

Impact case study (REF3)

Institution: University of Lincoln		
Unit of Assessment: 8 – Chemistry		
Title of case study: Supporting the Correct Identification of New Psychoactive Substances		
Period when the underpinning research was undertaken: 2011 - 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
BARON Mark	Associate Professor	1 Sep 00 to date
ELIE Mathieu	Senior Lecturer	14 Jan 02 to date
GONZALEZ-RODRIGUEZ Jose	Associate Professor	2 May 06 to date
ELIE Leonie	Senior Technician	28 Jan 08 – 4 Dec 20
Period when the claimed impact occurred: 2014 - 2020		
Is this case study continued from a case study submitted in 2014? N		
<p>1. Summary of the impact (indicative maximum 100 words) New Psychoactive Substances (NPS) became a major challenge for law enforcement agencies in the 2000s. However, a lack of legislation, poor identification of NPS, and capacity issues inhibiting timely processing of cases caused significant problems for prosecution. Researchers at UoL have pioneered analysis in NPS, identifying the chemical composition of legal highs and developing improved techniques for rapid chemical analysis of NPS. Through collaboration with police, trading standards, local authorities, and expert contributions to key court cases, since August 2013 this research has enabled regional agencies to close multiple headshops (shops selling NPS), triggering associated reductions in antisocial behaviour; highlighted a gap in legislative provision and supported judicial discussions leading to the 2016 UK Psychoactive Substance Act; and newly enabled federal police in Brazil to correctly identify NPS in thousands of submitted samples.</p>		
<p>2. Underpinning research (indicative maximum 500 words) New Psychoactive Substances (NPS) (also known as 'legal highs') emerged in the late 2000s and became a major challenge for law enforcement agencies in the UK and globally. Despite NPS being associated with increase in hospitalisations, adverse health effects, criminality and social issues as well as appealing to school children, vulnerable young adults and prisoners, there was no appropriate legislation to enable prosecution, nor to prioritise testing in forensic labs that were already pushed to capacity. This was compounded by difficulties in correctly identifying NPS, as many substances have closely related structural analogues and so lengthy validation procedures are required to guard against incorrect identification. Whilst the analysis of NPS is routine, these combined issues prevented police and key agencies from prosecuting or ceasing the trade of these dangerous substances.</p> <p>Researchers in the analytical chemistry team at the University of Lincoln recognized the opportunity to help address the problems around NPS, leading to a programme of research to explore the chemical composition of NPS and improve methods for testing. In 2011, the team conducted the first chemical analysis of NPS available for purchase online [3.1]. Using a combination of infra-red spectroscopy and standard gas chromatography-mass spectrometry (GC-MS), the team demonstrated that NPS products contained controlled substances, that contents often differed from those stated on the packaging, and that products with the same name could have different contents. These findings showed that illegal substances were being sold as legal, as well as users being exposed to products containing NPS not expected to be present in these products. The research also demonstrated that 'legal' active ingredients in NPS were chemically similar to well-known psychoactive drugs and so had the potential to do harm. Such was the surprise and significance of these initial findings, the publisher, Wiley, selected the</p>		

article for a global press release to maximise dissemination of this new evidence, ultimately coming to the attention of Lincolnshire Police.

At this time Lincolnshire Police were dealing with a worsening situation around NPS, with the strength of marketing of NPS products growing considerably, with branded names, stylish artwork and more eye-catching packaging. This rapidly changing and accelerating landscape provided an impetus for the team to extend analysis of NPS and explore approaches to resolve analytical challenges for the routine analytical laboratory. The UoL team conducted further research on samples from both the internet and *head shop* purchased 'legal high' products [3.2] pioneering the development of a fast GC-MS analytical method to resolve the problems associated with slow testing and lab capacity. The technique was able to deal with a larger number of samples in a shorter period of time: 23 NPS related substances could be identified within a 4-minute runtime which was approximately three times faster than the previous method. In accordance with the 2011 research, analysis confirmed legal high products do not always contain their stated ingredients; of the group of products purchased as 5-IAI, none contained 5-IAI, and several contained mixtures of substances either already controlled in the UK or under consideration by the Advisory Council on Misuse of Drugs (ACMD).

