HEROIN-RELATED DEATHS IN SOUTH WESTERN SYDNEY: 1992-1996

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EXECUTIVE SUMMARY

The coronial files of all heroin-related fatalities that occurred in the south western Sydney (SWS) region over the period 1992-1996 were inspected for details and trends in demographic characteristics, circumstances of death and toxicological findings. There were 176 heroin-related fatalities in SWS over the study period. There was a substantial, statistically significant increase in heroin-related fatalities over the study period, from 20 deaths in 1992 to 54 during 1996. The mean age of cases was 29.9 years, 89% were male, and 92% were classified as dependent on heroin at the time of death. Seven percent of cases had recently been released from prison, 2% were enrolled in methadone maintenance at the time of death, and 4% were classified as suicides. There were no significant trends in demographic characteristics of cases over the study period.

Fatalities predominantly occurred in public settings (70%), with Cabramatta being the location in which deaths most frequently occurred (38%). Deaths that occurred in Cabramatta were significantly more likely to have occurred in a public place than other cases (89% v 42%). There was a significant increase over the study period in the proportion of fatalities that occurred in public settings. A third of cases resided outside the SWS region at the time of death. Of those cases in which an estimate could be made, 15% were classified as having died instantly upon heroin administration. No intervention occurred in 71% of cases.

Morphine concentrations rose markedly over the study period, from 0.16 mg/L in 1992 to 0.37 mg/L in 1996. The major increase occurred in the period 1992-1994, with morphine concentrations stabilising after this period. The majority of cases involved heroin in combination with other drugs: alcohol (40%), benzodiazepines (30%) and antidepressants (9%). In only a third of cases was morphine the sole drug detected. The median blood alcohol concentration of cases in which alcohol was present was 0.12 g/100 ml. Males were significantly more likely to have alcohol detected at autopsy (44% v 11%), while females were more likely to have benzodiazepines detected (56% v 28%). The median blood morphine concentration among cases in which alcohol was detected was significantly lower than other cases (0.25 mg/L v 0.42 mg/L). In 78% of cases the cause of death was attributed to "acute narcotism" (or "narcotism"). Of the cases in which drugs other than morphine were detected, 69% were attributed solely to narcotism.

The problem of heroin-related fatalities in the SWS region grew throughout the study period. Specific and innovative responses to the problem in this region are necessary if the rise in the number of fatal cases is to be curbed. Possible interventions include educating heroin users on the dangers of the use of other drugs in combination with heroin, the provision of safe injecting rooms to reduce the number of street-based fatalities, expansion of methadone maintenance services in the region, distributing naloxone directly to heroin users, and an improvement of responses to overdoses by witnesses.

1.0   INTRODUCTION

The rate of fatal heroin overdoses in Australia rose from 10.7 per million in 1979 to 67.0 per million in 1995 (Hall & Darke, 1997). In overall terms, there were 70 fatal overdoses in Australia in 1979, compared to 550 in 1995 (Hall & Darke, 1997).   The estimated excess mortality rate among heroin users is 13 times that of peers of the same age and gender (English et al, 1995). Overdose is the largest single contributor to this excess mortality (Eskild et al, 1993; Frischer et al, 1993; Oppenheimer et al, 1994; O'Doherty & Farrington, 1997; Perucci et al, 1991).

The South Western Sydney   (SWS) region has, in recent years, become of major concern to drug and alcohol service providers, police and policy makers. The region covers an area of over 6000 km² and has a population of approximately 650,000. The major reason for mounting concern has been the emergence of the SWS suburb of Cabramatta as a major distribution point for cheap, high purity heroin (Maher, 1996; O'Brien et al, 1996). A study of street seizures of heroin in SWS reported a mean purity of 59%, with purity ranging up to 80% (Weatherburn & Lind, 1995).

Little Australian research has been conducted into fatal heroin overdoses in general, and in SWS in particular. Zador et al (1996) analysed the data from coronial files of all 1992 New South Wales heroin-related deaths. This study found that cases of heroin-related deaths were overwhelmingly male, occurred in a dependent non-treatment population of users, and typically occurred in the home. Of major importance, the study also found that 45% were positive for alcohol at autopsy, and 27% for benzodiazepines. Darke et al (1997b) compared deaths in 1992 and those that occurred in the region during 1995. Compared with 1992, cases were older, more likely to be male, more likely to have occurred in Cabramatta, more likely to occur in a public place and less likely to have had an intervention prior to death. There was a substantial increase in the blood morphine levels of cases. There were no significant differences in the prevalence of alcohol and benzodiazepines, however, with approximately a half and a quarter respectively being detected in each year.

The previous study of SWS overdose cases compared deaths in only two, non-consecutive years. The aim of the present study was to provide an analysis of all fatal heroin overdoses in the SWS region over the five year period 1992 to 1996. By examining cases over a consecutive and substantial period of time, trends in the demographic characteristics, toxicological findings and circumstances of death could be analysed in a region that has become the major heroin distribution point in Australia.

1.1   AIMS

The aims of the study were:

1.   To describe the demographic characteristics of heroin-related deaths in SWS between 1992 and 1996;
2.   To describe the circumstances of heroin-related deaths in SWS between 1992 and 1996;
3.   To determine the toxicological findings at autopsy of all cases of heroin-related deaths in the SWS region between 1 January 1992 and 31 December 1996;
4.   To ascertain trends in fatalities across the study period.

2.0   METHOD

2.1   *Procedure*

All heroin-related fatalities that occurred during 1992 in the SWS region were identified from the data reported by Zador et al (1996). All cases positive for blood morphine that occurred in SWS between 1993 and 1996 inclusive were identified by the Government Analytical Laboratories. The SWS region was defined as that covered by the South West Sydney Area Health Service. Data from 1992 and 1995 have been reported previously (Darke et al, 1997b).

Permission was obtained from the Department of Courts Administration to inspect the coronial file relating to each case. Each file was inspected by a member of the research team to ascertain whether the fatality was the result of a heroin overdose, or due to other causes. Overdose fatalities were determined by autopsy conclusions, circumstances of death (e.g. presence of injecting equipment), police investigations. Cases due to other causes were excluded from the study.

2.2   *Data Collection Form*

Information on the demographic characteristics, drug use history, circumstances of death, and toxicological findings of heroin-related deaths was retrieved from the coronial files. Documents contained in the files of particular relevance were police reports, ambulance officers' statements, witnesses' statements, autopsy reports, and results of toxicological analyses. The standardised data collection form used by Zador et al (1996) was employed to record the relevant data. The data collection form is outlined in more detail below.

2.2.1 *Demographic characteristics*

Demographic data obtained included age, sex, marital status, employment status, country of birth, and suburb/town of residence at the time of death.

2.2.2 *History of drug use*

Information was sought on the history of known drug use, and extent of heroin dependence of cases. History of known use of heroin, benzodiazepines and heavy alcohol use was obtained from family members' and friends' statements to police. Information was also sought on cases' history of treatment for heroin dependence.

As was the case with Zador et al (1996) an attempt was made to categorise extent of dependence on heroin of cases into three groups: dependent, recreational, and novice. A classification of "dependent" was not restricted to criteria of physiological dependence (tolerance and withdrawal symptoms). A subject was defined as "dependent" if the coronial file provided evidence of participation in the heroin lifestyle or heroin sub-culture (which may include physiological dependence). The following criteria were considered suggestive of the centrality of heroin use in the deceased's life: known history of heroin use, partner or friends known to be heroin users, history of heroin overdose or treatment for dependence (e.g. rehabilitation or methadone treatment) and criminal record. Cases which did not meet the criteria for inclusion in the "dependent" category were defined as "recreational" users if there was evidence of infrequent heroin use. A "novice" was considered to be a person whose death was due to first time use of heroin.

2.2.3 *Circumstances of death*

Information was obtained on the day and month of death, suburb of death, physical location of death (e.g. home, street, public toilet), time of death, the presence of other persons at the time of death, whether the death was due to suicide and intervention sought or administered (if any).

Intervention was considered to be administered if it was received by the subject while still alive. For example, intervention administered by ambulance officers or following admission to hospital was not included as "intervention" if the subject was clinically dead (absent respirations or pulse, fixed and dilated pupils) at the time of arrival of the ambulance, or at the time of presentation to hospital.

2.2.4 *Toxicological analyses*

Information on results of toxicological analysis was obtained from reports of laboratory analyses performed by the Division of Analytical Laboratories (NSW Department of Health) on blood and other tissue specimens taken at autopsy.

These reports were contained in the coronial files. As it was not possible to be certain whether the presence of two or more benzodiazepine drugs detected at autopsy represented the administration of two drugs or the original drug and its metabolite, all individually detected benzodiazepines were grouped into the single drug class "benzodiazepines".

2.3   *Statistical analyses*

T-tests were used for continuous data. Where distributions were highly skewed, medians were reported, and were analysed using the Mann-Whitney U statistic. For dichotomous categorical variables, Odds Ratios (OR) and 95% Confidence Intervals (95% CI) were reported. The chi-square statistic was reported for other categorical data. In order to determine whether trends occurred in continuous variables across the years of the study, multiple regressions were conducted.

