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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Aim: To examine the utility of two indicators of opioid overdose in comparison with Australian Bureau of Statistics (ABS) data on opioid-related deaths in NSW, Australia.

Method: Data on NSW Ambulance Service attendances at suspected drug overdoses, and data on deaths in which morphine was detected by the NSW Divisions of Analytical Laboratory/ICPMR (DAL), were compared against ABS cases of opioid overdose. The age and gender distribution of the data sources were compared. Time series analyses were conducted to examine the trends in each data source over time and the relationship between each data source. Finally, the geographic distribution of the data across NSW was compared.

Results: The three data sources were similar in terms of the age distribution of persons recorded on each database. The gender distribution of DAL and ABS cases was very similar, while ambulance calls were more likely to involve females than for the other two data sources. Time series analyses indicated that both DAL and ambulance attendance data significantly correlated with ABS data from the same time period, and that they were also able to significantly predict ABS coded opioid overdose deaths for up to 3 months. The geographic areas in which the data were recorded agreed significantly, with all data sources recording the highest rates in two Sydney districts known to contain the largest heroin markets in NSW.

Conclusions: While ABS coded data on opioid overdose deaths have long been used to chart heroin related deaths in Australia, DAL and ambulance data are significant and reliable indicators of heroin use and opioid related deaths, and may also be used to predict usage patterns for up to 3 months. They are more readily and quickly available than ABS data, and such information may be used to make healthcare and policy decisions that need to be made in a timely fashion.

1 INTRODUCTION

Opioid overdose deaths have become an issue of increasing concern in Australia over the past four decades. The most commonly used indicator of opioid related overdoses in Australia is the number derived from Australian Bureau of Statistics (ABS) coded deaths. These data have been used to examine trends on opioid overdose over the past four decades, and to consider changes in opioid related deaths over this time (Hall & Darke, 1998; Hall, Degenhardt, & Lynskey, 1999). ABS data are particularly useful because of the length of time for which they have been available and the relative consistency with which deaths have been recorded according to an internationally developed and utilised classification system (successive versions of the World Health Organization's International Classification of Diseases, or ICD (World Health Organization, 1993).

However, there are limitations in the extent to which such data are useful to health professionals, law enforcement and policy makers. These limitations stem largely from the considerable time lag between the time deaths occur, and the time at which data on such deaths are available. ABS data are typically available between 10-12 months after the end of the *entire* year (for example, data for January to December 2000 were only available in December 2001).

Given this time lag, it is difficult for decisions to be made about the necessity (or otherwise) of changes in the health sector's resource allocation, in law enforcement activities, or in government policies directed at reducing opioid-related harm. There is a need to identify indicators that provide valid, reliable and timely information about trends in opioid overdoses (most of which are due to illicit heroin use (Darke, Ross, Zador, & Sunjic, 2000)). Two possible indicators are: data on ambulance attendances to suspected heroin overdoses; and data from the NSW Division of Analytical Laboratories/ICPMR (DAL) on deceased persons in which morphine (a heroin metabolite) was detected and/or the deceased was a "known drug user". Data are available for a given month from the Ambulance Service within approximately two months; and from the DAL within approximately one month. The current study examines how well the data from these sources reflects opioid related harm as assessed against a "gold standard" indicator, ABS opioid overdose data.

2 METHOD

2.1 DATA USED IN THE CURRENT STUDY

2.1.1 ABS DATA ON OPIOID OVERDOSES

The ABS data used in this report cover the period January 1997 to December 2000. The ABS is responsible for collecting data every year on all persons who have died across Australia. These data are collected from the death certificates submitted to each State or Territory's Registry of Births, Deaths and Marriages. There is a range of data on the demographics and usual residence of the person. These certificates also typically state the sequence of events that led to a person's death. The ABS then uses its coding and sequencing rules to establish what the main or *underlying* cause of death was, that is, the factor that was primarily responsible for the person's death. The ABS also lists the factors that contributed to the death but which were not the main cause of death. If the information on a death certificate is not clear, the ABS will liaise with the Coroner in order to more clearly establish a person's cause of death.

All data on ABS opioid overdoses used in this report refer to deaths in which opioids were considered to be the underlying cause of death. This means that deaths included here are only those in which it was considered that opioids such as heroin, morphine, pethidine, methadone and codeine were *primarily responsible* for the person's death. There are more deaths in which opioids are considered to have contributed to a person's death, but were not the primary cause. The ABS uses the WHO's ICD system for classifying deaths. The current ICD edition is ICD-10 (World Health Organization, 1993). The ICD-10 codes used were the following: codes corresponding to accidental poisoning by opioids (X42 and X44), and mental and behavioural disorders due to opioids (F11).

