European Journal of Internal Medicine 66 (2019) 41–47

Contents lists available at ScienceDirect

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Original article

A quarter of admitted poisoned patients have a mild poisoning and require no treatment: An observational study

Laura Hondebrink[a,*], Saskia J. Rietjens[a], Dirk W. Donker[b], Claudine C. Hunault[a], Irma van den Hengel-Koot[a], Pauline M. Verputten[a], Irma de Vries[a], Karin A.H. Kaasjager[c], Douwe Dekker[a,c], Dylan W. de Lange[a,b]

[a] Dutch Poisons Information Center, University Medical Center Utrecht, Utrecht University, the Netherlands
[b] Department of Intensive Care Medicine, University Medical Center Utrecht, Utrecht University, the Netherlands
[c] Department of Internal Medicine, University Medical Center Utrecht, Utrecht University, the Netherlands

ARTICLE INFO

Keywords:
Intoxication
Emergency department
Poisoning severity score
Outcome

ABSTRACT

Background: Poisoned patients are frequently admitted following Emergency Department (ED) presentation, while the necessity of such admissions is hardly investigated. We determined the proportion and characteristics of poisoned patients who were admitted, but in retrospect had an uneventful admission.

Methods: For this observational cohort study, all patients presented to the ED of a Dutch University Hospital with various poisonings during a 1.5-year period (January 2015–July 2016) were included. The uneventfulness of admissions, defined as patients with a low Poisoning Severity Score (PSS) who received no treatment, was determined in retrospect.

Results: We included 417 patients who visited the ED for poisoning. 247 Patients were admitted: 30% to a general ward, 58% to a MCU, and 12% to the ICU. The poisoning severity scores of the admitted patients were none to mild in 38%, moderate to severe in 59%, and fatal in 2%. Upon admission, 60% of the patients received treatment. In retrospect, 77% of the admitted patients had a moderate, severe or fatal poisoning and/or required treatment. However, 23% of the admitted patients had a mild poisoning *and* required no treatment. This group involved younger patients (median age of 23 versus 42 years) and a higher proportion of patients reporting exposure to only one substance (65% versus 51%).

Conclusions: The majority of poisoned patients presented to the ED was admitted, while in retrospect, a quarter of these admissions were uneventful. Predictive parameters should be sought to identify patients who can be sent home safely.

1. Introduction

1.1. Background

Acute poisonings have a considerable impact on healthcare systems. Poison centers in the United States managed over 2 million inquiries on (suspected) poisonings in 2017, of which one third was referred to a health care facility [1]. In addition, annually five million US Emergency Department (ED) visits are drug-related, accounting for 4% of the total ED workload [2].

The outcome of poisoned patients entering an ED is often reported as admission rate, length of stay or mortality [3–7]. However, admission rates differ strongly between hospitals [8,9]. For example, in Spain and Belgium < 10% of poisoned patients, presented to a hospital were admitted [3,7], while admission rates up to 80% have been reported in the UK and the Netherlands. Moreover, in the UK and in the Netherlands studies have been performed to compare admission rates between several hospitals: a range between 17% to 81% in admission rates was reported [8,9]. These differences could have different origins, for example, differences in patient population (e.g. age distribution,

Abbreviations: CO, Carbon monoxide; ED, Emergency Department; ER, Extended Release; GHB, Gamma-Hydroxybutyric acid; ICU, Intensive Care Unit; LOS, Length of stay; MCU, Medium Care Unit; MDMA, 3,4-Methylenedioxymethamphetamine; PSS, Poisoning Severity Score; SNRI, Serotonin Norepinephrine Reuptake Inhibitor; SSRI, Selective Serotonin Reuptake Inhibitor; TCA, Tricyclic Antidepressant; THC, Δ-9-Tetrahydrocannabinol

* Corresponding author at: Dutch Poisons Information Center, University Medical Center Utrecht, Room B.00.119, P.O. Box 85500, 3508 GA Utrecht, the Netherlands.
E-mail address: l.hondebrink@umcutrecht.nl (L. Hondebrink).

https://doi.org/10.1016/j.ejim.2019.05.012
Received 29 January 2019; Received in revised form 13 April 2019; Accepted 13 May 2019
Available online 18 May 2019