A Spearman rank order correlation was conducted to ascertain whether elapsed time between death and autopsy was related to blood morphine concentrations. In cases where there was a range of time in which death could have occurred, the mid-point was chosen for these analyses. Spearman correlations were also calculated to determine the relationship between blood morphine and alcohol concentrations.

All analyses were conducted using SYSTAT (Wilkinson, 1990). ....

3.0   RESULTS

3.1   *Number of heroin-related fatalities*

A total of 176 heroin-related fatalities occurred in the SWS region during the five year period   1992-1996: 1992 (20 deaths), 1993 (17), 1994 (41), 1995 (44), 1996 (54). The number of fatalities by year are presented graphically in Figure   1.
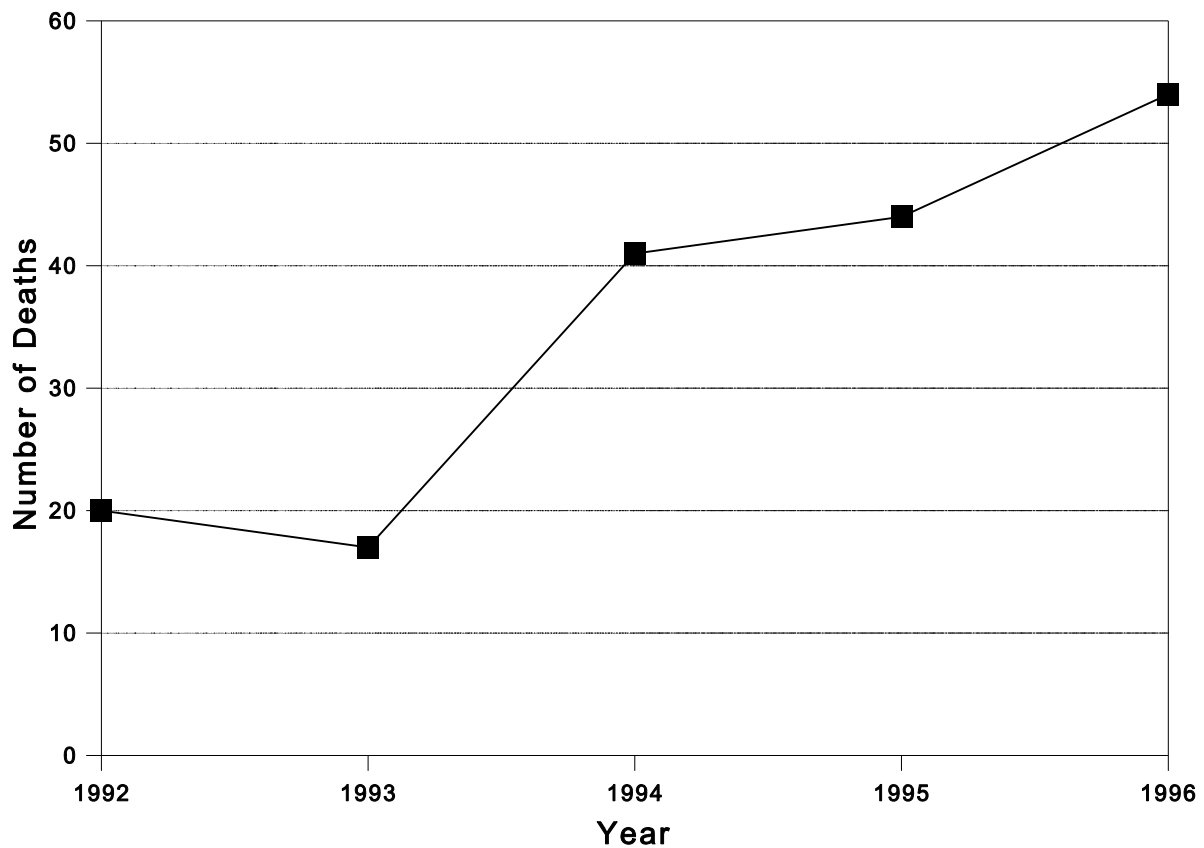
Figure 1:   Number of heroin-related fatalities in SWS, 1992-1996
As can be seen, the number of deaths rose substantially over the period 1993-1996. The increase in the number of deaths over the period was statistically significant (F_1=21.8, p<.05).

3.2   *Demographic characteristics*

The mean age of cases over the study period was 29.6 years (SD 7.0 yrs, range 16-50 yrs). Males were significantly older than females, being on average three years older at death (29.9 yrs v 26.7 yrs, t_{174}=1.9, p=.05). The distribution of age at death of cases over the study period is displayed in Figure 2. Only 6% of cases were below the age of twenty at death. The modal age range was the 30-34 year range (25% of cases).
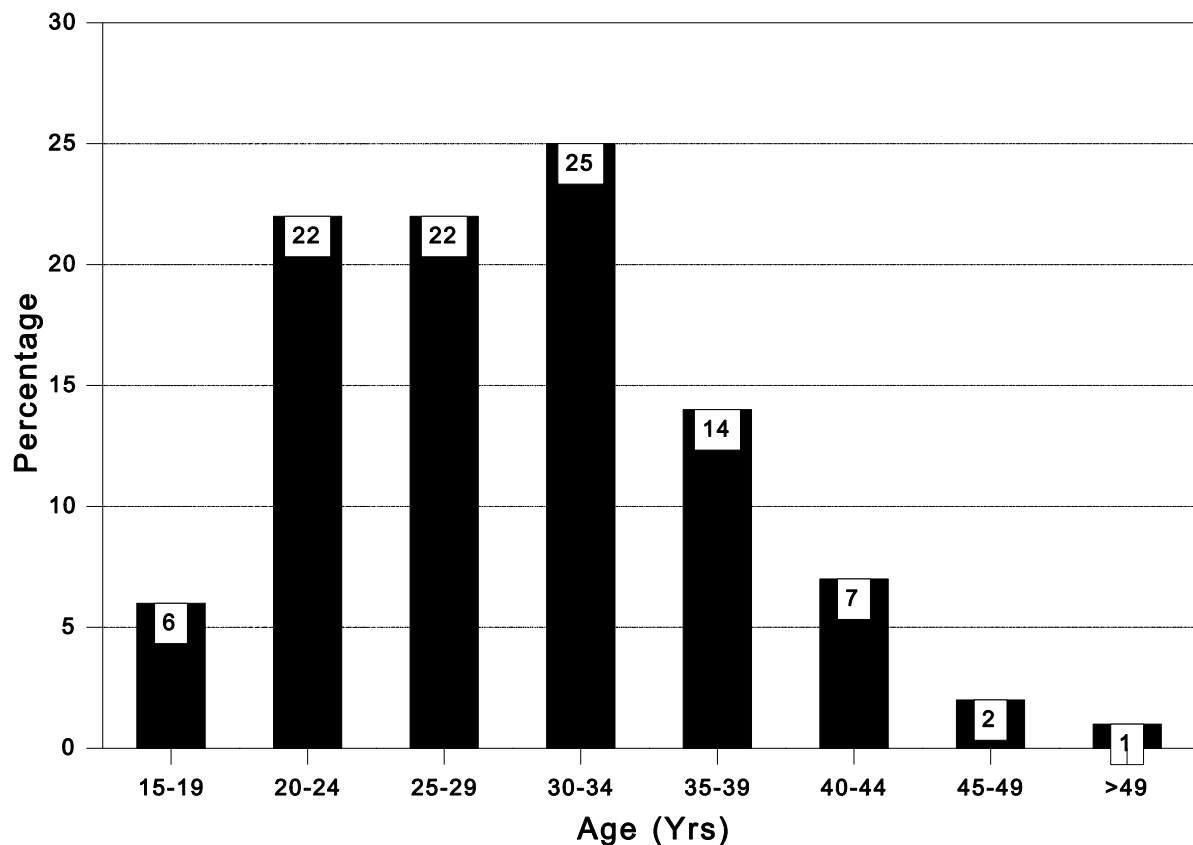
Figure 2:   Age distribution of SWS heroin-related fatalities, 1992-1996
The mean ages of fatalities by year over the study period are presented in Figure 3.
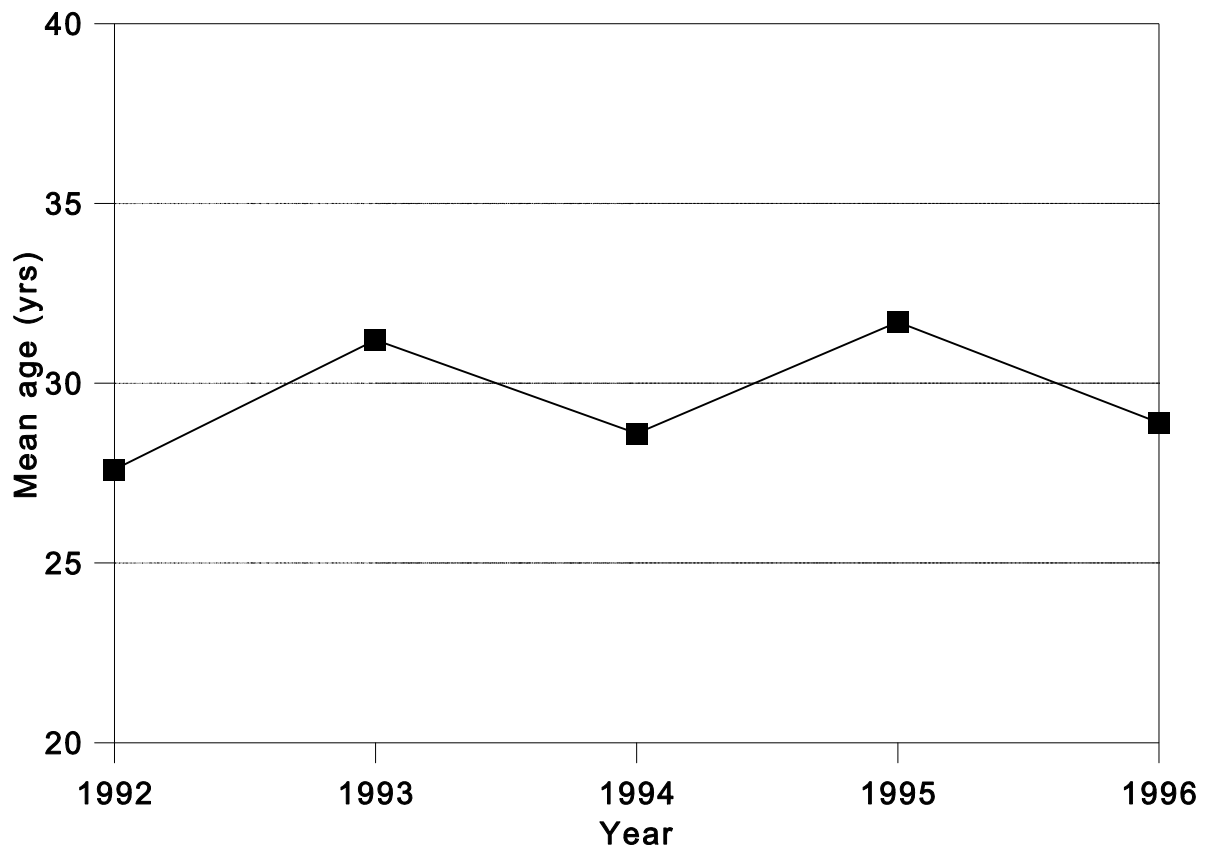
Figure 3:   Mean age of heroin-related fatalities in SWS, 1992-1996
There was no significant variation in the mean age of fatalities over the study period, which ranged from a minimum of 27.6 years in 1992 to a maximum of 31.7 years in 1995.

