



Intensity of care delivered by prehospital emergency medical service physicians to patients with deliberate self-poisoning: results from a 2-day cross-sectional study in France

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Abstract

Emergency management of deliberate self-poisoning (DSP) by drug overdose is common in emergency medicine. There is a paucity of data about the prehospital care of these patients. The principal aim was to describe the intensity of care received by patients with DSP who were managed by prehospital emergency medical service (EMS) physicians. A 48-h cross-sectional study was conducted in 319 EMS and emergency units in France. Patient and poisoning characteristics and treatments administered were recorded. Complications of poisoning, hospitalization, intensive care unit admission and death were recorded until day 30. The primary endpoint was the probability of receiving prehospital intensive care, including fluid resuscitation, vasopressor therapy, invasive ventilation, or antidotal treatments, depending whether prehospital treatment was carried out by an EMS physician or not. Data from 703 patients (median age was 43 [30–52] years, 288 (40%) men) were analyzed. One hundred and fifteen (16%) patients were attended by an EMS physician. Patients attended by EMS physicians were more likely to receive intensive treatment in the prehospital setting [odds ratio (OR) 7.4, 95% confidence interval 4.3–12.9]. These patients had more severe poisoning as suggested mainly by a lower Glasgow Coma Score (13 [8–15] vs. 15 [15–15]; $p < 0.001$) and a higher rate of admission to an intensive care unit [29 (25%) vs. 15 (2%), $p < 0.001$]. Patients with DSP attended by prehospital EMS physicians frequently received intensive care. The level of care seemed appropriate for the severity of the poisoning.

Keywords Emergency medicine · Poisoning · Attempted suicide · Emergency medical services

Introduction

Treatment of patients with deliberate self-poisoning (DSP) by drug overdose is relatively common in emergency medicine. Patients with DSP account for about 0.5% of

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emergency department visits [1–3]. The specific effects of DSP depend on the type and quantity of ingested medications [4–7]. Mortality and complications following DSP are relatively infrequent, usually less than 10% and are thus difficult to anticipate or predict [4, 6]. Symptomatic treatment is effective in most cases of DSP [7], however, some patients may benefit from early intensive care to reduce the occurrence of complications such as aspiration pneumonitis [8]. Early medical intervention may change the course of the poisoning by reducing drug absorption or counteracting the effects of a toxic agent. The prehospital use of naloxone for the treatment of opioid overdose is one typical example of such early medical intervention, with an 83% discharge rate just after its administration as an antidote [9].

Although data for some specific types of poisoning have been reported, the effectiveness of prehospital medical management of patients with DSP has been little evaluated. This is an important issue because under-triage by dispatch services would very likely result in an increase in associated complications. A lengthy delay between ingestion and hospital admission could increase the risk of aspiration pneumonitis and subsequent mortality [8]. However, over-triage is not a solution as medical resources are often constrained. Retrospective studies in France and Japan suggest that the level of prehospital care is appropriate, however the results may have been biased by the separate consideration of dispatch, ambulance and emergency department points-of view [10, 11]. In order to fully evaluate the prehospital management of patients with DSP, a coordinated, multicenter trial that includes dispatch, emergency medical services (EMS) and emergency departments simultaneously in a large territory is required [12]. We conducted a large, cross-sectional evaluation of the emergency management of DSP in order to investigate the intensity of care received by patients with DSP attended by EMS physicians as well as the adequacy of care intensity relative to the severity of the DSP.

Methods

Study design and settings

A multicenter, cross-sectional, prospective study was conducted in 319 dispatch centers, EMS and emergency departments on the 17th and 18th of March 2015. The study was approved by our national Review Board [Advisory Committee on the treatment of information in the field of Health Research (CCTIRS) the national commission for Liberties and Data Protection (CNIL)] and the ethics committee of Clermont-Ferrand, Grenoble, France (IRB 5891). According to French law, only oral patient consent was required due to the observational nature of the study. Oral consent was obtained during the patient's emergency department or

hospital stay. In case of death, consent was obtained from relatives.

