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Urban Overdose Hotspots:

A 12-Month Prospective Study in Dublin Ambulance Services

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Keywords: overdose, ambulance, prospective study, naloxone, heroin, epidemiology, physical health

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Abstract

Background: Opioid overdose is the primary cause of death among drug users globally. Personal and social determinants of overdose have been studied before, but the environmental factors lacked research attention. Area deprivation or presence of addiction clinics may contribute to overdose.

Objectives: To examine the baseline incidence of all new opioid overdoses in an ambulance service, and their relationship with urban deprivation and presence of addiction services.

Methods: A prospective chart review of pre-hospital advanced life support patients was performed on confirmed opioid overdose calls. Demographic, geographic, and clinical information, i.e. presentation, treatment, outcomes, was collected for each call. The Census data were used to calculate deprivation. Geographical information software mapped the urban deprivation and addiction services against the overdose locations.

Results: There were 469 overdoses, 13 of which were fatal; most were male (80%), of a young age (32 years), with a high rate of repeated overdoses (26%), and common poly-drug use (9.6%). Majority occurred in daytime (275), on the streets (212). Overdoses were more likely in more affluent areas ($r=.15$, $P<.05$), and in a 1000 m radius of addiction services. Residential overdoses were in more deprived areas than street overdoses (mean difference 7.8, $t(170)=3.99$, $P<.001$). Street overdoses were more common in the city centre than suburbs ($\chi^2(1) = 33.04$, $P < 0.001$).

Conclusions: the identified clusters of increased incidence – urban overdose hotspots - suggest a link between environment characteristics and overdoses. This highlights a need to establish overdose education and naloxone distribution in the overdose hotspots.

Keywords: overdose, ambulance, prospective study, naloxone, heroin, epidemiology, physical health

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Introduction

Opioid overdose (OD) is the primary cause of death among drug users globally [1]. Despite an international trend of decreasing drug-related deaths in recent years, opioids remain the major cause of deaths in Ireland [2]. In European countries with widespread heroin use, such as Ireland, opioids are implicated in 75% of the drug-related deaths [3-5]. In 2011, at least 251 deaths occurred from poisoning with opioids among drugs misusers in Ireland; this represents 69% of poisoning deaths in this population[6]. Drug overdose shortens the life expectancy of drug users compared to the general population. Most drug users witness an overdose and many are victims of overdose themselves [7-9]. Risk of fatal drug overdose is higher immediately after release from prison or after opioid substitution treatment [10, 11]. Acute opioid overdose poses a significant burden on frontline services, ambulance services and emergency departments but limited evidence is available on the experience or role of those services [12, 13]. Understanding the risk factors and determinants of overdose is critical to help decrease the mortality, morbidity and burden on healthcare and to maximise the potential contribution of emergency services.

Drugs are used in a context of social, personal and environmental characteristics [14]. Contextual effects, such as drug, set and setting, synergise and create higher chances for overdose [15]. The set represents individual risk factors which have been well studied: male gender, age, long-term drug use, psychiatric illness or transition to/from opioid substitution treatment [11]. The setting of drug use includes such understudied environmental factors as income distribution, family fragmentation, physical characteristics of urban areas (clean sidewalks or dilapidated houses),

education or allocation of health services [16-18]. All of these mediate the relationship between the setting and drug use. Building on this evidence base, this study examines two additional features of urban areas that could be related to opioid overdoses: deprivation and presence of addiction services, in the context of gathering incidence data on overdoses.

First, overdoses and overdose deaths are more frequent in areas of increased drug use and poverty [11]. For example, areas with unequal income distribution have higher rates of overdose deaths, independent of individual risk factors, such as gender or age [18].

Second, areas around addiction services are historically long-established epicentres of drug use. Addiction services have been traditionally set up in areas of high-need [19], where drug dealing, using and overdosing were already present or dealers may have been attracted to these areas, envisioning higher profits from drug sales, and subsequently increasing the rates of use and overdose. The evidence from alcohol and tobacco research reveals a link between allocation of outlets and prevalence of tobacco or alcohol use [20]. This relationship has not been studied for addiction clinics or methadone services. Nevertheless, the experience of community-based methadone services suggests that up to 40% of people in recognised methadone treatment continue to inject heroin and may therefore bring drug selling and illicit use into the areas around drug treatment centres[7]. This increases the risk of fatal overdose. Moreover, methadone dispensing may have an effect on overdoses, as shown by a 32% increase in overdoses observed in A&E in the two-month period immediately after the introduction of a new methadone prescribing legislation in Ireland, with a subsequent drop (47%) two months later [13].

