Technical Report 79

Heroin purity and composition: an analysis of street-level samples in Cabramatta, NSW.

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

Recent Australian research has documented the emergence of smoking as a relatively common route of heroin administration in south-west Sydney. However, transitions to injecting are also common, often occurring within the space of a few months. This contrasts with the situation in parts of Europe and the UK, where heroin smoking has been a stable pattern of use among some heroin users since the late 1980s.

The bioavailability of heroin is determined by a number of factors, including form/composition, route of administration, the presence of adulterants and impurities, and chasing/injecting techniques. If, as existing data suggest, the heroin sold in Cabramatta (and by extension the rest of Sydney) is predominantly heroin hydrochloride (salt) rather than base, it may not be pharmacologically suitable for chasing. This study therefore aimed to provide baseline data on the pharmacological properties of heroin available for sale in Cabramatta during the six-month period from October 1996 to March 31, 1997.

A retrospective sampling frame was generated comprising all police seizures ("exhibits") suspected of containing heroin logged in the exhibit books at Cabramatta Police Station in the six months October 1, 1996 to March 31, 1997 (n=487). A total of 33 street-level "exhibits", comprising 88 samples (e.g., multiple balloons and foils), were obtained from the NSW Police Service for these analyses.

All of the 88 samples analysed contained heroin as the hydrochloride salt. No heroin free base was encountered. The mean purity of the 88 heroin samples was 66.2 %. Fifteen percent of exhibits and samples were of very high purity (91-100 %), while none were less than 20 % pure. While the purity of these samples was significantly higher (at sample level) than the purity of the Cabramatta heroin analysed earlier by Weatherburn and Lind (1997), there was no linear trend in purity across the study period.

These analyses indicate that street-level heroin in Cabramatta was relatively free of harmful adulterants. Those detected were pharmacologically inactive diluents largely used to add bulk (sugars), or pharmacologically active adulterants used to improve the bioavailability of heroin HCL when smoked (caffeine). The reasons for the addition of paracetamol require clarification.

This study did not find evidence to support one pre-requisite for the development of a heroin smoking culture - the availability of heroin in a form that could be easily and efficiently smoked. No heroin free base was encountered. The adulterants and diluents present in these samples were similar to those commonly found in the UK and Europe, and to a lesser extent, the US. Given the ability of caffeine to increase the recovery rate of smoked heroin hydrochloride, its addition in one third of these samples may be an attempt to increase its volatility and hence facilitate heroin smoking. The reason for the addition of paracetamol requires clarification, as its impact on volatility is uncertain.

The street-level samples analysed for this study had an average purity of 66%, with 85% having an average purity of at least 50% heroin hydrochloride salts. This is in the range reported for small NSW seizures (<2g) by the Australian Federal Police in 1997-1998 (64% to 71%). These findings have several implications for the risk of fatal overdose.

These results also suggest that while there may be a demand for harm-reduction interventions designed to facilitate transitions from heroin injecting to smoking, careful consideration of the pharmacological factors associated with route of administration is required.

1 INTRODUCTION

1.1 Heroin use in Australia

The development of a heroin-using culture in Australia began in the early part of this century, where it was commonly included in patent medicines, and regularly used for "therapeutic reasons". A major illicit market developed in the decade following its prohibition (1954), and there was an increase in heroin use in the general Australian population in the late 1960s and early 1970s. In Australia, injection has historically been considered the dominant route of administration. Prior to the 1990s, there have been only isolated reports of heroin smoking or sniffing (see Swift et al, 1997).

Recent Australian research has documented the emergence of smoking as a relatively common route of heroin administration in south-west Sydney, particularly among Indochinese users (e.g., Hando et al, 1998; Maher et al, 1998; Maher and Swift, 1997; McKetin et al, 1999; Swift et al, 1999). However, transitions to injecting are also common, often occurring within the space of a few months. These transitions may be particularly rapid among "new injectors" (defined here as those who have been using intravenously for two or less years). Recent research designed to characterise initiation to injecting drug use and transitions from smoking to injecting among 184 young Indo-Chinese people aged 15 to 24 found that two-thirds (64 %) reported making a transition to injecting drugs that they had previously only used by non-injecting routes. The study, conducted in Sydney and Melbourne, found that most transitions involved heroin (72 %), with eight people reporting transitions to injecting involving Normison (7%), and eight reporting transitions involving cocaine (3%). The average age of initiation to injecting was 17 years (Maher et al, 1999).

Reasons provided for such transitions are the perceived superior effect of injecting (a better "rush"), and the beliefs that injecting is more cost-effective and smoking is a "waste" (Maher and Swift, 1997; Swift et al, 1999; see also Atillasoy et al, 1996; Perez-Jiminez and Robert, 1997). One third (32 %) of the sample interviewed by Maher et al. (1999) claimed that the main reason they had switched routes was because they believed the drug would be stronger and more cost-efficient (cheaper) if they injected it. Transitions from injecting to smoking appear to be relatively rare in Australia (Maher et al, 1998; Swift et al, 1999; but see Maher et al, 1999). This contrasts with the situation in parts of Europe and the UK, where heroin smoking has been a stable pattern of use

among some heroin users since the late 1980s (e.g. de la Fuente et al, 1996; Gossop, 1995; Grund and Blanken, 1993; Perez-Jiminez and Robert, 1997; Strang et al, 1997a).

The research presented in this report arose as an attempt to better understand these differences in patterns of heroin use: that is, why do most of the heroin smokers in Sydney make such rapid transitions to injecting, compared to their overseas counterparts? A plausible hypothesis is that route of administration has been affected by the characteristics of the heroin available in Sydney compared to the UK and Europe. This Introduction will briefly outline the literature on this issue.

1.2 Bioavailability

Street market heroin is available in two forms: as a heroin salt, such as the hydrochloride, which is freely soluble in water, or as heroin free base which is insoluble in water. Heroin which is injected or snorted is, in fact, heroin hydrochloride (HCl) (or some other salt). Smoking heroin is usually the free base, which is appreciably more volatile than the salts (i.e., vaporises more easily).

The conversion of morphine to heroin (diacetylmorphine) is a simple chemical process. However, illicit heroin usually contains acetylcodeine as well as O-6-monoacetylmorphine and small amounts of other opium alkaloids. Acetylcodeine arises from the acetylation of the codeine contained in crude morphine, and O-6-monoacetylmorphine is a degradation product of heroin.

The bioavailability of heroin (i.e., the percentage of heroin that is actually absorbed) is determined by a number of factors, including form/composition, route of administration, the presence of adulterants and impurities, and chasing/injecting techniques.

