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ORIGINAL RESEARCH

Naloxone use by Aotearoa New Zealand emergency medical services, 2017–2021

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Abstract

Objective: Emergency medical services (EMS) use of naloxone in the prehospital setting is indicated in patients who have significantly impaired breathing or level of consciousness when opioid intoxication is suspected. The present study characterised naloxone use in a nationwide sample of Aotearoa New Zealand road EMS patients to establish a baseline for surveillance of any changes in the future.

Methods: A retrospective analysis of rates of patients with naloxone administrations was conducted using Hato Hone St John (2017–2021) and Wellington Free Ambulance (2018–2021) electronic patient report form datasets. Patient demographics, presenting complaints, naloxone dosing, and initial and last vital sign clinical observations were described.

Results: There were 2018 patients with an equal proportion of males and females, and patient median age was 47 years. There were between 8.0 (in 2018) and 9.0 (in 2020) naloxone administrations per 100 000 population-years, or approximately one administration per day for the whole country of 5 million people. Poisoning by unknown agent(s) was the most common presenting complaint (61%). The median dose of naloxone per patient was 0.4 mg; 85% was administered intravenously. The median observed change in Glasgow Coma Scale score was +1, and respiratory rate increased by +2 breaths/min.

Conclusions: A national rate of EMS naloxone patients was established; measured clinical effects of naloxone were modest, suggesting many patients had reasons other than opioid toxicity contributing to their symptoms. Naloxone administration rates provide indirect surveillance information about suspected harmful opioid exposures but need to be interpreted with care.

Key words: *emergency medical services, naloxone, opioid toxicity, paramedic, prehospital.*

Key findings

- Emergency medical services (EMS) in Aotearoa New Zealand administer naloxone to one patient on average per day across the country of 5 million people (8–9 patients per 100 000 population-years).
- Most administrations (61%) involved a presenting complaint of poisoning by unknown agent(s). Median improvement after naloxone was +1 in Glasgow Coma Scale score and + 2 breaths/min in respiratory rate, suggesting other factors besides opioids may have contributed to symptoms. Patients with a presenting complaint of opioid intoxication or respiratory impairment had greater improvements noted.
- EMS naloxone administrations add to other surveillance to monitor suspected harmful opioid exposures in the community.

Introduction

Naloxone is a competitive antagonist of opioid receptors and an inverse agonist of μ opioid receptors, enabling reversal of excess sedative and respiratory-depressant effects caused by opioid agonists.[1,2] Because of this antidotal indication, prevalence of prehospital administrations of naloxone can be used as a public health surveillance signal for suspected harmful opioid exposures occurring in the community.

Aotearoa New Zealand has not experienced the same extent of

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population-level harm from the 'opioid epidemics' occurring in some other Western countries, and community access to naloxone is limited in comparison.[3] Police in Aotearoa New Zealand do not generally carry naloxone; however, EMS generally do, and naloxone administration is within the scope of practice of paramedics and intensive paramedics.[4,5] The rate of EMS naloxone use has not previously been investigated in Aotearoa New Zealand.

The present study aimed to determine incidence rates of patients treated with naloxone (in the absence of opioid administration by EMS personnel) to form a baseline to assist future monitoring and interpretation of similar data. To provide context for these rates and to assess their limitations, the study also aimed to characterise the patient cohort demographics and their clinical features.

Methods

Study design and setting

This retrospective cross-sectional observational study investigated EMS naloxone use in Aotearoa New Zealand. Together the two EMS services Hato Hone St John and Wellington Free Ambulance (WFA) provide all road-based EMS coverage for the country. The services share clinical guidelines, which advise naloxone can be given by EMS personnel in cases of suspected opioid intoxication where the patient's level of consciousness or breathing are significantly impaired, including cases of iatrogenic adverse effects from opioid administrations.[4,5] The preferred route of naloxone administration is intravenous (IV), with advised dosage of 0.1–0.4 mg given at 5-min intervals as required for adults. Intramuscular (IM) naloxone doses of 0.8 mg can be given every 10 min for adults. A weight-based dosing table guides paediatric IV and IM administrations, and real-time clinical advice is available to EMS personnel 24/7 through the clinical support desks of the services.

