

# Opioid overdose death in Wales: A linked data autopsy study

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## Research article

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# Abstract

## Background

Fatal opioid overdose is a growing public health problem, the incidence of which is rising in the UK and in other western countries. We sought to describe factors associated with deaths, demographic characteristics, and service usage patterns of decedents of opioid overdose in a nation of the UK.

## Methods

We carried out a retrospective cross-sectional analysis of opioid related deaths between 01/01/2012 and 11/10/2018 in Wales, UK, as identified from Office for National Statistics data. In addition to ONS records, the Welsh Demographic Service and National Health Service datasets were interrogated for records spanning the preceding three years. Records were linked on an individual basis using a deterministic algorithm. Decedents' circumstances of death, demographic characteristics, and residency and service use patterns were described. Additionally, data pertaining to circumstances of death were briefly analysed.

## Results

638 people died of opioid overdose in Wales between 01/01/2012 and 11/10/2018. Decedents were mostly male and around 50 years of age. Incidence per head of population was higher at the end of this period, peaking in 2015. In the 3 years prior to death the majority of decedents changed address at least once, but rarely moved far geographically. Over 80% of decedents visited the ED, the majority via emergency ambulance; over 60% were admitted to hospital; and over 30% visited specialist drug services on one or more occasion. Decedents who did not attend drug services were more likely to have died intentionally.

## Conclusions

High risk opioid users are often men of around 50 years of age living peripatetic lifestyles. It appears that those at high risk of dying from opioid overdose death use emergency medical services and are admitted to hospital comparatively often. They are less likely to visit specialist drug services however. Group differences between high risk opioid users who visit specialist drug services and those who do not appear to exist in relation to suicidality. Further research is needed in to delivering abstinence focussed or harm reduction based interventions via emergency services or inpatient hospital settings, and in understanding differences in suicidality between drug service attenders and non-attenders.

## Background

Opioids are involved in fatal overdose more often than any other drug (1). The global opioid market is growing, and fatal overdoses related to illicit opioids such as heroin (diamorphine) and to the misuse of opioid painkillers have increased to record levels in the UK, USA, Canada and Australia (2–5). The UK experiences the most opioid related deaths (ORDs) of any European nation total and per head of population (6). In addition to the human cost of opioid overdose, the economic cost to society is also significant. In a study based in the United States, both fatal and non-fatal opioid overdose was found to contribute significantly to the overall economic burden of opioid misuse, which was estimated at \$51.2 billion over one year (7).

Emergency service contact for non-fatal overdose has been found to predict of fatal overdose (8). Though data exists to suggest that hospital admissions related to opioid overdose have been on the increase for some time in the United States (9), an in depth longitudinal study of fatal opioid overdose decedents in the UK is lacking. We describe findings from a retrospective cross-sectional autopsy study using routine linked data to identify and describe characteristics of death (including substances involved and intent), demographic characteristics, residential mobility and patterns of healthcare service usage of opioid overdose decedents over three years prior to death.

## Methods

Data were captured from the ONS Births, Deaths and Marriages and NHS Wales Informatics Service (NWIS) datasets (see Table 2 for source datasets and associated coding frameworks). Records were linked by NWIS and analysed in the Secure Anonymised Information Linkage (SAIL) gateway (10,11). The matching algorithm used was devised by the NWIS, and applies deterministic and probabilistic routines in a logical sequence. The approach allows for consistently accurate matching, demonstrating high specificity (>99%) and sensitivity (>95%) (11). SAIL is a databank of anonymised data, containing billions of individual records containing healthcare related data about the population of Wales. SAIL contains core datasets, though other data can be imported in to SAIL for secure analysis of anonymised records.

Individual records were linked using each decedent's NHS number supplemented with demographic information including example name, address and date of birth. Demographic data were then separated from sensitive health record data and decedents were assigned a unique and encrypted Anonymised Linkage Field (ALF) number, which is meaningless outside of the SAIL gateway. Non-identifiable demographic data were then recombined with sensitive data and linked by ALF number on an individual basis. Residential anonymised linkage field numbers (RALFs) were created using the same process, but sensitive data related to residency, including home address. We were therefore able to capture data sufficient to describe the number of unique small geographic areas that decedents were resident in, and so describe changes of postal address and number of unique addresses held by each decedent. The small geographic areas were Lower Super Output Areas (LSOAs), which are mostly contiguous with postcode areas, and have populations of between 1000 and 3000 people.