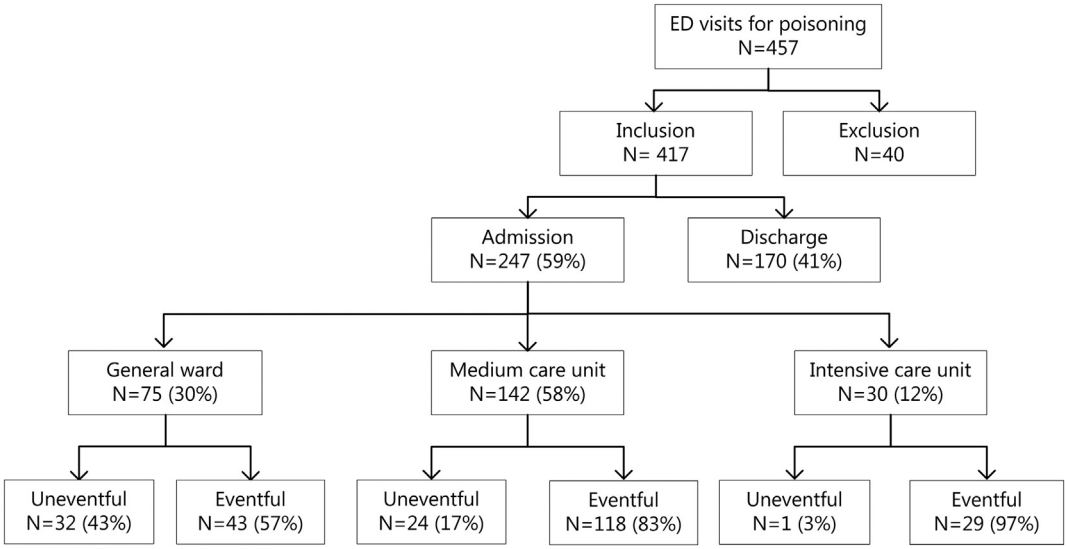

Fig. 1. Admission and outcome of poisoned patients presented to the Emergency Department (ED) during a 1.5-year period.
Uneventful admissions were admissions of patients who had a mild severity (PSS none or mild) and did not receive any treatment during admission. Eventful admissions were admissions of patients who had a moderate, severe or fatal PSS and/or were treated.

proportion of intentional versus accidental poisonings) and in local hospital facilities (e.g. experience of ED staff, the presence of ED observation units).

Notably, using admission rates as an outcome measure provides little insight into the severity of poisonings. Mortality rates provide some information, although mortality of poisoned patients entering an ED is generally below 1% [8,10–13]. To determine the actual necessity of admissions, other outcome measures may provide much more insight. For example, the severity of the clinical course and the treatment required during admission. While the need for treatment of poisoned patients has been used as an outcome measure, definitions of treatment are non-unanimous among studies, leading to large differences in the proportion of treated patients, varying from 25% to 95% [7,14,15].

In addition to the need for treatment, the use of standardized severity scoring systems as an outcome measure, e.g. the Poisoning Severity Score (PSS) [16], could aid in the retrospective assessment of triage accuracy and the related proportion of uneventful admissions. Although the PSS has several limitations [17], it is one of few available tools to classify the severity of poisonings in a standardized manner [18].

1.2. Importance

Combining the severity of the poisoning using the PSS and the applied treatment, facilitates the retrospective assessment whether admitted patients actually needed admission. Identification of patients who in retrospect did not need admission is a necessary step for subsequent development of prediction algorithms for the triage of future poisoned patients. This study is viewed as a first step in this process.

1.3. Objective

The aim of this study was to determine the proportion and characteristics of poisoned patients, presented to the ED of a Dutch University Hospital, who were admitted but in retrospect demonstrated an uneventful admission.

2. Methods

2.1. Design

We performed a single-center observational cohort study during a 1.5-year period (January 2015–July 2016) in the University Medical Center Utrecht (UMCU); a tertiary care facility. Our academic hospital had 30.171 admissions in 2017 [19], and has no specific ED observation unit for poisoned patients. Most patients are presented to our ED by paramedics and there are no specific guidelines for paramedics with respect to preference of hospitals in case of poisoning. Triage and treatment of poisoned patients was carried out by ED physicians according to the standard of care. Supervisors make the decision to admit a patient. Between ~8:00 and 23:00 h, the supervisor assesses the patient together with a resident and determines if admission is necessary. During the night, the supervisor is not physically present, but determines if admission is necessary based on phone consultation by the residents. While psychiatric evaluation at the ED prior to discharge is warranted for intentional poisonings in the Netherlands, somatic admission is not always necessary.

2.2. Patients

All patients presented to the ED of the UMCU in the Netherlands due to poisoning, based on physician reports in patients' files, were included. Patients files of patients with presenting complaints that could be caused by intoxications were manually checked, e.g., intoxication, collapse, decreased Glasgow Coma Scale (GCS), and seizures. Patients presenting more than once during the study period were included for each poisoning. Patients were excluded if they visited the ED for other primary causes than the poisoning (e.g., trauma patients who were poisoned, but were presented because of injury), if they were transferred to or from another hospital, or died before arrival at the ED.

2.3. Data collection

Demographic information and laboratory results were automatically extracted from electronic patient files using Statistical Analysis Software (SAS) Enterprise guide version 4.3. All other data were obtained from electronic patient files and entered systematically in encrypted electronic Case Report Forms in Microsoft Access.

Table 1
Exposures reported by poisoned patients by level of care.

	Admission		Admission		Admission		Admission	
	All		General ward		MCU		ICU	
	N	%	N	%	N	%	N	%
Poisonings[a]	247		75		142		30	
Total exposures[b]	490	100%	112	100%	330	100%	48	100%
Human medication	297	61%	54	48%	220	67%	23	48%
Sedatives	84	28%	7	13%	72	33%	5	22%
Analgesics	68	23%	25	46%	41	19%	2	9%
Antidepressants	42	14%	8	15%	33	15%	1	4%
Antipsychotics	35	12%	3	6%	30	14%	2	9%
Cardiovascular	18	6%	4	7%	9	4%	5	22%
Other	50	17%	7	13%	35	16%	8	35%
Alcohol	89	18%	31	28%	53	16%	5	10%
Drugs of abuse	53	11%	4	4%	45	14%	4	8%
Cocaine	11	21%	0	0%	11	24%	0	0%
THC	10	19%	1	25%	9	20%	0	0%
MDMA	9	17%	0	0%	7	16%	2	50%
GHB	8	15%	1	25%	6	13%	1	25%
Amphetamine	6	11%	0	0%	6	13%	0	0%
Other/unknown drugs	9	17%	2	50%	6	13%	1	25%
Household products	23	5%	16	14%	3	1%	4	8%
Smoke / CO	10	2%	4	4%	2	1%	4	8%
Other	11	2%	3	3%	3	1%	5	10%
Unknown	7	1%	0	0%	4	1%	3	6%
N substances								
One	133	54%	57	76%	56	39%	20	67%
Two	56	23%	10	13%	39	27%	7	23%
> Two	58	23%	8	11%	47	33%	3	10%

Sedatives mostly involved benzodiazepines (n = 81/84) and analgesics mostly involved acetaminophen (n = 32/68). Reported antidepressants (n = 42) were selective serotonin reuptake inhibitors (SSRIs, n = 23), serotonin norepinephrine reuptake inhibitors (SNRIs, n = 6), tricyclic antidepressants (TCAs, n = 5), lithium (n = 4), and trazodone (n = 2).
MCU: medium care unit, ICU: intensive care unit, GHB: Gamma-Hydroxybutyric acid, MDMA: 3,4-Methylenedioxymethamphetamine, THC: Δ-9-Tetrahydrocannabinol, CO: carbon monoxide.