Case identification

De-identified electronic patient records where naloxone was administered by EMS personnel were extracted from the EMS databases between 2017–2021 (Hato Hone St John) and 2018–2021 (WFA). Cases where an opioid was also administered by EMS were excluded to eliminate iatrogenic opioid exposures from the study. Data included dates/times of attendance and scene location by meshblock,[6] scene type (home, school, street etc.), 'status codes' (assigned by EMS personnel on scene soon after arrival, describing patient condition and urgency of transport, and again at discharge from EMS care; 0 – dead, 1 – immediate threat to life, 2 – potential threat to life, 3 – unlikely threat to life, 4 – no threat to life),[7] travel and management times, patient age, sex, and prioritised ethnicity,[8] details of naloxone dosing, initial and last vital sign observations including Glasgow Coma Scale (GCS) scores and respiratory rates (RRs), and presenting complaints (assigned by EMS personnel on scene after clinical interaction with the patient). Proportions of patients in each category of these variables were determined. Of note, only 'initial' and 'last' clinical observations during EMS care were available with no timing details available in relation to naloxone administration(s).

Ethical approval

Ethical approval was granted by the University of Otago Human Ethics Committee (HD22/007) and locality authorisations were granted by Local Review Committees of the services.

Data analysis

Main outcome: rates of naloxone patients

Crude incidence rates of naloxone patients per 100 000 population-years were calculated for people, females, and males with the *epitools* package[9] (version 0.5-10.1) in R Studio (version 2022.07.2+576; Posit, Massachusetts) with the direct method and 'exact' 95% confidence intervals (CIs). The estimated resident population of June 2018 was used for annual and overall rates,[10] and the World Health Organization (WHO) World Population Standard was used to calculate an age-adjusted rate to assist international comparisons.[11] Patient representation in the dataset was analysed *via* encrypted unique National Health Index (NHI) identifiers for reference. Annual crude incidence rates were also calculated to investigate trends over time. The proportion of naloxone patient records of all EMS electronic medical records was determined for reference for each year.

Patient demographics

Proportions of patient sex and ethnicity were determined. Median values with interquartile ranges (IQRs) were calculated for patient age by sex.

EMS attendance at the scene

Attendance scenes were characterised by proportions of various setting types. Scene location ('meshblock') information was converted into NZDep2018 indices and proportions of quintiles were determined to characterise the local area resources and level of deprivation (from quintile 1 – least deprived to quintile 5 – most deprived).[12] Median time with IQR was calculated for time from arrival at the scene to arrival at hospital, and proportions of patients by initial and final status were determined.

Naloxone administrations

Median total and individual naloxone doses were determined by route of administration. Use of different routes was described.

EMS vital sign observations and presenting complaints

Median initial vital sign observations, and GCS and RR changes from initial to last measurement were determined. To summarise the initial GCS and RR observations, GCS 8[13,14] and RR <11 breaths/min[15] were selected as crude cut-off limits to characterise patients, representing potential inability to protect one's

own airway and respiratory depression, respectively. This resulted in four 'initial observations' patient groups: GCS ≤8 and RR of ≤10; GCS ≤8 and RR of ≥11; GCS ≥9 and RR of ≤10; GCS ≥9 and RR of ≥11.

In an attempt to discern whether naloxone administration was associated with a clinically meaningful change in patient condition, the authors defined *a priori* a 'naloxone response' change as an improvement of ≥[+3] in GCS and ≥[+4] breaths/min in RR. These thresholds were chosen based on the investigators' own clinical experience using naloxone, as there is no evidence-based definition of what constitutes a positive naloxone response. Improvements in GCS and RR have been used previously to characterise naloxone patient responses in the EMS setting.[16] The proportion of patients with this response were determined across 'initial observations' and presenting complaint groups. As these were unverified cases of suspected opioid exposure, the predictive power of this 'threshold' criterion could not be tested.