Very little data has been published on the experience of opioid overdose by emergency ambulance services, in Ireland or elsewhere. Merchant et al., published a 1997-2002 time series of such events from Rhode Island , in which they reported 1,630 events evenly distributed over the period with the majority being males under 54 and most events occurring in private homes[21]. A 2002 Australian time-series indicated an initial drop in the numbers of fatal opioid overdoses following a community overdose initiative but the fall was not sustained[22]. In Dublin, emergency ambulance services are provided by Dublin Fire brigade and the Health Service Executive's National Ambulance Service, covering different geographic areas. Emergency ambulances are staffed by Paramedics or Advanced Paramedics who have, since 2004, been trained and equipped to provide naloxone (standard dose 0.4mg, repeated up to five times) in suspected opioid overdose using a standardised Clinical Practice Guideline[23].
This study had two aims. First, we established baseline *incidence* of all new overdoses reported to the ambulance services in Dublin over a 12 months period together with their presentation, treatment and outcomes if known to the ambulance service. Second, we examined the relationship between geographical distribution of overdoses, deprivation and presence of addiction clinics.

Methods

Setting

Two agencies provide ambulance services in Dublin: Dublin Fire Brigade (DFB) and the Health Service Executive (HSE), National Ambulance Service (NAS). Established in 1862, DFB is among the oldest ambulance services in the world. It attends to approximately 72,000 incidents

in Dublin annually. In 2011, naloxone figured in 281 (4.2%) of all medication administrations [24]. NAS attends to emergency calls in certain areas of Dublin and dealt with approximately 300,000 emergency calls nationally in 2013 [25].

Data collection

Characteristics and clinical data for all opioid overdoses reported to DFB and NAS, Dublin in a twelve months period were collected by the ambulance staff on patient care report (PCR) forms. PCRs are completed in all cases by ambulance service staff and copies are kept both in the receiving hospital and by the service itself. The study identified all PCRS indicating opioid overdose; trained DFB staff collected study data from DFB forms and the researchers collected data from PCRs in NAS. Population data were derived from the 2011 census.

a) PCR review. PCR is a paper based system for recording pre-hospital care, assessment observations, interventions and medications administered to patients by the emergency responders. Hard copies and scans of PCRs, coded under the 'Opioid Overdose' category, were reviewed to extract the following:

- number of PCRs recording opioid overdose,
- clinical presentation,
- clinical care provided (pre-post arrival),
- number and percentage of patients receiving naloxone,
- response to naloxone, and
- number of patients transported / refused transport.
- deaths, if confirmed by the ambulance service on scene

Accuracy of data entry was assessed by an external review of a 20% random sample of records.

No follow-up clinical data for care in the Emergency Department were collected for this study. Therefore, the clinical outcomes of the overdose events cannot be commented on, other than in respect of the small number of cases in which patients were confirmed to be dead by the ambulance service, using the criteria established by the relevant Clinical Practice Guideline.

b) Geographical information. In 2012 the Central Statistics Office (CSO) published Small Area Population Statistics (SAPS) for the 2006 and 2011 censuses. Small Areas (SA) are national boundaries created by Ordinance Survey Ireland (OSI) as a subdivision of pre-existing Electoral Districts, and are available for download from the CSO's website (www.cso.ie/census). As the smallest geographical areas for which census data are available, they provide the most accurate level for measurement. SAs are standardised in size, with a minimum of 65 households and a mean of fewer than 100, thus effectively providing street-level information on the Irish population. Population statistics are now available for 18488 Small Areas in Ireland.

c) ***Deprivation Index.*** The Pobal-Haase-Pratschke Deprivation index is a composite score "measuring the relative affluence or disadvantage of a particular geographical area" using data compiled from 2006 and 2011 census [26]. Each area is scored from approximately -40 (being the most disadvantaged) to +40 (being the most affluent), with zero as the average national score from the 2006 census. Fourteen indicators in three dimensions of affluence/ disadvantage comprise the deprivation index: demographic profile, social class composition and labour market situation. For the purpose of this study, we categorised overdoses by their location into street,

residential or service overdoses. The residential category comprised house and hotel. The services included hostel/ homeless shelter, treatment centre, hospital, shop, bar/ pub or police station.

*d) **Methadone clinics.*** As of October 2010, there were 9285 patients attending methadone treatment programmes nationally of which 3312 patients (36%) received care through General Practitioners, 5368 (57.5%) in the 66 Health Services Executive clinics and 604 (6.5%) patients were attending treatment in prison [27]. Fifty three clinics were located in Dublin, serving 4783 patients. We added clinic locations to our geographical map. We compared presence of a clinic in the area, patient-load and number of ODs in the a) Small Area, b) 500 m radius around clinic, and c) 1000 m radius around clinic.