2.1.2 NSW AMBULANCE DATA ON ATTENDANCES TO DRUG OVERDOSES

At the time of attendance at a patient, ambulance officers complete a case report which includes information about the treatment administered (identified by Protocol) as well as demographic data about the patient, including their age, sex, and location of attendance. The data used in this analysis are from case reports completed by ambulance officers for all patients treated in the period from 1st May 1995 to 30th June 2001. The data are based on the number of cases where ambulance officers have used the Ambulance Service protocol for drug overdose/poisoning and where naloxone was administered. The following points must be noted of the data:

a) Cases in which naloxone was not used for persons who had overdosed on heroin are not included, and as not all ambulance officers are authorised to administer naloxone, not all heroin overdose cases may have naloxone administered;
b) The drug overdose protocol includes *all* drug overdoses and does not distinguish between the drugs used by the patient;
c) Naloxone may be administered for other reasons, for example to unconscious patients who have not responded to other treatment;
d) Identification of drug overdose and the need for treatment is based on the ambulance officers' assessment of the patient at the time of treatment/transport.

Nonetheless, assuming that these sources of error remain relatively constant over time and across areas, these data potentially provide useful information on trends in non-fatal overdose.

2.1.3 NSW DAL/ICPMR DATA

The NSW DAL/ICMPR conducts pathology tests upon all cases in which post mortem examinations are conducted. All suspect drug-related deaths have post mortems conducted and toxicology analyses performed. The place of death, age and gender of the subjects are recorded. Two types of DAL data are included in this paper, which include cases of death between July 1994 and June 2001. These data are as follows:

a) All cases in which the deceased was identified by either police or pathologists as an illicit drug user or "known drug taker"; and
b) Cases in which the deceased was identified by either police or pathologists as an illicit drug user or "known drug taker", *and* morphine was detected in the deceased.

While the latter DAL data clearly are more restrictive in that they definitely include only deaths in which morphine (a metabolite of heroin) was detected, the former are useful in that the data are available around 6 weeks earlier. It was of interest in this study to examine both data sources, as if the more quickly available data were also good indicators, they could be preferable for the purposes of early indicators.

2.2 STATISTICAL ANALYSES

The frequency of age and gender distributions was calculated for each data source across time to assess the agreement between the three. While complete data on gender and age were available for DAL and ABS data, approximately half of ambulance cases had age (52%) data missing, and 46% had gender (46%) data missing. There was no apparent relationship between missing data and either geographical location or date of attendance.

The number of cases from each data source was plotted over time (monthly). Time series analyses were conducted and the nature of the trends for each data source examined. Cross correlations were carried out to examine the nature of the relationship between the data sources across time. By examining different time "lags", it was possible to assess if there was a significant time relationship between the different data sources, and if so, the length of time for which data from one source was significantly related to data from another. In this instance, one "lag" was equivalent to one month.

The geographical distribution of the cases from each data source was determined and the concurrence between these estimated. Postcodes were matched to the postal area by using the Telstra White Pages internet directory. Postal areas were then approximated to the Australian Bureau of Statistics (ABS) Statistical Local Area (SLA), and ABS Statistical Subdivision (SSD), to which they corresponded. These geographical areas have been developed by the ABS and are used in the Australian census. There are 43 SSDs in New South Wales, and 168 SLAs. Because SSDs outside the Sydney area had previously been found to have very low numbers of fatal heroin overdoses (Darke et al., 2000; Degenhardt, Hall, & Adelstein, 2001), areas outside the Sydney metropolitan area were aggregated to the level of ABS Statistical Divisions (SD). These were: Hunter (which includes the Newcastle and Hunter SSDs), Illawarra, Richmond-Tweed, Mid-North Coast, Northern (Northern Slopes, Northern Tablelands and North Central Plain SSDs), North Western (Macquarie-Barwon, Upper Darling, Central Macquarie SSDs), Central West (Bathurst-Orange, Central Tablelands, Lachlan), South Eastern (Queanbeyan, Southern Tablelands, Lower South Coast, Snowy), Murrumbidgee (Central Murrumbidgee, Lower Murrumbidgee), Murray (Albury, Upper Murray, Central Murray, Murray-Darling), Far West, and Mid-North Coast (Clarence, Hastings). Estimates of the rate per 100 000 population in each area were made using ABS population estimates obtained from the 1996 Australian census (Australian Bureau of Statistics, 1998).