Results

A total of 2018 patients were identified. There were no NHI identifiers in 175 patient records (9%) and their representations could not be investigated. Of the 1843 patient records containing encrypted NHIs corresponding to 1749 unique patients, a total of 1674 patients (96%) presented once in the dataset, 65 patients presented twice (4%), and 10 patients more than twice (0.3%). Rate of naloxone administrations was 8.1 per 100 000 population-years for females (95% CI 7.6–8.6) and 8.3 for males (95% CI 7.8–8.8). The crude overall incident rate of naloxone administrations was 8.2 patients per 100 000 population-years, and 7.3 per 100 000 population-years (95% CI 7.0–7.6) when age-standardised to the WHO World Standard Population. Annual numbers and rates of naloxone patients are presented in Figure 1. There was an average of 1.1 patients per day given naloxone by EMS in the country. The proportion of naloxone patients was 0.1% of all electronic medical records for the EMS services for each year of the study.

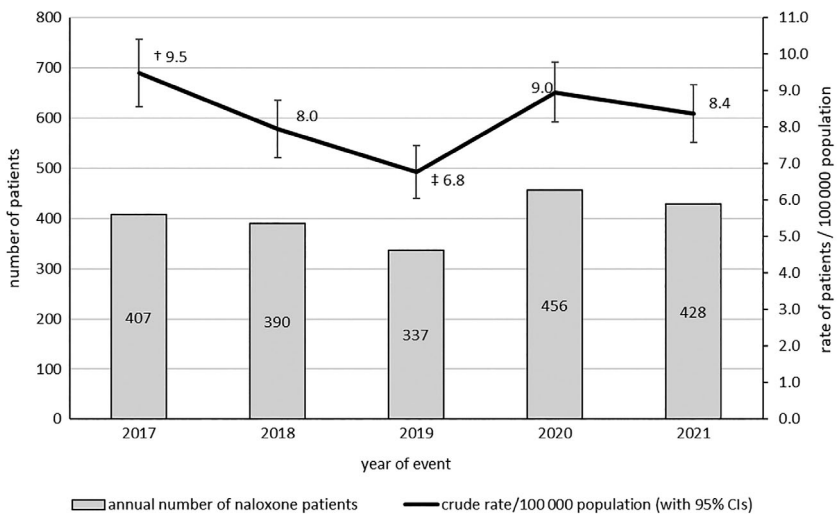

Figure 1. *Annual numbers and crude rates of patients administered naloxone by Aotearoa New Zealand EMS personnel. CI, confidence interval; EMS, emergency medical services. †Wellington region population (served by Wellington Free Ambulance) excluded from this rate because their data were not available for 2017. ‡Because of industrial action, paper-based records were in use Dec-2018 to Jun-2019 and an unknown number of cases may have been missed.*

Patient demographics

A total of 1003 patients were female (50%), whereas 1009 were male (50%), and six were of unknown sex (<1%). Patient median age was 47 years (IQR 32–61 years; full range 25 days to 98 years); 47 years for females (IQR 30–62 years) and 46 years for males (IQR 33–60.5 years). A total of 461 patients (23%) were Māori, 70 were Pasifika (New Zealanders of Pacific Island descent; 3%), 56 were Asian (3%), 1327 were European (66%), 25 were of other ethnicities (1%), and 79 were of unknown ethnicities (4%).

EMS attendance at the scene

Most EMS naloxone administration events occurred in homes ($n = 1428$; 71%). The remainder occurred in public settings ($n = 446$; 22%), aged care facilities ($n = 76$; 4%) and other healthcare facilities ($n = 68$; 3%). More deprived areas comprised a higher proportion of naloxone administration events, with 32% of events ($n = 641$) occurring in NZDep2018 index quintile 5 (most deprived) areas, 26% in quintile 4 ($n = 522$), 19% in quintile 3 ($n = 381$), 13% in quintile 2 ($n = 254$) and 10% in quintile 1 areas ($n = 209$). Nearly all patients were transported (1964; 97%). The median time from arrival at scene to arrival at hospital was 48 min (IQR 37–63 min).