[a] 15 patients had multiple poisoning episodes, resulting in a total of 38 episodes: 9 patients with 2 episodes, 4 patients with 3 and 2 patients with 4.

[b] Note that the number of exposures is higher than the number of poisonings (n = 247), since half of the patients reported ≥ 1 exposure.

2.4. Main measures

The primary outcome was the necessity of admission in retrospect. To determine this, we investigated the admission rate, Poisoning Severity Score (PSS) and treatment applied during admission.

2.4.1. Admission

Admission to the highest level of care (general ward, medium care unit (MCU) or intensive care unit (ICU)) was recorded. All patients with intentional poisonings received a psychiatric evaluation prior to discharge. Patients who had no need for admission to a medical ward, but did have an indication for admission to a psychiatric ward, were not considered as admitted patients in our study and were excluded from further (somatic) follow-up.

2.4.2. Poisoning severity score (PSS)

The poisoning severity of admitted patients was graded, using the PSS method, into five levels: none, mild, moderate, severe, and fatal [16]. For detailed information see https://www.who.int/ipcs/poisons/pss.pdf. PSS was assigned based on symptoms recorded in patients' files, and measurements of vital signs and diagnostic tests recorded during admission (general ward, MCU or ICU). All 12-lead electrocardiograms (ECGs) of admitted patients were evaluated by an experienced cardiologist. Symptoms and measurements recorded at the ED were not included in the PSS as we aimed to determine the proportion of uneventful admissions, which is based on the PSS (and treatment) during, and not prior to, admission. Two experienced toxicologists independently assigned the PSS for each patient. Whenever the toxicologists disagreed on the PSS, they entered discussion to reach consensus, according to the Delphi method [20].

2.4.3. Treatment

For each admitted patient, we determined whether treatment was applied at the ward (general ward, MCU or ICU). The following procedures were considered as treatment: cardiopulmonary resuscitation, mechanical ventilation, hemodialysis, temperature management (cooling or warming), and gastrointestinal decontamination measures (e.g., gastric lavage, activated charcoal, laxative). In addition, administration of antidotes and medication specifically aimed at the poisoning were considered as treatment, as were IV fluids when administered as (1) a continuous IV of > 100 mL/h of isotonic crystalloids (0,9% NaCl or Ringer's lactate), (2) a bolus IV of > 250 mL/30 min of isotonic crystalloids or (3) all other IV fluids regardless of volume (e.g. 3% NaCl, 5% glucose, KCl). Administration of benzodiazepines for insomnia, analgesics, thrombosis prophylaxis, antibiotics (unless applied as treatment for complications of the poisoning), thiamine for alcohol abuse, antivirals and an oral antiemetic were not considered as a treatment that required admission. Treatment applied at the ED was not included, since we determined the proportion of uneventful admissions, based on applied treatments combined with the PSS during admission.

2.4.4. Eventfulness of admission

The PSS and treatment are related outcomes: treatment is applied because of severe symptoms and a potentially severe intoxication can be mild due to treatment. Therefore, we combined these two outcomes into one. Patients who were admitted to a general ward, MCU or ICU, but had a mild severity (PSS none or mild) *and* did not receive treatment during admission were considered uneventful admissions. Admissions of patients who had a moderate, severe or fatal PSS *and/or* were treated during admission were considered eventful admissions.

Data were analysed with IBM SPSS Statistics (version 21; IBM, Armonk, NY). We defined age-related reference values for vital signs (see Supplementary Table 1), based on literature [21–24]. Agreement between the two raters on the PSS was evaluated using Cohen's kappa [25].

2.5. Ethics

The accredited Medical Research Ethics Committee of the UMC Utrecht approved this study (MREC number 14/397). Data were encrypted during data collection and during analyses to ensure privacy aspects.

3. Results

3.1. Inclusions

A total of 32.419 ED visits were recorded between 1st January 2015 and 1st July 2016, of which 457 were primarily due to poisoning (1.4%). 417 Patient visits were included in this study (Fig. 1), which involved 363 unique patients. Of these, 328 patients visited the ED once and 35 patients more than once: 24 patients visited the ED twice, six patients three times and five patients had more than three ED visits. We excluded 40 patients, 39 patients due to referral from (n = 7) or to (n = 32) another hospital and one patient who passed away during transport by ambulance before arrival at the hospital.

Table 2
Symptoms and poisoning severity score (PSS) of poisoned patients during admission by level of care.