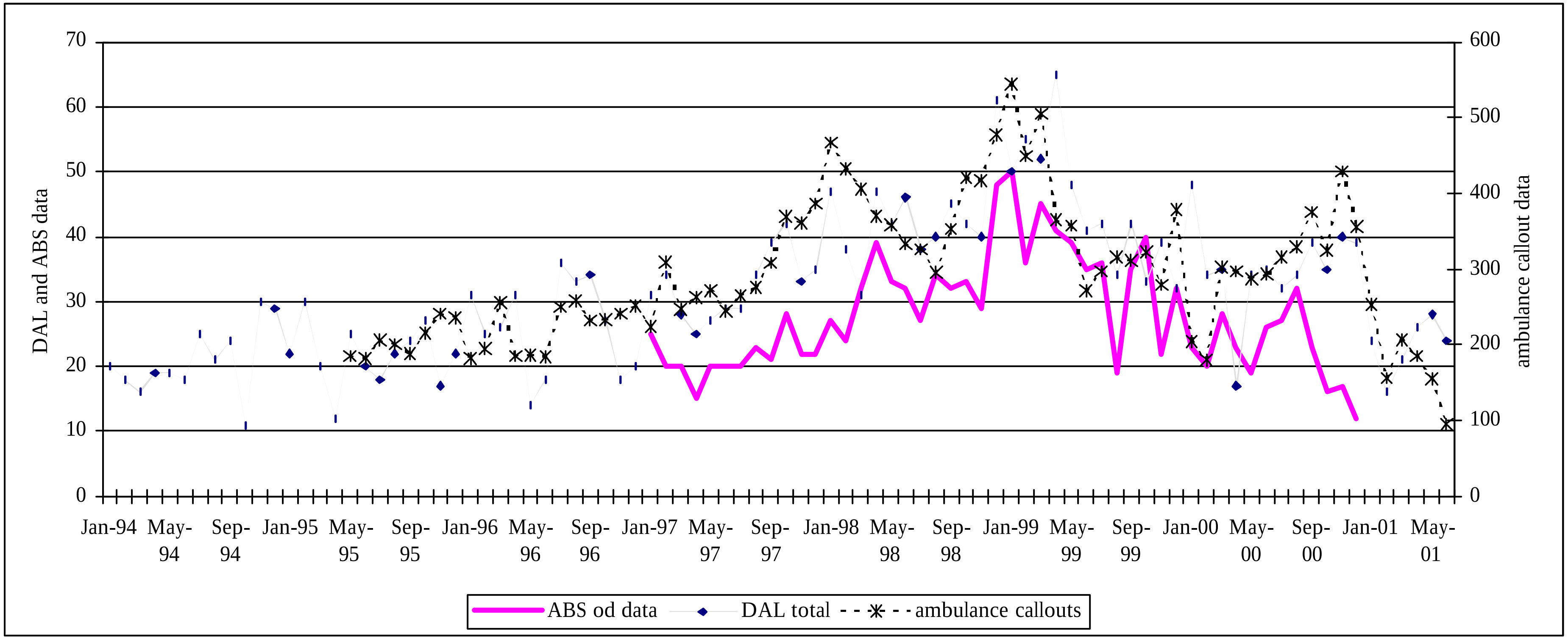
3 RESULTS

The age dstribution of all three data sources was consistent. Approximately 95% of ABS opioid overdose cases were aged 15-54 years, while 94% and 93% of ambulance attendance patients and DAL cases, respectively, were within this age range. The majority of cases were male in both ABS and DAL cases, with females more highly represented among ambulance attendances. Over the period, 81% of ABS cases, 69% of ambulance cases, and 82% of DAL cases were male.

3.1 TIME SERIES ANALYSES

Figure 1 shows the plot of the ABS data, ambulance attendance data, and DAL data available between 1994 and 2001 (note that only DAL total data are shown; the more restrictive DAL morphine positive data showed the same time-related pattern, but had slightly fewer numbers). Time series analyses revealed no evidence of a seasonal trend for any of the indicators of heroin related harm. Consistent with previous research examining heroin overdoses (Darke et al., 2000) there was no evidence of a pattern of overdoses that changed according to the month of each year. The number of DAL cases per month was of a similar magnitude to the number of ABS-coded opioid overdose deaths while ambulance calls were around 11 times more frequent in number. The latter finding is not surprising since it might be expected that many ambulance calls to overdoses would not result in the patient dying.

