BCPT Basic & Clinical Pharmacology & Toxicology

Basic & Clinical Pharmacology & Toxicology, 2017, **120**, 498–504 Doi: 10.1111/bcpt.12711

Usefulness of Transthoracic Echocardiography Parameters and Brain Natriuretic Peptide as Mortality Predictors in Hospitalized Acutely Poisoned Patients: A Prospective Observational Study

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(Received 23 October 2016; Accepted 16 November 2016)

Abstract: Acute poisonings represent a common cause of morbidity and mortality worldwide. The prognostic utility of the transthoracic echocardiography (TTE) parameters combined with brain natriuretic peptide (BNP) in acute poisoning with different xenobiotics, upon admission in the hospital, was not evaluated. This prospective observational cohort study included 229 acutely poisoned non-diabetic adults, with a median age of 44 years (range 18–90 years), 50.7% women, with an in-hospital mortality rate of 8.7%. Univariate logistic regression analysis showed that age, the left ventricle kinetic abnormalities, the E-wave deceleration time (EDT) and BNP correlated significantly with mortality in acutely poisoned patients. Multivariate logistic regression showed that only EDT [odds ratio (OR) 3.44, 95% confidence interval (CI) 1.54–7.69, p 0.003], BNP (OR 1.61, 95% CI: 1.02–2.55, p 0.04) and age (OR 2.66, 95% CI: 1.23–5.76, p 0.013) are predictive for mortality. The receiver-operating characteristic (ROC) analysis proved EDT [area under the ROC curve (AUC), 0.85; CI: 0.76–0.94; p 0.001], BNP (AUC, 0.83; CI: 0.75–0.91; p 0.001) and age (AUC, 0.82; CI: 0.74–0.90; p 0.001) as indicators for fatalities. In hospitalized patients acutely intoxicated with undifferentiated poisons, EDT as a parameter of left ventricle diastolic function and BNP are useful to early predict mortality.

Acute poisonings represent a common cause of morbidity and mortality worldwide [1,2]. Myocardial damage occurs after acute exposure to different xenobiotics, including drugs (i.e. antidepressants, antipsychotics, acetaminophen) [3–5], toxins (i.e. carbon monoxide [CO] and pesticides) [6,7], drugs of abuse (i.e. methadone and cocaine) [8,9] or herbal toxin (i.e. aconite and wild mushrooms) [10,11], and is a significant predictor of mortality in many of these situations [3,6,12]. Echocardiography alone, or combined with biomarkers, was used only in acute CO poisoning [13,14], and pesticide poisoning [15,16] to assess cardiac toxicity. However, the utility of systematic transthoracic echocardiography (TTE) evaluation upon admission in a medical or intensive care unit (ICU) ward, with respect to the outcomes and mortality, was not performed in acutely poisoned patients.

The aim of this study was to analyse whether the cardiac function parameters assessed using TTE upon admission in the hospital, combined with brain natriuretic peptide (BNP), can be useful as early in-hospital mortality predictors in acutely poisoned patients with undifferentiated agents. The physician involved in the medical and intensive care of these patients could use these objective markers to identify immediately after admission the patients at risk of death, and adjust their management accordingly.

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Materials and Methods

This prospective observational cohort study was performed in a referral centre for clinical toxicology, from an 1128-bed university hospital, which includes an emergency department (ED) with over 85,000 visits annually, over a period of 12 months (October 2015–September 2016). We enrolled patients older than 18 years, irrespective of gender, which were addressed to the ED reportedly within 5 hr from poison exposure and admitted with suspected toxicity, confirmed after routine toxicological tests (serum level for ethanol, digitalis, carboxyhaemoglobin, cholinesterase and urine toxicology screen) or gas chromatography–mass spectrometry analysis from initial sample, for other selected poisons. All subjects or their family (for unconscious patients) signed an informed consent prior to enrolment. The study was approved by the review board of the hospital and university and was conducted in accordance with the principles of the Helsinki Declaration and guidelines on Good Clinical Practice.

