LABORATORY INVESTIGATION
OF SUSPECTED POISONING
– POISONS, PILLS & POTIONS

Dr Robin Braithwaite
Director
Regional Laboratory for Toxicology
City Hospital, Birmingham
(www.toxlab.co.uk)
WHAT IS A POISON?

“All substances are poisons; there is none which is not a poison; the right dose differentiates a poison from a useful medicine”.

Paracelsus (1493-1541)
THE WORLD OF CHEMICALS

>17 million organic and inorganic chemicals

>1.3 million commercially available

~225,000 regulated/inventoried
TYPES OF COMPOUNDS INVOLVED IN POISONING

- Pharmaceuticals – human and veterinary
- Illicit drugs and other substances
- Beverages and food supplements
- Household products
- Agro chemicals
- Industrial chemicals
- Plants and herbal remedies
DEATHS WHERE FORENSIC INVESTIGATIONS REQUIRED

- Suspected suicide
- Sudden unexpected deaths
- ‘Cot’ deaths
- Drowning, hanging, suffocation
- Transportation deaths
- Drug and substance abuse
- Deaths in custody
- Non-Accidental poisoning
ASPECTS OF FORENSIC INVESTIGATION OF DEATH DUE TO SUSPECTED POISONING - I

• Recent medical and social history of deceased
• Signs and symptoms of poisoning prior to death
• Circumstances of the reported death and details of death scene
• Identity and quantity of all drugs and poisons available to deceased, or associated with death
• Collection of any ante-mortem specimens
ASPECTS OF FORENSIC INVESTIGATION OF DEATH DUE TO SUSPECTED POISONING - II

- Time between death and post-mortem
- Pathologist’s observation and findings at post-mortem
- Collection of appropriate specimens at post-mortem
- Stability and storage of specimens
- Scope of analytical investigations
POST-MORTEM TOXICOLOGY – SOME DIFFICULT PROBLEMS

- Lack of history of deceased
- Death scene uncertain
- Body putrefied or decomposed
- Body embalmed
- Burial/cremation
POST-MORTEM SPECIMEN COLLECTION IN THE INVESTIGATION OF SUSPECTED POISONING

- Blood (specific sites)
- Urine
- Vitreous fluid (eye)
- Stomach contents
- Tissues (e.g. liver, brain, muscle)
- Hair, nails
WIDELY USED ANALYTICAL TECHNIQUES IN CLINICAL & FORENSIC TOXICOLOGY

- Immunoassay (particularly drugs)
- Gas Chromatography – Head Space (FID) analysis (alcohols, volatiles)
- Gas Chromatography – NPD, – MS
- Liquid Chromatography – UV DAD, - MS
- Inductively Coupled Plasma - MS
IMPORTANT ASPECTS OF ANALYTICAL TOXICOLOGY

- Use of more than one technique
- Access to reference library of drug standards and metabolites
- Understand metabolic pathway of drug or poison
- Compare results in biological fluids with source of drug or poison
- Be prepared to think “outside the box”
Gramoxone 100

Contains 276 g paraquat dichloride (200 g paraquat) per litre.

A contact herbicide for use only by professional farmers and growers

For use only as an agricultural and horticultural herbicide not to be used in private gardens

Paraquat can kill if swallowed. Do not put in a food or drinks container. Keep out of reach of children.

1 litre

Toxic

Tank mixing formula
FATAL VOLATILE SUBSTANCE ABUSE

• Sudden death in 22 year old male. Found dead in doorway of flat by friend. History of volatile substance abuse (butane). A cylinder of Ronson Multi-Fill butane gas was found near to body
• Careful collection of specimens (blood, lung and brain) at post-mortem
• Analysis of specimens by enzymic digestion followed by head-space gas chromatography with FID/EC/MS detection
• Match components in specimens with profile of product-butane, isobutane and propane
• Potassium cyanide poisoning in a 34 year old electroplater
• Access to cyanide in the workplace
• Deceased entered workplace after hours
• The deceased was found dead in a chair in the factory office
• Suicide note next to body
### CYANIDE POISONING II

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Collection &amp; Type</th>
<th>CN⁻ (mg/L)</th>
<th>Ethanol (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>(Leg)</td>
<td>7.6</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>(Arm)</td>
<td>65.0</td>
<td>136</td>
</tr>
</tbody>
</table>
FATAL COPROXAMOL POISONING