Figure 1: Plot of ABS ICD-10 opioid overdose deaths (1997-2000), DAL data (1994-2001), and ambulance attendance data on suspected drug overdoses (1995-2001)



3.1.1 CROSS-CORRELATIONS

Table 1 shows the cross-correlations found between the three data sources. As can be seen, in a given month ("Lag 0"), there was a significant relationship between the number of ABS coded opioid overdose deaths, and the number of cases of heroin related overdoses as measured by both ambulance attendances (r = 0.54) and DAL cases (r = 0.69 for *total*, r = 0.67 for *morphine positive*).

Furthermore, DAL and ambulance data were significantly correlated with ABS data up to Lag 2 (ambulance calls) and Lag 3 (DAL data). This means that in any given month, the number of ambulance attendances or DAL cases was significantly related to (or "predictive" of) the number of ABS cases of opioid overdose for the following 2 or 3 months. After 3 months, there was no significant relationship between any of the data sources.

Table 1: Cross-correlations (95%SE) of ABS, DAL and ambulance attendance data

	Lag 0		Lag 1		Lag 2		Lag 3	
ABS – DAL *all cases*	0.69	(0.28)	0.57	(0.29)	0.50	(0.29)	0.51	(0.30)
ABS – DAL *morphine positive cases*	0.67	(0.28)	0.55	(0.29)	0.46	(0.29)	0.43	(0.30)
ABS – ambulance	0.54	(0.28)	0.34	(0.29)	0.28	(0.29)	ns	
DAL *all cases* - ambulance	0.55	(0.28)	0.48	(0.29)	0.29	(0.29)	ns	
DAL *morphine positive cases* – ambulance	0.59	(0.28)	0.52	(0.29)	0.36	(0.29)	0.31	(0.30)

Note: Lag 0 = correlation between two data sources within a given month;

Lag 1 = correlation between two data sources, with one at month 0 and the other at month 1;

Lag 2 = correlation between two data sources, with one at month 0 and one at month 2; and

Lag 3 = correlation between two data sources, with one at month 0 and one at month 3.

Data were only cross-correlated for the months in which ABS data were included: January 1997 to December 2000.

3.2 GEOGRAPHICAL DISTRIBUTION

Table 2 shows the distribution of the three data sources in geographical areas across NSW, which have been aggregated to ABS geographical areas. As can be seen, the areas in which rates of ABS deaths coded as ICD-10 opioid overdose deaths were also those in which rates of DAL cases and ambulance callouts were higher. The correlation between rates in the areas for ABS deaths and DAL cases was impressive (r = 0.93 for DAL total; r = 0.92 for DAL *morphine* positive), and the correlation between ABS deaths and ambulance calls was also good (r = 0.86). In the case of ambulance calls, the lower correlation probably reflects the fact that postcodes referred to the place in which the person was treated, rather than their residential address; as well as the fact that not all persons treated by ambulance officers will die. Interestingly, rates of DAL cases (which are also recorded by *location* of death, rather than *residence*) were substantially higher than ABS opioid overdose deaths in the Inner Sydney SSD (rates of 444 (DAL *total)* and 406 cases (DAL *morphine positive)* per million persons per annum, compared to 197 per million per annum for ABS deaths). A similar pattern was observed for the Fairfield-Liverpool SSD (rates of 191 and 184, compared to 59 per million persons per annum). These two areas were also areas in which relatively higher rates of ambulance calls were made (4906 and 2647 for Inner Sydney and Fairfield-Liverpool, respectively).