The initial status code was '0 – dead' in 13 patients (1% of 2018), '1 – immediate threat to life' in 1132 (56%), '2 – potential threat to life' in 717 (36%), '3 – unlikely threat to life' in 152 (8%) and '4 – no threat to life' in 4 patients (<1%). The final status code was '0' in 26 patients (1%), '1' in 784 (39%), '2' in 854 (42%), '3' in 335 (17%) and '4' in 19 patients (1%).

Naloxone administrations

The 2018 patients were given 3177 naloxone administrations in total, with a median of 1 dose per patient (IQR 1–2, full range 1–10 doses/patient). A total of 1724 patients (85%) were administered solely IV doses, whereas 20 (1%) were administered

solely intraosseous (IO) and 211 (10%) IM doses. Four patients (<1%) were given solely intranasal (IN) naloxone and 59 (3%) were given doses *via* combinations of these administration routes. The median total naloxone dose per patient was 0.4 mg (IQR 0.4–0.8, full range 0.04–2.4 mg), and the median dose per administration is described in Table 1.

EMS vital sign observations and presenting complaints

Median vital sign observation values for the whole patient cohort combined were mostly unchanged from initial to final measurements, though there was a trend for improvement in GCS and RR (Table 2). A third of all patients (539) had an initial GCS ≤8 and a RR of ≤10, indicating a potentially compromised airway and respiratory depression (Fig. 2). Initial oxygen saturation (SpO_2) was under 90% in 579 (29% of 2018) and under 80% in 291 patients (14%; Table 2). The median change in GCS from initial to last assessment was [+1] unit (IQR 0 to [+5]; full range [−12] to [+12]), and the median change in RR was [+2] breaths/min (IQR 0 to [+6]; full range [−52] to [+44]). An improvement of GCS ≥ [+3] and RR ≥ [+4] breaths/min was observed in 56% of patients who had an initial GCS ≤8 and a RR of ≤10 (Fig. 2). The duration of time between 'initial' and 'last' observations were not analysed.

The presenting complaint included 'poisoning by unknown agent(s)' in 1235 cases (61% of all 2018), and only 103 events (5%) had 'suspected opioid exposure' (Table 3). An improvement of GCS ≥ [+3] and RR ≥ [+4] breaths/min was observed in 23% of patients overall, but these increases were observed in 53% of those patients with a presenting complaint of suspected opioid exposure, in 24% of those with poisoning with an unknown agent, and in 16% of those with various presenting complaints of altered GCS due to unknown reasons (Table 3). The median change in GCS and RR was greatest in those whose presenting complaint was opioid intoxication, at [+6] and [+6] breaths/min, respectively.

Discussion

The incidence rate of patients who were administered naloxone (but no opioids) by EMS personnel was 8.2 per 100 000 population-years, or 1.1 patients/day for the country of 5 million. Although there is a paucity of recent comparable literature published on similar rates, New South Wales Health monitors this metric by quarterly numbers of EMS naloxone administrations, and during 2017–2021 there were on average approx. 6 patients/day in their state of 8 million people.[17] City of Baltimore EMS in the United States of America (USA) administered naloxone at a rate of 1100 per 100 000 person-years in 2017,[18] or 115-fold compared to the 2017 rate in our study.

Most attendances with naloxone administrations in our study were in homes and in high deprivation areas, and where the presenting complaint was unknown poisoning. With an even female/male split and a median age of 47 years, this patient cohort differed from younger and more male-dominant cohorts described in Australia,[15] Norway,[19] Canada,[20] and the USA.[18,21] In our study, the proportion of patients who were administered naloxone and who were Māori was greater than their proportion of the general Aotearoa New Zealand population (23% *vs.* 17%),[10] but the reasons for this could not be determined from these data. Some USA jurisdictions have noted possible ethnic discrepancies in prehospital naloxone administration,[22] whereas others did not find differences.[23] Further research and monitoring of this EMS naloxone 'signal' is warranted in Aotearoa New Zealand.

