

Professional paper

## SEVERE RENAL FUNCTION IMPAIRMENT IN ADULT PATIENTS ACUTELY POISONED WITH CONCENTRATED ACETIC ACID

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Acetic acid is a widely used organic acid with corrosive properties that depend on its concentration. If acetic acid is ingested in concentrations above 30 % it may severely damage the upper gastrointestinal tract and cause intravascular haemolysis, which can result in severe kidney and liver disorders and disseminated intravascular coagulation.

In this retrospective study, we analysed acetic acid ingestion data collected at the University Clinic for Toxicology of Skopje, Macedonia from 1 January 2002 to 31 December 2011. The analysis included systemic complications, kidney damage, and the outcomes in particular.

Over the ten years, 84 patients were reported at the Clinic to have ingested highly concentrated acetic acid. Twenty-eight developed kidney disorders, while the remaining 56 had no complications. Fatal outcome was reported for 11 patients, seven of whom had systemic complications and four severe gastrointestinal complications.

**KEY WORDS:** *corrosive poisonings, esophagogastroduodenoscopy, post-corrosive stenosis, renal failure*

Acetic acid is a widely used organic acid with corrosive properties that depend on its concentration. At concentrations between 2 % and 3 % it is mainly used as an antifungal or antibacterial agent (1); between 5 % and 8 % it is mainly found in vinegar and is safe for consumption as a vegetable preservative or condiment; and between 30 % and 90 % it is used as an antiseptic or a household cleaning agent. In some countries 80 % acetic acid known as "Essence" or "Esencija" is still popular in the preparation of pickled food. Yet even a small amount of acetic acid in this concentration may cause serious poisoning with a fatal outcome (2, 3).

When highly concentrated acetic acid is ingested, it can severely damage the upper gastrointestinal tract. Beside local harmful effects, the acid can also cause intravascular haemolysis, which can in turn lead to severe acute kidney and liver failure and disseminated intravascular coagulation (DIC). Chronic ingestion of a 5 % acid solution, on the other hand, may result in hypokalaemia, hyporeninemia, and osteoporosis (4).

In contrast to the European Union and the USA, where the production and use of acetic acid is strictly controlled, in the Balkan countries, Middle East, China, Thailand, and Russia, it is produced and used in higher concentrations and its abuse, mainly in suicidal attempts, is more frequent (5, 6).

The aim of this study was to establish our clinical experience and evaluate the severity of systemic complications and possible risk factors for the development of renal failure in patients diagnosed with acetic acid poisoning.

## MATERIALS AND METHODS

This retrospective study includes data collected from adult patients hospitalised at the University Clinic for Toxicology in Skopje between 1 January 2002 and 31 December 2011. Data collection included the age, gender, motive for ingestion (accidental or suicidal), degree of corrosive injury, and early and late post-corrosive complications. All 84 patients with acetic acid poisoning were admitted to the hospital within six hours of ingestion. Due to acute complications, four patients were immediately transferred to the Surgery Unit and subjected to diagnostic explorative laparotomy. Despite vigorous treatment, all died due to serious systemic and gastrointestinal disorders, specifically perforation and acute peritonitis. The rest of the admitted patients were hospitalised in the Intensive Care Unit (ICU) and underwent urgent oesophagogastroduodenoscopy (EGD) within 12 hours of admission. Control EGD was repeated 15 and 25 days after the poisoning. For upper endoscopy, we used a Olympus CLK4, GIF4 (Tokyo, Japan) endoscope, with a diameter of 9.2 mm, with Xylocaine gel for local anaesthesia. Insufflation and retrovisual methods were performed very carefully in order to avoid the risk of injuring the patient any further. Endoscopic findings were graded using Kikendall's classification (7) (Table 1). Acute renal failure was defined as a sudden increase in serum creatinine to above  $150 \text{ mmol L}^{-1}$ . Liver damage was defined as increase in serum alanine aminotransferase (ALT) and aspartate aminotransferase (ACT) three times the reference values. The criteria for DIC were disorders in the coagulation status, such as decreased platelet count, prolonged bleeding time, high D-dimer count, prolonged prothrombin time, and prolonged partial thromboplastin time (8).

For each patient we confirmed the amount of ingested acetic acid with anamnestic or hetero-anamnestic data. The final outcome was recorded either as systemic complications (acute kidney or liver failure in particular), DIC, and death, as significant statistical variables.

All patients who deliberately ingested corrosive substances were examined by a psychiatrist before they were released from the hospital.

## STATISTICAL ANALYSIS

For the analysis we used the Statistica 7.1 (StatSoft-USA) and SPSS 13.0 (SPSS Inc.-Chicago,USA) software to determine the percentiles of structure (%) in the series with attributive values, to calculate descriptive statistics in the series with numeric values (mean $\pm$ SD, range), and to assess the correlation between kidney complications (as a dependent variable) and age, amount of ingested substance, duration of hospitalisation, and degree of tissue damage (as independent variables) using logistic regression analysis. The level of significance was  $P < 0.05$ .

## RESULTS AND DISCUSSION

Over the 10 years, 932 patients were reported for poisoning with corrosive agents and 84 (9 %) of them ingested acetic acid. Acetic acid ingestion was more than twice as frequent in women ( $n=58$ ) as in men ( $n=26$ ). A vast majority ( $n=80$ ) ingested the acid with suicidal intent, and only four by accident. The most common reasons for suicide attempt were mental distress (most often states of depression and/or psychosis) ( $n=34$ ), family conflicts ( $n=29$ ), couple conflicts ( $n=15$ ), and school-related problems ( $n=2$ ). Three of the four accidental ingestions were due to mislabelling. The age of the patients was between 17 and 80 years [ $(50.35 \pm 17.75)$  years]. The amount of ingested acetic acid varied between 5 mL and 100 mL [ $(23.15 \pm 20.62)$  mL].