This study was conducted in EMS and emergency departments that are members of the IRU-SFMU group, a research network established by the French Society of Emergency Medicine (SFMU). The aim of this network is to promote and coordinate multicenter studies of high methodological quality in emergency medicine. The levels of emergency health system care (dispatch, prehospital and hospital) are homogeneously distributed across the country, including French Polynesia and French West Indies and Reunion Island. The IRU-SFMU network includes 27% of the 1185 emergency centers (i.e., EMS and emergency departments) in France. Studies within this network have already been conducted on chest pain and gastrointestinal bleeding [13–15].

In this emergency system, dispatch is provided by trained emergency physicians who deliver over-the-phone instructions and determine the required level of emergency response. Dispatch decisions are based on clinical judgment as no score or protocol is currently recommended to guide the dispatching of care to intoxicated patients in France. If necessary, physicians refer to toxicology databases available on the internet or pharmacology software. If the patient's condition is considered to be life-threatening, a prehospital EMS physician and an ambulance with at least one emergency medical technician (EMT) and a nurse on board are dispatched to the scene. If the condition is not considered to be life-threatening, only an ambulance with at least two EMTs is dispatched. For very mild cases of DSP, patients may be referred to a general practitioner or receive only medical advice by telephone. Prehospital EMS physicians can initiate intensive treatments, such as invasive ventilation, vasopressor support, and antidotal treatments or activated charcoal. EMTs cannot initiate such treatments and routinely take patients to the ED after communicating a report to the dispatch center.

Study population and data collection

During the 48 h of the study, all patients aged over 18 years and considered to have DSP following an emergency phone call to a dispatch center, were included. DSP was defined as an acute drug overdose (i.e., a supratherapeutic dose) with a suicidal intent. Unintentional overdose, intentional misuse or abuse, and malicious intoxications were not included. Patients in cardiac arrest at the time of the first emergency phone call were not included because a prehospital EMS physician is systematically dispatched to the scene in such cases.

Data were collected at dispatch, in the prehospital setting and in the hospital emergency departments by the emergency physician in charge of the patient using a standardized

study data collection form. Epidemiological patient data (age, sex, and medical history) and data on the substances ingested (drug class, concomitant alcohol intake, total number of ingested tablets and time of ingestion) were collected. Basic clinical data (vital signs at first contact) and administration of intensive treatments (invasive ventilation, IV fluid administration, vasopressors or antidotal treatments) were recorded. Complications resulting from the poisoning were also analyzed. Early complications included coma requiring intubation or antidotal treatment; hypotension requiring IV fluid administration (> 1 L in one hour) and/or vasopressor therapy; and any cardiac rhythm disorders that occurred in the prehospital setting or in the emergency department. Delayed complications included kidney failure, hepatic failure, aspiration pneumonia and rhabdomyolysis that occurred before discharge or during the 30 days. Other outcomes were hospital admission, including the type of department, length of stay (excluding psychiatric care), intensive care unit (ICU) admission, and death.

Statistical analysis

The aim of the study was to describe the intensity of care received by patients with DSP who were treated by prehospital EMS physicians. For the analysis, patients were divided into two groups: those attended by an EMS physician and those attended by EMTs. The primary endpoint was the probability of receiving prehospital intensive treatments including fluid resuscitation (> 1 L in 1 h), vasopressor therapy, invasive ventilation or antidotal treatments. The rate of administration of intensive treatments was compared between patients attended by an EMS physician and those attended by EMTs. For patients attended by an EMS physician, intensive treatments administered in the prehospital

