic of Korea), and National Institute of Metrology (China)

Establishment of International Chemical Reference Substances (ICRS)

We also participated in an inter-laboratory collaborative study organised by the European Directorate for the Quality of Medicines and HealthCare (EDQM) to establish the reference substance for Dexamethasone Phosphate for the WHO International Pharmacopoeia.

PROFICIENCY TESTING (PT) PROGRAMMES & SCHEMES

HSA participated in the following international pharmaceutical PT programmes to benchmark our performance standards.

Topic	Organisation
Assay of cimetidine tablets by UV-VIS spectrophotometry	Bureau of Drug & Narcotic (BDN)
Assay of esomeprazole magnesium trihydrate by liquid chromatography	EDQM
Determination of methylisothiazolinone (MI) and methylchloroisothiazolinone (MCI) in bubble bath, shower gel and hair conditioner	EDQM
Assay of maleic acid and glycine by titration	EDQM
Assay of ascorbic acid by titration	Laboratory of the Government Chemist (LGC)

We organised the following accuracy-based PT Schemes:

- PT Programme on Organic Contaminants in Marine Fuel Oil, comprising two analytes in the quantitative scheme and eight analytes in the qualitative scheme, for local and overseas oil testing laboratories
- PT Scheme on Toxic Elements in Lipstick Material, in partnership with the National Institute of Metrology (Thailand), for local and regional cosmetic testing laboratories



EXPANDING OUR CHEMICAL METROLOGY SERVICES

We are constantly expanding our metrology services and adding new substances to expand our Certified Reference Materials.

CERTIFIED REFERENCE MATERIALS (CRM) PRODUCED

This past year, we expanded our list of CRMs to include:

April 2021

- HRM-2015A: Trace Elements (Al, Sb*, As, Ba*, Cd, Ca, Cr, Cu, Pb, Mn*, Mo, Ni and Se*) in Water

May 2021

- HRM-2014A: Elements (As, Cd*, Hg and Pb) in Lipstick Material
- HRM-2016A: Mercury* in Water

February 2022

- HRM-1029A: N-nitrosodimethylamine (NDMA*) in methanol

*New additions



KEEPING THE STAKEHOLDERS OF OUR CHEMICAL METROLOGICAL SERVICES UP-TO-DATE

We kept our stakeholders and partners updated through the following outreach initiatives:

- Launched HSA CheMetrology News, which presents recent and upcoming metrological activities
- Partnered with the Singapore Accreditation Council to conduct training courses for local testing laboratories on basic statistical tools, method validation and measurement uncertainty
- Launched an online measurement uncertainty course for professionals working in clinical laboratories
- Partnered Eurachem and Cooperation on International Traceability in Analytical Chemistry (CITAC) to co-organise four sessions of online workshop on Assessment of Performance and Uncertainty in Qualitative Chemical Analysis. The workshop was attended by more than 500 individuals based in over 60 economies.

Close ties with the international community allow us to keep expanding our knowledge base.

INTERNATIONAL COLLABORATIONS

WHO NATIONAL CONTROL LABORATORY (NCL) NETWORK FOR BIOLOGICALS

As part of our efforts to stay connected with global vaccines development, HSA successfully joined the WHO NCL Network for Biologicals as an associate member in September 2021. Through this membership, HSA will now be able to share and access information pertaining to lot release of vaccines within the WHO databases.

ACTIVE SUPPORT OF WHO ACTIVITIES

WHO Collaborating Centre for Drug Quality Assurance

- Redesignation of WHO Collaborating Centre

Our Pharmaceutical Laboratory was redesignated by WHO as its Collaborating Centre for Drug Quality Assurance for another four-year term (March 2022 to February 2026). This is an important milestone for us as it marks a continued recognition of our professional and technical excellence.

- Monograph Development Work for the International Pharmacopoeia

In addition, WHO also invited our Pharmaceutical Laboratory to support and develop a nitrosamine test monograph (1- nitroso-4-methyl piperazine (MeNP) in Rifampicin products) for inclusion into the International Pharmacopoeia.