1.2.1 Form/Composition and route of administration

Since the late 1970s heroin from south-west Asia has become increasingly available in "base" form, often mixed with barbiturates and caffeine, in Europe and the UK (see Strang et al, 1997a; 1997b). In south-west Asia, heroin is most often sold as the free base, while it is typically converted to the hydrochloride salt elsewhere (United Nations International Drug Control Programme, 1998). Heroin in Cabramatta, Australia's largest open-air drug market located in the south-western suburbs of Sydney, primarily derives

from south-east Asia, and is typically comprised of a type known as "Chinese No. 4" (Australian Bureau of Criminal Intelligence, 1999). South-east Asian heroin is usually white, with uncut samples having the appearance and consistency of laundry powder. However, the product is increasingly being produced in finer and denser form and is often retailed in small rock-like units or chunks. The purity of uncut south-east Asian hydrochloride salt is typically 80 % or higher, is readily dissolved and injected, and only rarely contains the alkaloid impurities noscapine or papaverine. South-east Asian heroin base is reported as being less pure, with a higher probability of containing codeine and noscapine (Australian Bureau of Criminal Intelligence, 1999; United Nations International Drug Control Programme, 1998).

During the study period, heroin in Cabramatta was typically sold in pre-packaged "caps", whereby the drug is wrapped in a small piece of foil and sealed in small plastic balloons. "Half-weights" ("Asian halves" for Asian customers were typically 0.5 grams, and "junkie halves" for other customers weighed between 0.3 and 0.4 grams) were the next most common unit of retail sale. In 1995 and 1996, caps sold for an average of $30 and half-weights cost an average of $180 (Maher et al, 1998). Prices appear to have decreased considerably since this time (McKetin et al, 1999).

Heroin "chasing" or "chasing the dragon" involves heating the heroin on aluminium foil until it vaporises rather than burns. The fumes are then inhaled. As heroin hydrochloride (HCl) is highly water soluble and has a higher melting point than heroin base, it decomposes to a certain extent upon heating. This reduces the bioavailability of heroin, and renders it less useful for inhalation than heroin base. Heroin base is quite insoluble in water, but vaporises readily without decomposition, at lower temperatures than heroin HCl (Strang et al, 1997a). Under laboratory conditions, approximately 60 % of the heated heroin base is recovered, which is about three to four times as much as the hydrochloride form (Grund and Blanken, 1993).

In an early study, Mo and Way (1966) compared urinary excretion of morphine over 72 hours after chasing and injecting heroin HCl. The mean percentage recovery of morphine in the urine of injectors was 68 %, compared to only 26% for chasers. They concluded that smoking was only about 40 % as effective as injecting. A later Dutch study (Huizer, 1987) reported a recovery rate of only 17 % when heroin HCl was

smoked, compared to 62 % of heroin base – i.e., only 17 % of the heroin present in the original sample was recovered. However, Huizer found that adding caffeine considerably increased the recovery rate to 51 %. More recently, in the United States, Jenkins and colleagues (Jenkins et al, 1994) used a computer-assisted smoking device to deliver single "puffs" of heroin vapour to human subjects under controlled clinical conditions. In that study, only 28 % of the heroin HCl dose was delivered intact when vaporised at 200 °C. By contrast, 89 % of the heroin base vaporised without decomposition. This study confirms beyond doubt that heroin form or composition has a significant impact on bioavailability. Similar findings on bioavailability have been observed in relation to opium smoking, with some experts suggesting that only about 20 % of the active constituents of opium are actually absorbed when it is smoked (Kalant, 1997).

1.2.2 Presence and type of processing impurities and/or adulterants/diluents

The percentage of heroin that is vaporised also depends on the presence and type of impurities (e.g., the alkaloid impurities noscapine and papaverine) (Huizer, 1987) and added compounds (e.g., pharmacologically inactive diluents (cutting agents) such as sugars, or pharmacologically active adulterants such as caffeine). These may vary according to region of production (United Nations International Drug Control Programme, 1998), level of sale and other market variables (e.g., Des Jarlais et al, 1992). There has been speculation that heroin may contain various toxic additives such as rat poison, Ajax and chalk (see Coomber, 1999a; 1999b). "Unknown poisons" have also been implicated in a fatal neurologic condition following heroin smoking (e.g., Tan et al, 1994). In reality, street adulteration/dilution is less frequent than is commonly believed, and adulteration often occurs high in the distribution chain prior to importation (Coomber, 1997a; Huizer, 1988). Most additives are relatively harmless and some actually enhance the drug's effect by increasing its bioavailability when chased (Coomber, 1999a; 1999b). During the 1990s, the most common additives in the UK and Europe have been caffeine, paracetamol and various sugars (Coomber, 1997a; de la Fuente et al, 1996; Trimbos Institute, 1998). In the US there is great variability: the predominant diluent was sugar, with other common additives being quinine, procaine and caffeine (Coomber, 1999b).

The addition of caffeine, barbiturates, and methaqualone have been shown to increase volatility and therefore increase bioavailability from the base and salt forms of heroin (e.g., Cooke, 1991; Coomber, 1999a; Eskes and Brown, 1975; Gruhzit, 1958; Huizer,

1987; Huizer et al, 1977; Mo and Way, 1966). In the Netherlands, high levels of the impurity noscapine, found in street-samples of heroin base from the mid-1980s, have been shown to considerably reduce bioavailability when heroin is smoked (Huizer, 1987). The reasons for adding paracetamol to heroin are unclear. In one of a series of studies for his doctoral thesis, Huizer (1988) found that the addition of paracetamol substantially reduced the bioavailability of smoked heroin base but produced a large yield of O-6-monoacetylmorphine, a degradation product of heroin. The effects of paracetamol on the recovery of heroin hydrochloride were not investigated.

1.2.3 Chasing and injecting techniques

Despite evidence of reasonable recovery rates under controlled (laboratory) conditions, in practice, bioavailability may be significantly reduced. Grund and Blanken (1993) suggest that only 15-20 % of heroin used becomes available when heroin is smoked carefully and under "ideal" conditions, and that poor chasing techniques may reduce bioavailability even further. This literature suggests a much more complex relationship between purity and bioavailability or "drug effect" (and possibly dependence) when the drug is smoked. When administered intravenously, users' experiences show a more or less linear relationship to strength or purity – i.e., as purity increases, so does drug effect. This may not necessarily the case when heroin is smoked.

1.3 Purity, overdose and non-injecting routes of administration

An analysis of heroin obtained from undercover operations and seizures (including supply-level seizures) in Cabramatta between February 1993 and January 1995 revealed an average purity of 58.7 % (range: 13.2-79.8 %). More than three-quarters of the samples obtained in this study were at least 50 % pure (Weatherburn and Lind, 1997). More generally, an analysis of New South Wales seizures made by the Australian Federal Police (AFP) in 1997-98 indicated a purity of between 63.8 to 70.5 % for quantities of less than 2 g (Australian Bureau of Criminal Intelligence, 1999). In 1998, the average purity of AFP seizures in NSW had increased from 64 % in 1997 to 71 % (McKetin et al, 1999). However, it is not known how applicable these results are to heroin consumed at street level.