• Coproxamol:
  \[
  \begin{align*}
  \text{Paracetamol} & \quad 325 \text{ mg} \\
  \text{Dextropropoxyphene} & \quad 32.5 \text{ mg}
  \end{align*}
  \]

• Rapid death, particularly when combined with alcohol

• Death due to direct effect of dextropropoxyphene

• Very few deaths due to paracetamol induced liver damage (delayed death)
A SUSPECTED CO-PROXAMOL OVERDOSE IN AN 81 YEAR OLD FEMALE

<table>
<thead>
<tr>
<th>Specimen Collection and Type</th>
<th>Paracetamol mg/L</th>
<th>Dextro mg/L</th>
<th>Nordextro mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood (Rt Leg)</td>
<td>119</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Blood (Lft Leg)</td>
<td>106</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Blood (Rt Arm)</td>
<td>171</td>
<td>7.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Blood (Lft Arm)</td>
<td>424</td>
<td>31.5</td>
<td>1.9</td>
</tr>
</tbody>
</table>
Post-Mortem Redistribution of Drugs and Poisons

Tissue Blood

Death

Tissue Blood
ESTIMATION OF SIZE OF OVERDOSE

- It is very dangerous to try and estimate the ingested dose using the post-mortem blood concentration (C) and the drug’s apparent volume of distribution (Vd)

- Dose ≠ Vd x C

- Use of this approach almost always overestimates the size of the “overdose”
The dealers don’t know what they’re selling and the customers don’t know what they’re buying!

It’s good ‘E’?

It’s good ‘E’.

There’s a lot of snidey ‘E’ about tonight Pete.

One of these has got to be an ‘E’.

The only thing these tablets have in common, is that I paid £15 for each of them!
‘Her granny called her the Golden Girl, the lovely Lorna. But as she was dying after taking two ecstasy tablets she looked like a monster’
WHY DO PEOPLE DIE?

- Dehydration, hyperthermia and their sequelae (heat stroke)
- Hypertension and stroke
- Heart rhythm disturbance
- Hyponatraemia, cerebral oedema (excess water intake; ↑ ADH)
- Liver failure
Afghan farmers reap lethal crop

To take on heroin producers is to meddle with big business, writes Robert Fisk

Jalalabad — You can see them in the Jalalabad bazaar, young men with withered black arms and sunken eyes, the addicts returned from the Afghan refugee camps in Pakistan, still-living witnesses to the effects of heroin. “It’s good for the Afghans, people here to see them,” a Western aid official says coldly. “Now they can see the effect of all those poppy fields they grow — and if they’re as Islamic as they claim they are, maybe they’ll stop producing opium.” The official smiles gravely, then adds: “Or maybe not.”

Probably not. Afghanistan’s eastern Nangarhar province is now responsible for 80 per cent of the country’s poppy cultivation — it was producing around 1,380 tonnes of dry opium in 1995 — and heroin-processing laboratories have now been transferred from Pakistan to a frontier step inside Afghanistan, producing hundreds of kilos of heroin a day and fortified with enough anti-aircraft guns and
OPIUM (PAPAVER SOMNIFERUM)
Important Alkaloids

- Morphine
- Codeine

Main active constituents

- Thebaine
- Noscapine
- Papaverine

Important minor constituents
STRUCTURE OF MORPHINE AND RELATED OPIATES

Heroin (diamorphine)

Morphine

Dihydrocodeine

Codeine
The Heroin Epidemics
Leon Gibson Hunt and Carl D. Chambers
Two Birmingham men have died within 24 hours of each other after overdosing on an infected batch of heroin.

The drugs may be linked to the deaths of almost 40 drugs users across the country including three from Wolverhampton.

Police have issued a renewed warning to drug users in the region after the latest deaths of the two men in separate incidents.

An 18-year-old man was found dead at a flat in Granville Square off Broad Street in the city centre on Tuesday night at around 9pm. Another man, aged 39, who was found with him is critically ill in the poisons unit at City Hospital.

By Anne Alexander

A passerby found the body of a man in his 20s near a derelict building in Summer Hill Road, also in the city centre.

There have been several deaths recently in the city and Wolverhampton from drug users overdosing on poor quality heroin.

They include Derek John Anderson, aged 45, who was found dead in a flat in Drummond Street, Wolverhampton, in June.

Police in the West Midlands said they had information that infected heroin was available in the region.

