

## Circumstances surrounding non-fatal opioid overdoses attended by ambulance services

DESIREE MADAH-AMIRI<sup>1</sup>, THOMAS CLAUSEN<sup>1</sup>, LARS MYRMEL<sup>2</sup>, GUTTORM BRATTEBØ<sup>2,4</sup> & PHILIPP LOBMAIER<sup>1,3</sup>

<sup>1</sup>The Norwegian Centre for Addiction Research, The University of Oslo, Oslo, Norway, <sup>2</sup>Bergen Emergency Medical Services, Department of Anaesthesia and Intensive Care, Haukeland University Hospital, Bergen, Norway, <sup>3</sup>Division of Mental Health and Addiction, Oslo University Hospital, Oslo, Norway, and <sup>4</sup>Department of Clinical Medicine, University of Bergen, Bergen, Norway

### Abstract

**Introduction and Aims.** Opioid overdose fatalities are a significant concern globally. Non-fatal overdoses have been described as a strong predictor for future overdoses, and are often attended by the ambulance services. This paper explores characteristics associated with non-fatal overdoses and aims to identify possible trends among these events in an urban area in Norway. **Design and Methods.** This is a retrospective analysis of non-fatal overdoses from Bergen ambulance services from 2012 to 2013. Demographic, temporal and geographic data were explored. **Results.** During the two years, 463 non-fatal opioid overdoses were attended by ambulance services. Ambulance call-outs occurred primarily during the late afternoon and evening hours of weekdays. Summer months had more overdoses than other seasons, with a peak in August. Overdoses were nearly twice as likely to occur in a public location in August (risk ratio 1.92,  $P = 0.042$ ). Ambulance response times were more likely to be longer to private locations, and these victims were more likely to be treated and left at the scene. There was no difference in arrival time for drug-related and non-drug related dispatch. **Discussion and Conclusions.** The temporal patterns suggest that non-fatal overdoses occur during non-recreational time periods. The longer ambulance response time and disposition for private addresses indicate potential opportunities for peer interventions. Our analysis describes circumstances surrounding non-fatal overdoses and can be useful in guiding relevant, targeted prevention interventions. [Madah-Amiri D, Clausen T, Myrmel L, Brattebø G, Lobmaier P. Circumstances surrounding non-fatal opioid overdoses attended by ambulance services. *Drug Alcohol Rev* 2017;36:288-294]

**Key words:** non-fatal overdose, EMS, ambulance, opioid, pre-hospital.

### Introduction

There are estimated to be over one million problem drug users in Europe, many who face severe burdens associated with their disease [1]. Opioid overdose fatalities are the most serious consequence of drug use, and northern Europe and Scandinavia are particularly affected [1]. Annual fatality rates in Norway are estimated to be around 70 per million, as compared to the European mean estimate of 17 deaths per million [1]. Further, Norway's second largest city, Bergen, experienced an annual drug fatality rate of 119 per million during 2012 and 2013, with 80–90% being opioid related [2,3]. Given that these alarming fatality rates are the highest in the country, monitoring and prevention efforts in the region are needed.

Of all opioid overdoses, approximately 5% are fatal [4,5]. Non-fatal opioid overdoses make up a majority of overdoses experienced, and have severe implications for

people who inject drugs (PWID) [6]. Between 17 and 68% of PWID experience and 50 and 96% witness an overdose in their lifetime [6]. Non-fatal opioid overdose victims face high rates of morbidity following an overdose, including broken bones, head injuries, neuropathy and paralysis [7]. Furthermore, non-fatal overdoses have been described as a predictor for future fatal opioid overdoses [8–10].

Fatal opioid overdoses are primarily reported through direct measures, such as police reports and mortality registries. This method results in a significant time lag before reports are made public. The Norwegian annual cause-of-death reports present data on incidents that occurred from one to two years after the actual event. Hence, this information may not necessarily represent the current trends surrounding drug use and overdose patterns. Additionally, this information only describes fatalities deemed as a result of illicit drug use. Whether

Desiree Madah-Amiri FNP, Doctoral student, Thomas Clausen MD, PhD, Professor, Lars Myrmel RN, Guttorm Brattebø MD, FERC, Medical Director, Professor II, Philipp Lobmaier MD, PhD, Researcher. Correspondence to Miss Desiree Madah-Amiri, Norwegian Centre for Addiction Research, Institute of Clinical Medicine, The University of Oslo, P.O. Box 1039 Blindern, 0315 Oslo, Norway. Tel.: +47 23 36 89; E-mail: desireem@medisin.uio.no

Received 22 January 2016; accepted for publication 31 May 2016.

from underreporting, surveys subject to bias or a lack of a systematic reporting database, adequate information on non-fatal opioid overdoses in Norway is lacking.