We included consecutive hospitalized patients with acute self-poisoning or acute unintentional poisoning. Offending agents were represented by: drugs (including prescription medication and over-the-counter [OTC] medicines), drugs of abuse, non-pharmaceutical agents (i.e. pesticides, chemicals, alcohols, herbal toxins), toxic gases or combination of multiple poisons. Patients without a signed informed consent, younger than 18 years, with an associated disease that can influence TTE pattern or BNP (i.e. diabetes, acute myocardial infarction or heart failure, chronic renal disease), patients with ocular/dermal exposures, with an acute pathology associated with poisoning (i.e. trauma, burns, including caustic burns, anaphylaxis etc.) or patients with incomplete data were excluded from our study.

All patients underwent routine assessment and management in the ED, which involved clinical examination, assessment of poisoning severity score, toxicological screen, complete blood count, arterial blood gases analysis, biochemistry profile (glucose, electrolytes, creatine phosphokinase [CK], renal and liver function tests), and measures of basic or advanced cardiac life support, decontamination,

supportive and antidote therapy, where appropriate, and then were admitted to a medical or ICU ward. An electrocardiogram (ECG) was recorded, and the venous blood was collected immediately after admission for routine laboratory tests and BNP analysis. The tests were repeated thereafter at the discretion of the attending physician, if it was necessary, for selected patients who developed complications. Brain natriuretic peptide was not reassessed before discharge. We used PATHFAST® Cardiac Biomarker Analyser (LSI Medience Corporation, Tokyo, Japan) for BNP detection. The cut-off limit of <100 pg/mL for BNP is recommended by the guidelines in the acute setting [17].

We performed TTE in all poisoned patients, upon admission in the medical or ICU ward, to assess cardiac function, using a Fukuda Denshi Full Digital Ultrasound System UF-850XTD (Fukuda Denshi Co., Ltd., Tokyo, Japan). The following variables were calculated: left ventricle (LV) ejection fraction (EF), LV shortening fraction (SF), LV wall motion abnormalities (kinetics), E-wave deceleration time (EDT) of early LV diastolic filling, patterns of mitral diastolic filling (normal, abnormal relaxation, pseudonormal and restrictive filling), the ratio of the early (E) to late (A) ventricular filling velocities (E/A), maximum aortic velocity (AoVmax) and inferior vena cava (IVC) diameters (inspiration–expiration). The parameters were collected and analysed by the cardiologists in our team and their normal values were considered upon guidelines' recommendations [18–20].

The patients were observed only during hospitalization. The main outcome measure was the status at hospital discharge. A favourable outcome was considered for patients discharged home with no symptoms, complications or disabilities, all complications being resolved during hospitalization. We considered as complications poison-induced rhabdomyolysis (CK > 1000 U/L), encephalopathy and seizures, acute respiratory failure requiring mechanical ventilation for more than 24 hr, arrhythmias with haemodynamic instability, acute myocardial injury (based on ECG pattern and increased troponin levels), acute liver injury (increased transaminase levels >10 times the upper normal limit with mild to moderate increased alkaline phosphatase levels), acute kidney injury (urine volume <0.5 mL/kg/hr for 6 hr, based on Kidney Disease: Improving Global Outcomes criteria) and toxin-induced gastroenteral lesions indicated by a superior or inferior digestive endoscopy [21–23]. A poor outcome was defined as in-hospital death.

Statistical analyses were performed with SPSS software for Windows (v.22.0; SPSS, Chicago, IL, USA). Nominal variables are presented as frequencies and percentages, and continuous variables are presented as mean ± standard deviation (S.D.) or median [25–75 percentiles] if not normally distributed. To identify significant parameters associated with poisoning-related fatalities, two-tailed Student's *t*-test was used to compare normally distributed continuous variables, the Mann–Whitney *U*-test was used to compare skewed data, and the chi-square test and Cochrane's statistic were used for categorical variables. All significant variables in the univariate analyses for mortality were subjected to a multivariate logistic regression analysis. Risk was expressed as odds ratios (ORs) with confidence intervals (CI). Optimal cut points for the parameters analysed were determined using the area under the curve (AUC) of the receiver-operating characteristic (ROC) with 95% CI and the associated p value representing the likelihood of the null hypothesis (AUC = 0.5). p values <0.05 were considered statistically significant.