The overwhelming majority of cases during the study period were male (89%). There was no significant variation in the gender of subjects over the study period, which ranged from 75% male in 1992 to 100% in 1993 (Figure 4).

Figure 4: Gender of SWS heroin-related deaths, 1992-1996
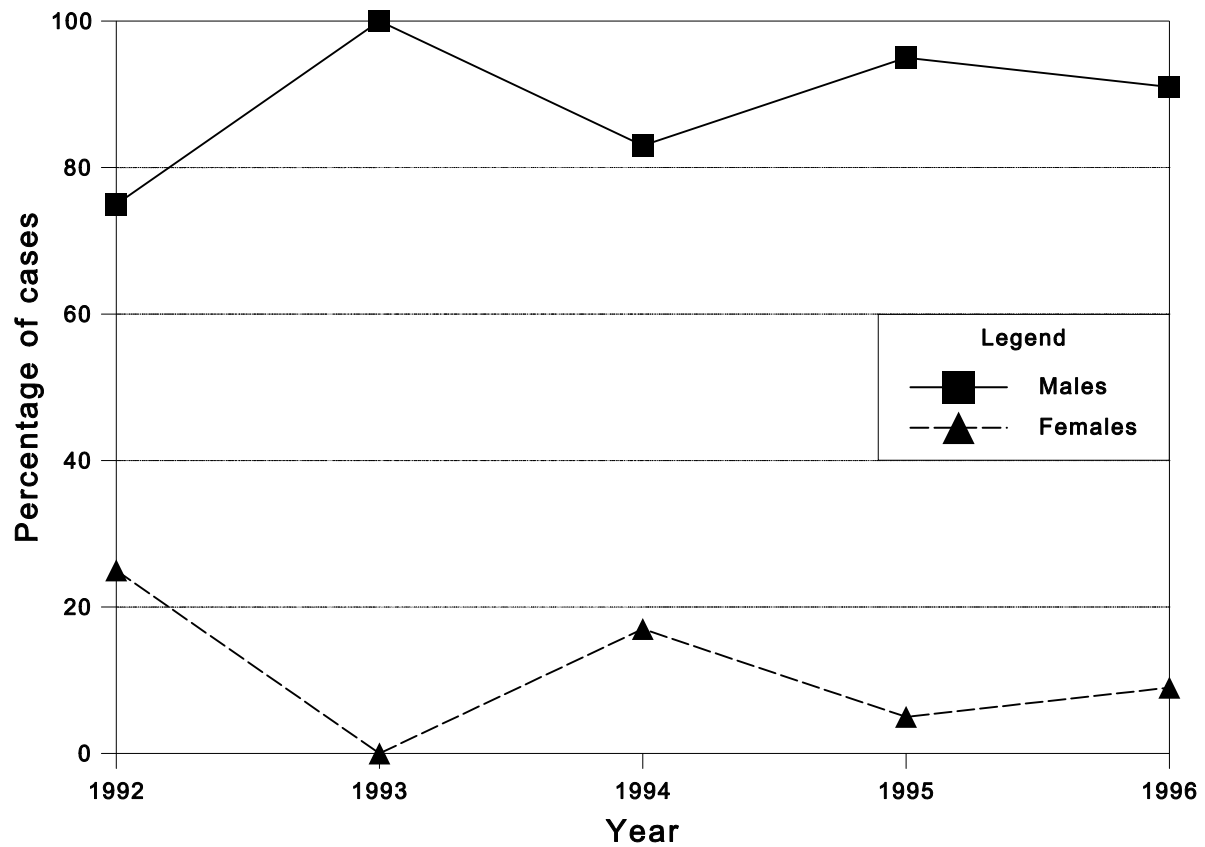
Marital status, employment status and country of birth of cases are presented in Table 1. The majority of cases were single, unemployed and born in Australia. After Australian born cases, the next largest group were born in south east Asia (9%).

Table 1:   Marital status, employment status and country of birth of SWS heroin-related fatalities, 1992-1996

Variable	Males (N=157)	Females (N=19)	All cases (N=176)
Marital status (%):			
Single	63	53	62
Married/defacto	36	47	37
Unknown	1	0	1
Employment status (%):			
Unemployed	75	95	77
Employed	24	5	22
Unknown	1	0	1
Country of birth (%):			
Australia	76	95	78
South East Asia	10	0	9
Europe	4	5	4
United Kingdom	3	0	3
Lebanon	2	0	2
South America	3	0	2
New Zealand	1	0	1
Unknown	1	0	1

3.3   *History of drug use*

Drug use histories of cases are presented in Table 2. Almost all cases (91%) over the study period were known heroin users (based upon statements by friends and relatives in coronial files). In addition, a third were known heavy alcohol users, and a quarter were known benzodiazepine users. The overwhelming majority of cases (92%) were classified as heroin dependent, with recreational users comprising 8% of cases. With the exception of one case, the route of heroin administration was by injection.

Four cases (2%) were enrolled in methadone maintenance (MM) at the time of death. Twelve cases (7%) had been released from prison in the month prior to death. Of these 12 cases, 4 died on the day of their release, one had been released the day prior to death and one died whilst in police custody.

Table 2: SWS   Known drug use, dependence status, and treatment status of heroin-related fatalities, 1992-1996

Variable	% (N=176)
History of known drug use	
Heroin use	91
Heavy alcohol use	32
Benzodiazepine use	22
Dependence status	
Dependent	92
Recreational	8
Novice	0
Route of final heroin administration	
Injection	99
Smoking	1
Methadone Treatment	
In methadone at time of death	2
Prison	
Recently released from prison/in custody	7

3.4   *Circumstances of death*

3.4.1 <u>Suicide</u>

Suicide by heroin administration accounted for 4% of cases (n=7). Proportions of suicides by year are presented in Table 3.

Table 3:   Percentage of suicides among SWS heroin-related fatalities, 1992-   1996

Year	1992 (N=20)	1993 (N=17)	1994 (N=41)	1995 (N=44)	1996 (N=54)	Total (N=176)
Suicides (%)	0	0	5	7	4	4

3.4.2 Location of death

The physical locations of deaths are presented in Table 4. As can be seen, the most common locations of deaths over the study period were in public places (street, public toilet, hotel/club, railway station). Overall, 70% of fatalities occurred in a public place.

Table 4:   Physical location of deaths in SWS, 1992-1996

Location of death	% (N=176)
Street	37
Own home	26
Home of friend or family	13
Car	8
Public toilet	7
Railway station	3
Hotel/club	3
Hospital	2

The physical location of deaths altered over the study period. Figure 5 depicts the proportions of deaths in home environments and in public places over the five years of the study period.