### Table 1. Data sources and frameworks

Data	Source Database	Coding framework
<b>Mortality Event data</b>	ONS (Births, deaths and marriages)	ICD-10
<b>Demographic</b> Decedent age and gender	ONS (Births, deaths and marriages)	ICD-10
<b>Residential Stability</b> Residential ALF (Anonymised Linkage Field) and LSOA (Local Super Output Area)	Welsh Demographic Service (WDS) database	NHS Wales Data Dictionary Version 4.9
<b>Service Utilisation</b> ED attendance data	Emergency Department Dataset (EDDS)	NHS Wales Data Dictionary Version 4.9
Substance misuse service attendance data	Substance Misuse DataSet (SMDS)	NHS Wales Data Dictionary Version 4.9
Hospital admission data	Patient Episode Database for Wales (PEDW)	ICD-10

An observation period of 1/1/2012 to 11/10/2018 was chosen as being sufficiently recent to reflect the current incidence of opioid overdose death, and also ensured that complete death registration data would be available. Initially we included decedents of ORDs. We then refined our selection to include deaths where an opioid drug was the primary or secondary cause of death, and where the underlying cause of death indicative of opioid overdose. Primary and secondary causes of death were coded as opioid poisoning due to T40. = Opium; T40.1 = Heroin; T40.2 = Other opioids (Morphine, Oxycodone, Hydrocodone); T40.3 = Methadone; T40.4 = Synthetic opioids excluding methadone (Fentanyl, Propoxyphene, Meperidine). Underlying cause of death was coded as F11–F19 = Mental and behavioural disorders due to psychoactive substance use; X40-44 = Unintentional poisoning by and exposure to narcotics and psychodysleptics X60-69 = Intentional self-poisoning by and exposure to narcotics and psychodysleptics X85 = Assault (homicide) by drugs, medicaments and biological substances or Y10-19 = Poisoning by and exposure to narcotics and psychodysleptics (undetermined intent). We sought to avoid inclusion of ORDs which may have involved opioid drugs as a co-ingestion, but where cause of death would primarily be attributable to another type of drug or injury.

Medians and interquartile ranges (IQR) were calculated where continuous data were not normally distributed, and means and standard deviations (SD) where data were normally distributed. Normality was assessed using the Kolmogorov-Smirnoff test and visual inspection of q-q plots and distribution density functions. We did not report aggregate numbers of less than five to protect the anonymity of the subjects. As census samples of available cases during the study period were included, sample size calculations were not performed. Multinomial regression analysis was undertaken to establish predictors of intentional death as opposed to accidental or death of undetermined intent. Recent iterations of Microsoft Excel and IBM SPSS (Statistical Package for the Social Sciences) were used for data analysis.

## Results

From 1/1/2012 to 11/10/2018, 1057 ORDs were recorded by the ONS. Of these, 638 deaths met our selection criteria of being primarily attributable to opioid overdose. 419 ORDs were excluded as involving opioid drugs as a contributory (or potentially contributory) factor of varying or unknown weighting. Sensitivity and specificity of the selection criteria against the wider sample were calculated as 0.98 and 0.83 respectively (see Table 2).

**Table 2. Sensitivity and specificity**

All ORDs n=1057		Primary (1 and/or 2) cause of death = T40-T40.4	
		Present	Absent
Underlying cause = F11-19, X40-44, X60-69, X85, Y10-19	Present	638 (a)	68 (b)
	Absent	12 (c)	339 (d)
Sensitivity (a/a+c)=0.98 Specificity (d/d+b)=0.83			

The inclusion and exclusion of cases is summarised in Figure 1. At analysis, we found that our sample were mostly male, with 27.43% (n=175) female. Average age was 49.61 (20.72) years.