It has been argued that Aotearoa New Zealand is relatively unprepared in community access to naloxone if there is a sudden increase in harmful opioid exposures.[3] Although intranasal naloxone is available as a 'general sales' item not requiring a prescription, its current price (~NZ $100/AU $95 in March 2023) may be a barrier to access for members of the public who may wish to carry it. If access to take-home-naloxone and its funding status change, the availability of naloxone in the community may change as well, possibly affecting the rates of EMS naloxone administrations in future comparisons. Since the majority of naloxone administrations in the present study were in areas with fewer resources, the cost of naloxone may be a significant

TABLE 1. *Naloxone given by EMS personnel to patients in individual administrations; 2017–2021*

Naloxone given in a single dosing	Patients (%)†	Median dose; mg [IQR]	Full dose range; mg
All routes of administration	2018 (100%)	0.4 [0.4–0.8]	0.01–2.0
Intravenous	1771 (88%)	0.4 [0.2–0.4]	0.01–2.0
Intraosseous	32 (2%)	0.4 [0.2–0.4]	0.1–0.8
Intramuscular	267 (13%)	0.8 [0.8–0.8]	0.2–2.0
Intranasal	5 (0.2%)	0.8 [0.8–1.2]	0.8–1.6

†Multiple routes used in 59 patients who are therefore counted on multiple rows. EMS, emergency medical services; IQR, inter-quartile range.

TABLE 2. *Median initial and last vital sign observations in patients given naloxone by EMS personnel; 2017–2021*

	Initial†				Last†			
Observations	Median	IQR	*n*	Data missing	Median	IQR	*n*	Data missing
GCS	7	3–11	2017	1	11	6–14	2017	1
Respiratory rate/min	12	8–18	2014	4	16	12–20	2013	4
SpO_2%								
• On air/medical air	95	88–98	1350	0	98	96–99	672	0
• On oxygen (O_2)	98	93–99	195	0	99	97–100	873	0
• Not documented whether on air or O_2	95	88–98	421	52	98	96–100	421	52
Heart rate beats/min	90	70–110	2017	1	87	70–104	2017	1
Systolic BP/mmHg	120	100–140	1962	56	124	109–140	1962	56
Diastolic BP/mmHg	75	60–90	1926	92	77	64–90	1926	92
Temperature/°C	36.3	35.6–36.8	1621	397	36.2	35.6–36.8	1621	397
Pupil size/mm	2	1–3	1747	271	3	2–4	1747	271
Blood glucose/mmol/L	7	5.9–9	1835	183	7	6–9.1	1835	183

†Initial and last observations during EMS care, not in relation to naloxone administration(s). BP, blood pressure; EMS, emergency medical services; GCS, Glasgow Coma Scale score; IQR, inter-quartile range; SpO_2, oxygen saturation.

determining factor in its distribution outside healthcare facilities and EMS.

The present study established a 'baseline' for comparisons in the future. EMS are at the forefront of responding to opioid intoxications in the community and treat patients with naloxone when clinically indicated. An analysis of these naloxone administration events can be repeated relatively easily to monitor for any changes over time. Although Aotearoa New Zealand has a significantly lower rate of opioid deaths compared to many other Western countries presently, it is prudent to prioritise public health surveillance so that responses can be initiated when needed. Establishing useful surveillance markers that can be trended over time will help to inform the public health system. EMS naloxone administrations can be used as one such marker for periodic monitoring, with the advantage that the data are routinely and prospectively collected and accessible through electronic databases.

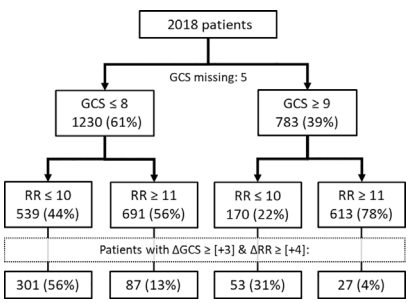

Figure 2. *Initial observations and changes in patients who were administered naloxone by EMS personnel; 2017–2021. Δ, change [in]; EMS, emergency medical services; GCS, Glasgow Coma Scale score; RR = respiratory rate, breaths per minute.*