Results

The patient screening and final study population are presented in fig. 1. We analysed 229 patients, with a mean age of 44.8 years (range 18–90 years), 50.7% women. Time to ED arrival was 3.2 ± 1.3 hr (range, 0.5–5 hr). The selected clinical characteristics (demographics, Glasgow Coma Scale score [GCS], poison types, vital signs, etc.) with respect to the outcome are included in table 1. Age influenced significantly the mortality (table 1). The average initial GCS was 11 (range 3–15). The GCS below 8 was associated with a poor outcome in our patients (table 1). The majority in our cohort were self-poisonings, and only 22 patients (9.6%) had an accidental exposure to a toxin. The poisons encountered in our cohort were as follows: 30.6% drug poisoning (sedative hypnotics in 25, antidepressants and cardiovascular drugs each in 14 patients, anti-epileptic in seven, antipsychotic in five, antimicrobials in three and antidemential agents in two patients); 29.4% combination of poisons; 13.5% pesticides (organophosphates in 21, carbamates in seven, rat poison in three patients); 8.7% toxic gases (CO and mixtures); 7.4% toxic alcohols and chemicals (ethylene glycol in seven, methanol in six, formaldehyde and hydrocarbon mixtures each in two patients); 6.1% OTC (non-steroidal anti-inflammatory drugs in seven, acetaminophen in five and salicylates in two patients); 5.7% illegal drugs (opiates in five, cannabis and ethnobotanicals each in three, and cocaine in two patients); 0.9% herbal toxins (wild mushrooms). The mortality rate was higher in acute poisoning with non-pharmaceutical agents (table 1). Sixty patients (26.2%) had ethanol co-ingestion, which had no influence on mortality.

Vital signs were not substantially different within outcome groups. ECG was abnormal upon admission in 57.2% patients (table 1). The ECG abnormalities recorded were represented by arrhythmias (ranging from premature atrial or ventricular complexes to paroxysmal arrhythmias or asystole) in 85 (37.1%) patients, conduction disturbances (ranging from transient first-degree atrioventricular blocks to bundle branch blocks) in 15 (6.6%) patients, ST segment and T wave changes (ranging from negative T waves in two contiguous leads to ST segment elevation or depression with inverted T waves) in 31 (13.5%) patients.

Of the entire cohort, 116 patients (50.6%) developed complications (21.8% multiple complications involving more than two systems and organs, 10.9% cardiovascular, 5.2% central nervous system, liver complications and rhabdomyolysis 3.5% each, 3.1% respiratory, 1.7% renal and 0.9% gastrointestinal complications). Of the 229 patients, 20 patients died (8.7%) as a result of multiple complications. The average total number of days in the hospital was 4.5 ± 3.6, significantly prolonged in non-survivors (7.1 ± 5.6 days *versus* 4.2 ± 3.2 days, p 0.001). Deaths were recorded in patients poisoned with toxic alcohols and chemicals (3.1%), prescription drugs (1.7%), combination of poisons (1.7%), toxic gases (1.3%) and organophosphate pesticides (0.9%).

There was no significant statistical difference in BNP level within age and gender groups, although the levels of BNP upon admission were significantly higher in the fatalities group (table 1). Brain natriuretic peptide was notably increased in patients poisoned with toxic gases compared with patients intoxicated with combination of poisons (227.15 ± 314.62 *versus* 69.69 ± 164.51 pg/mL, p 0.02) and, respectively, with OTC poisoning (227.15 ± 314.62 *versus* 20.06 ± 23.33 pg/mL, p 0.024).