The emergence of non-injecting routes of administration (NIROA) has prompted considerable controversy in Australia, with some commentators arguing for the facilitation of such routes as a public health measure to reduce heroin-related harm (e.g.,

see Wood, 1996). In addition to their potential to decrease the occurrence of blood-borne diseases, non-injecting routes of administration have also been promoted as protective against overdose death (Hunt et al, 1998). There has been a 55-fold increase in the rate of overdose fatalities in Australia since 1964 (Hall et al, 1999). One third of all NSW fatalities between 1992 and 1996 occurred within the immediate surrounds of Kings Cross and Cabramatta, with deaths in Cabramatta significantly more likely to occur in public places (Darke et al, 1999b).

A study of fatalities in NSW in this period found that while injecting was the route of administration implicated in the majority (99 %) of fatalities, non-injecting routes precipitated death in 1 % (10) of cases. Four deaths occurred following smoking, four following snorting and two cases after oral administration. These cases were demographically similar to injection-related fatalities, polydrug use (particularly alcohol consumption) was the norm and the toxicological profiles of the groups were similar (Darke and Ross, in press). While these data indicate that intravenous administration constitutes a greater overdose risk factor than non-injecting routes, they also indicate that no route of administration can guarantee immunity to overdose.

Purity is often perceived as the main factor involved in overdose fatalities, despite increasing evidence implicating polydrug use in heroin-related deaths (see Darke and Zador, 1996). A time-series analysis of the relationship between heroin purity in south-west Sydney (reported by Weatherburn and Lind, 1997) and fatal heroin overdose found that the two were moderately correlated, with a role played by both mean purity and the range of purity. However, purity accounted for only 40 % of the variance in overdose deaths, supporting suggestions that it is a contributing, but not the sole, factor in overdose aetiology (Darke et al, 1999a). Nonetheless, data on the nature of heroin sold in south-west Sydney, including its composition, average purity, range of purity, and the presence or otherwise of adulterants, may contribute to a better understanding of the pharmacological factors influencing route of administration. It may also provide potential for reducing the risks of heroin overdose and the transmission of blood-borne viruses.

1.4 Aims

If, as existing data suggest, the heroin sold in Cabramatta (and by extension the rest of Sydney) is predominantly heroin hydrochloride (salt) rather than base, it may not be pharmacologically suitable for chasing. Transitions to injecting would therefore not be surprising, and indeed, in most cases, would appear inevitable. In the wake of calls for health professionals to promote "reverse transitions" (from injecting to smoking), there is an urgent need for a better understanding of the contribution of heroin's pharmacological properties to routes of administration. This may help to inform the development of harm minimisation strategies that rely on the adoption of non-injecting routes of use. With the exception of routine analyses of heroin seizures by Government laboratories, there are no data on this issue in Australia.

This study therefore aimed to provide baseline data on the pharmacological properties of heroin available for sale in Cabramatta during the six-month period from October 1996 to March 31, 1997. Specifically, it aimed to:

(i) examine its form (i.e., salt or base)
(ii) its purity, and
(iii) the presence of impurities and adulterants.

2 METHODS

2.1 Sample selection

2.1.1 Sampling frame

There is a specified police procedure for the handling of illicit drugs, including those examined in this research. During a typical unplanned drug detection in which an offender is identified, the drug(s) and packaging are weighed and photographed in situ in front of the offender, who is charged at the nearest police station. The drug(s) and offender are taken to a custody officer, and the drug(s) sealed in an exhibit bag in front of the offender, who is then charged, photographed and fingerprinted. The drugs are entered into the exhibit book by the exhibit officer (in the presence of the arresting officer), and the sealed exhibit bag is then placed into the security cabinet in the exhibits room. The procedure differs slightly during a planned operation, with a nominated independent case exhibit officer attending the location of the operation with the exhibit bags (Brian Moir, NSW Police Service, personal communication, August 30).

A retrospective sampling frame was generated comprising all police seizures ("exhibits") suspected of containing heroin logged in the exhibit books at Cabramatta Police Station in the six months October 1, 1996 to March 31, 1997 (n=487). This period was chosen as the most opportune time frame in order to maximise the availability of exhibits (i.e., to minimise the likelihood that exhibits had been destroyed and to maximise the availability of data from the NSW Division of Analytical Laboratories (DAL) confirming the presence of heroin). The period also contained several overdoses (14-17/3/97) and a number of heroin-related fatalities.

The majority of exhibits were indicative of the heroin available at street level, comprising relatively small seizures (i.e., 75 % weighed 1g or less including packaging) made by the local patrol. A small proportion (9.1 %) arose from large seizures and/or resulting from other than local operations (e.g., district, regional and transit police, State and Federal Taskforces, and Drug Enforcement Agency). Documentation from the NSW Division of Analytical Laboratories confirming the presence of heroin was available for just under half the exhibits (42.7 %).

2.1.2 Criteria for selecting samples

At least one exhibit was sought for each of the 27 weeks comprising the study period. As the aim was to examine the properties of heroin consumed by users, we decided to select seizures from as close to street level as possible – i.e., from arrests of street-level users and dealers/user-dealers in the Cabramatta area. Exhibits were selected in accordance with the following criteria: primarily from local seizures, linked to a known offender, and consisting of a small number (1-4) of balloons or foils, with a laboratory weight of no more than 100-150mg as recorded on the DAL report in the Cabramatta exhibit book. Thus, ideally, exhibits with accompanying verification of heroin content were chosen, but these were not always available. Exhibits also had to be physically available. A small proportion of the original or "first choice" exhibits (see below) was unobtainable because they were required in court cases or had already been destroyed.

Under provisions contained in Section 10 (2) paragraph (a) of the NSW Drug Misuse and Trafficking Act 1985 No. 226, authority was received from NSW Health, Pharmaceutical Services Branch, for Dr Michael Dawson (chemist) to be in possession of the necessary reference standards: heroin, O-6-monoacetylmorphine and acetylcodeine, and up to four grams of street heroin (excluding packaging). Once this authority was in place, the NSW Police Service was in a position to supply samples of seized heroin to conduct this research project.

Of the 487 exhibits, 27 were deemed to meet all selection criteria and were requested ("first choice"), representing approximately one per week of the time frame. An additional 26 were selected as "reserves" if the first choice was unavailable, or because they were seized at the scene of a suspected fatal overdose. The final sample obtained from police comprised 33 exhibits, 23 of which had been requested as first choice or "reserve" exhibits. As some of the requested exhibits were unavailable (required in court or already destroyed), we were subsequently provided with an additional 10 non-requested, but available, seizures. Two of these non-requested exhibits weighed appreciably more than those which were requested (gross weights (with packaging) of 1.5 g and 3.5 g). These were selected primarily for the purposes of further analyses on the conversion of salt to base. Two of the 33 exhibits were collected from the scene of suspected heroin-related fatalities. These 33 exhibits yielded a total of 88 individual samples, as many exhibits consisted of multiple items such as balloons and foils. The

characteristics of each of these exhibits are presented in Appendix 1. A summary of the characteristics of the final sample and the sampling frame are presented in Table 1.