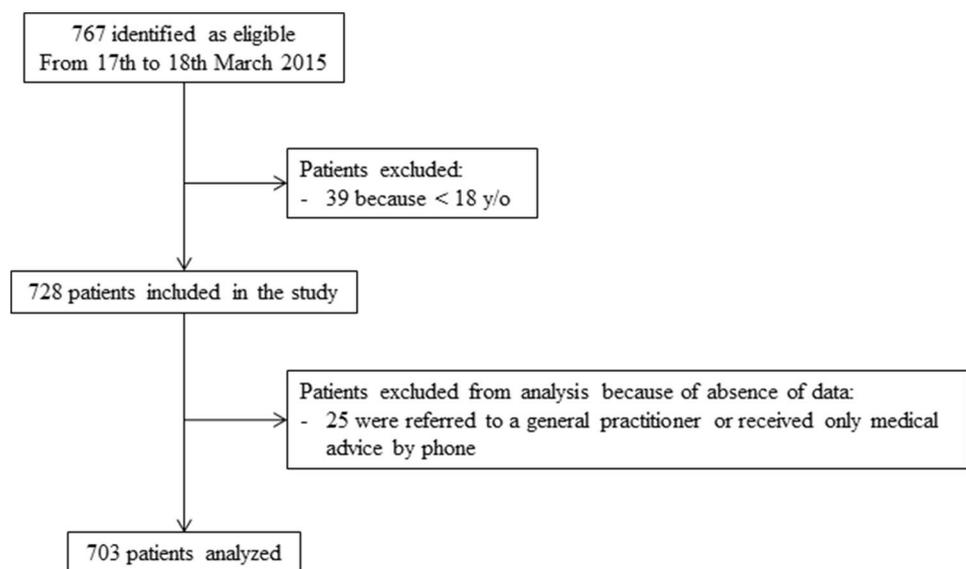
setting were analyzed, while for patients attended by EMTs, intensive treatments administered in the hospital emergency department were analyzed.

Chi-squared or Fisher exact tests were used when appropriate. Sensitivity, specificity, negative and positive predictive values were calculated for the prediction of intensive care treatment, ICU admission and hospital length of stay ≥ 2 days by dispatch decision, as well as for the prediction of ICU admission by prehospital administration of intensive treatment. The 95% confidence intervals for sensitivity and specificity were calculated using the “exact” Clopper–Pearson method. Confidence intervals for the predictive values were calculated using the standard logit method. Between-group comparisons of poisoning characteristics, vital parameters, and patient outcomes were also carried out. Quantitative data are expressed as medians (interquartile ranges, IQR) and were analyzed using Mann–Whitney *U* tests. The alpha risk was set at 0.05 (bilateral tests). Missing data were not replaced. A sample size was not calculated a priori as no previously published data were available to make a hypothesis on the effect size of the primary outcome. Statistical analyses were performed with SPSS (v20, SPSS Inc., Chicago, IL, USA). This study is reported according to the STROBE guidelines for cross-sectional studies (the STROBE checklist is provided in the Supplementary materials).

Results

The study flowchart is displayed in Fig. 1. Of the 767 patients screened for eligibility during the study period, 39 patients were under the age of 18 years and were not included. No patients declined participation; no patients were excluded due to multiple inclusions. Thus, 728

Fig. 1 Flowchart of the study



patients with DSP (median age 43 [30–52] years, 288 (40%) men) were included. Of those, 25 (3%) patients were referred to a general practitioner or received only medical advice by telephone. No outcome data were available for these patients. Finally, data from 703 patients were analyzed. The sample characteristics and the substances ingested are shown in Table 1. One hundred and fifteen (16%) patients were attended by an EMS physician, either after the initial emergency call ($n = 88$, 77%) or at the request of the first responders at the scene ($n = 27$, 23%). Patients attended by an EMS physician were more likely to receive intensive treatment (32 (28%) vs. 29 (5%),

odds ratio (OR) 95% confidence interval 7.4 [4.3–12.9]; $p < 0.001$) either in the prehospital setting or after admission to hospital. The specificity and sensitivity of dispatch decisions were, respectively, 0.87 (0.84–0.90) and 0.52 (0.39–0.65). In particular, invasive ventilation was more commonly administered in the EMS physician group, with only two patients in the group attended by EMTs intubated after arrival in the emergency department (Table 2). Activated charcoal was infrequently used (Table 2). The performance characteristics of dispatch decisions to predict the need for intensive treatment, ICU admission and length of hospital stay ≥ 2 days are presented in Table 3.