Data analysis.

In accordance with the primary objective of this study, descriptive analysis was carried out on the key indicators: opioid overdose calls and clinical information on each call (frequencies, correlations, t-tests and chi-square). Information extracted from PCRs was entered into an MS Excel® spread sheet. De-identified data was then exported into an IBM SPSS 20 (Statistical Package for Social Sciences) database, from which the statistical analyses were performed. Small Area geographic data were downloaded from the CSO (www.cso.ie/census). Full Deprivation Index data for Small Areas was provided by the researchers. Addresses of overdose incidents were given geographic coordinates using a free online geo-coding tool (www.gpsvisualizer.com/geocoder), and mapped into Small Areas using geographic information system (GIS) software, ArcGIS Version 10.1.The geo-data and data on repeat overdoses by

individuals were available only for the DFB data. Ethical approval for the study was provided by Human Research Ethics Committee at University College Dublin (UCD).

Results

Demography and clinical presentation.

In the 12-month study period, the ambulance services attended to 469 (DFB=358, NAS=111) opioid overdoses (OD). Mean age was 33 years (range 2-70*), 80% were male. Other substances were noted in 131 (27.9%) cases and the most frequent were alcohol (29), benzodiazepines (24), antidepressants (10) and stimulants (8); 45 (9.6%) cases noted multiple substances. The most common clinical presentation was 'unresponsive' (39%), followed by 'reported overdose' (14.7%), and respiratory depression (11.7%).The unresponsive category also included decreased Glasgow Coma Score (GCS) and collapse. See table 1 for more detail.

*Three children aged two, four and four accidentally overdosed with parents' methadone or pain medication.

<insert Table 1 here>

Treatment

Naloxone was administered in 357 (76%) cases – mean dose 0.61 mg; mean number of doses = 1.5 (range 1-5), 42.6% received one dose. The overwhelming majority of administrations were intramuscular (IM) with small proportions (9.8%) of IM/Subcutaneous, IM/IV and intra-osseous administrations. Mean GCS score before the incident was 7.2 (3-15), and this increased

to 12.3 (3-15) after the incident. First aid prior to ambulance arrival was provided in 12 instances (9%). Assisted ventilations (23%) and oxygen (60%) were administered regularly.

Outcomes

Most cases were transported to hospital (88.5%). The GCS scores didn't improve for 70 (14.9%) people and 45(9.6%) had GCS post naloxone administration lower than eight. The complete pre- and post- naloxone scores were recorded in 182 (38.8%) PCRs. Thirteen people were found dead or resuscitation was discontinued on the scene during the study period. Out of the 358 DFB records, there were 96 (26.8%) repeat overdoses among 36 participants - five female (14.6%) and 31 (85.4%) male. Mean number of repeat overdoses was 2.2 (range 1-9). Three repeat ODs were fatal.

Location, time and incidence of overdoses

The three most frequent places where OD occurred were street (n=212, 45.2%), residential (n=178, 38%), and hostel/ treatment centre (n=74, 15.8%). The majority of the ODs (70%) took place during the day, between 12PM and 12AM. Based on the total number of all incidents at Dublin Fire Brigade (DFB) in 2011, the overdose prevalence in the DFB data was 0.49% (358/72000x100). Based on the same total, the overdose incidence was: 4.9 cases per 1000 cases per year.

City centre versus suburbs

A total of 176 Small Areas with one or more ODs were identified in the DFB data*; 148 Small Areas (84%) had only one or two overdoses; however, 55% of all ODs occurred in just 28

Small Areas (16%). This suggests that opioid overdose was concentrated in certain Small Areas – 28 hotspots – of Dublin city. Of those, one had 32 ODs. See Table 2 for more details.

<insert Table 2 here>

The majority of ODs (86%) were concentrated in the city centre, the rest were in South Dublin (6%), Fingal (5%), Dun Laoghaire (1%), or at unknown locations (2%). Figure 1 shows DFB overdoses on the map of Dublin.

*NAS geo-data were unavailable; therefore, the figures presented here are for DFB data only.

<insert Figure 1 here>

We examined 355/358 (99.2%) DFB ODs where data was available to compare the geographical location with the setting in which the incident occurred (residential (109), street (195) or services (51)). Street ODs were concentrated in city centre/quays whereas residential ODs were dispersed throughout Dublin regions, with smaller numbers of ODs per Small Area than street ODs.