Addressing the opioid overdose epidemic requires the utilisation of public health measures, including the use of local data to target interventions [11]. Information from ambulance records has been used to understand patterns associated with various drug related emergencies, such as  $\gamma$ -hydroxybutyric acid (GHB) overdoses, pharmaceutical drug misuse, cannabis and volatile substance use. As demonstrated in these studies, ambulance information can be useful to guide and evaluate prevention services on a local level. Studies from Australia [12,13], the United States [14–16] and Europe [17–19] have used ambulance data to examine opioid overdoses locally, and have also contributed globally to developing an evidence base to better understand the global diversity in practices and outcomes.

Drug use patterns and treatment responses vary across the world, and it is therefore necessary to have estimates from a variety of settings to better understand mechanisms of actions that can be targeted with prevention measures. In Dublin, opioid overdose hotspots determined from ambulance calls identified areas of increased incidence, giving guidance for prevention programs in the most affected areas [19]. Australia has extensive data collection and monitoring of drug related ambulance attendances, which have relevance for influencing public health programs and health policy [20]. These epidemiological studies have provided the necessary data to guide and eventually evaluate the effect of prevention efforts. Although Bergen, Norway experiences some of the highest rates of fatal drug overdoses per population globally, prior local ambulance monitoring studies have not been conducted.

This study examined characteristics of non-fatal overdoses attended by emergency medical services (EMS) in Bergen, Norway from 2012 to 2013 by retrospectively reviewing ambulance records. The aim of this study was to: (i) describe the demographic, temporal and geographic conditions surrounding non-fatal opioid overdoses; and (ii) investigate possible trends among these cases.

## Methods

### *Setting*

There are estimated to be between 7000 and 10000 PWID in Norway [21]. There were more than 7400 clients enrolled in opioid maintenance treatment in 2014, yet large numbers are still outside of formal treatment [22]. Heroin is the most commonly reported injected drug [21], and for heroin users, injection is the preferred route of administration [23]. Despite access to treatment in the target population, overdose fatalities

remain high in the society and are highest among those outside of formal treatment.

Bergen is the second largest city in Norway, with a population of approximately 270 000 [3]. Although smaller in size than the capital city of Oslo, in recent years Bergen has experienced more drug-induced deaths per population [2].

### *Study design*

The study was a retrospective analysis of non-fatal opioid overdoses attended by Bergen EMS from 1 January 2012 to 31 December 2013.

### *Bergen Emergency Medical Services*

The Bergen EMS attend to approximately 31 000 emergency calls annually and use standardised paper records for documentation on all patients. Documentation in these forms includes patient demographics, clinical and treatment information, and details of disposition after treatment.

Every ambulance call is dispatched by the Bergen emergency medical dispatch centre, which collects information on the caller, location, various time variables, the patient's response to treatment and where the patient is admitted in an electronic database.

The ambulance crews are equipped with naloxone, an opioid antagonist that reverses the effects of an opioid overdose. Treatment protocols include the use of this drug for a suspected opioid overdose. Indication for treatment includes reduced consciousness, respiratory depression and decreased pupil size.

### *Case selection*

Opioid overdose victims typically present with decreased respiratory rate and loss of consciousness [24]. A positive response following naloxone administration has been used by others as an indication of an opioid overdose [25], and was used for case selection in this study. Cases were included if a positive response (increased respiratory rate) followed naloxone administration by the ambulance staff. Cases were excluded if the patient did not respond to naloxone, or if the patient did not survive.

Possible opioid overdoses were identified through the emergency medical dispatch centre electronic data base based on caller information and ambulance feedback. In addition, all ambulance records coded as an 'acute response' were screened for possible opioid overdoses. The data from the records on suspected opioid overdoses were reviewed manually. Each entry represents an independent opioid overdose event; hence, the number of overdosing individuals was not analysed.

### Exposure measures

When not treated as outcome measures, several key variables were considered exposure measures. These included: demographic, temporal and location measures; time from call until arrival; caller-reported symptoms and disposition after treatment.