Table 1 Description of the cohort

	All ($n = 703$)	EMTs ambulance ($n = 588$)	EMS physician ($n = 115$)	P
Age (years [IQR])	42 [30–52]	41 [28–50]	48 [36–55]	<0.001
Male	288 (41)	232 (39)	56 (49)	0.08
Comorbidities				
Psychiatric	370 (53)	306 (52)	64 (56)	0.54
Suicide attempt	248 (35)	209 (36)	39 (34)	0.75
Toxicological characteristics				
Alcohol	282 (40)	232 (39)	50 (43)	0.47
Benzodiazepines	511 (73)	425 (72)	86 (75)	0.65
Antipsychotics	117 (17)	86 (15)	31 (27)	0.002
Serotonin reuptake inhibitors	81 (12)	61 (10)	20 (17)	0.04
Paracetamol	109 (16)	97 (16)	12 (10)	0.12
Cardiac drugs	41 (6)	31 (5)	10 (9)	0.19
Opioids	49 (7)	38 (6)	11 (9)	0.32
NSAID	61 (9)	52 (9)	9 (8)	0.86
Others	135 (19)	104 (18)	31 (27)	0.03
Ingested tablets (n [IQR])	20 [10–40]	18 [10–35]	37 [16–66]	<0.001
Delay from ingestion (min IQR)	229 [107–692]	211 [106–650]	479 [117–860]	0.03

Data are presented as n (%) unless otherwise stated

NSAID non-steroidal anti inflammatory drugs, IQR interquartile range, EMT emergency medical technician, EMS emergency medical service

Table 2 Treatments received in the prehospital setting (EMS physician) and in the emergency department (EMTs ambulance)

	All ($n = 703$)	EMTs ambulance ($n = 588$)	EMS physician ($n = 115$)	P
Fluid resuscitation and/or vasopressor therapy	26 (4)	13 (2)	13 (11)	0.005
Invasive ventilation	13 (2)	2 (0)	11 (10)	<0.001
Antidotal treatments				
Naloxone	7 (1)	3 (1)	4 (3)	0.02
Flumazenil	24 (3)	10 (2)	14 (12)	<0.001
Others	13 (2)	9 (2)	4 (3)	0.24
Activated charcoal	8 (1)	7 (1)	1 (1)	1

Data are presented as n (%)

EMT emergency medical technician, EMS emergency medical service

Table 3 Performance characteristics of dispatch decision for the prediction of different outcomes

	Sensitivity	Specificity	Negative predictive value	Positive predictive value
Prediction of advanced prehospital care by dispatch decision	0.52 (0.39–0.65)	0.87 (0.84–0.90)	0.95 (0.94–0.96)	0.28 (0.22–0.34)
Prediction of ICU admission by dispatch decision	0.66 (0.50–0.80)	0.87 (0.84–0.89)	0.97 (0.96–0.98)	0.25 (0.20–0.31)
Prediction of hospital LOS \geq 2 days by dispatch decision	0.56 (0.42–0.70)	0.87 (0.84–0.90)	0.96 (0.95–0.97)	0.27 (0.21–0.33)
Advanced prehospital care prediction of ICU admission	0.52 (0.37–0.67)	0.95 (0.93–0.97)	0.97 (0.96–0.98)	0.41 (0.11–0.52)

Data are represented as n (95% confidence interval)

ICU intensive care unit, LOS length of stay

Between-group comparison of DSP severity

Patients attended by an EMS physician were more likely to have ingested antipsychotic drugs, serotonin reuptake inhibitors and other uncommon substances (Table 1) than those attended by EMTs. They had ingested a larger number of tablets and time since ingestion was longer. Between-group comparison of the vital parameters showed that only the Glasgow Coma Scale score differed: it was lower in the patients attended by an EMS physician (Table 4).

Six (5%) patients in the EMS physician group and 1 (0.2%) patient in the EMTs group experienced cardiac rhythm disorders ($p < 0.001$). Twenty-five (22%) patients in the EMS physician group and 13 (2%) patients in the EMTs group were in a comatose state ($p < 0.001$). Delayed complications were more frequent in the EMS physician group, as were longer lengths of stay. Four (3%) patients died in the EMS physician group and 2 (0.3%) patients died in the EMTs group ($p = 0.007$). Thirteen (11%) patients in the EMS physician group, and 13 (2%) patients in the EMTs group received fluid resuscitation and/or vasopressor therapy ($p = 0.005$). Patients attended by an EMS physician were more frequently hospitalized or admitted to ICU (Table 5).