Street OD Small Areas were more likely to be in the city centre (60) than suburbs (18), compared to residential overdose Small Areas in the city (31) and suburbs (63); see Table 3 for details. Our Chi-square test revealed that the number of residential OD Small Areas significantly differed by location ($\chi^2(1) = 33.04, p < 0.001$).

<insert Table 3 here>

Urban deprivation and methadone clinics

We explored the relationship between overdose and deprivation. The mean deprivation score for Dublin is currently negative (-5.73), not zero. Our 176 Small Areas with overdoses had a better average deprivation score than the city average (-4.73) indicating they were more affluent overall (range -31 to 28). There was a small, but statistically significant relationship between the number of overdoses in the area and area affluence, $r=.15$, $p<.05$.

However, when we compared the deprivation of overdoses that occurred in a residence/ house (n=109) with those in the street (n=195), on average, residential ODs had a lower deprivation score (-8.8, $SE=1.33$), than street ODs (-1, $SE=1.44$). This difference was significant $t(170)=3.99$, $p<.001$. For city centre, the residential ODs' deprivation score was closer to the city average.

Finally, we also explored the relationship between overdose and location of methadone clinics. Most ODs happened in the 1000m radius region around certain methadone clinics. This suggests that ODs do occur near methadone clinics, but not all clinics.

Discussion

Dublin ambulance services attend to an opioid overdose almost every day. This study established the incidence of opioid overdoses in Dublin ambulance service and found the majority of them occurring during the day, on the streets.

Our overdose and death rates were comparable with other countries. The 10-year death rate of the Edinburgh addiction cohort recruited from primary care was 21 percent [28]. A naturalistic longitudinal study of injecting drug users in inner city Dublin found 63 percent dead after 25 years [29] but principally because of blood borne infections. Luxembourg had 340 opiate- and cocaine-related fatal overdoses between 1985 and 2011 (approx. 13 annually) [30]. Budapest had 299 fatal opioid overdoses between 1994 – 2012 (approx. 16 annually) [31]. In Scotland, the greatest risk of drug-related death was in the first two weeks of treatment [11]. In Kansas, an opioid mortality study detected fentanyl, methadone or oxycodone in 789 overdoses from 2001 - 2011 (approx. 79 annually) [32].

The wider international trends show a decrease in drug-related deaths across Europe, reflected in the national figures from Ireland. The annual number of drug-related deaths and deaths among drug users decreased from 652 in 2009 to 607 in 2011 [6]. The number of heroin deaths decreased the most, from 115 in 2009 to 60 in 2011 [6]. Methadone deaths increased to 113, compared to 60 in 2010 [2]. This trend is similar in Scotland and could be due to the changes on the drug markets and increased poly-substance deaths (59 percent of all poisonings) [6].

The relationship shown between area affluence and overdoses is particularly significant and probably relates to the clear distinction between street and home events that we describe. Half of all events occurred in the street and the large majority of these were quite close to drug treatment centres within the city centre, which is rated as relatively affluent, giving an overall score which appears slightly more affluent than the average for Dublin city. However, the deprivation scores associated with overdoses in homes is significantly worse than the overall figure. This strongly

suggests that the homes, or current residences, of opioid users are in deprived areas, a finding which is consistent with most other data on illicit opioid use in Ireland[6].

Previous studies also showed that deprived areas may have more overdoses [16-18]. The concentration of heroin overdose in hotspots around drug treatment clinics may be attributable to a number of reasons. Addiction-clinic areas have a predictable supply of methadone which may leak into the black market and community [16, 33]. Many methadone patients continue to use illicit opioids and other drugs [7] and dealers may therefore be attracted to clinic-areas, envisioning higher profits from drug sales to methadone patients and fuelling up the opioid load in the area [19, 20]. Finally, the normalisation theory suggests that social norms, related to public use of drugs, may be more lax in the clinic areas where patients are witnessed collecting their methadone every day [34].

The clinical findings are striking. In 418 (89%) of these calls, evidence of opiate use was observed and in 357 (76%), naloxone was administered. For the 315 patients for whom a GCS score was recorded on arrival, the initial score was 7.2, with an average score of 6.4 in events occurring in the street. These GCS scores indicate very low levels of consciousness and are low enough to lead to an inability to safeguard the airway. The improvement to a mean level of 12.3 on scene, following treatment by ambulance staff, is striking evidence of the efficacy of the naloxone treatment provided. In 120 (25.6%) of cases, the patient was in respiratory or cardiac arrest or had respiratory depression requiring ventilatory support. The challenging environments in which patients received care are difficult ones in which to provide complex care, but given the severity of the presentations it is striking that successful resuscitations were achieved frequently.