Det. Ch Insp Gordon Fraser said: “We would urge anyone with any knowledge of the source of this heroin to contact us in confidence.”

A post mortem has been carried out on the 18-year-old and toxicology results are awaited.

A post mortem was due to take place on
IMPORTANT FACTORS IN HEROIN RELATED DEATHS

- The dose and route of administration
- Use of other drugs and alcohol
- Tolerance to opioid drugs
- Death scene
- Post-mortem findings
Heroin → rapid deacetylation → 6-monoacetylmorphine (6-MAM) → rapid deacetylation → Morphine (M) → glucuronide conjugation → Morphine-3-glucuronide (M-3-G) and Morphine-6-glucuronide (M-6-G).
INVESTIGATION OF POST-MORTEM SPECIMENS – HEROIN RELATED DEATHS (Blood, Urine)

• 6-MAM, Morphine, Codeine
• ‘Free’ and ‘Conjugated’ drug concentrations of morphine
• Other opioids present e.g. Methadone
• Papaverine, “cutting” agents/adulterants
• Alcohol, other depressants?
• Hair (Chronic drug use)?
A daughter’s descent into heroin hell
The grieving family of a young addict are allowing pictures of her ravaged body to be used in an anti-drugs video, reports Richard Savill.
Britain’s worst serial killer

Doctor ‘enjoyed power of life and death’

A 61-year-old doctor has been found guilty of nine murders after a trial lasting nine months.

The jury in the case of Dr. Peter Tobin heard evidence from 30 witnesses and saw thousands of documents.

The prosecution said the doctor had used his status as a GP to prey on vulnerable women and children.

The trial, which took place at the High Court in Edinburgh, was described as one of the most significant in recent years.

The defense argued that the doctor had been wrongly accused and that there was insufficient evidence to prove his guilt.

The verdict will be handed down in the coming weeks.

The 15 known victims, police fear 85 more

The 15 known victims of Dr. Peter Tobin's crimes include women aged between 56 and 86.

Marie War, 61, who was murdered on March 22, 1994.

Jeanette Brown, 67, who was murdered on May 14, 1994.

Maureen Miller, 56, who was murdered on November 17, 1994.

Patricia Edwards, 76, who was murdered on December 22, 1994.

Donna Marlow, 50, who was murdered on March 1, 1995.

Maria Sánchez, 50, who was murdered on April 28, 1995.

Judith Williams, 58, who was murdered on May 30, 1995.

Joanne Martin, 57, who was murdered on June 20, 1995.

Robin Knights, 64, who was murdered on July 30, 1995.

Dorothy Miller, 55, who was murdered on September 9, 1995.

Rosemary Anderson, 63, who was murdered on November 12, 1995.

Paula Martin, 58, who was murdered on December 19, 1995.

The police are appealing for anyone with information about the doctor's crimes to come forward.

They believe there may be more than 85 victims in total.

The doctor has been convicted of 19 counts of murder and one of attempted murder.

He will be sentenced later this month.
INVESTIGATION OF DEATH OF DR SHIPMAN’S PATIENTS - I

- 9 cases identified from history
- 6 of 9 embalmed
- Interment 1-28 months
- No cause of death found at autopsy
- No blood or liver specimens available
- Muscle tissue taken at Autopsy
INVESTIGATION OF DEATH OF DR SHIPMAN’S PATIENTS - II

- High concentration of morphine in muscle from 9 bodies
- High proportion of ‘free’ morphine
- Results indicate recent large dose of morphine or diamorphine
- Shipman found guilty of all 15 deaths
The bearded Harold Shipman made copious notes during the prosecution’s long introduction, as seen by the court artist Priscilla Coleman.
FORENSIC TOXICOLOGY THE FUTURE

- Increased application of LC-MS techniques
- Better understanding of metabolic pathways of drugs – pharmacokinetics
- Better understanding of mechanisms of action/toxicity – pharmacodynamics
- Role of genetic factors in metabolism and toxicity of drugs - genomics
- Ability to do research on post-mortem specimens – Human Tissue Authority
Chemistry may detect a poison; but it fails, without the aid of physiology and pathology, to show whether it was or was not the cause of death; and in some instances, it cannot enable us to determine whether the poison was introduced into the body during life or after death…

Alfred Swaine Taylor MD FRS (1806-1880) Forensic Toxicologist, Guy’s Hospital London