Figure 5:   **Proportions of home and publicly located SWS**
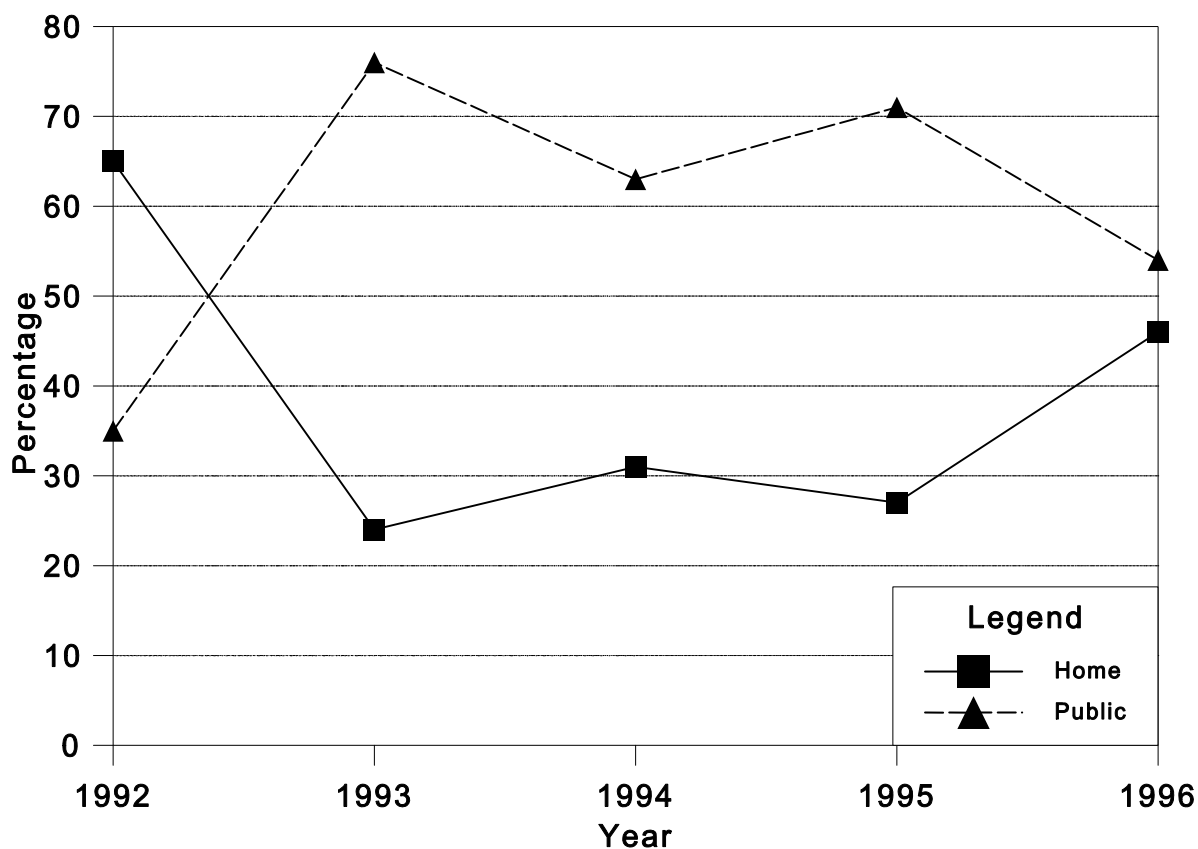
heroin-related .. .. deaths, 1992-1996
In 1992, deaths that occurred in either the home of the deceased or that of a friend/family of the deceased accounted for the majority of deaths (65%). Since 1992, deaths in public locations have constituted the majority of fatalities. The increase in the proportion of publicly-located deaths was significant (χ^2=15.6, df=8, p<.05).

Deaths that occurred in the suburb of Cabramatta constituted 38% of all cases. The second highest proportions of deaths occurred in Fairfield (6%), Liverpool (6%) and Warwick Farm (6%). Cabramatta accounted for substantially more deaths than any other suburb in all years of the study, although the proportions varied greatly: 1992 (15%), 1993 (50%), 1994 (32%), 1995 (59%), 1996 (28%). Deaths that occurred in Cabramatta were significantly more likely to have occurred in a public place than other SWS deaths (89% v 42%, OR 7.0, 95% CI 3.3-4.8).

A third (33%) of cases resided outside the SWS region at the time of their death While 38% of deaths occurred in Cabramatta, only 3% of cases resided in that suburb at the time of death (6/67 cases).

3.4.3 <u>Time of death</u>

The times at which deaths occurred over the study period are presented in Table 5. In 81% of cases the time of death was able to be estimated within the six hour periods presented in Table 5. The majority of the cases in which the time of death could be estimated died between midday and midnight (62%). The most common time of death was in the midday to 6pm period (37%).

Table 5:   Time of death of SWS heroin-related fatalities, 1992-1996

Time of death	% (N=142)*
Midnight to 6 AM	23
6 AM to midday	14
Midday to 6 PM	37
6 PM to midnight	25

*   *In 34 cases time of death was not able to be ascertained within these intervals*

The days of the week upon which deaths occurred are presented in Figure 6. Day of death was able to be determined in all but seven cases. The day on which deaths most frequently occurred was Thursday (21%), which occurred significantly more frequently than chance ($\chi^2=6.0$, 1 df, p<.05). There was no over-representation of weekend deaths over the study period (26%).

Figure 6:   Days of week on which SWS heroin-related fatalities deaths occurred, 1992-1996
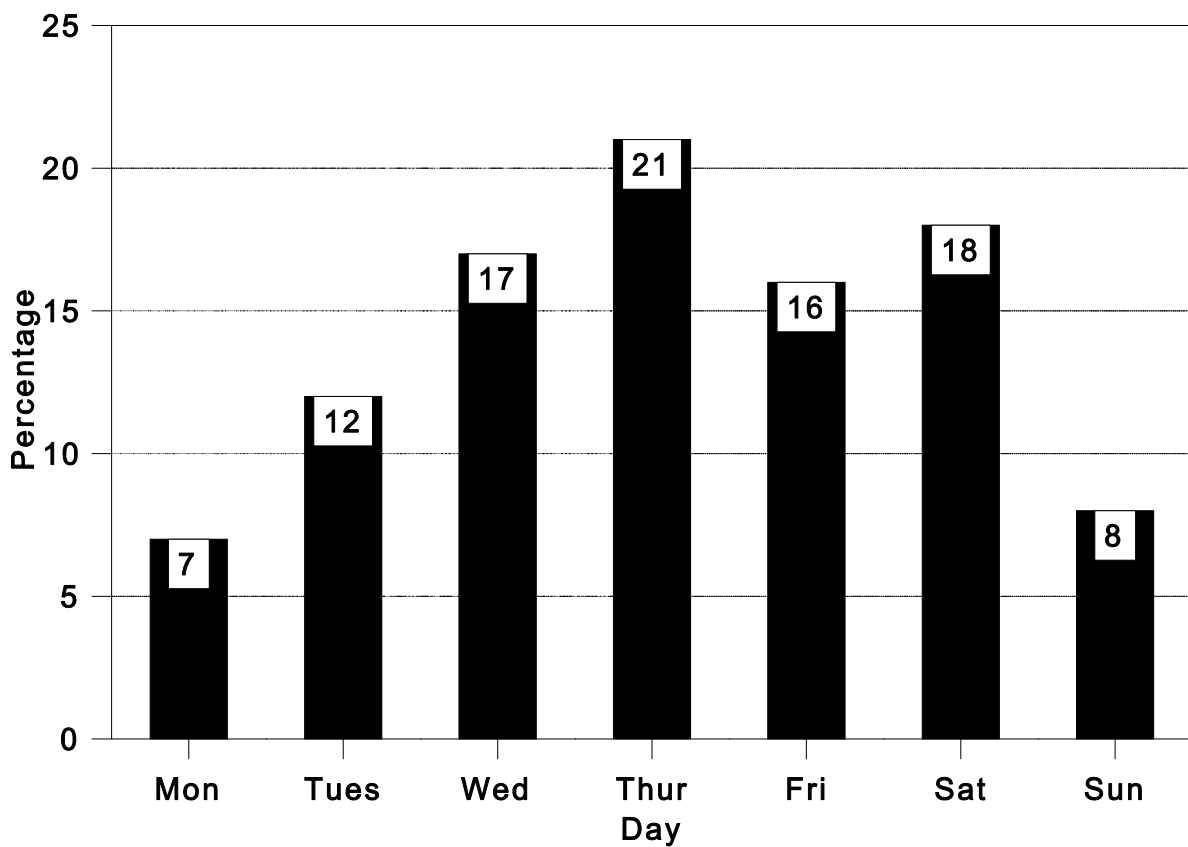
The months in which deaths occurred are presented in Figure 7. Month of death was able to be determined in all cases. There were significant monthly variations in deaths (χ^2=26.5, df=11, p<.001). As can be seen, the most deaths occurred in the winter months of July (15%) and June (13%).