Discussion

This is one of the first large, cross-sectional studies of the intensity of care received by patients with DSP attended by EMS physicians as well as the adequacy of care intensity relative to the severity of the DSP. Overall, attendance by an EMS physician was strongly associated with the use of intensive treatments, especially invasive ventilation. The prehospital use of naloxone and flumazenil was also significantly greater in that group. This indicates a good specificity of the dispatch process. However, our results indicate that the identification of severe DSP and the allocation of resources by dispatch services in such cases may be suboptimal since, although the negative predictive value was high, the prevalence of severe DSP was low.

Dispatching appropriate medical resources to patients with DSP is a real challenge. The sensitivity and specificity of dispatch decisions has often been found to be low [10, 16, 17]. The present study showed that 26 patients with DSP who required intensive treatments in the prehospital setting were correctly identified by the dispatch physician. However, it is important to note that 28 patients with severe DSP were not identified by the dispatch physician, thus although the specificity of dispatch decisions was high (0.87, 95% CI 0.84–0.90), sensitivity was low (0.52, 95% CI 0.39–0.65). These results confirm previous conclusions of a study into a physician-manned emergency dispatch system in France [10]. The French emergency system is limited in terms of

Table 4 Vital parameters at first contact

	All ($n = 703$)	EMTs ambulance ($n = 588$)	EMS physician ($n = 115$)	P
Glasgow Coma Scale	15 [14–15]	15 [15–15]	13 [8–15]	<0.001
Systolic arterial pressure (mmHg)	121 [111–136]	122 [112–136]	120 [105–140]	0.29
Heart rate (/min)	86 [73–98]	86 [73–98]	83 [70–99]	0.64
Respiratory rate (/min)	16 [15–20]	16 [15–20]	15 [14–20]	0.12

Data are presented as medians and interquartile ranges

EMT emergency medical technician, EMS emergency medical service

Table 5 Patient outcomes and complications

	All (<i>n</i> = 703)	EMTs ambulance (<i>n</i> = 588)	EMS physician (<i>n</i> = 115)	<i>P</i>
Hospital admission	413 (59)	328 (56)	85 (74)	< 0.001
Length of hospitalization (days, [IQR])	2 [1–2]	2 [1–2]	2 [2–4]	< 0.001
ICU admission	44 (6)	15 (3)	29 (25)	< 0.001
Death	6 (1)	2 (0)	4 (3)	0.007
Hospital complications				
Renal failure	13 (2)	4 (1)	9 (8)	< 0.001
Liver failure	7 (1)	4 (1)	3 (3)	0.09
Aspiration pneumonia	31 (4)	15 (3)	16 (14)	< 0.001
Rhabdomyolysis	11 (2)	7 (1)	4 (3)	0.09

Data are presented as *n* (%) otherwise stated

EMT emergency medical technician, EMS emergency medical service

resources (approximately 1 EMS physician per 150,000 inhabitants in France), thus it is impossible to set a safety objective based on over-triage. Therefore, the minimum objective should be to allocate available resources to patients with severe DSP who require more intensive treatments (i.e., improve specificity).

The impact of attendance by an EMS physician vs. EMTs cannot be determined by the present study. Data in the literature indicate that treatment delays may be detrimental for patients with poisoning [8, 18]. In this cohort, it is likely that EMS physicians had a beneficial impact on early complications such as cardiac rhythm disorders (5%) and/or coma (22%). However, the impact of attendance by an EMS physician on later complications remains to be evaluated. In the whole cohort, the proportion of patients diagnosed with aspiration pneumonitis during their hospital stay (*n* = 31, 4%) was higher than the proportion who required intubation (*n* = 13, 2%). This illustrates the challenge of appropriately identifying patients who require airway protection, even with the use of scales such as the Glasgow Coma Scale. Previous studies have shown that aspiration pneumonitis occurs in approximately 15% of patients with a GCS score above 8, and patients with a GCS score below this threshold might not require intubation [19, 20]. The rate of late complications was higher in the EMS physician group but this cannot solely be attributed to the severity of poisoning. Equally, it is not possible to ascertain whether the rate of late complications would be higher if prehospital advanced care by an EMS physician was not provided. Nonetheless, some patients with DSP treated by EMS physicians benefited from potentially life-saving interventions such as antidotal treatments and/or mechanical ventilation.