	Admission		Admission		Admission		Admission	
	All		General ward		MCU		ICU	
	N	%	N	%	N	%	N	%
Patients[a]	247		75		142		30	
Neurologic								
Coma	14	6%	1	1%	1	1%	12	40%
GCS ≤10[b]	26	11%	3	4%	21	15%	2	7%
GCS ≤8[b]	11	4%	2	3%	8	6%	1	3%
Sleepiness	83	34%	20	27%	49	35%	14	47%
Headache	28	11%	9	12%	15	11%	4	13%
Seizures	0	0%	0	0%	0	0%	0	0%
Agitation	53	21%	6	8%	31	22%	16	53%
Aggression	13	5%	1	1%	10	7%	2	7%
Confusion	25	10%	5	7%	12	8%	8	27%
Hallucinations	13	5%	0	0%	12	8%	1	3%
Ataxia	13	5%	4	5%	7	5%	2	7%
Temperature > 38 °C[c]	21	9%	5	7%	8	6%	8	27%
Temperature < 36 °C[c]	42	17%	8	11%	18	13%	16	53%
Cardiovascular								
Asystole	0	0%	0	0%	0	0%	0	0%
Hypertension	58	23%	12	16%	24	17%	22	73%
Hypotension	44	18%	7	9%	21	15%	16	53%
Tachycardia	65	26%	10	13%	33	23%	22	73%
Bradycardia	40	16%	8	11%	16	11%	16	53%
Prolonged QTc[d]	13	5%	0	0%	8	6%	5	17%
Pulmonary								
Tachypnea	58	23%	8	11%	30	21%	20	67%
Bradypnea	65	26%	13	17%	31	22%	21	70%
Hypoxia (< 90%)	31	13%	6	8%	14	10%	11	37%
Other								
Nausea	43	17%	14	19%	22	15%	7	23%
Vomit	27	11%	11	15%	12	8%	4	13%
Stomach ache	17	7%	3	4%	8	6%	6	20%
PSS								
None	13	5%	8	11%	5	4%	0	0%
Mild	82	33%	40	53%	38	27%	4	13%
Moderate	97	39%	20	27%	73	51%	4	13%
Severe	50	20%	7	9%	26	18%	17	57%
Fatal	5	2%	0	0%	0	0%	5	17%

See Supplemental Table 1 for age-defined cut-off values for tachycardia, bradycardia, hypertension, hypotension, tachypnea and bradypnea.
PSS: Poisoning Severity Score, MCU: medium care unit, ICU: intensive care unit.
[a] 15 patients had multiple poisoning episodes, resulting in a total of 38 episodes: 9 patients with 2 episodes, 4 patients with 3 and 2 patients with 4.
[b] Intubated patients were excluded for analysis of GCS values below 10 or 8. (N = 26 on the ICU).
[c] Temperature was measured at the general ward, MCU, ICU in 81%, 80% and 90% of the patients, respectively.
[d] Prolonged QTc: QTc was calculated for patients ≥ 18 years in whom ≥ 1 ECG was performed (n = 5 at general ward, n = 54 at MCU and n = 14 at ICU) using Hodges' formula ($QT_C = QT + 1.75$(heart rate - 60)) with the heart rate and QT interval supplied from ECG measurement. QTc > 470 ms in females and > 450 ms in males was considered prolonged.

3.2. Patients

Gender was equally distributed and the median age [IQR] was 34 years [29 years], range: 6 months - 82 years. The majority of poisonings were intentional (82%). Most patients were adults (85%, median age: 39 years), while 15% were younger than 18 years (median: 13 years). Comorbidities were common (74% of patients): 15% had a somatic disease only, 54% a psychiatric disease only and 31% had a combination of both. Most prevalent somatic comorbidities (ICD classifications) were endocrine, nutritional and metabolic diseases (6%) and diseases of the circulatory system (5%). Most prevalent psychiatric comorbidities (DSM-V classification) were substance use and addiction disorders (15%), depressive disorders (15%), personality disorders (12%) and trauma and stress-related disorders (6%).

3.3. Outcome

3.3.1. Admission rates

The admission rate was 59% ($N = 247$). Most patients were admitted to a MCU ($N = 142$, 58%), while 75 patients were admitted to a general ward (30%) and 30 patients to the ICU (12%) (Fig. 1). 44 Children (69%) and 203 adults (58%) were admitted. The median hospital length of stay [IQR] for patients admitted to a general ward, MCU, or ICU was 16 h [23h], 17 h [14 h] and 2.5 days [7 days], respectively. 170 Patients (41%) were not admitted for somatic reasons. Of these patients, 146 were discharged home (35% of all poisoned patients on the ED) after psychiatric evaluation and 24 patients (6%) were admitted to the in-hospital psychiatric ward.

Of the admitted patients, 54% reported exposure to more than one substance, with a maximum of 11 substances. In total, the 247 admitted patients reported 490 exposures (Table 1). Many patients reported oral exposures (87%), although inhalation (4%), parenteral (1%), ocular (1%), nasal (1%) and dermal (1%) exposures also occurred (unknown route in 5%). Most poisonings involved exposure to medication (61%), which often involved the patient's own medication (71%).

For an overview of exposures reported by patients discharged from the ED, see supplemental Table 2.