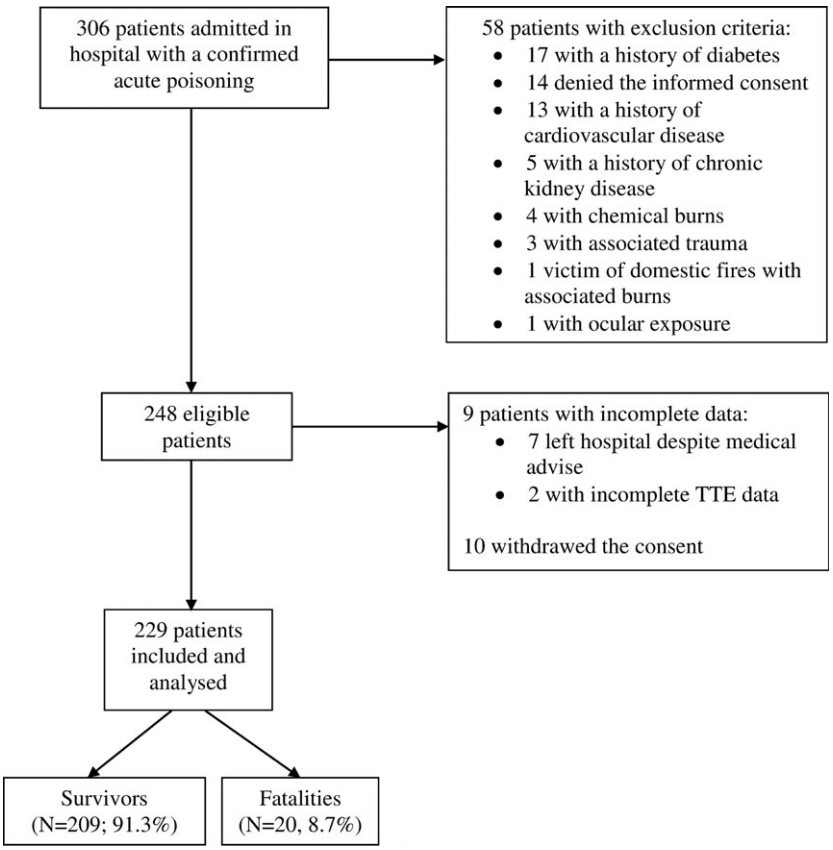

Fig. 1. Flow chart of patients included in the study and their outcome.

Table 1.
Selected characteristics of the patients with acute poisoning with respect to the outcome.

Characteristics	Total (n = 220)	Survivors (n = 209)	Fatalities (n = 20)	*p* Value (survival *versus* dying)
Age (years)[1]	41 [33–59]	40 [32–56]	61.5 [57.5–73]	0.001
Gender; F (%)[2]	116 (50.7)	105 (45.9)	11 (4.8)	0.432
GCS score ≤8; n (%)[2]	45 (19.7)	36 (15.7)	9 (3.9)	0.006
Vital signs[1]				
HR (beats/min)	90 [75–106]	90 [75–105]	88 [68–112]	0.980
SBP (mmHg)	120 [110–140]	120 [110–140]	117.5 [80–136]	0.213
DBP (mmHg)	76 [70–80]	77 [70–80]	72 [50–83]	0.116
Poison type; n (%)[2]				0.010
Drugs	97 (42.4)	93 (40.6)	4 (1.7)	
Non-pharmaceutical agents	70 (30.6)	58 (25.3)	12 (5.3)	
Combination of poisons	62 (27.0)	58 (25.3)	4 (1.7)	
Ethanol co-ingestion (mg/dL)[1]	1 [1–30.5]	1 [1–30.5]	2 [1–43.8]	0.617
BNP (pg/mL)[1]	23.1 [6.0–81.0]	21.7 [5.0–67.0]	161.5 [74.5–317.5]	0.001
Abnormal ECG (%)[2]	57.2	50.0	7.2	0.035

[1]Data are presented as median [25–75 percentiles] and *p* value by Mann–Whitney *U*-test.
[2]% within entire cohort and *p* value by chi-square proportion test.
GCS, Glasgow Coma Scale; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; OTC, over-the-counter; BNP, brain natriuretic peptide.

Among TTE parameters analysed, we noticed that alteration in both diastolic and systolic LV function, along with the presence of LV regional or global wall kinetic abnormalities, had a significant impact on the mortality (table 2). We also found a positive statistical correlation between the elevated BNP level (>100 pg/mL) and the prolongation of EDT (>220 ms) in all studied groups (*p* 0.034), also between BNP >100 pg/mL and a decreased left ventricle ejection fraction (LVEF) (<50%) in the cohort analysed (*p* 0.001).

The LVEF was significantly lower in poisoning with toxic alcohols and chemicals (50.0 ± 10.5%), as compared with combination of poison exposures (54.3 ± 7.9%, *p* 0.05),

prescription drug poisoning (54.9 ± 7.8%, p 0.026), pesticide exposures (54.9 ± 6.8%, p 0.043) and OTC intoxication (59 ± 6.3%, p 0.002). Also, compared with OTC poisoning, LVEF was significantly decreased in toxic gas exposure (51.9 ± 9.4%, p 0.011).