Table 2: Average rate per annum per 1 000 000 total population of ABS overdoses, DAL cases and ambulance attendances by ABS statistical subdivision (Sydney metropolitan area) or ABS statistical division (outer areas)

	ABS	DAL	DAL	Ambulance
Sydney metropolitan area		***All cases***	***Morphine +***	
Inner Sydney	197.3	443.7	405.8	4906.1
Eastern Suburbs	70.2	70.2	58.9	413.1
St George Sutherland	41.3	51.1	42.6	339.3
Canterbury Bankstown	60.2	42.1	37.1	367.9
Fairfield Liverpool	59.0	191.4	184.3	2647.6
Outer SW Sydney	47.5	52.1	32.4	559.3
Inner W Sydney	69.3	99.9	91.9	525.5
Central W Sydney	50.0	58.9	39.3	304.5
Outer W Sydney	44.7	70.4	54.7	511.9
Blacktown Baulkham Hills	34.2	27.4	21.9	127.3
LN Sydney	39.2	59.7	47.2	248.6
Hornsby Kuringai	23.1	20.1	17.1	123.6
Northern Beaches	51.5	49.2	40.3	265.1
Regional NSW				
Gosford Wyong	46.2	62.9	48.1	438.2
Hunter	49.5	48.6	37.4	386.8
Illawarra	44.9	57.0	48.9	394.2
Richmond-Tweed	51.2	71.1	53.7	146.0
Mid-North Coast	52.5	71.1	39.0	438.6
Northern	43.4	25.2	21.0	238.0
North Western	25.6	38.4	23.5	213.2
Central West	37.7	66.7	53.6	326.2
South Eastern	34.9	40.5	23.8	99.2
Murrumbidgee	18.4	11.7	10.1	127.4
Murray	24.8	29.3	15.8	126.3
Far West	0.0	9.9	9.9	266.3
Total (NSW)	**52.1**	**75.7**	**63.3**	**641.8**

Note: Results presented here are based upon the period for which all data sources were available, namely January 1997 to December 2000.

4 DISCUSSION

This study has shown that two leading edge indicators of heroin overdose – ambulance attendances at drug overdoses, and deaths in which persons were suspected "drug users" and morphine was detected – have a strong correlation with an accepted "gold standard" indicator of opioid overdoses, namely ABS coded deaths. Both ambulance attendances and DAL cases appear to be valid indicators of opioid overdoses.

The benefit of this strong agreement is that both these indicators are available much more quickly than ABS deaths. At present, it is estimated that ambulance attendance data for a given month are available within two months, and this time delay is expected to decrease., DAL data for any given month are available within a month, if cases in which the deceased was a "known drug taker" are used. In contrast, ABS data for a given month are not available for between 11-23 months, and furthermore, deaths occurring in December may not be registered and released in ABS figures until the next year. Clearly, the two alternative indicators provide a much faster and relatively accurate indicator of opioid overdoses.

Ambulance and DAL data may also be used to predict trends in overdoses. The present study found that both ambulance attendance and DAL data were significantly correlated with ABS coded deaths up to two (ambulance calls) or three months (DAL data) later. This means that such data may be used to gain an understanding of future trends for a limited time period. This is of particular importance for health professionals, law enforcement and policy makers who are required to respond quickly and effectively to changes and trends in overdoses. However, these data cannot be used to predict overdoses for any longer than three months. Hence, it is not valid to make any predictions about trends for a coming year from existing data. This can be explained as trends in heroin use and overdose may be affected by a wide range of variables, such as changes in heroin purity (Darke, Hall, Weatherburn, & Lind, 1999) and increased access to methadone maintenance treatment, which is known to reduce the risk of overdose by a factor of four (Capelhorn, Dalton, Halder, Petrenas, & Nisbet, 1996).

There was good agreement between the indicators across different geographic areas, suggesting that both DAL and ambulance data are relatively good indicators of geographic trends in opioid overdose deaths. Two areas in which DAL and ambulance data seemed to relatively overestimate numbers of incidents (compared to ABS coded opioid overdose deaths) were the Inner Sydney and Fairfield-Liverpool areas. This was particularly the case for the Fairfield-Liverpool area, in which rates of ambulance calls were 45 times the rate of ABS coded opioid overdose deaths, compared to the average across NSW of a 12-fold higher rate. This finding may be because both ambulance callout data and DAL data recorded the place of attendance/death, and that higher rates of ambulance attendances and DAL cases in these areas reflect the fact that some persons may have come to the area and used opioid drugs while still in the area, rather than using in their place of residence. This suggests that both ambulance callout data and DAL data may also be good indicators of areas of opioid *use* as well as opioid *overdoses.*

4.1 CONCLUSION

It appears that both ambulance attendance data and toxicology data provide good proxies of so-called "gold standard" indicators of heroin overdose. It would seem wise to make efforts to reduce the time lag between the collection of such data and its availability, to ensure that health professionals, law enforcement and policy makers have access to good, reliable indicators of this serious consequence of opioid use.

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