2.2 Procedure

This project received approval from the NSW Police Service and NSW Department of Health. The Committee on Experimental Procedures Involving Humans at the UNSW was advised of this project, but as it did not come under its terms of reference, an exemption from approval was granted. Permission was gained from NSW Police to access 24 samples of 200 mg over a 6 month period. All exhibit books covering this period were accessed and information pertinent to the selection criteria was entered for each exhibit into a spreadsheet program on a laptop computer to facilitate selection of the final sample. Requests for suitable samples were submitted by the Chief Investigators, and the final sample was collected from the Patrol Commander according to police protocol. All analyses were conducted by Dr Dawson at the laboratories of the Department of Chemistry, Materials and Forensic Science, University of Technology, Sydney.

2.3 Analytical methods

Reference materials were purchased from either the Curator of Standards at the Australian Government Analytical Laboratories or Sigma-Aldrich, USA.

At the laboratory, each exhibit was photographed with its packaging, and the contents were recorded.

Ion chromatography was used to determine whether the samples contained heroin as the free base or as the hydrochloride (or other salt).

High performance liquid chromatography with diode array detection was used to provide quantitative information on the content of the following substances in each sample:- diacetylmorphine hydrochloride (heroin hydrochloride), O-6-Monoacetylmorphine hydrochloride (degradation product) and acetylcodeine hydrochloride (synthesis by-product).

Gas chromatography/mass spectrometry was used to confirm the presence of compounds amenable to analysis by this procedure – such as, heroin, O-6-

Monoacetylmorphine acetylcodeine, codeine, morphine, caffeine, paracetamol, procaine, methaqualone, noscapine and papaverine (this technique provides qualitative data on drugs that can be volatilised and chromatographed). Some samples contained trace amounts of noscapine and other compounds which tentative library searches identified as opiate-related compounds. High performance liquid chromotography with refractive index detection was used to provide data on the types of sugars present in the samples.

All samples were handled and stored in accordance with Clauses 76, 113, 114, 119, 120, 122, 123 and 153 of the NSW Poisons and Therapeutic Goods Regulation 1994.

3 RESULTS

3.1 Characteristics of final sample

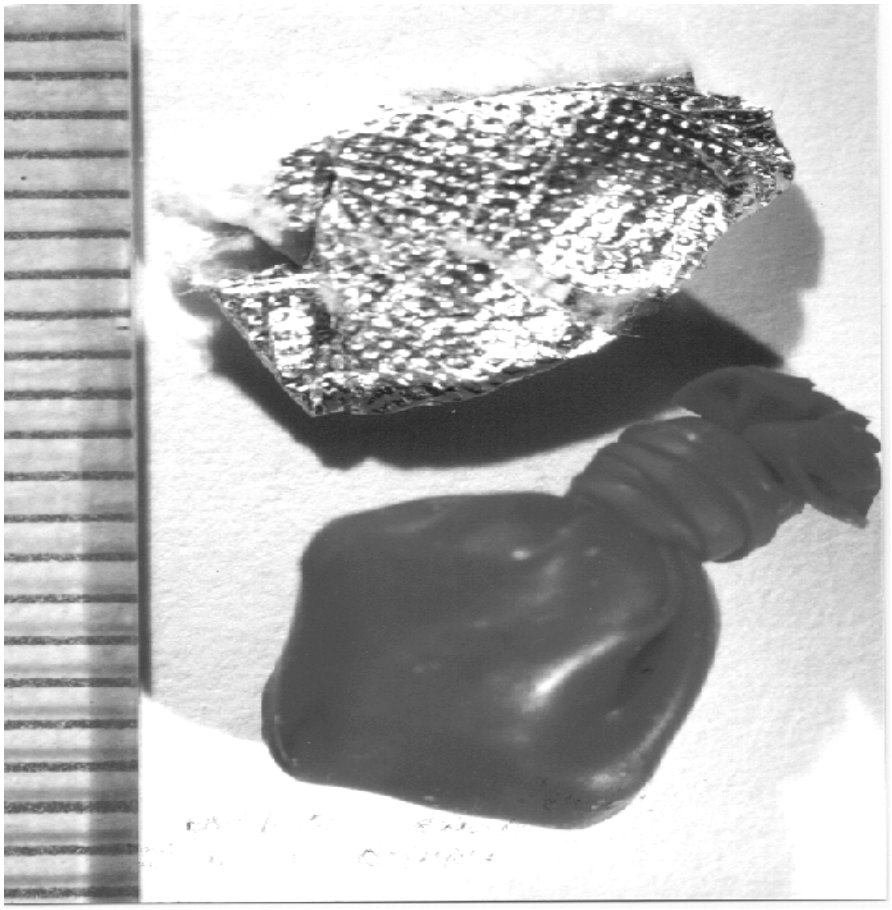
Table 1 describes some basic characteristics of the final sample and the sampling frame. Consistent with the selection criteria, the majority of the samples comprised local seizures (90.9 %) associated with charges of possession (66.7 %) or supply (21.2 %). Only a small proportion of exhibits had no associated charge: – two exhibits were found on recently deceased persons, and a further two were found or recovered by police officers and recorded under the category of "offender unknown". The majority of exhibits contained suspected heroin packaged for sale at the street level (i.e., 57.6 % were wrapped in foil and sealed in small plastic balloons, and 39.4 % were wrapped in foil alone). Figure 1 illustrates both types of packaging represented in one of the exhibits analysed for this study. The median laboratory weights of exhibits in the final sample (0.07 g) was half that of the sampling frame (0.14 g), and are largely consistent with the selection criteria for exhibits. Three quarters of the final sample had laboratory reports attached, all of which confirmed the presence of heroin. Most exhibits consisted solely of heroin. However, two of the exhibits in the final sample also contained benzodiazepines in tablet form (diazepam and flunitrazepam).

Table 1: Characteristics of all suspected heroin seizures logged at Cabramatta Patrol between October 1, 1996 and March 31, 1997 (n=487) and the final sample available for analysis (n=33).

	Sampling frame (n=487)	Final sample (n=33)
Level of seizure (%)		
Local	82.8	90.9
Other[+]	17.2	9.1
Offence (%)		
Possession of prohibited drug	52.2	66.7
Supply/deemed supply	34.0	21.2
No charge	13.2	3.0
Other	0.6	9.1
Contents		
Balloons (%) (median no./range)	61.4 (1/0-91)	57.6 (1/0-5)
Foils (%) (median no./range)	45.0 (0/0-29)	39.4 (0/0-5)
Unwrapped packages/vials (%) (median no. /range)	6.6 (0/0-4)	9.1 (0/0-2)
Other drugs in seizure (%)	6.4	6.1
*Gross weight (g)**		
Median	0.44	0.30
Range	0.02-1077.6	0.05-3.5
Laboratory report attached (%)	42.7	75.8
Of these….		
*Lab weight (g)**		
Median	0.14	0.07
Range	0.01-28.2	0.01-1.45
Heroin confirmed present (%)	97.6	100.0

*The discrepancy between the gross weight and the laboratory weight on the forensic report may largely be accounted for by the fact that the gross weight included packaging.
[+]"Other" comprises district, regional and transit police, Drug Enforcement Agency and special Taskforces.