E-wave deceleration time was significantly prolonged in patients exposed to toxic alcohols and chemicals, as compared with patients with prescription drug poisoning (236.5 ± 33.7 *versus* 206.4 ± 46.7 ms, p 0.005), with pesticide poisoning (206.3 ± 39.4 ms, p 0.011), combination of poisons (201.9 ± 33.8 ms, p 0.001), with OTC poisoning (197.75 ± 42.7 ms, p 0.006), patients exposed to illicit drugs (189.1 ± 21.1 ms, p 0.001) and with vegetal poisons intoxication (166.5 ± 20.5 ms, p 0.017). The IVC diameter was notably increased in patients with non-pharmaceutical agents acute poisoning, as opposed to patients with drug poisoning (19.34 ± 3.17 *versus* 18.04 ± 2.59 mm, p 0.025). The rest of the TTE parameters showed no significant differences among poison groups.

After univariate logistic regression analysis, several variables correlated with mortality, but only age, EDT and BNP showed a predictive value for mortality in acute poisoning after multivariate logistic regression analysis (table 3). We observed all predictive variables, and these three demonstrated a good discriminatory power for mortality using ROC methodology (fig. 2). The following cut-off values were indicated corresponding to the minimal false-negative and false-positive results: BNP of 100 pg/mL with 65% sensitivity, 79% specificity, 31% positive predictive value (PPV), 96% negative predictive value (NPV); EDT of 220 ms with 90% sensitivity, 72% specificity, 24% PPV, 98% NPV. A BNP 80 pg/mL cut-off was also tested, which increased the sensitivity to 75%, but the PPV was lower, while specificity and NPV remained unchanged.

Discussion

This is the first study, to our knowledge, which prospectively analysed the TTE parameters assessed systematically upon admission in a heterogeneous cohort of acutely poisoned patients presenting to the hospital within 5 hr of exposure and concomitantly correlated these parameters with clinical parameters, ECG and BNP. Despite a relatively small number of fatalities (20 patients, 8.7%), we observed an important

Table 2.
Transthoracic echocardiography patterns in acute poisoning based on the outcome.

Parameter observed	Total (n = 229)	Survivors (n = 209)	Fatalities (n = 20)	p Value
LVEF (%)[1]	55 [50–60]	56 [51–60]	41.5 [39–50]	0.001
LVSF (%)[1]	28 [24–32]	28 [25–32]	20.5 [15–26]	0.001
EDT (ms)[1]	207 [179–233]	201 [178–226]	255 [236–267]	0.001
E/A ratio[1]	1.1 [0.8–1.5]	1.1 [0.9–1.5]	0.8 [0.7–0.9]	0.001
AoVmax (m/s)[1]	1.1 [1.0–1.3]	1.1 [1.0–1.3]	0.8 [0.7–1.0]	0.004
IVC diameter (mm)[1]	19 [17–20]	19 [17–20]	18 [16–22]	0.595
Abnormal LV Kinetics; n (%)[2]	58 (25.3)	44 (19.2)	14 (6.1)	0.001

[1]Data are presented as median [25–75 percentiles] and p value by Mann–Whitney U-test.
[2]% within entire cohort and p value by chi-square proportion test.
DT, deceleration time; LVEF, left ventricle ejection fraction; LVSF, left ventricle shortening fraction, AoVmax, aortic maximal velocity; IVC, inferior vena cava; LV, left ventricle.

Table 3.
Univariate and multi-variate logistic regression analysis for selected significant variables associated with mortality in acute poisoning.

	Univariate logistic regression			Multivariate logistic regression		
Variable	OR	95% CI	p	OR	95% CI	p
Age	3.441	1.985–5.964	0.001	2.658	1.226–5.762	0.013
GCS ≤8	0.254	0.098–0.658	0.005			
SBP	0.978	0.958–0.998	0.033			
DBP	0.951	0.920–0.984	0.004			
Abnormal ECG	0.281	0.077–1.022	0.054			
BNP	1.399	1.010–1.937	0.043	1.613	1.022–2.548	0.040
LVEF	0.247	0.143–0.427	0.001			
LVSF	0.182	0.085–0.388	0.001			
EDT	3.614	2.022–6.457	0.001	3.444	1.543–7.690	0.003
E/A ratio	0.128	0.034–0.444	0.001			
AoVmax	0.417	0.222–0.783	0.006			
LV Kinetics abnormalities	8.750	3.179–24.085	0.001			