Naloxone is used to temporarily achieve complete or partial reversal of opioid effects, including respiratory depression, caused by natural or synthetic opioids, and specific analgesics

[35-37]. It is a licensed medication (specific opiate antagonist) with no agonist properties, no potential for abuse and is inexpensive. Overdose education and naloxone distribution (OEND) save lives [9]. Large-scale comparative studies have shown that opioid overdose death rates were reduced in cities and areas where OEND was implemented [38-40].

Despite this evidence, OEND doesn't exist in many countries, including Ireland. Implementation of OEND programmes is hindered by policy, legal and personal barriers. For example, medical professionals are reluctant to deal with drugs issues [41]; minimal awareness of naloxone programmes persists [42]. Reluctance and unawareness can be addressed in OEND training for medical and lay staff in drug agencies, as well as other overdose witnesses.

Literature from other countries shows that bystanders, peers, or family members of overdose victims, are most often the initial emergency responders and are best positioned to intervene immediately, when the first overdose symptoms appear [9, 43]. The response of these lay persons can save lives, if they are provided with naloxone. This study describes the context in which most overdoses occur in Dublin and highlights the potential for family members or other drugs users to offer prompt care, using naloxone. Recently, a Dublin advisory committee on lay naloxone administration has been established; data from this study will inform the provision of OEND programmes to family members and other potential rescuers.

Study limitations.

This study was limited in several ways. We were confined by the data sources which covered only one city. This data was not triangulated with other sources, e.g., death registry or hospitals. Caution should be used when interpreting our death rates; they are only the deaths

confirmed on the scene of the incident. PCRs are not always reliable; they are handwritten under situational pressures and may sometimes be illegible. This data was already recorded and we could not go back to clarify uncertainties. The NAS geo-data were unavailable. Our results may underestimate the real overdose rates, because most non-fatal overdoses are not reported due to a fear of criminal prosecution [44]. Although we explored the association between area deprivation, presence of addiction service and overdose, we did not control for other area characteristics that might have influenced the overdose rates. These include for example, characteristics of built environment, e.g., dilapidation of buildings or number of dark lanes, whose anonymity or seclusion might attract drugs (i.e., shooting galleries).

Despite the limitations, our study provides one year of data in the largest city in Ireland. Recent data estimates that over 14,000 people have used illicit opiates in this region and indicates that 85% of people seeking treatment for opiate use in Ireland do so in this region [45]. Use of smaller area units allowed more precise assessment of variables that may affect overdoses.

Conclusion

Our study found most overdoses occur in daytime hours, near community drug service facilities. Knowing where and when overdoses happen can inform appropriate actions and allocate resources. For example, naloxone can be stored at the premises and trained staff can administer naloxone within the hours of operation. Our findings clearly point out to a need to establish a lay-delivered overdose prevention and naloxone distribution system for opioid overdose in Ireland.

References

[1] Beletsky L, Rich JD, Walley AY. Prevention of fatal opioid overdose. JAMA. 2012;308:1863-4.

[2] Health Research Board. Drug-related deaths and deaths among drug users in Ireland: 2010 figures from the National Drug-Related Deaths Index. Dublin: HRB; 2013.

[3] Health Research Board. National Drug Related Death Index, revised figures 2012. Dublin: HRB; 2012.

[4] Mongan D. Non-fatal overdoses and drug-related emergencies 2010. Drugnet Ireland. 2012:17-8.

[5] Tuusov J, Vals K, Tonisson M, Riikoja A, Denissov G, Vali M. Fatal poisoning in Estonia 2000-2009. Trends in illegal drug-related deaths. Journal of forensic and legal medicine. 2013;20:51-6.

[6] HRB. Drug-related deaths and deaths among drug users in Ireland: 2011 figures from the National Drug-Related Deaths Index. Dublin: Health Research Board; 2014.

[7] Cullen W, Bury G, Langton D. Experience of heroin overdose among drug users attending general practice. Br J Gen Pract. 2000;50:546-9.

[8] Darke S, Zador D. Fatal heroin 'overdose': a review. Addiction. 1996;91:1765-72.

[9] Bennett T, Holloway K, Bird SM. Does take-home naloxone reduce non-fatal overdose? Lancet. 2014;383:124-5.

[10] Seymour A, Oliver JS, Black M. Drug-related deaths among recently released prisoners in the Strathclyde Region of Scotland. Journal of forensic sciences. 2000;45:649-54.

[11] Cousins G, Teljeur C, Motterlini N, McCowan C, Dimitrov BD, Fahey T. Risk of drug-related mortality during periods of transition in methadone maintenance treatment: A cohort study. Journal of substance abuse treatment. 2011;41:252-60.