3.3.2. Poisoning severity score

During admission, the most frequently reported symptoms were

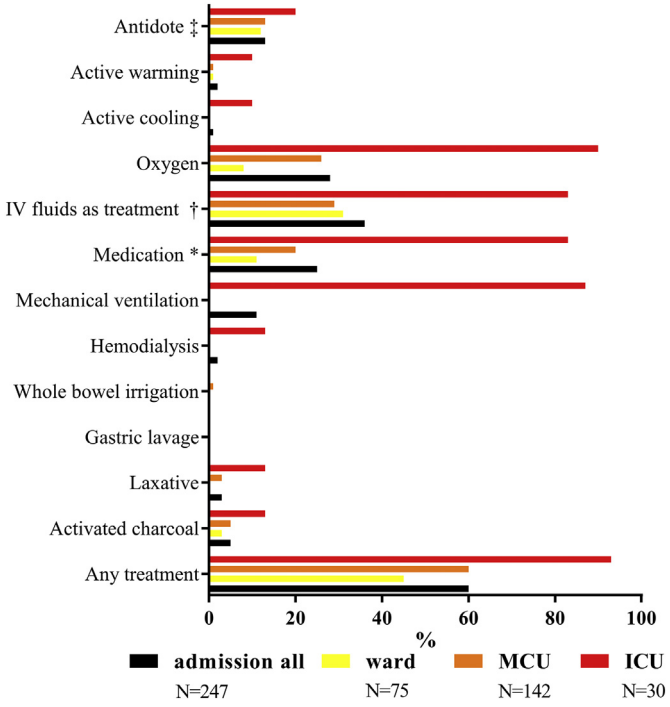

Fig. 2. Treatment at the ward of poisoned patients during admission by level of care.
Treatment of all patients (admission all) is displayed, as well as treatment of patients admitted to a general ward (ward), medium care unit (MC), and intensive care unit (ICU).
*Medication was defined as administration of not yet prescribed medicines, except for benzodiazepines for insomnia, paracetamol, ibuprofen, thrombosis prophylaxis, thiamine for alcohol abuse, antibiotics (unless applied as treatment for the intoxication), antivirals, oral anti-emetics.
†IV fluids were considered as treatment when administered as (1) a continuous IV of > 100 mL/h of isotonic crystalloids (0,9% NaCl or Ringer's lactate), (2) a bolus IV of > 250 mL/30 min of isotonic crystalloids or (3) all other IV fluids regardless of volume (e.g., 3% NaCl, 5% glucose, KCl).
‡Antidotes involved *N*-acetylcysteine (n = 23/33), naloxone (n = 5/33), flumazenil (n = 3/33) and snake antivenom (n = 2/33).

tachycardia, hypertension, tachypnea, bradypnea, sleepiness and agitation. The proportion of patients with symptoms increased with admission to a higher level of care (Table 2).

Concerning the evaluation of the poisoning severity, the agreement between the two raters prior to consensus was substantial [25] with a kappa value of 0.78.

The PSS of the admitted patients were none to mild for 95 patients (38%), moderate to severe for 147 patients (59%), and fatal for 5 patients (2%). The severity of the poisonings increased with the level of care: moderate, severe or fatal poisonings were observed in 27 (36%), 99 (69%) and 26 (87%) patients admitted to a general ward, MCU or ICU, respectively (Table 2). The 5 fatal cases involved intentional exposures in adults who were initially admitted to the ICU. Based on reported exposures, the deceased patients were exposed to acetic acid (1 L of cleaning vinegar, likely 4–6%), carbon monoxide, insulin, drain cleaner (96% sulphuric acid) and a combination of oxycodone and ethanol.

3.3.3. Treatment

During admission, 60% of the patients received some kind of treatment, mostly involving IV fluids or medication (Fig. 2). The proportion of patients who were treated also increased with the level of care; almost all ICU patients required (extensive) treatment (93%, 2 paediatric patients (7%) did not require treatment). At the MCU and general ward 60% and 45% of patients received some form of treatment, respectively.

3.3.4. Eventfulness of admission

We combined the PSS (none/mild versus moderate/severe/lethal) and treatment (treated versus non-treated) as one outcome. Of the admitted patients, 77% (N = 190/247) were treated *and/or* had a moderate, severe or fatal PSS. In contrast, 23% (N = 57/247, 95% CI [18%; 28%]) of admissions were uneventful, i.e., had a mild severity (PSS none or mild) *and* did not receive any treatment during admission. The proportion of uneventful admissions decreased with an increasing level of care: 43% (N = 32/75), 19% (N = 24/142) and 3% (N = 1/30) of the patients at a general ward, MCU and ICU, respectively (Fig. 1 and Table 3). Uneventful admissions were shorter than eventful admissions (median: 12 vs 20 h, p < .0001). The median length of uneventful admissions of adult patients was 11 h (N = 37, IQR: 8 h), while that of children was 16 h (N = 20, IQR: 17 h).

Patients with an uneventful admission were younger than patients with an eventful admission (median age: 23 vs 42 yrs., p < .001). Of the uneventful admissions, 36% involved children, compared to 12% of the eventful admissions (Table 3 and Supplemental Table 4). The gender distribution, the proportion of intentional exposures, and the presence of co-morbidities was comparable in both groups. The proportion of patients who reported exposure to only one substance, was slightly higher in the uneventful admissions (65% versus 51%) (Table 3). No remarkable differences in reported exposures were observed between uneventful and eventful admissions (See Supplementary Table 3).

Of the 57 uneventful admissions, 21 were preceded by some kind of treatment at the ED. This involved activated charcoal (N = 8), IV fluid administration (N = 8), medication (N = 5), antidote (N = 1, flumazenil) administration, and/or treatment for mild hypothermia (N = 1). Since we investigated the eventfulness of admission, we did not include the clinical course and treatment at the ED, prior to admission.

4. Discussion

This study reports on the outcome of poisoned patients who were exposed to a variety of substances and who presented to the ED of a Dutch University Hospital. The majority of these patients was admitted (59%). Of these patients, 61% had a moderate, severe or fatal poisoning and 60% received treatment during admission. Notably, 23% of the admitted patients had an uneventful admission (i.e. a mild clinical course *and* no treatment necessary).

In retrospect, the admitted patients who were not treated and, in addition, remained asymptomatic or developed only mild poisoning symptoms (PSS none or mild) could theoretically have been discharged from the ED. This indicates a potential for improvement of admission strategies in current daily practice.