OR, odds ratio; CI, confidence interval; GCS, Glasgow Coma Scale; SBP, systolic blood pressure; DBP, diastolic blood pressure; BNP, brain natriuretic peptide; LVEF, left ventricle ejection fraction; LVSF, left ventricle shortening fraction; EDT, E-wave deceleration time; AoVmax, aortic maximal velocity.

relationship between alteration in LV function and BNP levels with the risk of mortality.

Our results showed, in accordance with those reported in herbicide poisoning [12], that age influenced in-hospital mortality of patients acutely poisoned with undifferentiated xenobiotics, as expected, because elderly might have a modified toxicokinetics or toxicodynamics of poisons, explained by associated comorbidities or changes in metabolic pathways.

Brain natriuretic peptide elevations are accurate in diagnosing diastolic dysfunction with the same effectiveness as in systolic dysfunction. Asymptomatic LV dysfunction alone leads to higher baseline BNP levels. As a general guideline, the cut-off point used in acute settings for BNP is less than 100 pg/mL [17,24]. A meta-analysis suggested that lower BNP thresholds may provide important prognostic information in different clinical settings, but data to clearly establish whether other BNP threshold provides an independent prediction of risk are lacking [25]. NT-proBNP was proved to have a negative correlation with LVEF in patients acutely poisoned with CO [14]. Our previous experience showed that biomarkers are indicators for the need of ICU admission, being correlated with early complications, and the short-term outcome [26].

Based on the assessment of acutely poisoned patients with heterogeneous agents upon admission, we proved that BNP is increased in non-survivors, and a BNP cut-off point of 100 pg/mL accurately discriminated between survival and death in acute poisoning, and conferred a 1.6 times increased risk of mortality. These results are important for the future studies, because we tried to minimize the possible role of confounding factors imposing the above-mentioned exclusion criteria in acutely poisoned cohort studied. The only interference could come from the age and gender, knowing that BNP levels are elevated in older patients and in women more than men [24]; however, the most commonly used decision threshold for BNP remains 100 pg/mL irrespective of age or gender, as guidelines emphasized for the acute setting [17,24]. Also, we did not find a significant difference in this biomarker level within gender groups and age in patients acutely poisoned with heterogeneous agents. We consider that only the acute effect of the poison on the heart, either direct toxicity, or subsequent to metabolic alterations, explained the changes in BNP level, which was correlated with the presence of left ventricular dysfunction, and with death. Brain natriuretic peptide might be added to troponin, which was strongly associated with in-hospital mortality in a cohort of adults with acute drug overdoses [27], in the initial evaluation of a poisoned patient.

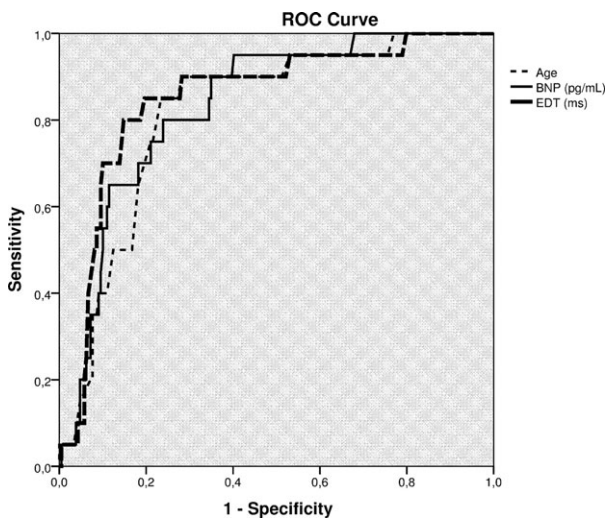

Fig. 2. Receiver-operating characteristic curves validate the discriminatory power of the parameters predicting mortality. Areas under the curves: EDT (E-wave deceleration time): 0.849 (95% confidence interval 0.762–0.936, p 0.001); BNP (brain natriuretic peptide): 0.832 (95% confidence interval 0.754–0.910, p 0.001); age: 0.819 (95% confidence interval 0.735–0.903, p 0.001).