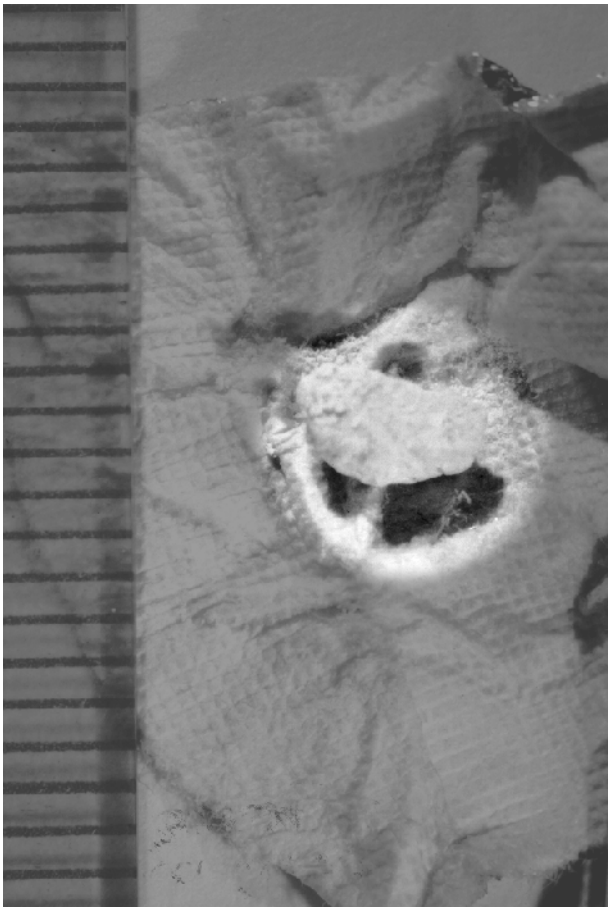
Figure 1: Contents of exhibit 32, comprising one balloon (a "cap") and one foil (scale: 1 division=1mm).



3.2 Composition

Samples were white or off-white powders or solid aggregates. Off-white or beige samples typically took the form of solid aggregates (see Figure 2). None of the samples resembled West Asian heroin, which is most commonly medium brown in colour (United Nations International Drug Control Programme, 1998). Ion chromatography revealed all samples contained chloride ion at, or greater than, the theoretical amount expected if the samples contained heroin hydrochloride. Similarly, the samples were highly soluble in water, thus it is reasonable to conclude that the opiates in the samples were present as the hydrochloride salts. All of the 88 samples analysed (excluding the benzodiazepine tablets) contained heroin.

Figure 2: Heroin contained in exhibit 32, comprising off-white/beige solid (highlighted).



3.3 Purity

Purity was assessed by means of high performance liquid chromatography. The mean purity of the 88 heroin samples, expressed as the percentage of each sample comprised of major opiates (that is diacetylmorphine, O-6-monoacetylmorphine and acetylcodeine occurring as the hydrochloride salts), was 66.2 % (SD=19.1, range=27-98 %). If these data are examined at the level of exhibit (n=33), the mean purity was 68.1 % (SD=17.2, range=29-94 %). Both levels indicate a mean purity greater than the mean of 58.7 %. (n=322 samples; SD=14.8, range=13.2-79.8 %) reported by Weatherburn and Lind (1997). A t-test revealed that the purity of the heroin analysed for this report was significantly higher (at sample level) than the purity of the heroin analysed by Weatherburn and Lind (66.1 vs. 58.7%; t_{408}=-3.9, $p<0.001$). While nearly 80 % of samples in their study had a purity of at least 50 % heroin, 85 % of exhibits (or 84.1 % of samples) in this report had an average purity of at least 50 % heroin.

Table 2 indicates the ranges of purity among the exhibits and samples. One significant observation was that 15 % of exhibits and samples were of very high purity (91-100 %), while none were less than 20 % pure. This table illustrates the intra-sample variability in purity – while an exhibit may have had a mean purity within one range (e.g., 51-60 %) its constituent samples may have had purities spanning two ranges (51-70 %) (see Appendices 2 and 3). For example, exhibit 29 contained 5 balloons and 5 foils. While the average purity of this exhibit was 57 %, the purity of its constituents ranged from 51-72 %.

Table 2: Summary of purity data, by exhibit (n=33) and sample (n=88).

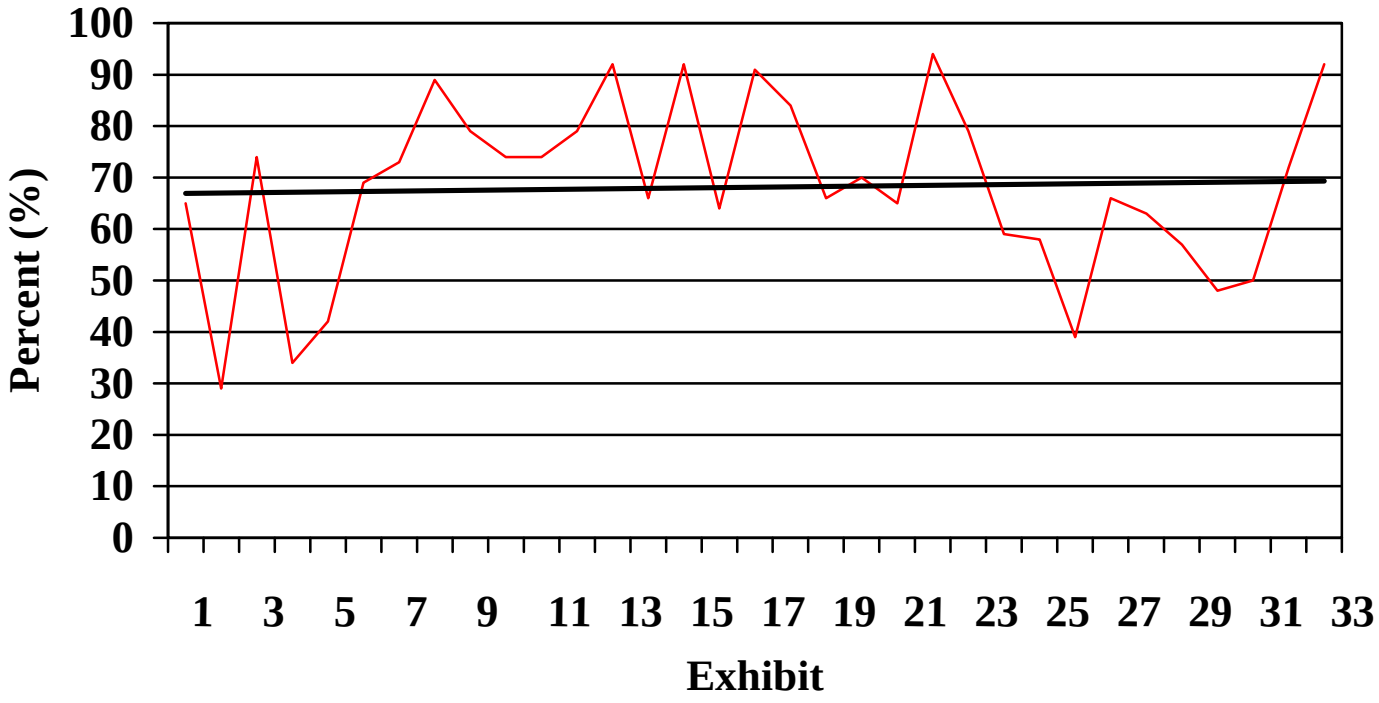
Range of purity (%)	Exhibits (%)	Samples (%)
0-10	0	0
11-20	0	0
21-30	3.0	5.7
31-40	6.1	5.7
41-50	9.1	5.6
51-60	9.1	23.9
61-70	27.3	15.9
71-80	24.2	15.9
81-90	6.1	12.5
91-100	15.1	14.8