Lincoln's reputation in forensic science and the team's work on correct identification of NPS, led to a collaboration with the Instituto de Criminalística, Brasilia; provider of forensic science services to the Brasilia Police Force. The Institute had identified an analytical problem in their casework, in which the existing methods had led to the incorrect identification of a specific type of NPS, the N-benzylphenethylamines (NBOHs), which mimic the effect of hallucinogenic drugs such as LSD. To address this, a research collaboration was established between Lincoln and the Institute, to determine the cause of this error and develop an analytical resolution. Dr Ana Andrade, one of the institutes senior forensic drug analysts was seconded for 3 years (2015-2018) to work with the NPS group at Lincoln. This collaborative research [3.3] identified that the standard GC-MS method was transforming the chemical structure of NBOHs into the molecular structure of another NPS drug group. The latter group consisted of both proscribed and legal NPS – as did the NBOHs – and so there was uncertainty about which illegal NPS were being converted to legal substances and vice versa. Investigation further identified the cause of the problem as thermal degradation, and developed an inexpensive solution based on improved methods for data interpretation, by introducing a slight adjustment in the standard GC-MS method including shortening of the solvent delay window, allowing for correct identification without the need for derivatization or other analytical processes [3.4].

3. References to the research (indicative maximum of six references)

- 3.1 Baron M.G., Elie M.P., Elie L.E. (2011) An Analysis of Legal Highs-do they contain what it says on the tin? *Drug Testing and Analysis*, 3 (9) 576-581.
<http://dx.doi.org/10.1002/dta.1434>
<https://onlinelibrary.wiley.com/doi/epdf/10.1002/dta.1434>
- 3.2 Ellie M. P., Elie L. E., Baron M. G. (2013) Keeping pace with NPS releases: fast GC-MS screening of legal high products, *Drug Testing and Analysis*, 5 (5) 281-290.
<http://dx.doi.org/10.1002/dta.1434>
- 3.3 Neto J.C., Andrade A.F.B., Lordeiro R.A., Machado Y., Elie, M., Junior E.F., Arantes L.C. (2017) Preventing misidentification of 25I-NBOH as 2C-I on routine GC-MS analyses, *Forensic Toxicology* 35 (2) 415-420.
<https://doi.org/10.1007/s11419-017-0362-0>
<http://eprints.lincoln.ac.uk/26957/7/25i-nboh%20aceito.pdf>
- 3.4 Andrade A.F.B., Elie M., Zacca J.J., Souza M.P., Caldas L.N.B., Gonzalez-Rodriguez, J (2020) Challenges in the Identification of Thermolabile New Psychoactive Substances: the 25I-NBOH case, *Forensic Science International* 312 110306.
<https://doi.org/10.1016/j.forsciint.2020.110306>

4. Details of the impact (indicative maximum 750 words)

Analytic uncertainty offers a loophole to defence lawyers to challenge an analytical identification as not definitive, a significant issue if controlled NPS cannot be distinguished from uncontrolled NPS with certainty and leaving a case open to scrutiny by defence councils. University of Lincoln research has provided the appropriate analytical techniques to reduce analytical uncertainty in the correct identification of powder and herbal NPS. Working closely with Lincolnshire Police and Lincolnshire Trading Standards, and establishing a dedicated NPS casework laboratory, this research has contributed directly to local, regional, national and international impacts:

a. **Closure of Headshops and reduced anti-social behaviour (regional impact).**

Pre-August 2013 context: In April 2013, the research team at the University of Lincoln were approached by Lincolnshire Police working with Lincolnshire County Council Trading Standards to analyse samples of an NPS product, 'Sparkle', seized from the Lincoln head shop, Head Candy [**Evidence 5.1**]. At the time they were concerned with finding controlled substances in NPS as a route to prosecution. Our analysis demonstrated that the samples contained the NPS MDAI, but as this was legal at the time Head Candy could continue operating despite the known risks to health and wellbeing. To address this legislative void, Lincolnshire County Strategic Partners established the New Emerging Drugs Steering Group (NEDS) to improve understanding of NPS through analysis of the NED market, and to develop a response protocol to maximise forensic and intelligence data capture. Members of the UoL research team were invited to join NEDS to contribute their established analytic expertise.