[12] Cook S, Moeschler O, Michaud K, Yersin B. Acute opiate overdose: characteristics of 190 consecutive cases. Addiction. 1998;93:1559-65.

[13] Cullen W, Griffin S, Bury G, Plunkett PK. Opiate overdose in Dublin. Irish Journal of Medical Science. 2003;172:46.

[14] Parkin S. Habitus and Drug Using Environments: Health, Place and Lived-experience: Ashgate Publishing, Ltd.; 2013.

[15] Zinberg NE. Drug, Set and Setting: The Basis for Controlled Intoxicant Use. New Haven, CT: Yale University Press; 1986.

[16] Cerda M, Ransome Y, Keyes KM, et al. Revisiting the role of the urban environment in substance use: the case of analgesic overdose fatalities. Am J Public Health. 2013;103:2252-60.

[17] Galea S, Ahern J, Vlahov D, et al. Income distribution and risk of fatal drug overdose in New York City neighborhoods. Drug Alcohol Depend. 2003;70:139-48.

[18] Hembree C, Galea S, Ahern J, et al. The urban built environment and overdose mortality in New York City neighborhoods. Health & place. 2005;11:147-56.

[19] City Clinic. City Clinic 20 years of reflections, remembrances and recollections 1993 - 2013. Dublin: Health Service Executive; 2013.

[20] Peterson NA, Lowe JB, Reid RJ. Tobacco outlet density, cigarette smoking prevalence, and demographics at the county level of analysis. Subst Use Misuse. 2005;40:1627-35.

[21] Merchant RC, Schwartzapfel BL, Wolf FA, Li W, Carlson L, Rich JD. Demographic, geographic, and temporal patterns of ambulance runs for suspected opiate overdose in Rhode Island, 1997-20021. Subst Use Misuse. 2006;41:1209-26.

[22] Hargreaves K, Lenton S, Phillips M, Swensen G. Potential impacts on the incidence of fatal heroin-related overdose in Western Australia: a time-series analysis. Drug Alcohol Rev. 2002;21:321-7.

[23] Pre-hospital Emergency Care Council. Clinical Practice Guidelines. Dublin: PHECC; 2013.

[24] DFB. Clinical Audit in DFB EMS. Phecc Voice Newsletter. 2012:1-4.

[25] O'Donnell C. Ambulances aim to treat as well as transport. Forum. Dublin: ICGP; 2013. p. 12-3.

[26] Haase T, Pratschke J, Gleeson J. All-island deprivation index: towards the development of consistent deprivation for the island of Ireland. http://trutzhaase.eu/wp/wp-content/uploads/R-2012-All-Island-Deprivation-Index.pdf.

[27] Doyle J. Letter to Dáil Eireann about the number of methadone and stabilisation centres in each drug task force area. PQ No: 39293/10. Dublin2010.

[28] Macleod J, Copeland L, Hickman M, et al. The Edinburgh Addiction Cohort: recruitment and follow-up of a primary care based sample of injection drug users and non drug-injecting controls. BMC Public Health. 2010;10:101.

[29] O'Kelly FD, O'Kelly CM. The natural history of injecting drug use: a 25-year longitudinal study of a cohort of injecting drug users in inner city Dublin. Ir J Med Sci. 2012.

[30] Origer A, Lopes da Costa S, Baumann M. Opiate- and Cocaine-Related Fatal Overdoses in Luxembourg from 1985 to 2011: A Study on Gender Differences. Eur Addict Res. 2013;20:87-93.

[31] Horvath M, Dunay G, Csonka R, Keller E. Deadly heroin or the death of heroin - overdoses caused by illicit drugs of abuse in Budapest, Hungary between 1994 and 2012. Neuropsychopharmacologia Hungarica : a Magyar Pszichofarmakologiai Egyesulet lapja = official journal of the Hungarian Association of Psychopharmacology. 2013;15:253-9.

[32] Okic M, Cnossen L, Crifasi JA, Long C, Mitchell EK. Opioid overdose mortality in Kansas, 2001-2011: toxicologic evaluation of intent. Journal of analytical toxicology. 2013;37:629-35.

[33] Mayer JD, Kirlin B, Rehm CD, Loeser JD. Opioid availability in outpatient pharmacies in Washington State. Clin J Pain. 2008;24:120-3.

[34] Murray E, Treweek S, Pope C, et al. Normalisation process theory: a framework for developing, evaluating and implementing complex interventions. BMC medicine. 2010;8:63.

[35] Sporer KA, Kral AH. Prescription naloxone: a novel approach to heroin overdose prevention. Annals of emergency medicine. 2007;49:172-7.