All 638 included cases were successfully linked to the Welsh Demographic Service (WDS) and the NHS service datasets. Using publicly available Welsh Government census data we calculated the incidence per 100,000 people. We found that incidence increased over the observation period of 2012-2018 with the number (and rate) of deaths peaking in 2015 (Table 3).

**Table 3. Opioid overdose deaths per 100,000 people**

Incidence			
Year	Wales Pop (mid-year)	Deaths	per 100,000
2012	3074067	69	2.24
2013	3082412	79	2.53
2014	3092036	97	3.14
2015	3099086	117	3.77
2016	3113150	102	3.28
2017	3125165	101	3.23

The primary and secondary substances involved in each death were most often coded as T40.2 - other opioids. According to the ICD-10 coding framework used by the ONS, other opioids refer to the opioid analgesics morphine, oxycodone and hydrocodone and their derivatives. The least often involved were T40.4 other synthetic opioids, which include fentanyl, propoxyphene, and meperidine.

In terms of intent, a minority of deaths were found to be intentional or undetermined with most recorded as accidental. These data are summarised in Table 4.

**Table 4. Death characteristics**

Substances and intent per decedent	
Primary substance contributing to death	Other opioids n = 217 (34.01%) Heroin n = 194 (30.41%) Methadone n = 84 (13.17%) Other synthetic opioids n = 51 (7.99%)
Secondary substance	Other opioids n = 48 (7.52%) Heroin n = 23 (3.61%) Methadone n = 12 (1.88%) Other synthetic opioids n = 9 (1.41%)
Intent	Accidental n = 553 (86.68%) Intentional n = 52 (8.15%) Undetermined n = 33 (5.17%)

In the 3 years prior to death more than half of decedents changed address. The number of unique addresses per decedent was greater than the number of LSOAs, indicating that people had moved both between and within areas. The number of unique addresses also outnumbered the number of times decedents changed address, indicating some decedents moved 'back and forth' between addresses during the observation period. The median number of addresses and LSOAs that decedents had lived in are summarised in Table 5.

**Table 5. Residential mobility**

No. of unique addresses per decedent (in 3 years prior to death)	Median = 2 IQR (Interquartile range) = 1
No. of decedents living in more than one address over 3 years	320 (50.16%)
No. of unique LSOAs per decedent	Median = 1 IQR = 1
No. of decedents living in more than one LSOA	291 (45.61%)
No. of changes of address per decedent	Median = 2 IQR = 2
No. of decedents changing address at least once	337 (52.82%)
Decedents for whom no data were available	8 (1.25%)
	Total addresses in sample = 1078 Total LSOAs = 648 Total changes of address = 1221

More than 80% of decedents visited the ED in the 3 years prior to death, with just under a quarter doing so within a month of death. The majority attended on several occasions and were conveyed by emergency ambulance. Additionally a sizeable minority were conveyed to the ED by police vehicle during this period. Fewer than 10% of deaths occurred in the ED.

Over 60% of decedents were admitted to hospital in the 3 years prior to death, with most staying in hospital for longer than a day. Most were admitted more than once during the observation period. The length of stay varied greatly, and less than 5% died in hospital.

Under a third of decedents visited specialist drug services in the 3 year period, though those that did make contact did so on multiple occasions. mThirty percent of those attending drug services died whilst enrolled in treatment. All service usage data are summarised in Table 6.