Figure 3 indicates that there was no apparent linear trend in purity over the study period. The lack of a complete time series for these data precludes firm conclusions being drawn about purity data for all logged seizures. However, these data do not provide any suggestion of a sustained increase or decrease in purity over the six months examined.

3.2 Adulterants/Diluents

The proportion of samples and exhibits containing adulterants is displayed in Figure 4 (details for individual samples are presented in Appendix 2). Gas chromatography/mass spectrometry analysis showed the presence of caffeine and a number of minor constituents in approximately one third (36.4%) of samples, or 27.3 % of all exhibits. Additionally, 40.9 % of samples (or 36.4 % of exhibits) showed the presence of paracetamol and related compounds. Caffeine *and* paracetamol (and related compounds) were present in one in five (21.6 %) samples, or 12.1 % of exhibits. In the majority of exhibits containing multiple samples (e.g., several balloons or foils), these substances

Figure 3: Average purity (%) (including linear trend line) of 33 heroin exhibits covering the period October 1, 1996-March 31, 1997.



were present in all items comprising the exhibit. As noted previously, caffeine has been found to aid volatilisation of heroin, and hence increase recovery rates of smoked heroin HCl, while it is possible that paracetamol *decreases* recovery rates.

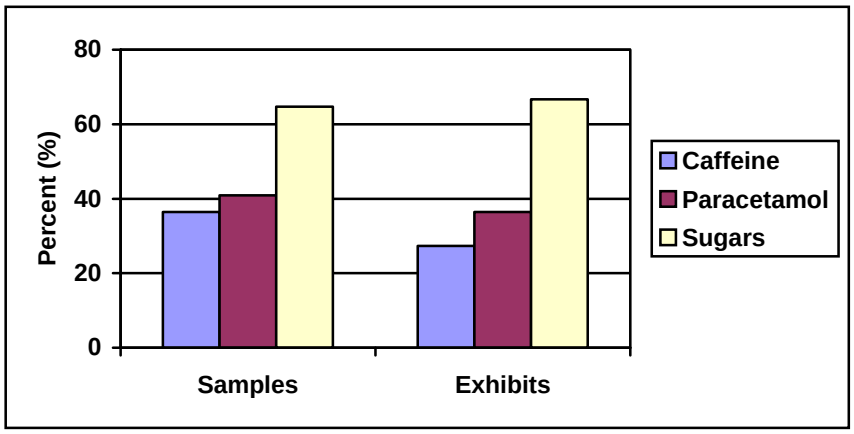
Sugars, largely used to add bulk, were present in approximately two thirds of samples (57/88: that is, 64.7 %) and exhibits (22/33: that is, 66.7 %), predominantly in the form of sucrose. All exhibits containing sugars contained sucrose, although in one exhibit (no. 29) it was detected only in trace amounts (<5 %). The assay method used was unable to distinguish between glucose, sorbitol or mannitol; sugars in the form of glucose, sorbitol or mannitol were detected in only 7 samples (8 %), or 3 exhibits (9.1 %).

Only one in five samples (16/88: that is, 18.1%), or one in ten exhibits (3/33: that is, 9.1%) contained all three diluents - caffeine, paracetamol and sugars.

A number of samples contained trace amounts of noscapine. No samples contained scopolamine or other tropane alkaloids, procaine or methaqualone.

These analyses indicate that street-level heroin in Cabramatta is relatively free of harmful adulterants. Those detected are pharmacologically inactive diluents largely used to add bulk (sugars), or pharmacologically active adulterants used to improve the bioavailability of heroin HCL when smoked (caffeine). The extremely low levels of the opiate alkaloids noscapine and papaverine are consistent with the heroin being of south-east Asian origin. The reasons for the addition of paracetamol require clarification.

Figure 4: Proportion of samples (n=88) and exhibits (n=33) containing caffeine, paracetamol and sugars.



4 DISCUSSION

All of the samples analysed for this study contained heroin as the hydrochloride salt. Previous Australian research has documented the existence of the first of Griffiths and colleagues' (Griffiths et al, 1994) pre-requisites for the development of a heroin smoking culture - pre-existing patterns of drug taking which favour heroin smoking over injecting (e.g., Maher et al 1998, 1999; McKetin et al, 1999; Swift et al 1999). However, the current study did not find evidence to support the second pre-requisite - the availability of heroin in a form that could be easily and efficiently smoked. No heroin free base was encountered.

The adulterants and diluents present in these samples were similar to those commonly found in the UK and Europe, and to a lesser extent, the US. Approximately one third (36%) of the samples contained caffeine, 41% contained paracetamol and related compounds, and two thirds (65%) contained sugars. Only one in five of the 88 samples contained all three diluents. The absence of dangerous contaminants is consistent with previous research based on interviews with drug dealers in the UK which suggests that, contrary to common perception, dangerous adulteration is largely mythical and that very little "cutting" actually takes place (Coomber, 1997).

Given the ability of caffeine to increase the recovery rate of smoked heroin hydrochloride, its addition in one third of these samples may be an attempt to increase its volatility and hence facilitate heroin smoking. The reason for the addition of paracetamol requires clarification, as its impact on volatility is uncertain. Anecdotal reports from local dealers gathered by the second author (LM), suggest it may be a marketing tool, added to make the heroin “burn yellow” when it is smoked. Further research on the effects of paracetamol on the volatility of heroin should be conducted to provide a possible explanation for its presence in illicit heroin samples and help resolve conflicting reports on this issue.

The extent to which street-level adulteration of heroin occurs in Australia is unknown. Coomber’s work (1997, 1999a, 1999b) implies that most cutting occurs at a relatively high level of the distribution network. However, given the source of European heroin is typically south-west Asia, this does not necessarily apply to the marketing and distribution of the south-east Asian heroin available in Sydney.