Figure 7:   Months of deaths, 1992-1996
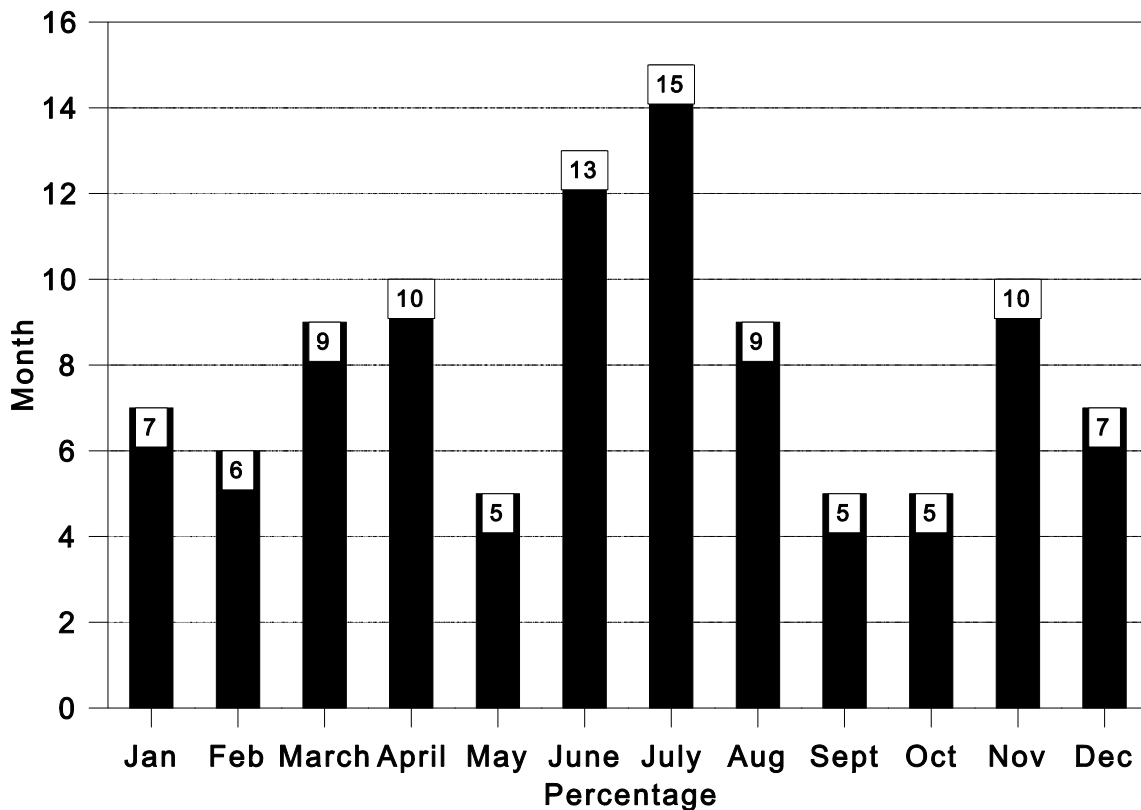
Estimated time between final heroin administration and death are presented in Table 6. An estimate of the elapsed time between heroin use and death was able to be made in 78% of cases. In the remaining cases, circumstances did not permit an estimate to be made. Deaths that occurred instantly after heroin administration constituted 15% of cases. In 17% of cases, death was estimated to have occurred more than three hours after the ingestion of heroin. In 9% of cases, an estimate within the parameters displayed in Table 6 was unable to be made, but circumstances indicated that death was not instant.

Table 6: **Estimated time between final heroin administration and death** of SWS heroin-related fatalities, 1992-1996

Estimated time lapse	% (N=138)*
Instant	15
1-15 minutes	28
15 minutes-1 hour	24
1-2 hours	3
2-3 hours	4
>3 hours	17
Not instant, time uncertain	9

* In 38 cases no estimate could be made

3.4.4 Interventions

Nearly a half of cases died in the presence of others, a third died alone, and a fifth died segregated from others (Table 7).

Table 7: **Presence of other persons at time of death of SWS heroin-related .. fatalities, 1992-1996**

Presence	% (N=176)
Died in presence of others	47
Died alone	34
Died segregated from others	19

The frequency with which interventions occurred prior to death are shown in Table 8. While others were present in 47% of cases, no intervention occurred prior to death in 71% of cases. In 19% of cases an ambulance called prior to death.

Table 8: **Frequency of interventions used for resuscitation of cases, 1992-   1996**

Intervention	%* (N=176)
None	71
Ambulance	19
CPR	7
Hospital	2
Place in shower	1
Inject saline	1
Inflict pain	1
Withdraw blood	1

* Percentages add to >100% as multiple interventions occurred in some cases

3.5   *Toxicological findings*

3.5.1 Blood morphine concentrations

Toxicological results were unavailable for three cases. The median blood morphine concentration of cases over the study period was 0.34 mg/L (0.03-19.0 mg/L). There was no difference in the median morphine concentrations of males and females (0.34 mg/L v 0.38 mg/L). The distribution of blood morphine concentrations is presented in Figure 8. The data are presented in 10 mg intervals (0.1=0.0-0.10, 0.2=0.11-0.20, etc.). Twenty one percent of cases had blood morphine concentrations below the toxic level designated by the Division of Analytical Laboratories (0.16 mg/L). There was no significant correlation between blood morphine concentration and time between death and autopsy (r_s=-0.09).

Figure 8: **Distribution of blood morphine concentrations among SWS heroin-related deaths, 1992-1996**
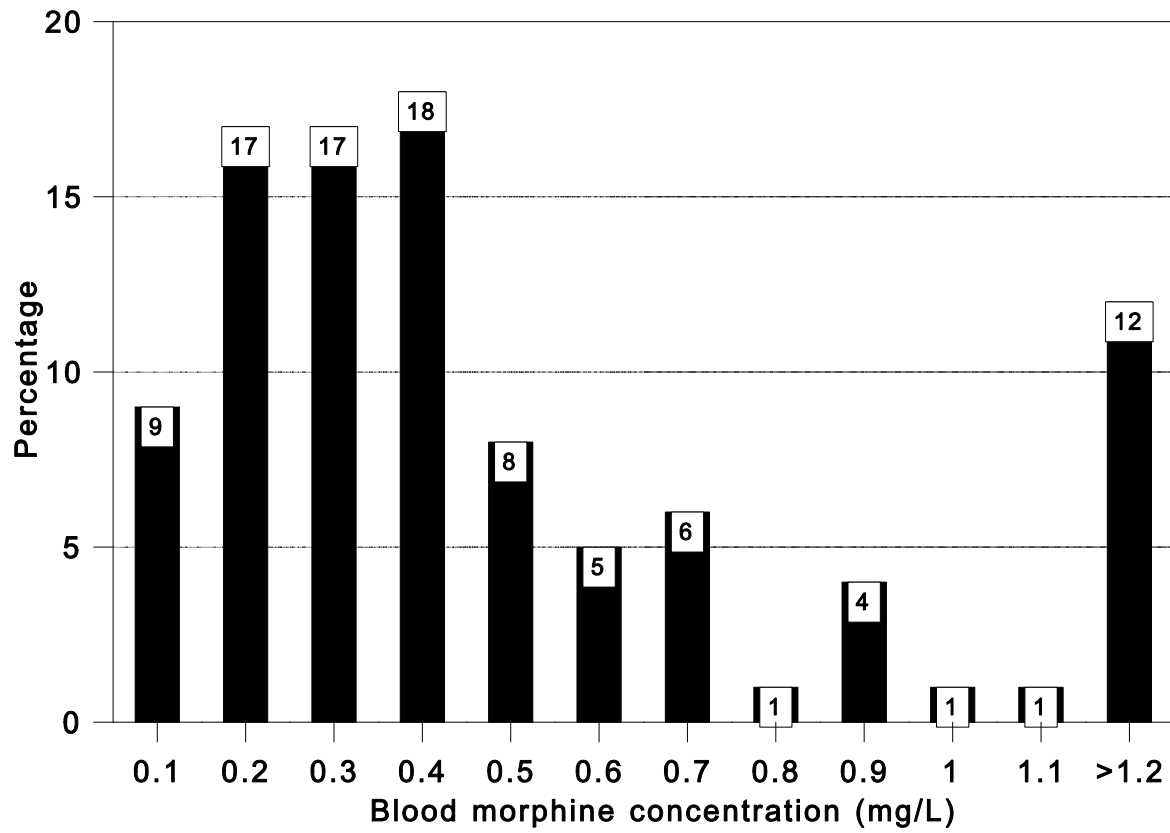
Median blood morphine concentrations for the study period are presented in Figure 9. There was a large and significant increase in morphine concentrations over the study period (F=4.6, df=1, p<.05). The major increase appears to have occurred in the period 1992-1994, when concentrations rose from 0.16 mg/L in 1992 to 0.37 mg/L in 1994. Morphine concentrations appeared to stabilise after this period.

Morphine was the only drug detected in 33% of cases over the study period. It is important to note that contaminants were detected in relation to only one of the 176 cases that occurred over the study period, the contaminant being quinine.