- *Impact since August 2013:* During the period 2014-2016, tackling the sale of NPS in the UK became the responsibility of local authorities, largely under consumer protection legislation as there was no direct legislation prohibiting the sale of NPS. Lincolnshire Trading Standards approached the Lincoln researchers to analyse and identify a total of 95 multi-sample products seized from three headshops: Marley's, Lincoln (2014), Katmandu, Boston (2014) and 27B High Street, Boston (2015). The outcomes of the Headshop sample analysis were used as the **basis for an expert witness statement** by Robert Forrest (Senior Coroner, South Lincolnshire) in which he evaluated the harmfulness of the substances identified by Lincoln analysts in the samples (**Evidence 5.2**). Lincolnshire Trading Standards described UoL's contribution as *'crucial in building and pursuing cases'* against these three headshops, *'essential in demonstrating, with confidence, that the products contained NPS... As a result, the strength of the evidence was sufficient for all three headshops to cease trading in NPS products before the cases proceeded to trial.'* (**Evidence 5.3**). A subsequent benefit of these closures was a **reduction in antisocial behaviour** within the areas where the headshops had been operating, leading to the City of Lincoln being the **first city to impose a Public Space Protection Order** on the use of NPS [**Evidence 5.1**].

As a result of their growing reputation as experts in the field, UoL were further approached by Norfolk Trading Standards to analyse samples seized from two headshops within the Norfolk jurisdiction. During 2015, the team analysed 11 multi-packet products, providing evidence which enabled Norfolk Trading Standards *'to build a case against both shops using safety legislation that requires information to be provided on the ingredients of products and any consequences of use.'* As in the Lincolnshire cases, this resulted in both **shops ceasing trading in NPS products** [**Evidence 5.4**].

b. **Highlighting the need for appropriate NPS legislation in the UK (national impact).**

Pre-August 2013 context: In 2013, Chester West and Chester County Council (CWACC) prosecuted a headshop owner, calling Dr Baron as an expert scientific witness in a case that was the first of its kind to be pursued in the UK. At this time,

legal NPS were not covered by the Misuse of Drugs Act 1971 and so criminal conviction for supply and use was not available. The findings of the University of Lincoln research highlighted the need for the development of appropriate legislation, by alerting law enforcement agencies to the possibility of pursuing convictions of NPS suppliers for either supplying controlled substances or incorrectly labelled products. Whilst the case did not lead to a successful prosecution (on a technicality) it highlighted the challenges arising from a lack of appropriate legislation, leading to the judge calling on Parliament to introduce greater controls.

- *Impact since August 2013:* As a direct result of this case, CWACC representatives met with Home Office solicitors and proposed the introduction of new legislation to tackle issues identified in the case. The **new subsequent Psychoactive Substances Act**, which came into force in 2016, draws on these recommendations and has made the supply of NPS a criminal offence. Andrew Rees, Team Leader Consumer Protection & Investigations, CWACC stated that Lincoln's research '*was essential... to accurately identify the active ingredient in each NPS product as the case was built upon the products containing harmful substances and that the product labelling was insufficient to protect consumer*' and '*Despite the failure of the prosecution I still consider this to be one of the most significant pieces of work we have undertaken. I have no doubt that our joint efforts led to the introduction of the new legislation.*' [Evidence 5.5].

c. **Providing evidence to strengthen and accelerate legal investigations in Brazil (international impact)**

The improved methods developed with the Instituto de Criminalistica Brasilia have been used by the Federal District Civil Police (Brazil) forensic laboratories to analyse the family of NPS known as NBOHs. The previous, time consuming and inadequate methods of analysis had led to a backlog of cases awaiting identification, with turnaround time too slow to realistically inform prosecutions. However, as a result of the research, labs have become able to rapidly analyse samples, at low cost, able to identify degradation products (which they would not have looked for previously) and with far more accurate results. This has enabled the drug laboratory to significantly **increase the throughput of thousands of correctly identified NPS samples** and **enabling police to pursue prosecutions** more promptly (Evidence 5.6).

5. Sources to corroborate the impact (indicative maximum of 10 references)

- 5.1 Testimonial from Lincolnshire Police.
- 5.2 Coroner's Witness statement.
- 5.3 Testimonial from Lincolnshire County Council Trading Standards.
- 5.4 Testimonial from Norfolk County Council Trading Standards.
- 5.5 Testimonial from CWACC Trading Standards.
- 5.6 Testimonials from Instituto de Criminalistica, Brasilia (2018 and 2020).