Notably, valid considerations of the physician may underlie the decision for admission. This decision to admit a poisoned patient depends, among other things, on poisoning specific factors, such as the type and level of exposure and time after exposure. For example, a patient exposed to a relevant dose of a substance with the potential to induce arrhythmias should be admitted for observation. Since not all such patients will actually develop arrhythmias, a proportion of admissions will be uneventful in retrospect. Besides, some patients are admitted to await the time to reach the maximum serum concentration (T_{max}) and are therefore observed for a potential deterioration. However, our data does not suggest a difference between eventful and uneventful admissions in the proportion of patients exposed to an extended release formulation (14% vs 11%, Table 3). Also, the T_{max} can be significantly prolonged during overdoses [26] and the exact time of exposure is often uncertain.

In addition to poisoning specific factors, patient related factors, such as the patient's age, the living environment, the symptoms observed, the circumstances of exposure (i.e. intentional vs. unintentional), and

Table 3
Characteristics of poisoned patients with an eventful or uneventful admission.

	Eventful admissions (N = 190)								Uneventful admissions (N = 57)							
	All		Ward		MCU		ICU		All		Ward		MCU		ICU	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Patients[a]	190	100%	43	23%	118	62%	29	15%	57	100%	32	56%	24	42%	1	2%
LOS [IQR]	20 h [27 h]		20 h		18 h		86 h		12 h [11 h]		11 h		12 h		19 h	
Recidivist	37	19%	6	14%	27	23%	4	14%	15	26%	4	13%	11	46%	0	0%
Gender																
Male	83	44%	20	47%	47	40%	17	59%	28	49%	19	59%	8	33%	1	100%
Female	107	56%	23	53%	72	61%	12	41%	29	51%	13	41%	16	67%	0	0%
Age groups	Median age: 42 yrs								Median age: 23 yrs							
0–4	8	4%	6	14%	1	1%	1	3%	8	14%	6	19%	1	4%	1	100%
5–12	4	2%	3	7%	0	0%	1	3%	2	4%	2	6%	0	0%	0	0%
13–17	12	6%	11	26%	0	0%	1	3%	10	18%	7	22%	3	13%	0	0%
18–25	34	18%	4	9%	27	23%	3	10%	14	25%	8	25%	6	25%	0	0%
26–65	122	64%	17	40%	86	73%	19	66%	22	39%	8	25%	14	58%	0	0%
> 65	10	5%	2	5%	4	3%	4	14%	1	2%	1	3%	0	0%	0	0%
Co-morbidity																
Psychiatric	74	39%	12	28%	53	45%	9	31%	20	35%	6	19%	14	58%	0	0%
Somatic	21	11%	7	16%	10	8%	4	14%	5	9%	5	16%	0	0%	0	0%
Both	54	28%	7	16%	38	32%	9	31%	11	19%	5	16%	6	25%	0	0%
Intentional	156	82%	28	65%	109	92%	19	66%	45	79%	23	72%	22	92%	0	0%
N substances																
One	96	51%	32	74%	45	38%	19	66%	37	65%	25	78%	11	46%	1	100%
Two	43	23%	5	12%	31	26%	7	24%	13	23%	5	16%	8	33%	0	0%
> Two	51	27%	6	14%	42	36%	3	10%	7	12%	2	6%	5	21%	0	0%
ER[b]	27	14%	7	16%	18	15%	2	7%	6	11%	3	9%	3	13%	0	0%

MCU: medium care unit, ICU: intensive care unit, LOS [IQR]: Median length of stay [interquartile range], ER: extended release.

[a] 15 patients had multiple poisoning episodes, resulting in a total of 38 episodes: 9 patients with 2 episodes, 4 patients with 3 and 2 patients with 4. In 26% of these 38 episodes, the admission was uneventful, in line with all patients (57/247 = 23% uneventful admissions).

[b] At least one exposure with an extended release formulation was reported.

comorbidities can underlie the decision the admit or discharge a poisoned patient. In this study, no differences were observed between eventful and uneventful admissions in gender distribution, the proportion of intentional exposures, and the presence of comorbidities, while patients with an uneventful admission were relatively younger (Table 3).

The rational for admission for the patients who were treated at the ED and had an uneventful admission was mostly “observation”. In view of the reported exposures in this group and the current lack of a decision or screening tool, admission for observation was comprehensible. Theoretically, several factors can (partly) explain why these admissions were uneventful, such as the treatment applied at the ED, the possibility that reported exposures were unreliable [27] or an overestimation of the risk of a certain exposure. In the future, with improved tools or better models to predict the poisoning severity, it might be shown that these patients can be safely discharged from the ED.

Comparing our data to other studies is difficult, as they only investigated either the PSS or applied treatment, only included patients of specific age (children, elderly), patients with specific exposures, or patients who were admitted to a specific ward (e.g., ICU) (for review see Schwarz et al. [17]). A study including all patients presented to an ED with poisoning reported a much lower proportion of moderate to severe poisonings (19%, total $N = 286$). This study, however, determined the severity of poisoning of patients admitted to a ED observation unit [28], instead of the wards, MCU and ICU. In our study, more than half of the admitted patients received treatment, which is in between the proportion of treated patients exposed to a variety of substances reported by others [14,15,29]. Discrepancies in the proportion of treated patients are due partly to different definitions of treatment. For example, any IV administration of crystalloids is considered a treatment in some studies [29], while in others it is only considered treatment if > 1 L a day is administered [14]. In addition, not all studies distinguish treatment at the ward from treatment at the ED, whereas others investigate only interventions that require admission to the MCU or ICU [15].