- Participation in other WHO Events:

Event

- WHO consultation meet on quality control laboratory tools and specifications for medicines
- Follow-up consultation meet on screening technologies, laboratory tools and pharmacopoeial specifications for medicines

TOBACCO TESTING-RELATED ACTIVITIES

WHO Collaborating Centre for Tobacco Testing and Research

In view of Singapore's contribution and achievements to the field of tobacco regulation, WHO formally invited Cigarette Testing Laboratory's Laboratory Director in September 2021 to chair TobLabNet for a further two years. The role of chair involves providing strategic and operational direction to advance tobacco product regulations.

Speaking at a Virtual Workshop Organised by Australia's McCabe Centre for Law and Cancer

Representing WHO TobLabNet, we were invited to speak on the science and regulation challenges of emerging tobacco products.

PARTICIPATION IN PHARMACEUTICAL AND COSMETICS-RELATED INTERNATIONAL EVENTS

European Directorate for the Quality of Medicines and Health Care (EDQM)

- 26th Annual Meeting of the European Network of Official Medicines Control Laboratories (OMCLs)
- 9th joint session of the European Network of Official Cosmetics Control Laboratories (CD-P-COS) and the European Network of Official Cosmetics Control Laboratories (OCCLs)

ASEAN Meetings

- 2nd ASEAN Pharmaceutical Testing Laboratory Committee (APTLC) Meeting
- Workshop on ASEAN Australia New Zealand Free Trade Agreement (AANZFTA), on cooperation in international standards engagement in cosmetics
- Western Pacific Regional Forum for the Harmonization of Herbal Medicines (FHH)
- 8th FHH International Symposium

ASEAN Laboratory Studies

- Established ASEAN Reference Substance (PARS), Chlorpropamide with five other countries, namely Brunei, Indonesia, Laos, Malaysia and Myanmar through an inter-laboratory collaborative study
- Joined an inter-laboratory study of Lumefantrine PARS, led by Indonesia
- Provided support on the methodology on the identification and determination of 1,4-Dioxane in cosmetic products by headspace GC-MS with ASEAN Cosmetic Scientific Body (ACSB) members for reference purposes



We received the following awards in recognition of our scientific contributions to the community.

AWARDS AND ACHIEVEMENTS

MNDA TEAM AWARD

The HSA team received the Minister for Home Affairs National Day Awards (MNDA) Team Award in recognition of our contribution to Singapore's campaign against Cannabis Rescheduling at the United Nations Commission on Narcotic Drugs (CND).

We were part of an inter-agency committee, which also comprised representatives from the Ministry of Home Affairs (MHA), Central Narcotics Bureau, Attorney-General's Chambers, Ministry of Foreign Affairs and Ministry of Health. We provided technical advice to the committee and was part of the delegation representing Singapore at the CND meetings.

MHA OPS EXCELLENCE AWARD

We were awarded the MHA Ops Excellence Award in 2021 for our role in analysing mulch samples to reduce vegetation fires.

In 2019, the Singapore Civil Defence Force (SCDF) spearheaded a multi-agency study involving the Home Team Science and Technology Agency, National Parks, National Environment Agency and HSA. The purpose of this study was to investigate the cause and come up with solutions to reduce vegetation fires along expressway road dividers.

We analysed mulch samples submitted by SCDF to determine the volatile organic compounds emitted and the particle size of the samples.



ISO/IEC 17025:2017 ASSESSMENT

We achieved full compliance to ISO/IEC 17025:2017 at the Singapore Laboratory Accreditation Scheme (SAC-SINGLAS) annual assessment.

Pharmaceutical Laboratory (PL)

PL's scope of accreditation has now been expanded to include two new tests:

1. Determination of Sennosides in health products by HPLC-DAD
2. Determination of Cannabinoids in health products by LC-MS/MS

Cigarette Testing Laboratory (CTL)

CTL expanded its scope of accreditation to include the Determination of Nicotine Content in Smokeless Tobacco Products - WHO TobLabNet Official Method SOP12.

Cosmetics Laboratory (CL)

CL's scope of accreditation has now been expanded to include two new tests:

1. Screening and Determination of Parabens in Cosmetic Products by HPLC-DAD
2. Screening of Hair Dyes (2,2-[(2-Nitro-1,4-phenylene) diimino]bis[ethanol] and "2,6-Bis[(2-hydroxyethyl) amino]toluene") by HPLC-DAD