### Outcome measures

These measures included the overdose location (public or private), time from dispatch until ambulance arrival (less than or more than 10 min) and the disposition for the victim (being transported for further treatment or left at the scene).

### Data analysis

Statistical analyses were conducted using SPSS Version 22.0. Age differences among genders were tested using the independent samples *t*-test.  $\chi^2$  tests were used to analyse differences between days of the week, months of the year, and to explore the relationship between ambulance arrival times and the symptoms reported (drug related and non-drug related). Analysis of variance was used to compare the age of the victim during the various months. Cox regression was used to analyse categorical outcomes [26].

### Ethics

This study was approved by the Norwegian Data Protection Official for Research and the Regional Ethics Committee.

## Results

### Demographic data

During the 2 year period the Bergen EMS successfully treated 463 patients with suspected opioid overdoses with naloxone. The yearly incidence of non-fatal opioid overdoses was estimated to be approximately 84 per 100 000 population. Table 1 shows the main characteristics of the victims. There were significantly more males ( $n=313$ , 67.6%) than females ( $n=105$ , 22.7%). Ages ranged from 17 to 63 years ( $M=32.8$ ,  $SD=9.42$ ), and was not statistically different between men ( $M=33$ ,  $SD=9.42$ ) and women ( $M=32.4$ ,  $SD=9.52$ ;  $P=0.632$ ).

### Temporal data

Time of day, week day and month of year were analysed. Non-fatal opioid overdoses were categorised by day of the week and hour of the day (Figure 1). The patterns generally followed normal sleep-wake cycles, with the

**Table 1.** Characteristics of overdose dispatch to Bergen ambulance services from January 2012–December 2013 for public and private locations

	Public space <i>n</i> (%)	Private residence <i>n</i> (%)	Total <i>n</i> (%)
Non-fatal overdoses	261 (56.4)	202 (43.6)	463 (100)
Mean age	33	32.7	
Median age	31	31	
<i>Gender</i>			
Male	172 (76.1)	141 (73.4)	313 (67.6)
Female	54 (23.9)	51 (26.6)	105 (22.7)
Missing			45 (9.7)
<i>Weekday</i>			
Monday	34 (13)	30 (14.9)	64 (13.8)
Tuesday	42 (16.1)	27 (13.4)	69 (14.9)
Wednesday	38 (14.6)	29 (14.4)	67 (14.5)
Thursday	53 (20.3)	31 (15.3)	84 (18.1)
Friday	36 (13.8)	23 (11.4)	59 (12.7)
Saturday	37 (14.2)	35 (17.3)	72 (15.6)
Sunday	21 (8)	27 (13.4)	48 (10.4)
<i>Month</i>			
January	13 (5)	17 (8.4)	30 (6.5)
February	18 (6.9)	20 (9.9)	38 (8.2)
March	14 (5.4)	14 (6.9)	28 (6.0)
April	10 (3.8)	6 (3)	16 (3.5)
May	21 (8)	10 (5)	31 (6.7)
June	23 (8.8)	29 (14.4)	52 (11.2)
July	26 (10)	17 (8.4)	43 (9.3)
August	49 (18.8)	22 (10.9)	71 (15.3)
September	22 (8.4)	17 (8.4)	39 (8.4)
October	18 (6.8)	8 (4)	26 (5.6)
November	23 (8.8)	18 (8.9)	41 (8.9)
December	24 (9.2)	24 (11.9)	48 (10.4)
Total	261 (56.4)	202 (43.6)	463 (100)
<i>Ambulance response times</i>			
0–4 min	74 (28.4)	34 (16.8)	108 (23.3)
5–10 min	108 (41.4)	96 (47.5)	204 (44.1)
More than 10 min	36 (13.8)	49 (24.3)	85 (18.4)
Missing	43 (16.5)	23 (11.4)	66 (14.3)
Total	261 (56.4)	202 (43.6)	463 (100)

fewest occurring from 4:00 until 9:00 in the morning. The majority occurred during late afternoon and evening hours, with the highest occurrences between the hours of 16:00 and 17:00 ( $n=36$ , 7.8%) and 20:00 and 21:00 ( $n=34$ , 7.3%). There was no significant difference for calls among the different days of the week ( $P=0.08$ ). The majority occurred on weekdays, with the fewest occurring on Fridays ( $n=59$ , 12.7%) and Sundays ( $n=48$ , 10.4%) (Table 1).