**Table 6. Service use patterns**

<b>No. of decedents who attended ED over:</b>	
3 years prior to death	531 (83.23%)
2 years	495 (77.59%)
1 year	423 (66.3%)
1 month	157 (24.61%)
No. of attendees conveyed by ambulance	426 (80.23%) 1641 separate visits
No. of attendees conveyed by police car	102 (19.21%) 147 separate visits
No. of attendees died in department	44 (8.29%)
	Median attendances per decedent=4 (IQR=5) Total attendances=3173
<b>No. of decedents admitted to hospital over:</b>	
3 years prior to death	406 (63.64%)
2 years	362 (56.74%)
1 year	281 (44.04%)
1 month	98 (15.36%)
	Median admissions per decedent = 2 (4) Total admissions = 1549
Decedents admitted for ≤ 1 day on at least one occasion	230 (56.65%)
For ≥ 1 day - ≤ 1 month on at least one occasion	340 (83.74%)
For ≥ 1 month on at least one occasion	39 (9.61%)
	Median length of stay=2 (6) days
No. died in hospital	27 (6.65%)
<b>No. of decedents assessed for drug service treatment over:</b>	
3 years prior to death	178
2 years	155
1 year	118
1 month	15
	Median assessments per decedent=2 (2) Total assessments = 331
<b>No. of decedents entered in to drug service treatment contracts over:</b>	
3 years prior to death	175
2 years	167
1 year	142
1 month	77
	Median contracts per decedent=3 (3) Total contracts=554
No. of attendees who died whilst in a treatment contract	62

Multinomial logistic regression was carried out to determine predictors of intentional death (as opposed to accidental or undetermined), which was the dependent variable. Factors were drug service attendance, hospital admittance and ED attendance. The number of drug service visits, hospital admission episodes and ED visits were covariates. Only drug service non-attendance significantly predicted death by intentional overdose  $\beta=2.06$ ,  $p=0.002$ ,  $OR=7.84$  (95%  $CI=2.18, 28.21$ ).

## Discussion

We found that mortality coding related to cause of death was broad, with several different opioid drugs grouped by class. By dividing the number of different drugs by the number of deaths attributed to each class we can assert that heroin was most likely the single largest contributor to death in our sample. In contrast with North American data (12), our data do not suggest that fentanyl overdose presents a significant a public health concern in Wales.

Overdose deaths increased between the years 2012 and 2018, with 2015 yielding the most overdose deaths per head of population during this period. Most of these deaths were accidental.

According to the English Housing Survey (13), residents in England change address every 11 years on average, with private renters moving more often (every 4 years) than council tenants (slightly over 11 years) or homeowners (18 years). Our findings indicate that those at high risk of opioid overdose exhibit greater residential mobility than the general population. Other researchers have struggled to follow up members of this population via traditional methods including via post (14,15). Our data suggests that difficulties in following up this population for research purposes can be attributable to high risk overdose user's peripatetic lifestyles.

NHS Digital and publicly available census data covering 2017-2019 shows that in Wales, around 26% of the population attended the ED per year (16,17). In comparison, our data suggests that people at high risk of fatal opioid overdose visit the ED disproportionately often. Our findings are supported by those of Ryan and Spronken (18), who carried out a small scale retrospective analysis of ED usage by decedents of opioid overdose and found that 33 of 36 decedents visited the ED within one year of death.

The majority of decedents in our study were admitted to hospital more than once during the observation period. According to NHS Digital data, in the year 2018-2019 and publicly available census data, 29% of the population of England completed a 'Finished Admission Episode' (FAE), which is the first period of inpatient care under one consultant within one healthcare provider (19). In comparison it would appear that people at high risk of fatal opioid overdose are admitted to hospital more often than the general population.

Public Health Wales (PHW) data suggest that 40% of high risk opioid users in Wales are in contact with specialist drug treatment services (20). Our data suggests that a smaller proportion make contact.

Additionally, we found that not attending drug services predicted intentional death, as opposed to accidental or death of undetermined intent. These findings suggest a difference in suicidality between service user groups. High risk opioid drug users with a proclivity for suicidal behaviour may be less likely to visit drug services, or visiting drug services may be associated with a reduction in suicidality amongst high risk opioid users. Further research should be carried out to investigate these possibilities.

## Limitations

We were able to describe the circumstances of death, and the service usage characteristics of opioid overdose prior to death for high risk opioid users using multiple data sets over a prolonged observation period. The authors are unaware of an observational study in to opioid overdose death utilising routine linked data in this way. We were however, unable to collect diagnostic or treatment data of a sufficient quality for report from emergency or hospital datasets.