In theory, the development of additional prediction models, applicable to all ED patients (also for patients who were treated at the ED), may limit the proportion of uneventful admissions. Several studies predicted different outcomes of poisoned patients presented to an ED, although the investigated patient population (e.g., specific age groups) and setting (e.g., ED, ED observation unit) differs between studies. For example, predictors of mortality [6,30], the need for ICU treatment [31], and the PSS [32] were reported. A few studies assessed the prognostic value of some specific predictors [33–35] or developed algorithms for the management of poisoned patients [14]. However, these algorithms are not a prediction model (they do not quantify the importance of the different predictors nor combine them), and none of the algorithms has been externally validated. The chances of different possible outcomes are related to multiple factors and therefore difficult to estimate intuitively. Clinical prediction models can combine these factors to predict an outcome for an individual patient (in this case, the need for a treatment or a severe clinical course), and with that, these models can determine the most appropriate level of care (discharge or admission to a general ward, MCU, ICU). When successful, such a model is also beneficial in optimizing health care costs involved with intoxicated patients.

In addition to developing predictive models, application of observation units for poisoned patients presented to an ED can certainly aid in reducing uneventful admissions. The use of observation units for specific patient groups was shown to be equal in quality and lower in costs compared to in-hospital admission. Most admitted poisoned patients are discharged within 24 h and patients can also be monitored for (delayed) toxicity at such an observation unit. Few studies have investigated the outcome of poisoned patients admitted to an observation unit, but only a small proportion of these patients required in-hospital admission [36–39].

Our study has some limitations. It does not allow for extrapolation to all poisoned patients presented to EDs, since characteristics of

poisoned patients and admission criteria may vary between different EDs and countries. For example, in some countries all patients with intentional poisonings are admitted, likely resulting in a higher proportion of uneventful admissions. In addition, a different patient population (age distribution, proportion of intentional poisonings and/or drugs of abuse poisonings) could result in differences in admission rates. Also, we relied on retrospective data collection from electronic patient records and thus on self-reported exposures. Finally, we excluded 39 patients due to referral from or to another hospital for unknown reasons. If these 39 patients all would have had eventful admissions, the percentage of uneventful admissions would decrease slightly, from 23% to 20%.

In conclusion, in this study we showed that almost a quarter of admitted poisoned patients remained asymptomatic or developed mild poisoning symptoms and did not require treatment. Predicting which patients could be discharged directly from the ED, could reduce admissions and subsequently reduce health care costs.

Future research should focus on predictive parameters to determine which patients need observation or treatment and which patients can be safely discharged.

Funders

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Prior presentations

Part of the data was presented as a poster at:

EAPCCT XXXVI 2017, European Association of Poisons Centres and Clinical Toxicologists, May 16–19, 2017, Basel, Switserland.
EAPCCT XXXV 2016, European Association of Poisons Centres and Clinical Toxicologists, May 24–27, 2016, Madrid, Spain.

Conflicts of interest

The authors declare that they do not have a conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejim.2019.05.012.