There was a statistically significant difference for non-fatal opioid overdoses among the various months ( $P<0.001$ ). August had the most overdoses during the two years ( $n=71$ , 15.3%) with the lowest rates in April ( $n=16$ , 3.5%) (Table 1). The monthly average the 2 year period was 19.3, totally approximately 232 non-fatal

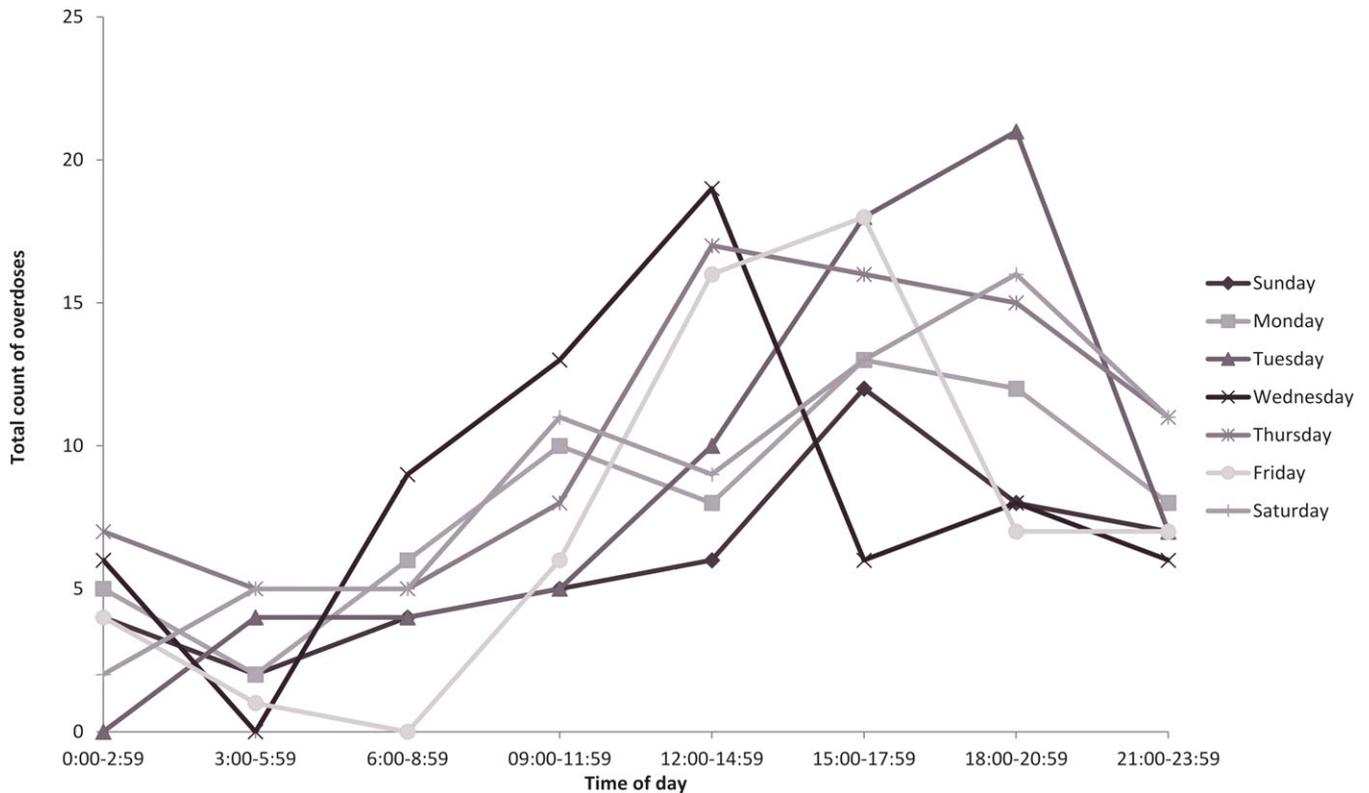


Figure 1. Ambulance call-out frequency for overdoses according to the day of the week and time of day in Bergen, Norway 2012–2013. [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

opioid overdoses a year (Table 1). The age of the victim was not significantly different for the various months ( $P=0.137$ ).