The street-level samples analysed for this study had an average purity of 66%, with 85% having an average purity of at least 50% heroin hydrochloride salts. This is in the range reported for small NSW seizures (<2g) by the Australian Federal Police in 1997-1998 (64% to 71%) (McKetin et al, 1999). The average purity of samples in the present study represented a small but significant increase from that reported in Cabramatta by Weatherburn and Lind between 1993 and 1995 (66.2% vs. 58.7%). However, the lack of a complete time series for this study, and differences in the methodology between studies, should be considered when interpreting these findings. There was no evidence of any change in purity over the six months of this study, with the trend line completely flat (Figure 3).

These findings have several implications for the risk of fatal overdose. Firstly, the presence of heroin in salt rather than base form encourages intravenous administration. This route is associated with a greater risk of overdose (and the transmission of blood-borne viruses). These data also lend support to recent Australian findings (Darke et al, 1999a) that purity may be only one of many factors implicated in the occurrence of overdose fatalities. While fatal overdoses are increasing (Hall et al, 1999), there were no indications of large increases in street-level heroin purity across the study period. There was also only a modest increase in the purity of street-level seizures examined between this and the Weatherburn and Lind study that was not commensurate with the large increase in the number of overdose fatalities. Recent (1999) data from NSW heroin seizures made by the Australian Federal Police also indicate little change in average purity since the period of this study (1999 average purity=67%) (McKetin, 1999). Further, the majority of overdose deaths are occurring among older, more experienced users, who have presumably developed tolerance to the effects of heroin (Darke et al, 1999b; Hall et al, 1999). Finally, the lack of toxic contaminants in these samples supports the findings of previous research that they play little role in overdose deaths (see Darke and Zador, 1996).

These results also need to be placed in the context of recent Australian research which has sought to document patterns and contexts of heroin smoking (e.g., Maher et al, 1998, 1999; Maher and Swift, 1997; Swift et al, 1999). While "reverse" transitions appear to be relatively rare in Australia, a recent study of young Indo-Chinese IDU found that just over a quarter (27%) reported ever having stopped injecting a drug and returning to

smoking, snorting or swallowing that drug. Poor health (10%) was the main reason cited for reverse transitions. Four people cited fear of HIV/Hepatitis C, a further four cited family problems and three people cited vascular problems as the main reason they had made a transition to non-injecting (Maher et al, 1999). These results suggest that there may be a demand for harm-reduction interventions designed to facilitate transitions from injecting to smoking among this population.

However, the availability of heroin in salt, rather than base, form in Sydney would appear to mitigate against the success of such interventions. Nevertheless, a small proportion of local users do manage to maintain smoking behaviour (e.g., Maher et al, 1998; Swift et al, 1999). A better understanding of the factors influencing route of administration and potential ways to surpass the pharmacological barriers to smoking are crucial steps in attempting to minimise the harms associated with injecting. For example, in the absence of heroin base in the local market, the addition of caffeine to heroin hydrochloride may provide a means to increase the smoking efficiency of street-level heroin. Users could also be taught more efficient ways of smoking that maximise the bioavailability of heroin administered by this route.

Finally, this study has established a system that could be used to perform ongoing analytical studies that would require only minimal financial assistance. This system could be readily incorporated, for example, into the NSW Illicit Drug Reporting System (e.g., McKetin et al, 1999), to include the annual collection and analysis of street-level heroin samples. Because the present sampling frame was constructed retrospectively, we encountered problems with the removal and destruction of exhibits. Our experience suggests that systematic data collection will necessitate the development of criteria and mechanisms (in consultation with the NSW Police Service) to allow for prospective sampling.

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Appendix 1: Characteristics of the 33 exhibits analysed.

Exhibit	Date of seizure	Police agency	Offence	Contents	Gross weight+	Lab weight (g)+	Heroin confirmed	Other drugs in seizure
1	October 3, 1996	local	supply	2 balloons	0.40	0.08g	yes	No
2	October 27, 1996	local	possession	5 balloons	0.70	N/A*	N/A	No
3	November 3, 1996	local	possession	5 balloons	1.0	0.16	yes	No
4	November 5, 1996	Local	supply	3 balloons	0.60	0.10	yes	No
5	November 7, 1996	local	no charge (deceased)#	1 balloon	0.30	0.03	yes	No
6	December 3, 1996	local	possession	5 foils	3.50	1.45	yes	No
7	December 5, 1996	local	no charge (found drugs)	2 balloons	0.80	0.07	yes	No
8	December 9, 1996	local	possession	5 foils	1.0	N/A*	N/A	No
9	December 12, 1996	local	supply	2 balloons	0.20	0.09	yes	No
10	December 18, 1996	local	possession	1 unwrapped package	0.10	0.06	yes	No
11	December 18, 1996	local	no charge (deceased)#	1 balloon	0.20	0.02	yes	No
12	December 31, 1996	local	possession	1 foil	0.27	N/A*	N/A	No
13	January 2, 1997	local	possession	2 balloons	0.25	N/A*	N/A	No
14$	January 4, 1997	local	possession	2 stoppered glass vials	---	---	---	No
15	January 10, 1997	other region	supply	2 balloons	0.43	0.09	yes	No
16	January 11, 1997	other region	possession	1 foil	0.12	0.04	yes	No
17	January 14, 1997	local	possession	1 foil	0.10	0.04	yes	No
18	January 22, 1997	local	possession	2 foils	0.14	0.05	yes	No
19	January 23, 1997	local	possession	2 balloons	0.30	0.09	yes	No
20	January 29, 1997	local	possession	2 balloons	0.34	0.03	yes	No
21	February 1, 1997	other region	possession	2 foils	0.15	N/A*	N/A	No
22	February 9, 1997	local	supply	5 foils	1.50	0.10	yes	No
23	February 11, 1997	local	supply	3 balloons	0.05	0.14	yes	No
24	February 12, 1997	local	possession	1 foil	0.10	0.04	yes	No
25	February 16, 1997	local	no charge (found drugs)	4 foils	0.07	0.11	yes	Benzodiazepine
26	February 20, 1997	local	possession	2 balloons	0.30	0.07	yes	No
27	February 21, 1997	local	possession	1 unwrapped package	N/A (missing)	0.01	yes	Benzodiazepine

28	February 22, 1997	local	supply	2 balloons	0.38	0.06	yes	No
29	March 15, 1997	local	possession	5 balloons and 5 foils	1.50	N/A*	N/A	No
30	March 19, 1997	local	possession	2 foils	0.42	0.05	yes	No
31	March 19, 1997	local	possession	5 balloons	0.62	N/A*	N/A	No
32	March 20, 1997	local	possession	1 balloon and 1 foil	0.16	N/A*	N/A	No
33	March 26, 1997	local	possession	2 balloons	0.21	0.06	yes	No

$ The contents of this exhibit did not match the entry described in the log book. The entry above describes the contents of the exhibit we received. Subsequently, no data are presented for exhibit weight or presence of heroin.

* No laboratory report attached

Suspected overdose

+ The discrepancy between the gross weight and the laboratory weight on the forensic report may largely be accounted for by the fact that the gross weight included packaging.