Figure 9: **Median blood morphine concentrations of SWS**
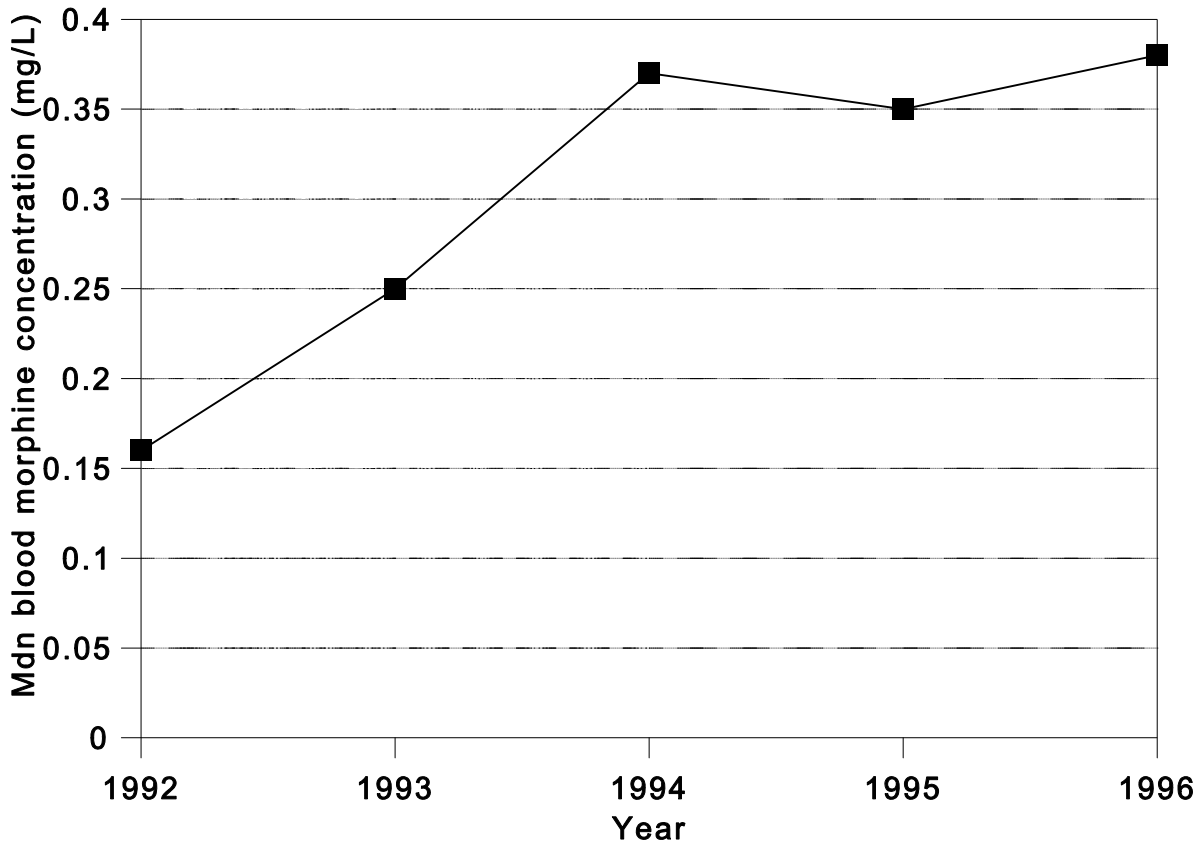
heroin-related .. .. deaths, 1992-1996

3.5.2 <u>Blood Alcohol</u>

Over the study period, 40% of cases had alcohol detected at autopsy. Males were significantly more likely than females to have alcohol detected (44% v 11%, OR 6.2, 95% CI 1.4-27.8). Among those in whom alcohol was detected, the median blood alcohol concentration was 0.12 g/100 ml (range 0.01-0.33 g/100 ml). The blood alcohol concentrations of cases are presented in Figure 10. Nearly a third of cases (31%) had blood alcohol concentrations above the legal driving limit of 0.05 g/100 ml, with 24% of cases having blood alcohol concentrations greater than 0.10 g/100 ml.

Figure 10:   Blood alcohol concentrations of SWS heroin-related
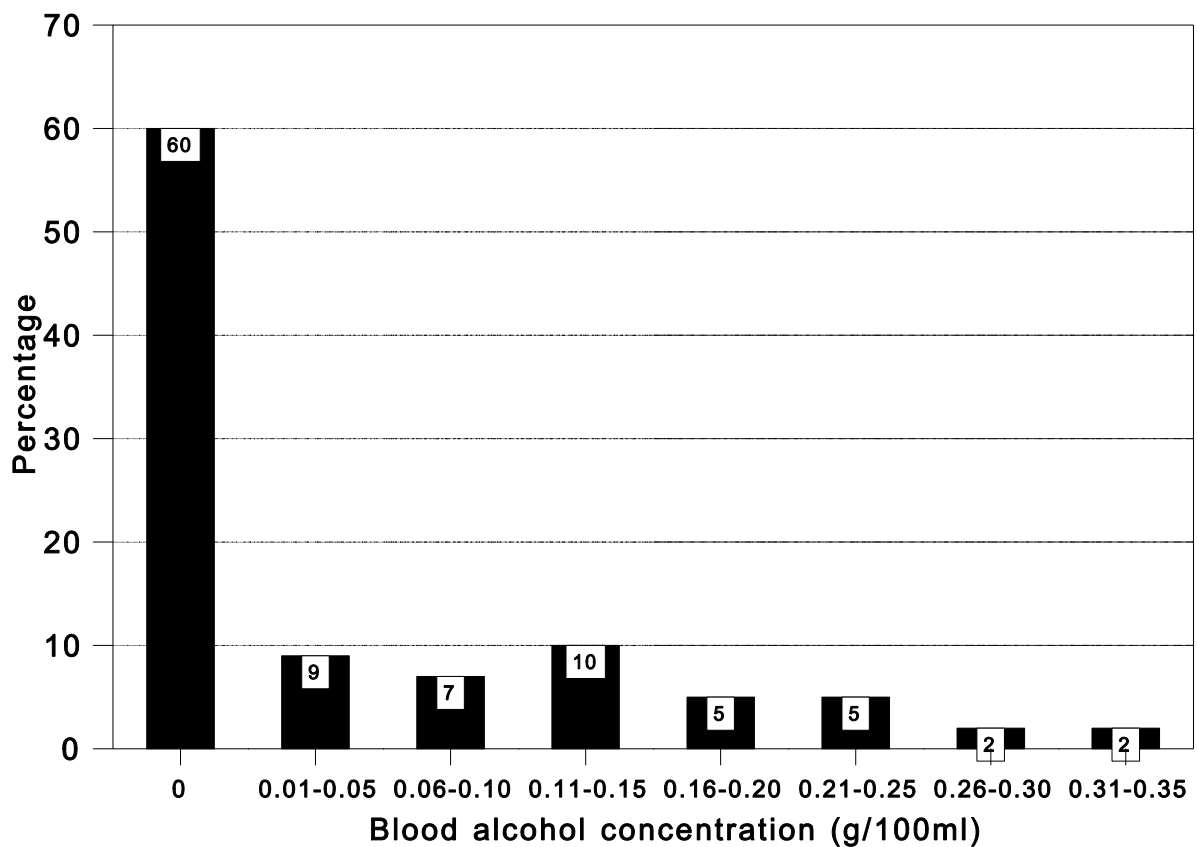
fatalities, ... 1992-1996

The percentages of cases by year in which blood alcohol was detected are presented in Figure 11. There was no significant difference in the proportions of cases in which alcohol was detected over the study period. There was a significant negative correlation between blood morphine and blood alcohol concentrations (r_s=-0.39, p<.001). The median blood morphine concentration of cases in which alcohol was detected was 0.25 mg/L, compared to 0.42 mg/L in cases where alcohol was not present (U=4843, p<.001).