*Geographical location*

Ambulance pick-up locations were categorised into either being public or private. Public pick-up locations included: indoor and outdoor public spaces ( $n=223$ , 48.2%), a popular low-threshold facility ( $n=25$ , 5.4%), medical facilities ( $n=10$ , 2.2%) and other locations ( $n=3$ , 0.6%). Private locations included private homes ( $n=176$ , 38%) and overnight housing facilities ( $n=26$ , 5.6%) (Table 1).

Non-fatal opioid overdoses in public locations peaked in August (Figure 2). These represented nearly 20% of the total non-fatal opioid overdoses in public places for the period. In multivariable model (adjusting for age, gender and month), assessing factors associated with overdosing in a public location, overdosing in August was the only significant finding in the model (risk ratio 1.92,  $P=0.042$ , 95% confidence interval 1.024, 3.618) (Table 2).

*Ambulance response time*

The ambulance response time ranged from 1.7 to 51 min, with median response time of 6.9 min. The response

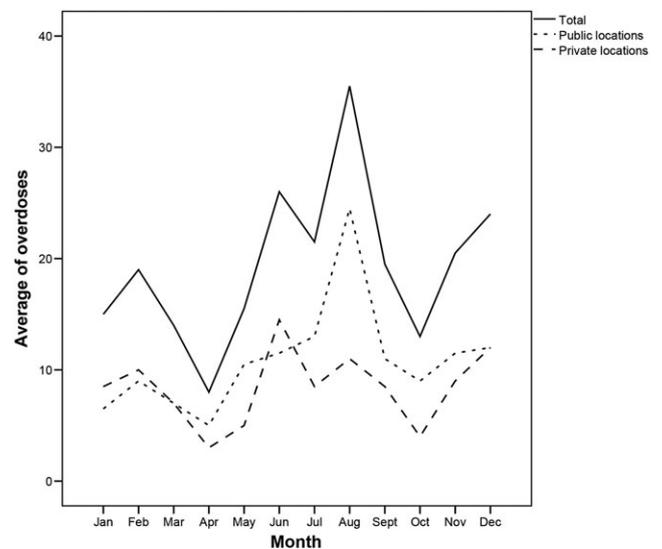


Figure 2. Average numbers of monthly nonfatal overdoses attended by Bergen Emergency Medical Services for public and private locations during January 2012– December 2013.

times were split into three groups (less than 5 min, 5–10 min more than 10 min), and nearly half ( $n=204$ , 44.1%) arrived within 5–10 min (Table 1). In 23.3% ( $n=108$ ) of the cases the ambulance arrived in less than 5 min, and took more than 10 min for 18.4% ( $n=85$ ) of the cases. Information was missing for the remaining ( $n=66$ , 14.3%).

**Table 2.** Factors predicting the likelihood of overdosing and being picked up by the Bergen ambulance services in a public location

Covariate	RR	95% CI	P value
Gender	1.03	0.73, 1.45	0.857
Age	1.00	0.99, 1.02	0.949
Month			
January	1.12	0.49, 2.56	0.784
February	1.25	0.59, 2.65	0.553
March	1.46	0.67, 3.16	0.337
April	1.95	0.80, 4.72	0.140
May	1.69	0.77, 3.72	0.189
June	1.12	0.55, 2.31	0.749
July	1.26	0.60, 2.65	0.540
August	1.92	1.02, 3.62	0.042*
September	1.39	0.67, 2.88	0.383
October	1.55	0.69, 3.48	0.292
November	1.43	0.70, 2.91	0.330
December	Ref		

Cox regression, adjusted for the following variables: age, gender and month.

\* $P < 0.05$ .

CI, confidence interval; RR, risk ratio.

The strongest predictor of longer response times (more than 10 min) was dispatch to a private home (risk ratio 1.66,  $P = 0.03$ , 95% confidence interval 1.053, 2.602) in an adjusted model (gender, month and pick-up location). The majority of callers reported that victims were unconscious ( $n = 279$ , 60.3%) or suffered from reduced consciousness ( $n = 79$ , 17.1%). Ambulance response time was not significantly different for drug-related ('intoxicated') and nondrug-related ('unconscious, reduced consciousness, respiratory or cardiac problems and other') dispatch ( $P = 0.692$ ).