EMS naloxone administration data have several important limitations. Prehospital naloxone administration should not be assumed to be equivalent with opioid toxicity. Naloxone is indicated in suspected opioid intoxication cases of reduced GCS or RR and may therefore be given to patients who displayed these signs and symptoms but were in fact not adversely affected by an opioid. There are many clinical conditions causing impaired breathing or decreased level of consciousness, other than opioid toxicity, that might prompt a prehospital provider to administer naloxone to a patient, particularly when there is limited available information for decision making. Furthermore, in the context of drug intoxication, there may also be non-opioid substances contributing to the clinical effects which will not be affected by naloxone administration. Some cases of opioid intoxication do not require or receive naloxone administrations if the patient can be managed by other means during EMS care and transport.[24] The initial GCS was 8 or lower in 61% of cases in the present study, and a third of all patients in the present study also had an initial RR of ≤10 breaths/min. The median observed changes in these two parameters during EMS care were very modest for the overall patient cohort. As only 5% of the cases in the present study had a presenting complaint of suspected opioid intoxication, the present study highlights how EMS personnel frequently administer naloxone – as clinically indicated – in suspected cases where the patient's level of consciousness or respiratory rate are impaired. Opioid intoxications were not verified in the present study, and therefore we were unable

TABLE 3. *Presenting complaints and changes of GCS and RR observed in EMS naloxone patients; 2017–2021*

Presenting complaint	Patients; *n* (% of total 2018)	Patients with improvement†; *n* (% of row total)	Median change in GCS (IQR)	Median change in breaths/min (IQR)
Poisoning by unknown agent(s)	1235 (61%)	296 (24%)	+1 (0–5)	+2 (0–6)
Altered GCS	473 (23%)	77 (16%)	+1 (0–4)	0 (0–4)
Opioid(s) exposure suspected	103 (5%)	55 (53%)	+6 (1–11)	+6 (0–12)
Other complaint‡	88 (4%)	9 (10%)	0 (0–3)	0 (−4 to 4)
Cardiac arrest	51 (3%)	11 (22%)	0 (0–3)	0 (0–6)
Various respiratory complaints§	43 (2%)	18 (42%)	+4 (0–8)	+6 (−2 to 12)
Stroke	25 (1%)	2 (8%)	0 (0–2)	0 (−4 to 2)
All patients	2018 (100%)	468 (23%)	+1 (0–5)	+2 (0–6)

†Improvement of GCS ≥ [+3] and RR ≥ [+4/min] observed. ‡Other: For example, motor vehicle accident, assault, fever/infection etc. §Various: For example, 'shortness of breath', 'respiratory depression' etc. EMS, emergency medical services; GCS, Glasgow Coma Scale score; IQR, inter-quartile range; RR, respiratory rate.

to conclusively determine whether these patients were affected by opioids or not. Interpreting changes in GCS, RR, and other observations in the present study is limited by the absence of timings of these (in some cases subjective) measurements and naloxone administrations. Investigating exact timings was not feasible from the dataset. The specific limitations in our data in 2017 and 2019 (see Fig. 1 footnote) highlight the importance of understanding the properties of such surveillance signals which may also change over time, and which complicate international comparisons. It is vital to characterise the local context of prehospital naloxone use when interpreting surveillance signals, including local naloxone availability and indications.

Conclusions

The present study established annual rates of EMS naloxone administrations which can be used as a comparison point for further surveillance of suspected harmful opioid exposures in Aotearoa New Zealand. Despite its limitations, the rate of EMS naloxone administrations can provide population-level information, acting as a marker that can be trended over time to inform the public health system.

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Author contributions

Conceptualisation: EKK, ACP; Methodology: all; Analysis: EKK; Interpretation: all; Original draft manuscript: EKK, ACP; Manuscript review and revision: all. All authors have read and approved the final manuscript.

Competing interests

None declared.

Ethics approval statement

Ethical approval was granted by the University of Otago Human Ethics Committee (reference HD22/007) and locality authorisations were granted by Local Review Committees of the services.

Data availability statement

Research data are not shared.

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