## Conclusions

High risk opioid users are often men of around 50 years of age living peripatetic lifestyles. It appears that those at high risk of dying from opioid overdose death use emergency medical services and are admitted to hospital comparatively often. They are less likely to visit specialist drug services however. Group differences between high risk opioid users who visit specialist drug services and those who do not appear to exist in relation to suicidality. Further research is needed in to delivering abstinence focussed or harm reduction-based interventions via emergency services or inpatient hospital settings, and in understanding differences in suicidality between drug service attenders and non-attenders.

## Abbreviations

ONS: Office for National Statistics  
NWIS: NHS Wales Informatics Service  
SAIL: Secure Anonymised Information Linkage  
ALF: Anonymised Linkage Field  
WDS: Welsh Demographic Service  
LSOA: Lower Super Output Area  
EDDS: Emergency Department DataSet  
SMDS: Substance Misuse DataSet  
PEDW: Patient Episode Database for Wales  
ORD: Opioid Related Death  
FAE: Finished Admission Episode

## Declarations

Ethics approval and consent to participate

The study was subject to ethical review by an independent Information Governance Review Panel (IGRP) constituted by the SAIL databank, which gave the project a favourable opinion (agreement number 0712).

Consent to publish

Not applicable

#### Availability of data and materials

The data that support the findings of this study are available from the SAIL databank but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of SAIL.

#### Competing interests

The authors declare that they have no competing interests.

#### Funding

The study was funded by PRIME Centre Wales. PRIME provides funding for research teams and projects focussed on improving emergency (including prehospital) and primary care health service delivery.

#### Authors' Contributions

MJ carried out data collection and led write up. All authors contributed to, read, and approved the final manuscript. AW consulted on statistical reporting and analysis.

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Data scoping, capture, linkage and anonymization was carried out by SAIL (Secure Anonymised Information Linkage) databank.

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## Figures

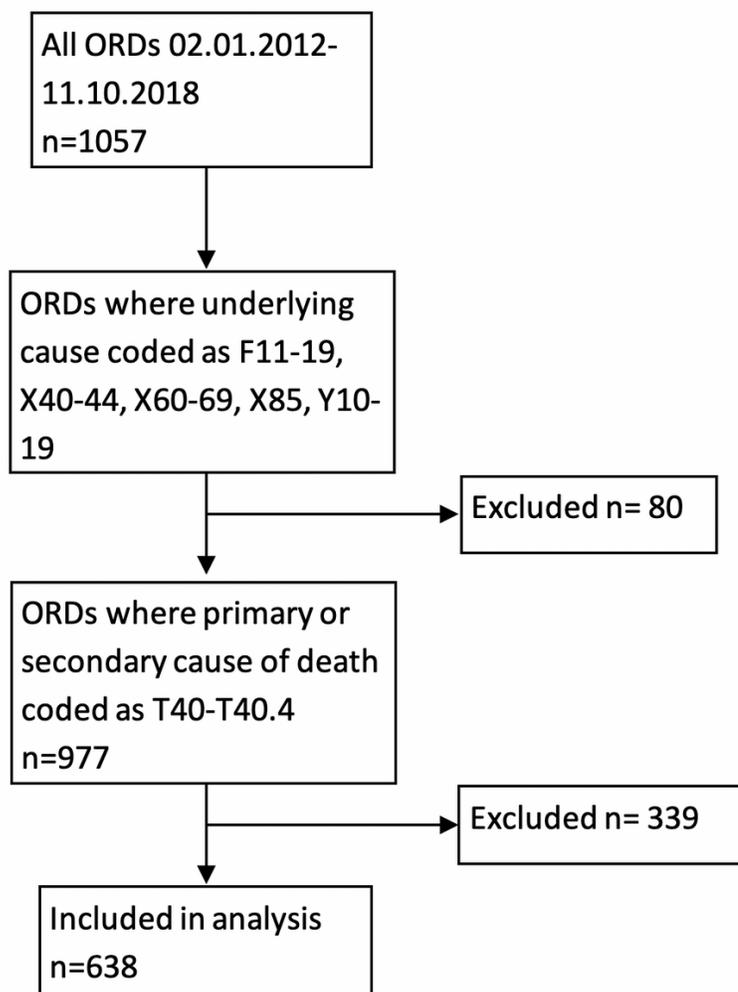


Figure 1

Sample selection criteria