Overall, disposition after treatment was approximately evenly split between being left at the scene following treatment ( $n = 226$ , 48.8%) and taken to a medical facility for further follow-up ( $n = 237$ , 51.2%). Of those that were picked up from a public location, 41.4% ( $n = 108$ ) were left at the scene and 58.6% ( $n = 153$ ) were transported further. The strongest predictor of being left at the scene was having overdosed at a private location (risk ratio 1.47,  $P = 0.009$ , 95% confidence interval 1.100, 1.956) in a regression model adjusting for age, gender, month and pick-up location.

## Discussion

Through analysis of available ambulance records, we have described circumstances surrounding non-fatal opioid overdoses in Bergen, Norway. Non-fatal opioid overdoses occurred most often in the evening, with no increase seen on the weekends. Summer months had higher rates than the other seasons, with an almost doubled risk during

August. Ambulance response times differed for public and private locations, yet we found no difference for drug-related and non-drug-related dispatch.

### Demographic data

Gender and age distribution was similar to previous studies [12,13,18,27]. This is similar to the gender distribution assumed among people in opioid maintenance treatment [28], demonstrating little risk difference among the genders [1]. Although there is reported to be an ageing population in Norway, our average age was similar to a previous Norwegian study from 1999 [27].

### Temporal trends

Our study found that the majority of non-fatal opioid overdoses occurred in the late afternoon and evenings, with consistently high rates during the weekdays. This is similar to other studies [12], demonstrating that non-fatal opioid overdose patterns do not follow a late-night weekend peak seen with volatile substances [29], GHB [30] and ecstasy-related overdoses [31]. This weekday pattern suggests that non-fatal opioid overdoses are non-recreational in origin, and may primarily occur with daily users.

Similar to a seasonal peak described by others [16], this study found the majority of overdoses happened during the summer, peaking in August. In particular, we found a sharp increase in overdoses in public locations in August. In Norway, this corresponds with a 'drug holiday' phenomenon, where residents from more rural areas in the country come to the cities to purchase and ingest drugs during the summer month of August. A previous study has shown that nearly 30% of overdose fatalities that occur in the city are non-residents, supporting this possible migration pattern with a seasonal twist [32]. This means an extra responsibility for cities experiencing such influx to provide PWID with low-threshold interventions and services. Moreover, these findings demonstrate the need for regions experiencing high rates of overdoses to examine their local temporal patterns in order to prepare appropriately.

### Location

The location for ambulance dispatch differed when compared to previous studies [13,14]. In Rhode Island, Merchant *et al.* reported 71% to a private residence, where we found only 43.6% were to a private residence. This may be explained by the use of drugs in the 'open drug scene' park instead of in a private residence. Ambulance response times to a private residence were more likely to be longer than to public locations, likely because private address could be suburban, whereas

public locations for drug consumption mainly remained central. In addition, ambulance dispatch to a private home was more likely to treat the victim at the scene, as opposed to transporting for further medical care. This may be because of the likelihood that the victim has someone home with them (the emergency caller), able to continue monitoring after ambulance discharge and following naloxone administration. It also reflects that at the time, the ambulance protocol was to treat the victim and leave them at the scene once stabilised.

### *Strengths and limitations*

Limitations exist for this study. The data was collected exclusively from ambulance records and does not include information about non-fatal opioid overdoses from other non-ambulance sources. Given the demonstrated reluctance to always call the ambulance in the event of an overdose [33], the ambulance may not serve as a complete source. Additionally, the data provided was analysed anonymously, which allowed only for an analysis of independent non-fatal opioid overdose events, not individuals. Ideally, more thorough information about the victims, such as their place of residence, specific substances ingested, injection drug use and their dose and response to naloxone could have been useful for a pre-hospital analysis. It is likely that the true number of non-fatal opioid overdoses is higher than what is estimated by this study, because some overdoses may not have been reported, such as if the victim was alone. Despite the limitations, this study provides ambulance data on non-fatal opioid overdoses for one of the most affected areas in Europe, and demonstrates the potential utility of ambulance data in the development of prevention work.

### *Implications*

With non-fatal opioid overdoses being associated with subsequent fatal overdoses [9], the need for understanding and responding to the circumstances surrounding non-fatal instances is critical. Hence, our findings may have practical implications for public health interventions aiming to reduce morbidity and mortality associated with opioid overdoses. While we observe that non-fatal opioid overdoses most often occur during late afternoon and evenings and during ‘summer holiday months,’ the services provided to PWID are not necessarily at peak availability at these times—on the contrary, opening hours are during the daytime and vacation for staff members at service facilities are typical during holiday seasons as well. In order to provide appropriate and ‘tuned in’ services, better knowledge of the local scene and flexibility to adjust service provision systems according to the periods of highest need is recommended.