Evaluation of the cardiac structures by ultrasound can rapidly provide data that would be of great interest in managing poisoned patients. Items of particular interest in the ED investigation of an unstable patient include the assessment of the LV function and contractility, or markers of the patient's volume status, such as IVC diameter, and the response of these parameters to therapeutic manoeuvres [28,29]. In several acute poisoning, such as those associated with shock (i.e., calcium-channel blocker overdose), or with severe volume depletion as a consequence of the poison (i.e. salicylate overdose), echocardiography could bring important information to refine the management of the poisoning [30]. The role for echocardiography in assessing a poisoned patient was proved in CO poisoning, where changes in diastolic function, preceding systolic function abnormalities [31] or various patterns of LV systolic dysfunction were observed [15], and showed a better accuracy, as opposed to ECG changes in detecting CO-induced cardiac damage [32].

The results obtained in this cohort of acutely poisoned patients showed that the assessment with TTE of cardiac function parameters, especially EDT >220 ms, as a measure of diastolic function of the LV, showed a 2.44 times increased odds of mortality in this setting. Considering that diastolic dysfunction is a feature that precedes systolic dysfunction, we believe that our observations regarding patients exposed to different poisons (with various mechanisms of action) are important, and prolonged EDT which positively correlates with BNP levels over 100 pg/mL truly reflects the poison-induced subclinical heart damage, even in the absence of ECG changes. Although several changes in systolic function were observed in the analysed cohort, they failed to predict significantly the mortality. This may be explained by the relatively low prevalence of recognized cardiotoxic drugs (i.e. antidepressants) or cardiotoxins (i.e. CO) in our cohort. The mortality rates recorded on different poisoned groups are increased compared with those reported elsewhere [1,33]. An explanation could be the absence of specific antidotes for digitalis glycosides (i.e. digoxin immune Fab) and toxic alcohols (i.e. fomepizole) in our country.

To the best of our knowledge, this is the largest study to demonstrate prospectively the utility of echocardiography parameters combined with a conventional cardiovascular biomarker to early predict, upon hospital admission, the outcome for a patient with acute poisoning. The present investigation

has several important clinical implications: there are some objective available tests, such as the BNP level, or the presence of a diastolic dysfunction assessed with TTE, that are good predictors of in-hospital mortality in non-diabetic heterogeneous acutely poisoned patients. This is important for daily practice, because there are circumstances when the serum poison levels are not readily available, a GCS score <8 failed to accurately predict the mortality, and identifying high-risk patients could improve the medical and intensive care in this setting.

Several limitations should be mentioned. Including patients from a single tertiary centre in north-east Romania implies a possible selection bias in the population studied, although the epidemiological and toxicological data are consistent with those reported in the United States or Europe [1,2]. A larger sample was not available for this analysis given the constraints applied from the exclusion criteria, to avoid bias from comorbidities in the echocardiography and cardiovascular biomarkers analysis. We could not calibrate the influence of toxin serum concentration, and we failed to monitor all patients at least 30 days after the acute poisoning, although in some cases, reassessment after 1 month from the acute event proved that ETT parameters returned to normal range. Finally, these results do not apply to the excluded population. Future multicentre prospective studies are warranted to confirm and further explore the implications of systematic echocardiography and biomarker assessment in every patient admitted with an acute poisoning in the hospital, and to assess the role of associated chronic pathologies in overdose risk and mortality.

In conclusion, TTE parameters such as EDT and LVEF, combined with BNP obtained upon hospital admission, can predict the in-hospital mortality of non-diabetic acutely poisoned adults. As echocardiography parameters are objective, can be obtained fast and are less invasive, and BNP is widely available and routinely used in ED for patients presenting with acute dyspnoea, they can be successfully applied in everyday practice as part of the general approach of an acute poisoning, to improve the management of these poisonings and early address the worse outcome and mortality.

Acknowledgements

This study was funded by the 'Gr. T. Popa' University of Medicine and Pharmacy Iasi, Romania (internal research grant No. 30884/30.12.2014).

Conflict of Interest

All authors have no conflicts of interest to disclose.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Table S1. Selected characteristics of the patients with acute poisoning with respect to the outcomes.