Figure 11:   Proportions of SWS heroin-related fatalities in which
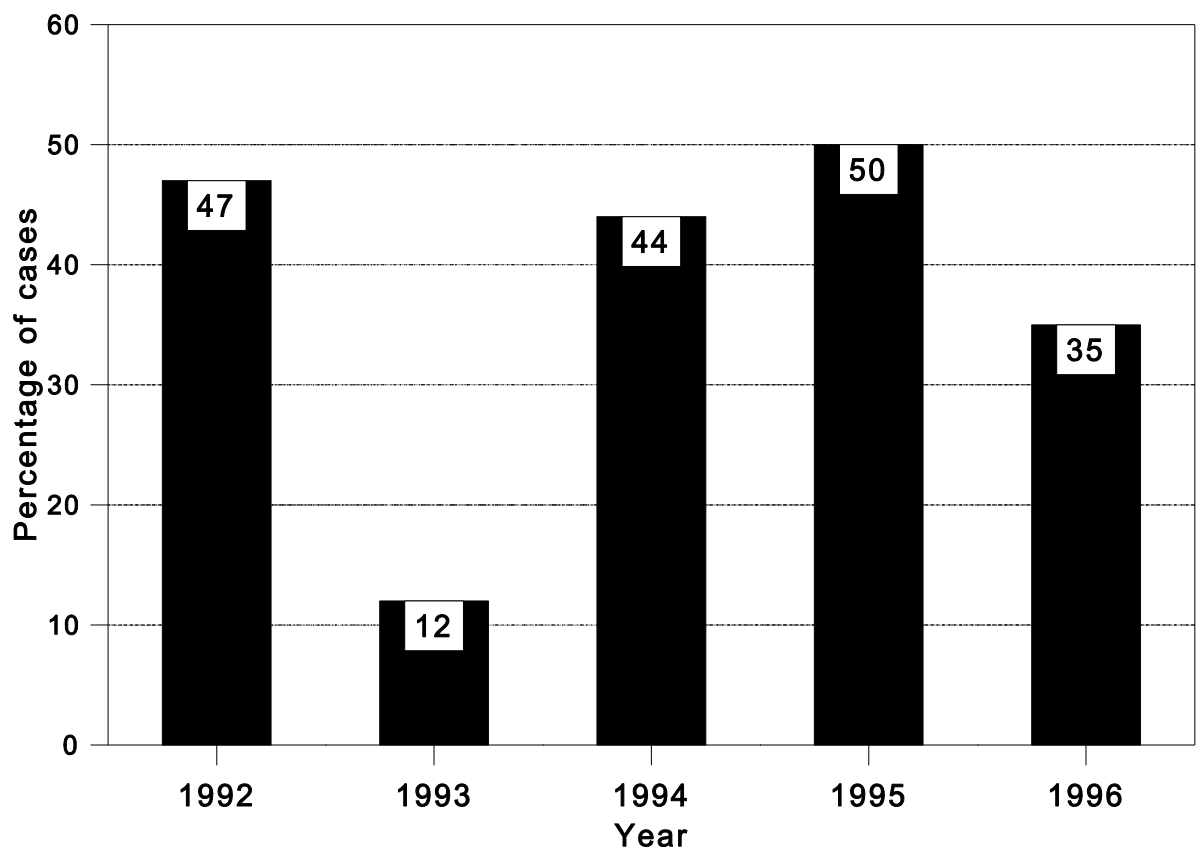
alcohol   ....   was detected, 1992-1996

3.5.3 Benzodiazepines

Benzodiazepines were detected in 30% of cases over the study period. Females were significantly more likely than males to have benzodiazepines detected (56% v 28%, OR 3.3, 95% CI 1.2-8.9). The proportions of cases in which benzodiazepines were detected are presented in Figure 12. There was no significant variation over the years of the study period in the proportions of cases in which benzodiazepines were detected.

Figure 12:   Proportions of SWS heroin-related deaths in which benzodiazepines were detected, 1992-1996
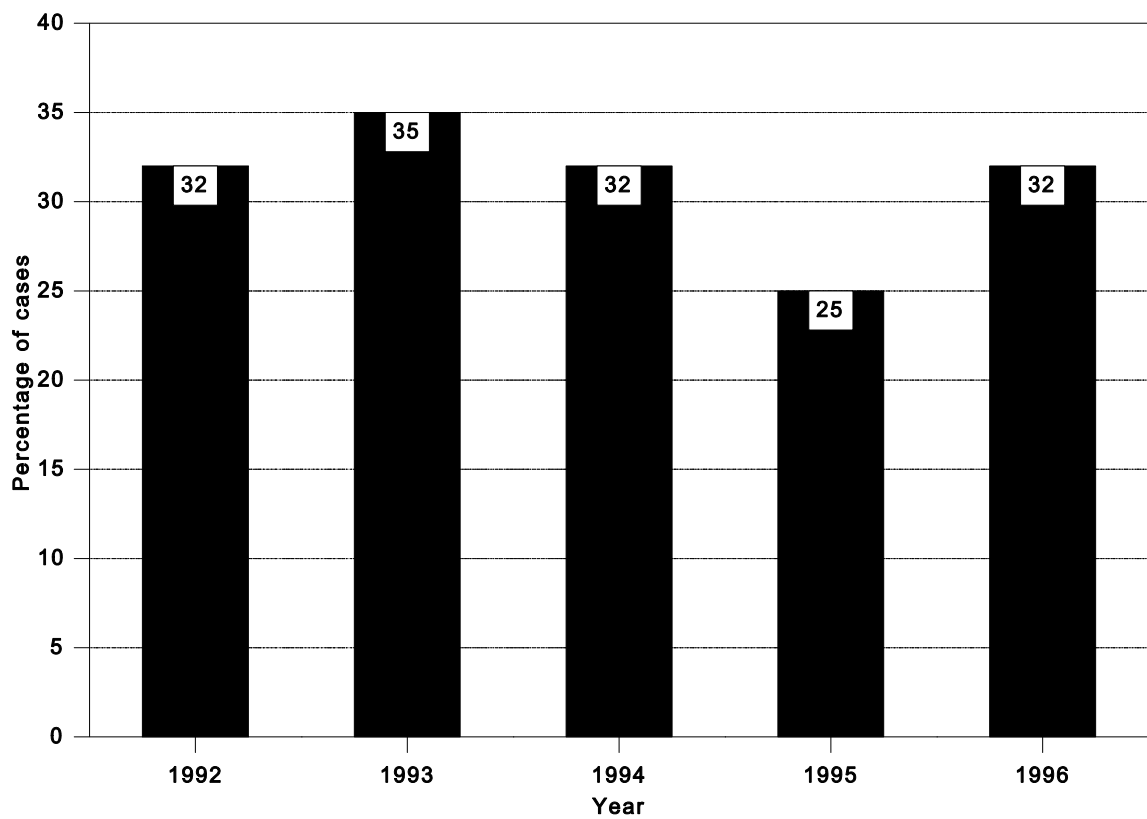
3.5.4 Other drugs

Other drugs detected at autopsy are presented in Table 9. The most frequently detected were antidepressants (9% of cases). The most commonly detected antidepressant was the tricyclic dothiepin. Overall, the 16 cases in which antidepressants were detected consisted of 13 tricyclics, 2 SSRIs and one MAO inhibitor.

Methadone was detected in 7% of cases. Barbiturates were not detected in any case. There were no significant trends in the proportions of any of the drugs represented in Table 9 over the study period.

Table 9:   Prevalence of other drugs among SWS heroin-related deaths, ... 1992-1996

Drug	% (N=173)*
Antidepressants	9
Methadone	7
Amphetamines	5
Antipsychotics	2
Cocaine	2

Barbiturates	0

* No toxicological data in 3 cases

3.6   Pathologists' conclusions

The causes of death designated by pathologists over the study period are listed in Table 10.

Table 10:   Pathologists' conclusions regarding cause of death of SWS heroin-related fatalities, 1992-1996

Cause of death	% (N=176)
Acute narcotism	78
Morphine and alcohol toxicity	14
Multiple drug toxicity	3
Morphine and benzodiazepines	2
Morphine and antidepressants	1
Morphine and cocaine	1
Morphine and pneumonia	1

In over three quarters of cases that occurred over the study period the cause of death was attributed to "acute narcotism" (or "narcotism"). Mention of the role of alcohol was made in 14% of cases.

Of the cases in which drugs other than morphine were detected, 69% were attributed solely to narcotism. There were no significant differences in the proportions of cases attributed to acute narcotism over the five years of the study period.

Coronial inquests were held in 11 of the 176 cases (6%) that occurred over the study period.

4.0 DISCUSSION

4.1 *Major findings of the study*

The current study documented a substantial, statistically significant increase in heroin-related fatalities in SWS, from 20 deaths in 1992 to 54 during 1996, with 176 deaths occurring over a five year period. Deaths were overwhelmingly among older, dependent males. Fatalities predominantly occurred in public settings, with Cabramatta the location in which deaths most frequently occurred. Morphine concentrations rose markedly over the study period. The majority of cases, however, involved heroin in combination with other drugs.

4.2 *Demographic characteristics*

The "typical" overdose case in SWS over the study period was male, approximately thirty years old, Australian born, single and unemployed. Males formed the overwhelming majority of cases in all years, never constituting less than three quarters of cases, and 89% of cases over all years. In fact, during 1993, *all* cases were males. Overall, the demographic characteristics of cases showed remarkable consistency throughout the study period. It should be noted that the general demographic characteristics of SWS cases are similar to those reported in other countries (cf. Darke & Zador, 1996).

As was reported by Zador et al (1996) in relation to 1992 NSW cases, females in the current study were approximately three years younger than males. It is unclear whether this represents a shorter overall heroin using career than their male counterparts, or an earlier onset of heroin use. Studies of heroin users consistently indicate that female injecting drug users are more likely to have an injecting drug using sexual partner than male injectors (Powis et al, 1996; Sasse et al, 1991). It is possible that females are being initiated earlier than males into heroin use, by older male sexual partners.

The majority of cases were Australian born. The second largest group after the Australian born were Asian born cases. This is consistent with the demographic characteristics of the SWS region, which has a larger Indochinese population. It is worthy of note that all Asian born cases were male.