Naloxone distribution programs have gained acceptance over the past two decades for their effectiveness in overdose prevention [34], and may be particularly relevant for opioid overdoses experienced in private homes. These events may be potential opportunities for ambulance services to engage in preventative initiatives, such as peer naloxone trainings and distribution of referrals. Implementing tailored prevention programs requires the application of local-level data to the communities in which they intend to serve. Proxy information provided by ambulances can give an indication of specific times, locations and populations most affected by injection drug use. This information can be used to optimise prevention programs, as well as serve as a baseline to evaluate their efforts.

### **Acknowledgements**

The authors would like to thank the Bergen Ambulance services for their recording and entry of data used for this article. Funding was received by the Norwegian Directorate of Health.

### **Conflict of interests**

PL has acted as paid consultant for Indivior, a pharmaceutical company involved in the development and supply of a range of drugs for the addiction field.

### **References**

- [1] European Drug Report. Lisbon: European Monitoring Centre for Drugs and Drug Addiction, 2015 (cited 2015 June 5). Available at [http://www.emcdda.europa.eu/attachements.cfm/att\\_239505\\_EN\\_TDAT15001ENN.pdf](http://www.emcdda.europa.eu/attachements.cfm/att_239505_EN_TDAT15001ENN.pdf).
- [2] Amundsen EJ. Narkotikautløste dødsfall. Statens institutt for rusmiddelforskning: Oslo, 2015.
- [3] Statistical yearbook of Norway 2013. Oslo: Statistics Norway, 2013.
- [4] Darke S, Mattick RP, Degenhardt L. The ratio of non-fatal to fatal heroin overdose. *Addiction* 2003;98:1169–71.
- [5] Bird SM, Parmar MKB, Strang J. Take-home naloxone to prevent fatalities from opiate-overdose: protocol for Scotland’s public health policy evaluation, and a new measure to assess impact. *Drugs (Abingdon Engl)* 2015;22:66–76.
- [6] Martins SS, Sampson L, Cerda M, Galea S. Worldwide prevalence and trends in unintentional drug overdose: a systematic review of the literature. *Am J Public Health* 2015;105:29–49.
- [7] Warner-Smith M, Darke S, Day C. Morbidity associated with non-fatal heroin overdose. *Addiction* 2002;97:963–7.
- [8] Coffin PO, Tracy M, Bucciarelli A, Ompad D, Vlahov D, Galea S. Identifying injection drug users at risk of nonfatal overdose. *Acad Emerg Med* 2007;14:616–23.
- [9] Stooze MA, Dietze PM, Jolley D. Overdose deaths following previous non-fatal heroin overdose: record linkage of ambulance attendance and death registry data. *Drug Alcohol Rev* 2009;28:347–52.
- [10] Gjersing L, Bretteville-Jensen AL. Are overdoses treated by ambulance services an opportunity for additional interventions? A prospective cohort study. *Addiction* 2015;110:1767–74.
- [11] Davis CS, Green TC, Zaller ND. Addressing the overdose epidemic requires timely access to data to guide interventions. *Drug Alcohol Rev* 2015; doi: 10.1111/dar.12321 [Epub ahead of print].