[36] McDermott C, Collins NC. Prehospital medication administration: a randomised study comparing intranasal and intravenous routes. Emergency medicine international. 2012;2012:476161.

[37] Merlin MA, Saybolt M, Kapitanyan R, et al. Intranasal naloxone delivery is an alternative to intravenous naloxone for opioid overdoses. The American journal of emergency medicine. 2010;28:296-303.

[38] Walley AY, Xuan Z, Hackman HH, et al. Opioid overdose rates and implementation of overdose education and nasal naloxone distribution in Massachusetts: interrupted time series analysis. BMJ. 2013;346.

[39] CDC. Community-based opioid overdose prevention programs providing naloxone - United States, 2010. MMWR Morbidity and mortality weekly report. 2012;61:101-5.

[40] Coffin PO, Sullivan SD. Cost-Effectiveness of Distributing Naloxone to Heroin Users for Lay Overdose Reversal. Annals of Internal Medicine. 2013;158:1-9.

[41] BMA Board of science. Drugs of dependence: The role of medical professionals. Oxford: British Medical Association; 2013.

[42] Pflanz-Sinclair C, Matheson L, Aucott L, Naloxone GP Research Project Steering Group. General Practitioner Engagement with the Scottish National Naloxone Programme: A Needs Assessment Project. Aberdeen: NHS Health Scotland; 2013.

[43] Kim D, Irwin KS, Khoshnood K. Expanded access to naloxone: options for critical response to the epidemic of opioid overdose mortality. Am J Public Health. 2009;99:402-7.

[44] Gaston RL, Best D, Manning V, Day E. Can we prevent drug related deaths by training opioid users to recognise and manage overdoses? Harm reduction journal. 2009;6:26.

[45] O'Brien M, Moran R, Kelleher T, Cahill P. National Drug Treatment Reporting System, Statistical Bulletin 1997 and 1998. National Data and Data by Health Board Area. Dublin: HRB; 2000.

Table(s)

Table 1 Characteristics of overdoses (n=469, missing data reported in each variable)

Characteristic (n=464)	Description	Patient total	Location data missing	Street n=212 (45.2%)	Residential n=178 (38%)	Services n=74 (15.8%)
Opioids (n=441)	Evidence of opioid use at scene	418 (89.1)*	5	197 (92.9)	155 (87.1)	61 (82.4)
Other substances (n=131)	Alcohol	29 (6.2)	0	15 (7.1)	11 (6.2)	3 (4.1)
	Benzodiazepines	24 (5.1)	0	10 (4.7)	9 (5.1)	5 (6.8)
	Antidepressants	10 (2.1)	0	2 (0.9)	8 (4.5)	0
	Multiple	45 (9.6)	1	11 (5.2)	28 (15.7)	5 (6.8)
	Yes (unspecified)	15 (3.2)	0	4 (1.9)	8 (4.5)	3 (4.1)
	Stimulants	8 (1.7)	0	1 (0.5)	6 (3.4)	1 (1.4)
Clinical presentation (n=402)	Unresponsive	183 (39)	1	99 (46.7)	57 (32)	26 (35.1)
	Respiratory arrest	47 (10)	0	19 (9)	17 (9.6)	11 (14.9)
	Respiratory depression	55 (11.7)	0	33 (15.6)	16 (9)	6 (8.1)
	Cardiac arrest	19 (4.1)	0	1 (.5)	13 (7.3)	5 (6.8)
	Decreased SPO2	3 (.6)	0	1 (.5)	1 (.6)	1 (1.4)
	GCS 15	12 (2.6)	0	7 (3.3)	4 (2.2)	1 (1.4)
	Aggression	1 (.2)	0	1 (.5)	0	0
	Poisoning	12 (2.6)	0	1 (.5)	9 (5.1)	2 (2.7)
	Respiratory rate 20	1 (.2)	0	0	0	1 (1.4)