In terms of drug use characteristics, cases were overwhelmingly dependent, long-term heroin users. In addition, a third were also known to be heavy alcohol users and a quarter were known benzodiazepine users. Consistent with other studies, and inconsistent with popular perception, it is older, experienced heroin users who constitute the majority of fatal overdose cases (Hall & Darke, 1997; Oppenheimer et al, 1994; Zador et al, 1996). Young, inexperienced users were rare. Cases who were under the age of twenty at time of death constituted only 6% of all cases. The reasons for the over-representation of older users in fatal cases is unclear. It is possible that this is a reflection of cumulative risk. The

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cases in this study would on average have been using heroin for a decade or longer, given that heroin initiation usually occurs in the late teens (Clayton, 1986). Given that any injection will carry a risk of overdose, however small, repeated administration over a decade will result in a high cumulative risk of overdose. It should be noted that increasing age has been associated with the probability of non-fatal overdose (Darke et al, 1996). A second hypothesis is that older users may be more dependent, use heroin more frequently and engage in more polydrug use. Finally, it is possible that older users may not metabolise heroin and other drugs as efficiently as younger users, particularly given the high prevalence of hepatitis C among heroin users (Crofts et al, 1997). Whatever the causal mechanisms, it is the older heroin user who is most at risk, and to whom specific overdose prevention interventions should be targeted.

In all but one case, the route of administration was by injection. This is of relevance, given that heroin smoking is known to be widespread in the SWS region (Swift et al, 1997). The low prevalence of smoking fatalities is consistent with studies of route of administration and non-fatal overdoses, which indicate that overdosing while smoking heroin is infrequent (Gossop et al, 1996; Swift et al, 1997). However, it is important to document that both fatal and non-fatal overdoses can occur while smoking heroin. The view that heroin smoking is a safe means of using the drug is erroneous. There are risks of overdose and dependence associated with heroin use, whatever route of administration is employed.

Only 2% of cases were enrolled in MM at the time of death. This finding is identical with those reported for 1992 NSW cases (Zador et al, 1996). Less frequent heroin injecting associated with MM (Ward et al, 1992), and a high tolerance for opioids while maintained on methadone may explain the low prevalence of MM patients in heroin-related fatalities. It is the untreated, older heroin user who is most at risk of fatal overdose.

A notable proportion of cases (7%) had recently been released from prison (and in one case was still incarcerated) prior to death. Four deaths occurred on the very day of release. While large proportions of heroin users use heroin whilst in prison, it is at a substantially reduced frequency (Dolan et al, 1996). Tolerance for the drug would thus be substantially diminished. Whether used alone, or in conjunction with other drugs, heroin use after a period of enforced abstinence (or reduced frequency of use) carries a high risk of overdose. It should be noted that similar findings have been reported for experiencing a non-fatal overdose after prison release (Darke et al, 1996; McGregor et al, in press).

4.3   *Circumstances of death*

Only 4% of cases over the study period were attributed to suicide, the `typical' overdose fatality being non-intentional. It is well documented that there is a

high prevalence of depression and dysthymia among heroin users (Darke & Ross, 1997; Steer et al, 1992). However, depressive mood states should not be conflated with suicidal intention. Many heroin users in this study may well have used the drug to self-medicate depression, or use the drug in a reckless manner. However, the deliberate use of heroin as a means of suicide appeared unusual.

The majority of deaths (70%) over the study period occurred in public settings, with street environments being the most common. This was not the case in 1992, but remained so for each subsequent year. The preponderance of deaths in public places in SWS stands in contrast to the earlier work on NSW overdose fatalities in 1992 by Zador et al (1996), in which the majority of fatalities occurred in home environments. It is unknown at this point in time whether similar trends have occurred across the state. It is likely, however, that there are special circumstances operating in SWS which are not reflected in the broader overdose topography.

The major circumstance that stands out in the SWS region is the prominence of Cabramatta as a heroin market. Cabramatta accounted for substantially more heroin-related deaths than any other suburb in the region. Furthermore, deaths that occurred in Cabramatta were significantly more likely to have occurred in a public place than those that occurred in other suburbs (89% v 42%). The data indicate that Cabramatta attracts heroin users to the suburb to buy heroin, which is used immediately, in public locations. Only 6 of the 67 deaths that occurred in Cabramatta were from that suburb. Also, a third of all SWS cases were from outside the SWS region altogether. Heroin users who travel to Cabramatta to obtain heroin, if they do use the drug immediately, will be forced to use it in some form of public location.

Deaths in the study that were estimated to have occurred instantly upon heroin administration formed a minority of cases (15%). In fact, in approximately a fifth of cases the estimated period between heroin administration and death was more than two hours. These results are consistent with findings from the few studies that have investigated this aspect of overdose (Manning et al, 1983; Monforte, 1977; Nakamura, 1978; Zador et al, 1996). Despite the fact that time was available for intervention in most instances, no intervention at all occurred in 71% of cases.

The absence of any over-representation of week-end deaths is consistent with the profile of cases as long-term, dependent users. An over-representation of week-end deaths would be expected only if recreational users constituted the majority of cases. The over-representation of Thursday deaths is, in all probability, related to the receipt of government benefits on that day. The finding that more deaths occurred in the inter months is puzzling, with no obvious explanation.

4.4   *Toxicological findings*

One of the major findings of the current study was the significant increase in blood morphine concentrations over the study period. Morphine concentrations increased sharply between 1992 and 1994, and then appeared to stabilise. It is probable that the increase in median morphine levels observed over the study period is related to increases in heroin purity over that period.

It should not be assumed, however, that the increases in the number of fatal cases in SWS over the study period can be attributed to variations in heroin purity. First, a fifth of cases in this study had blood morphine concentrations below the designated toxic level for opioid naive individuals, which this population was most certainly not. Secondly, a recent time series analysis of heroin samples and fatalities in SWS over two years of the study period (1993-1995) indicated that variations in heroin purity accounted for only a minority of variations in fatal overdoses (Darke et al, in press). Blood morphine concentrations of living SWS heroin users have also been found to have considerable overlap with those detected in fatal SWS cases (Darke et al, 1997a). Thirdly, the majority of overdoses involved drug combinations. Finally, the "honeypot" effect of the Cabramatta drug market needs to be taken into account.

As noted above, the majority of deaths involved drugs in combination with heroin. The three most common other drugs detected were alcohol, benzodiazepines and antidepressants. It is possible that the high purity of heroin in SWS increases the risk of polydrug overdose. As purity increases, the safety margin in combining drug decreases. While tolerant to high purity heroin when used alone, when used in combination with other CNS depressants a combination overdose may result. The negative correlation between blood morphine and blood alcohol concentrations illustrates this point. Of relevance here is the finding from the comparative study of current SWS heroin users and fatal cases in 1995, alcohol was present in 1% of current users, and 50% of fatal cases (Darke et al, 1997a).

The presence of antidepressants in 9% of cases is worthy of further exploration. Tricyclic antidepressants constituted the majority of these cases. The dangers of interactions of tricyclic antidepressants and opioids are well known (Calwell, 1997). While the safer SSRIs are prescribed at much more frequent levels than tricyclics, they only appeared in two cases. It is probable that the tricyclic antidepressants are contributing to the deaths of those cases in which they were detected. The use of antidepressants by heroin users clearly requires further study.

Despite the preponderance of polypharmacy fatalities, cause of death was overwhelming attributed solely to the effects of heroin. Attribution solely to heroin occurred in over two thirds of cases in which other drugs were present.

4.5 *Implications and Conclusions*

The current research indicated that the number of SWS heroin-related fatalities continued to rise throughout the study period. In fact, the number of deaths rose 23% in 1996 compared to 1995, the final years of the study. The problem facing authorities in SWS has also changed in nature in recent years, with deaths in public locations now representing the majority of cases.

Several potential interventions to reduce the mortality associated with heroin use in SWS arise from the current data. Despite the high purity of heroin in the region, most deaths continued to involve polydrug use. In particular, the reduction of the concomitant use of alcohol, benzodiazepines and antidepressants with heroin is strongly implicated as a mean of risk reduction. An increase in awareness of the role of multiple drug use, among both heroin users and service providers, in what are termed "heroin overdoses" is essential. Both heroin users, and service providers, need to be disabused of the myth that heroin overdoses are solely, or even mainly, attributable to fluctuations in heroin purity.

The data indicate that, possibly unlike other regions, the majority of heroin-related fatalities in SWS occurred in a street setting, particularly in Cabramatta. One possible means of intervening to reduce street-based heroin use and overdose is the provision of safe injecting rooms in SWS. Appropriately staffed, such rooms would provide immediate assistance in cases of overdose. Clearly, however, general public acceptance of such a facility is likely to be problematic. Location would clearly be of major importance. If the rooms became drug market places, then it is unlikely to be well received by the public, and may well be a counter-productive initiative.

A less controversial proposal is the wider provision of MM. Patients enrolled in MM made up only 2% of fatalities across the five year period. The demographic characteristics of cases in this and other studies indicate that a particular target group are older, dependent heroin users.

Finally, it is clear that responses to overdose are poor. It is essential that heroin users be encouraged to call immediately for ambulance assistance. In most cases, there is time for intervention. Similarly, it has been proposed that opioid overdose morbidity and mortality could be substantially reduced by distributing the opioid antagonist naloxone to heroin users (Darke & Hall, 1997; Strang et al, 1996). Given the reluctance of heroin users to seek assistance it may be worthwhile considering a controlled trial of naloxone distribution to high risk heroin users. This would, however, only be employed as an intervention in those cases where overdose occurs in a home environment, with others present to administer the drug.

In summary, heroin-related fatalities continued to rise in SWS throughout the five years of the study. Specific and innovative responses to the problem in this

region are necessary if the rise in the number of fatal cases is to be curbed.

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