Most of the treatment provided by EMS physicians was for early neurological complications related to the ingested drug. The vast majority of substances ingested were benzodiazepines (73%), antipsychotics (17%) and antidepressant

drugs (12%) (Table 1). Not surprisingly, antipsychotics and antidepressant drugs, including serotonin reuptake inhibitors, were more common in the group of patients attended by an EMS physician. These drugs are more toxic than benzodiazepines [21–23], thus the main early complication was coma, which resulted in a high intubation rate in the EMS physician group (10%). In view of this result, it could be recommended that a prehospital EMS physician should be dispatched whenever coma is suspected, particularly since EMTs have a lower success rate and a higher rate of adverse events for rapid sequence intubation than EMS physicians [24, 25]. However, this needs to be further investigated since the use of antidotal treatment can avoid intubation in certain types of poisoning.

EMS physicians frequently administered antidotal treatments (*n* = 17, 15%). This rate of administration was relatively high, especially considering the low prevalence of opioid intoxication in this cohort [26]. Flumazenil was the most commonly used antidote despite the uncertainty of its benefit–risk ratio [27]. In contrast, only one patient was administered activated charcoal. The prehospital use of activated charcoal is also debated and it is recommended that it should only be administered to patients within a short time of the ingestion of high-risk poisons [28, 29]. This highlights the need for evaluation of the effectiveness and benefit–risk ratios of specific toxicological treatments in the prehospital setting. The effectiveness of naloxone in the management of opioid poisoning has been well demonstrated [9], however this is not the case for other types of antidote or poisoning. Another issue that remains to be resolved is the role of antidotes or decontamination therapy and the most appropriate person for their administration (paramedic or physician).

This study has several limitations. First, bias due to both the geographical representativeness of the centers and weekly or monthly variations in DSP may have occurred. Twenty-six percent of all French emergency structures, including all

university hospitals and the vast majority of regional hospitals distributed throughout France participated in the study. Second, the exhaustiveness of inclusions was not assessed and some patients with DSP may have been missed. Patients could not be included if the poisoning was not recognized by the dispatch system during the emergency phone call (unexplained coma, elderly patients, etc.) [30]. Third, some variables may have been correlated: the dispatching of an EMS physician is associated with a higher probability that the patient will require intensive treatment. Nevertheless, examination of the patient characteristics showed that a relatively large proportion had signs of severe poisoning. In these patients, the use of intensive treatment seems legitimate, even if evidence that advanced prehospital care has a real impact on DSP patient outcomes is lacking. Some preliminary data advocate the use of early intensive treatment especially in the case of coma [8], however prospective studies with robust methodology are required for definitive conclusions to be drawn.

In conclusion, patients with DSP attended by prehospital EMS physicians frequently receive appropriate, intensive treatment according to the severity of the poisoning. The identification of patients with severe DSP by dispatch physicians remains a challenge. In the present study, an EMS physician was dispatched for approximately half the cases of severe DSP, allowing resuscitation treatments to be rapidly administered. The impact of such prehospital intensive treatments on the clinical course of patients with DSP needs to be evaluated.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants The study was approved by our national Review Board [Advisory Committee on the treatment of information in the field of Health Research- (CCTIRS) the national commission for Liberties and Data Protection (CNIL)] and the ethics committee of Clermont-Ferrand, Grenoble, France (IRB 5891).

Informed consent According to French law and the observational nature of this study, patients' oral consent was required. Informed consent was obtained from all individual participants included in the study.

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