- [12] Dietze P, Jolley D, Cvetkovski S. Patterns and characteristics of ambulance attendance at heroin overdose at a local-area level in Melbourne, Australia: implications for service provision. *J Urban Health* 2003;80:248–60.
- [13] Clark MJ, Bates AC. Nonfatal heroin overdoses in Queensland, Australia: an analysis of ambulance data. *J Urban Health* 2003;80:238–47.
- [14] Merchant RC, Schwartzapel BL, Wolf FA, Li W, Carlson L, Rich JD. Demographic, geographic, and temporal patterns of ambulance runs for suspected opiate overdose in Rhode Island, 1997–2002. *Subst Use Misuse* 2006;41:1209–26.
- [15] Alexander JL, Burton JH, Bradshaw JR, Colin F. Suspected opioid-related emergency medical services encounters in a rural state, 1997–2002. *Prehosp Emerg Care* 2004;8:427–30.
- [16] Knowlton A, Weir BW, Hazzard F, *et al.* EMS runs for suspected opioid overdose: implications for surveillance and prevention. *Prehosp Emerg Care* 2013;17:317–29.
- [17] Degenhardt L, Hall W, Adelstein BA. Ambulance calls to suspected overdoses: New South Wales patterns July 1997 to June 1999. *Aust N Z J Public Health* 2001;25:447–50.
- [18] Seidler D, Schmeiser-Rieder A, Schlarp O, Laggner AN. Heroin and opiate emergencies in Vienna: analysis at the municipal ambulance service. *J Clin Epidemiol* 2000;53:734–41.
- [19] Klimas J, O'Reilly M, Egan M, Tobin H, Bury G. Urban overdose hotspots: a 12-month prospective study in Dublin ambulance services. *Am J Emerg Med* 2014;32:1168–73.
- [20] Lloyd B, Matthews S, Gao XC. Trends in alcohol and drug related ambulance attendances in Victoria: 2012/13. Fitzroy, Victoria: Turning Point; 2014 (cited 2016 April). Available at: <http://www.turningpoint.org.au/site/DefaultSite/filesystem/documents/TP.ambocallout.fullreport.080514.pdf>.
- [21] The Drug Situation in Norway 2014. Oslo: SIRUS, 2015 (cited 2015 April). Available at: <http://wpstatic.idium.no/www.sirus.no/2015/01/TheDrugSituationInNorway2014.pdf>.
- [22] Waal H, Busseund K, Clausen T, Skeie I, Håseth A, Lillevold P. Statusrapport 2014. Norwegian Centre for Addiction Research: Oslo, 2015.
- [23] Amundsen EJ, Bretteville-Jensen AL. Hard drug use in Norway. *Nord Stud Alcohol Drug* 2010;27:87–94.
- [24] O'Connor P. Opioids: Merck manual, 2008 [Available at: <http://www.merckmanuals.com/professional/special-subjects/drug-use-and-dependence/opioids> (accessed 19 May 2015)].
- [25] Dietze PM, Cvetkovski S, Rumbold G, Miller P. Ambulance attendance at heroin overdose in Melbourne: the establishment of a database of Ambulance Service records. *Drug Alcohol Rev* 2000;19:27–33.
- [26] Nijem K, Kristensen P, Al-Khatib A, Bjertness E. Application of different statistical methods to estimate relative risk for self-reported health complaints among shoe factory workers exposed to organic solvents and plastic compounds. *Norsk Epidemiologi* 2005;15:111–6.
- [27] Buajordet I, Naess AC, Jacobsen D, Brors O. Adverse events after naloxone treatment of episodes of suspected acute opioid overdose. *Eur J Emerg Med* 2004;11:19–23.
- [28] European Drug Report. European Monitoring Centre for drugs and Drug Addiction, 2015. Report No. Available at <http://www.emcdda.europa.eu/edr2015> (accessed 4 November 2015).
- [29] Cvetkovski S, Dietze P. The incidence and characteristics of volatile substance use related ambulance attendances in metropolitan Melbourne, Australia. *Soc Sci Med* 2008;66:776–83.
- [30] Boyd JJ, Kuisma MJ, Randell TT. Temporal differences in gamma-hydroxybutyrate overdoses involving injecting drug users versus recreational drug users in Helsinki: a retrospective study. *Scand J Trauma Resusc Emerg Med* 2012;20:7.
- [31] Horyniak D, Degenhardt L, Smit de V, *et al.* Pattern and characteristics of ecstasy and related drug (ERD) presentations at two hospital emergency departments, Melbourne, Australia, 2008–2010. *Emerg Med J* 2014;31:317–22.
- [32] Gjersing L, Jonassen KV, Biong S, *et al.* Diversity in causes and characteristics of drug-induced deaths in an urban setting. *Scand J Public Health* 2013;41:119–25.
- [33] Bennett AS, Bell A, Tomedi L, Hulsey EG, Kral AH. Characteristics of an overdose prevention, response, and naloxone distribution program in Pittsburgh and Allegheny County, Pennsylvania. *J Urban Health* 2011;88:1020–30.
- [34] Clark AK, Wilder CM, Winstanley EL. A systematic review of community opioid overdose prevention and naloxone distribution programs. *J Addict Med* 2014;8:153–63.