	Overdose	69 (14.7)	2	11 (5.2)	41 (23)	15 (20.3)
Characteristic (n=464)	**Description**	**Patient total**	**Location data missing**	**Street n=212 (45.2%)**	**Residential n=178 (38%)**	**Services n=74 (15.8%)**
Mean GCS scores	Pre (n=315)	7.2		6.36	7.78	7.7
	Post (n=288)	12.3		12.63	11.78	12.59
Care provided (n=118)	Ventilations	105 (22.4)	0	46 (21.7)	42 (23.6)	17 (23)
(n=295)	O_2 administration	282 (60.1)	2	140 (66)	100 (56.2)	40 (54.1)
(n=387)	Naloxone	357 (76.1)	3	182 (85.8)	117 (65.7)	55 (74.3)
(n=359)	Mean dose of Naloxone	.61		.58	.63	.7
(n=354)	Route: IM	308 (65.7)	3	173 (81.6)	90 (50.6)	42 56.8)
	IM/Sq	1 (0.2)		0	1 (0.6)	0
	IO	7 (1.5)		0	5 (2.8)	2 (2.7)
	IV/IM	38 (8.1)		6 (2.8)	23 (12.9)	9 (12.2)
(n=406)	First aid prior to ambulance	42 (9)	0	9 (4.2)	17 (9.6)	16 (21.6)
(n=457)	Transport	415 (88.5)	4	189 (89.2)	154 (86.5)	68 (91.9)
Death	On the scene	13 (2.8)	0	1 (.5)	9 (5.1)	3 (4.1)
Repeat OD (n=358)	Confirmed	96 (26.8)	0	56 (26.4)	26 (14.6)	14 (18.9)
	Mean no. of repeat ODs	2.24		2.26	2.19	2.29

*Numbers in the "Values" column include cases with unknown location, i.e. n=469. Therefore, numbers in the location columns don't add up.

Table(s)

Table 2 Urban Overdose Hotspots in Dublin City

Number of Small Areas – SA (n=176)	Number of Overdoses – OD (n=353*)	No of OD x No of SA
1	32	32 (9.1%)
2	13	26 (7.4%)
1	11	22 (6.2%)
2	9	18 (5.1%)
2	8	16 (4.5%)
3	6	18 (5.1%)
2	5	10 (2.8%)
6	4	24 (6.8%)
9	3	27 (7.7%)
148	1-2	160 (45.3%)

*NAS geo-data were unavailable

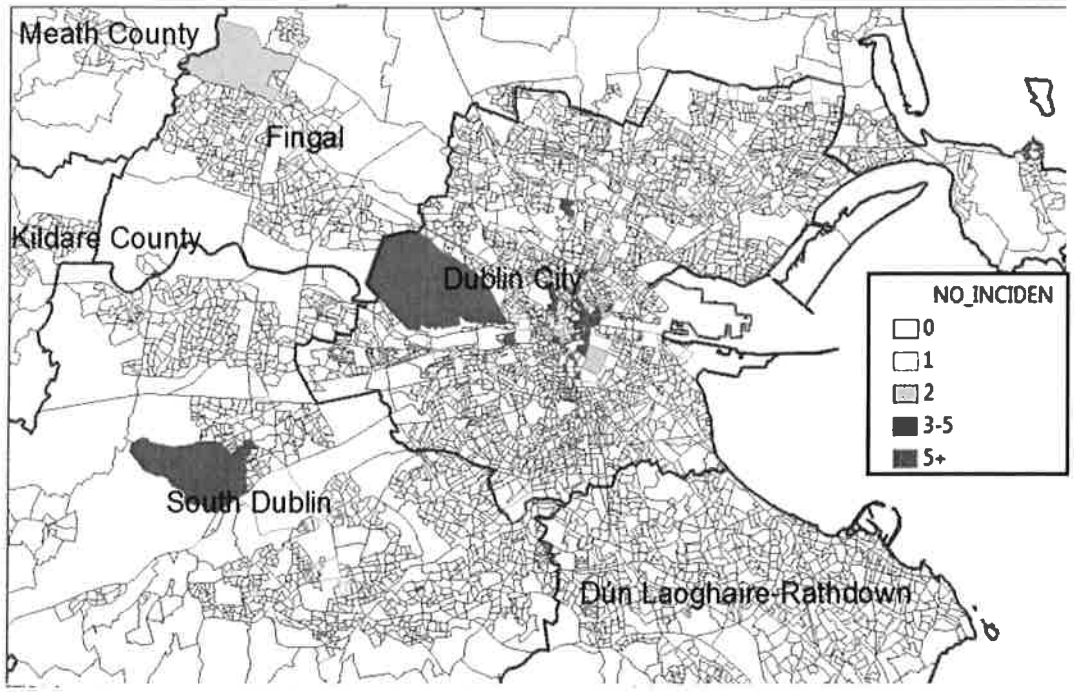
Table 3 Distribution of overdoses in the City centre versus suburbs (n=172)

n=172		Location		Total
		Street	Residential	
City Centre / Suburb	Centre	60 (76.9%)	31 (33.0%)	91 (52.9%)
	Suburb*	18 (23.1%)	63 (67.0%)	81 (47.1%)
Total		78	94	172

*$p < 0.001$

Figure(s)

Figure 1. Spatial distribution of overdoses (n=358*)



*NAS geo-data were unavailable.