Appendix 2: Percentage purity data for each of the samples analysed expressed as % major opiates, and presence of adulterants

Exhibit*	Exhibit wt (mg)	Paracetamol	Caffeine	Sucrose	Glucose, sorbitol or mannitol	% Diamorphine HCl	% O-6-Mono acetylmorphine HCl	% Acetyl codeine HCl	% Major opiates as hydrochloride salts
1a	42	Yes	Yes			58	2	7	67
1b	32	Yes	Yes			55	1	6	62
2a	23	Yes	Yes	Yes		20	5	4	29
2b	16	Yes	Yes	Yes		24	6	4	34
2c	18	Yes	Yes	Yes		19	5	3	27
2d	8	Yes	Yes	Yes		19	5	3	27
2e	14	Yes	Yes	Yes		19	5	3	27
3a	27			Yes		80	1	7	88
3b	29			Yes		71	1	6	78
3c	8			Yes		49	2	8	59
3d	17			Yes		44	1	7	52
3e	35			Yes		85	1	7	93
4a	26		Yes	Yes	Yes	37	1		38
4b	26		Yes	Yes	Yes	27			27
4c	27		Yes	Yes	Yes	35	1		36
5	23	Yes		Yes		40	2		42
6a	165			Yes		61			61
6b	231			Yes		64			64
6c	334			Yes		74			74
6d	186			Yes		79			79
6e	317			Yes		68			68
7a	29	Yes				64	2	1	67
7b	9	Yes				77	2	1	80
8a	93					92	4		96
8b	10					85	2		87
8c	16					92	2		94
8d	14					81	2		83
8e	15					81	2		83
9a	9			Yes		78	1		81
9b	23			Yes		70	2	5	77
10	53			Yes		74			74
11	15			Yes		74			74
12	95			Yes		79			79
13a	36			Yes		92	1		93
13b	21			Yes		89		1	90
14a	22		Yes	Yes		46	6	13	65
14b	54		Yes	Yes		47	6	13	66
15a	27					87	2	9	98
15b	31					76	1	9	86
16	35			Yes		59	5		64
17	19	Yes				79	3	9	91
18a	17	Yes				72	3	7	82
18b	21	Yes				76	2	8	86
19a	26			Yes	Yes	47	3	6	56
19b	27			Yes	Yes	64	4	7	75
20a	8			Yes	Yes	71	6	8	85
20b	6			Yes	Yes	44	6	5	55

21a	42	Yes				50		8	58
21b	26	Yes				68		4	72
22a	16					86		10	96
22b	17					83		8	91
22c	17					85		8	93
22d	18					88		8	96
22e	18					86		8	94
23a	10	Yes		Yes		71	2	4	77
23b	17	Yes		Yes		73	1		74
23c	20	Yes		Yes		78	2	5	85
24	18			Yes		54		5	59
25a	16	Yes				52	2	4	58
25b	23	Yes				45	1	10	56
25c	32	Yes				55	1	5	61
25d	33	Yes				45	1	9	55
26a	26			Yes		32		7	39
26b	36			Yes		32		6	38
27	11					62	1	3	66
28a	24	Yes				50		10	60
28b	23	Yes				55		11	66
29a	41	Yes	Yes	Trace only+		57			57
29b	54	Yes	Yes	Trace only		54			54
29c	16	Yes	Yes			60			60
29d	25	Yes	Yes	Trace only		55			55
29e	13	Yes	Yes	Trace only		72			72
29f	26	Yes	Yes	Trace only		54			54
29g	30	Yes	Yes	Trace only		52			52
29h	35	Yes	Yes	Trace only		53			53
29i	29	Yes	Yes	Trace only		51			51
29j	17	Yes	Yes	Trace only		63			63
30a	14		Yes	Yes		38	5	4	47
30b	13		Yes	Yes		39	5	4	48
31a	10		Yes	Yes		38	3	5	46
31b	10		Yes	Yes		41	4	5	50
31c	17		Yes	Yes		40	5	6	51
31d	24		Yes	Yes		42	5	4	51
31e	17		Yes	Yes		44	1	6	51
32a	30	Yes	Yes	Yes		67		4	71
32b	32	Yes	Yes	Yes		70		3	73
33a	15		Yes			90	2		92
33b	13					89	2		91

*a,b,c etc - are suffixes to denote that there are multiple samples associated with a particular exhibit. Refer to the corresponding exhibit number in Appendix A to match the suffix to the exhibit contents.
+ less than 5%
NB: All but one of the samples (Exhibit 32) had been previously analysed by the Government Analyst, that is an unknown amount from each exhibit had been used by the Government Analyst. However, only 75% of the final sample had a laboratory report attached to the corresponding entry in the log book (as indicated in Table 3.1).
NB: Total weight of exhibits=3.256g (Authority was granted to be in possession of up to 4.000g)

Appendix 3: The average percentage purity data for each exhibit

Exhibit*	Exhibit wt (mg)	% Major opiates as hydrochloride salts	Average % purity per exhibit
1a	42	67	
1b	32	62	65
2a	23	29	
2b	16	34	
2c	18	27	
2d	8	27	
2e	14	27	29
3a	27	88	
3b	29	78	
3c	8	59	
3d	17	52	
3e	35	93	74
4a	26	38	
4b	26	27	
4c	27	36	34
5	23	42	42
6a	165	61	
6b	231	64	
6c	334	74	
6d	186	79	
6e	317	68	69
7a	29	67	
7b	9	80	73
8a	93	96	
8b	10	87	
8c	16	94	
8d	14	83	
8e	15	83	89
9a	9	81	
9b	23	77	79
10	53	74	74
11	15	74	74
12	95	79	79
13a	36	93	
13b	21	90	92
14a	22	65	
14b	54	66	66
15a	27	98	
15b	31	86	92
16	35	64	64
17	19	91	91
18a	17	82	
18b	21	86	84
19a	26	56	
19b	27	75	66
20a	8	85	
20b	6	55	70
21a	42	58	
21b	26	72	65
22a	16	96	
22b	17	91	

22c	17	93	
22d	18	96	
22e	18	94	94
23a	10	77	
23b	17	74	
23c	20	85	79
24	18	59	59
25a	16	58	
25b	23	56	
25c	32	61	
25d	33	55	58
26a	26	39	
26b	36	38	39
27	11	66	66
28a	24	60	
28b	23	66	63
29a	41	57	
29b	54	54	
29c	16	60	
29d	25	55	
29e	13	72	
29f	26	54	
29g	30	52	
29h	35	53	
29i	29	51	
29j	17	63	57
30a	14	47	
30b	13	48	48
31a	10	46	
31b	10	50	
31c	17	51	
31d	24	51	
31e	17	51	50
32a	30	71	
32b	32	73	72
33a	15	92	
33b	13	91	92

*a,b,c etc - are suffixes to denote that there are multiple samples associated with a particular exhibit. Refer to the corresponding exhibit number in Appendix 1 to match the suffix to the exhibit contents.