References

[1] Gummin DD, Mowry JB, Spyker DA, Brooks DE, Osterthaler KM, Banner W. 2017 annual report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 35th annual report. Clin Toxicol (Phila) 2018. https://doi.org/10.1080/15563650.2018.1533727.
[2] Substance Abuse and Mental Health Services Administration, Drug Abuse Warning Network. 2011: national estimates of drug-related emergency department visits. HHS publication no. (SMA) 13–4760, DAWN series D −39. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2013https://www.samhsa.gov/data/sites/default/files/DAWN2k11ED/DAWN2k11ED/DAWN2k11ED.pdf, Accessed date: 12 October 2017.
[3] Muñoz R, Borobia AM, Quintana M, et al. Outcomes and costs of poisoned patients admitted to an adult emergency Department of a Spanish Tertiary Hospital: evaluation through a Toxicovigilance Program. PLoS One 2016;11(4):e0152876.
[4] Mazer-Amirshahi M, Sun C, Mullins P, Perrone J, Nelson L, Pines JM. Trends in emergency department resource utilization for poisoning-related visits, 2003–2011. J Med Toxicol 2016;12(3):248–54.
[5] Downes MA, Balshaw JK, Muscat T, Ritchie N, Isbister GK. Impact of an emergency short stay unit on emergency department performance of poisoned patients. Am J Emerg Med 2017;35:764–8.
[6] Yu JH, Weng YM, Chen KF, Chen SY, Lin CC. Triage vital signs predict in-hospital mortality among emergency department patients with acute poisoning: a case control study. BMC Health Serv Res 2012;12:262–9.
[7] Hendrix L, Verelst S, Desruelles D, Gillet JB. Deliberate self-poisoning: characteristics of patients and impact on the emergency department of a large university hospital. Emerg Med J 2013;30(1):e9.
[8] Duineveld C, Vroegop M, Schouren L, et al. Acute intoxications: differences in management between six Dutch hospitals. Clin Tox (Phila) 2012;50(2):120–8.
[9] Kapur N, House A, May C, Creed F. Service provision and outcome for deliberate self-poisoning in adults–results from a six Centre descriptive study. Soc Psychiatry Psychiatr Epidemiol 2003;38(7):390–5.
[10] Gudjonsdottir GA, Thordardottir AM, Kristinsson J. A prospective study on acute poisonings presenting to the Emergency Department at Landspitali University Hospital in Iceland 2012. Laeknabladid 2017;103(6):275–80.
[11] Khudair IF, Jassim Z, Hanssens Y, Alsaad WA. Characteristics and determinants of adult patients with acute poisoning attending the accident and emergency department of a teaching hospital in Qatar. Hum Exp Toxicol 2013;32(9):921–9.
[12] Limjindaporn C. Acute poison exposure in the emergency department: a 2-year study in a university hospital. J Med Assoc Thai 2010;93(S7):S41–9.
[13] Beaune S, Juvin P, Beauchet A, Casalino E, Megarbane B. Deliberate drug poisonings admitted to an emergency department in Paris area - a descriptive study and assessment of risk factors for intensive care admission. Eur Rev Med Pharmacol Sci 2016;20(6):1174–9.
[14] Ambrosius RG, Vroegop MP, Jansman FG, et al. Acute intoxication patients presenting to an emergency department in the Netherlands: admit or not? Prospective testing of two algorithms. Emerg Med J 2012;29(6):467–72.
[15] van den Oever HLA, van Dam M, van 't Riet E, Jansman FGA. Clinical parameters that predict the need for medium or intensive care admission in intentional drug overdose patients: a retrospective cohort study. J Crit Care 2017;37:156–61.
[16] Persson HE, Sjöberg GK, Haines JA, Pronczuk de Garbino J. Poisoning severity score. Grading of acute poisoning. J Toxicol Clin Toxicol 1998;36(3):205–13.
[17] Schwarz ES, Kopec KT, Wiegand TJ, Wax PM, Brent J. Should we be using the poisoning severity score? J Med Toxicol 2017;13(2):135–45.
[18] Cairns R, Buckley NA. The poisoning severity score: if it did not exist we would have to invent it. J Med Toxicol 2017;13(2):131–4.
[19] University Medical Center Utrecht. Annual report 2017. https://www.umcutrecht.nl/getmedia/164598fc-fd76-4f7a-9de0-5b7024d701ec/UMC-Utrecht-Jaardocument-2017-V10-7.pdf.aspx; 2018, Accessed date: 13 August 2018.
[20] Jones J, Hunter D. Consensus methods for medical and health services research. BMJ 1995;311:376–80.
[21] American Heart Association. https://www.heart.org/en/health-topics/high-blood-pressure/the-facts-about-high-blood-pressure; 2019, Accessed date: 11 April 2019.
[22] Derksen-Lubsen G. Compendium Kindergeneeskunde - Diagnostiek en Behandeling. 4th ed. Houten: Bohn Stafleu van Loghum; 2011.
[23] El-Radhi AS, Barry W. Thermometry in paediatric practice. Arch Dis Child 2006;91:351–6.
[24] Hunter J, Rawlings-Anderson K. Respiratory assessment. Nurs Stand 2008;22:41–3.
[25] Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics 1977;33:159–74.
[26] Roberts DM, Buckley NA. Pharmacokinetic considerations in clinical toxicology: clinical applications. Clin Pharmacokinet 2007;46(11):897–939.
[27] Camilleri R. A meta-analysis of the reliability of the history in suspected poisoning. J Emerg Med 2015;48(6):679–84. Jun.
[28] Mong R, Arciaga GJ, Tan HH. Use of a 23-hour emergency department observation unit for the management of patients with toxic exposures. Emerg Med J 2017;34(11):755–60.
[29] Hendrix L, Verelst S, Desruelles D, Gillet JB. Deliberate self-poisoning: characteristics of patients and impact on the emergency department of a large university hospital. Emerg Med J 2013;30(1):e9.
[30] Hu YH, Chou HL, Lu WH, et al. Features and prognostic factors for elderly with acute poisoning in the emergency department. J Chin Med Assoc 2010;73(2):78–87.
[31] Brandenburg R, Brinkman S, de Keizer NF, Kesecioglu J, Meulenbelt J, de Lange DW. The need for ICU admission in intoxicated patients: a prediction model. Clin Toxicol (Phila) 2017;55(1):4–11.
[32] Alanazi MQ, Al-Jeraisy M, Salam M. Severity scores and their associated factors among orally poisoned toddlers: a cross sectional single poison center study. BMC Pharmacol Toxicol 2016;17(1).
[33] Brett AS, Rothschild B, Gray R, Perry M. Predicting the clinical course in intentional drug overdose. Implications for use of the intensive care unit. Arch Intern Med 1987;147(1):133–7.
[34] Heard K, Bebarta VS. Reliability of the Glasgow Coma Scale for the emergency department evaluation of poisoned patients. Hum Exp Toxicol 2004;23(4):197–200.
[35] Eizadi Mood N, Sabzghabaee AM, Yadegarfar G, Yaraghi A, Ramazani Chaleshtori M. Glasgow coma scale and its components on admission: are they valuable prognostic tools in acute mixed drug poisoning? Crit Care Res Pract 2011:952956https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3087408/.
[36] Judge BS, Ouellette LM, VandenBerg M, Riley BD, Wax PM, Toxicology Investigators Consortium (ToxIC) Case Registry. Utilization of observation units for the care of poisoned patients: trends from the toxicology investigators consortium case registry. J Med Toxicol 2016;12(1):111–20.
[37] Calello DP, Alpern ER, McDaniel-Yakscoe M, Garrett BL, Shaw KN, Osterhoudt KC. Observation unit experience for pediatric poison exposures. J Med Toxicol 2009;5(1):15–9.
[38] Plumb J, Dudley NC, Herman BE, Kadish HA. Utilization of a pediatric observation unit for toxicologic ingestions. Pediatr Emerg Care 2012;28(11):1169–72.
[39] Zebrack M, Katish H, Nelson D. The pediatric hybrid observation unit: an analysis of 6477 consecutive patient encounters. Pediatr 2005;115(5):e535–42.