The time elapsed from acid ingestion to hospitalisation varied between one and six hours [ $(3.45 \pm 1.36)$  h], that is, well within the optimal time frame for urgent EGD of less than 24 h after ingestion (9).

Hospitalisation varied between 1 and 38 days [ $(19.56 \pm 8.39)$  days], depending on the severity of clinical condition, post-corrosive complications of the upper GIT, and systemic complications. The length of hospital stay was longer (17 days to 22 days) in patients with systemic complications. Hospitalisation in ICU varied between 1 and 27 days [ $(9.07 \pm 5.73)$  days].

days]. The average length of stay between 7 to 10 days demonstrates that this kind of poisoning is particularly severe.

On admission, urgent EGD revealed grade IIB mucosal damage according to Kikendall's classification in the majority of patients ( $n=39$ ), followed by grade III ( $n=26$ ), grade IIA ( $n=14$ ), and grade IV injuries ( $n=4$ ) (Table 1). On release from the hospital 39 patients showed normal EGD findings, 22 had gastric stenosis, 11 had combined gastric and oesophageal stenosis, and five oesophageal stenosis (Table 2).

Of all patients with acetic acid poisoning, 28 developed systemic complications, while 56 developed none. Most complications were related to the kidney alone, kidney and liver combined, liver alone, or

kidney, liver, and DIC combined (Table 2). Eleven patients died; four due to GIT complications in the acute phase of poisoning in the first 96 hours and seven due to systemic organ failure (after 96 h).

Using the logistic regression analysis we found a significant correlation between renal complications as a dependent variable and age, quantity of ingested acid, hospitalisation time, and grade of injury as dependent variables (Chi square=54.13 and  $P<0.001$ ).

Odds ratios (Table 3), presenting priority relations, suggest that one millilitre increase in ingested acid increases the risk of renal complications by 68 % (OR=1.68,  $P=0.04$ ). The association between renal

**Table 1** Injuries of the upper gastrointestinal tract, classified according to Kikendall's grading of post-corrosive injuries, in patients with acetic acid poisoning (N= 84) verified by oesophagogastroduodenoscopy on admission

Grades	Injury	N
I	Oedema and erythema	/
II A	Haemorrhage, erosions, superficial ulceration	14
II B	Circumferential lesions	40
II	Deep grey brown/black ulcers	26
IV	Perforation	4

**Table 2** Gastrointestinal findings before release from the hospital, renal complications, and mortality in patients with acetic acid poisoning (N=84)

Gastrointestinal findings	N
Normal findings	39
Oesophageal stenosis	5
Gastric stenosis	22
Gastric and oesophageal stenosis	11
Without complications	56
Acute kidney failure	28
Acute kidney failure, liver failure	23
Acute kidney failure, liver failure, DIC	17
Acute phase, gastrointestinal complications (<95 h)	4
Chronic phase, systemic complications (>96 h)	7
Total	11

DIC- disseminated intravascular coagulation

**Table 3** Analysed parameters and odds ratio (OR) for the development of renal complications in patients with acetic acid poisoning

Variables	OR (95 % CI)	P
Quantity ingested	1.68 (1.04, 2.73)	0.04*
Hospitalisation	1.76 (0.69, 4.44)	0.23
Age	1.03 (0.97, 1.09)	0.36
Injury grade II A		
Injury grade II B	8.92 (0.88, 90.27)	0.07

\* indicates statistical significance

complications and other variables was not statistically significant.

In contrast to Macedonia, countries of the Middle East, Russia, and Asia, most other countries rigorously regulate the production, sales, and use of corrosive chemicals or agents, including acetic acid (10, 11). The collected data for this research cover a 10-year period, from 2002 to 2011. Before 2007, when Macedonia harmonised its regulations with the EU, acetic acid was freely marketed in concentrations between 75 % and 95 %. In our study, most of the records of heavy poisoning and complications relate to before 2007. This is also true for the number of poisonings. The new 2007 regulation introduced much stricter control of the use, production, and import of acetic acid, and its concentrated form was limited to 60 % to 80 %.

Most studies show higher poisoning rates among women (12, 13), and our study has confirmed it with the staggering double the men's rate. Most of the patients took acetic acid to commit suicide, as a way of dealing with mental distress or a family conflict. These results are comparable to other studies showing a high percentage of suicidal poisonings with corrosive substances (14, 15). The abuse of acetic acid occurs among all age groups, but most often in patients who are in their most productive years (13). This lays a burden on the community and the health system. Furthermore, poisonings in children are associated with massive systemic complications, despite low amounts of acid ingested (16, 17).

The reported rates of post-corrosive complications, stenosis in the upper GIT in particular, seem to be high. Cheng et al. (18) reported that 60 % of the 273 poisoned patients developed upper GIT stenosis within three weeks of caustic substance ingestion. In our study, stenosis developed along the whole GIT in 45 % of the patients after 25 days of acetic acid ingestion. Even in small amounts, acetic acid can cause serious damage and stenosis of the oesophagus and the stomach, which further complicates the treatment and can result in death due to perforation or tracheal necrosis (19).

Corrosive agents can also cause systemic complications that limit treatment and healing. Concentrated acetic acid has the greatest ability of all corrosive substances to produce systemic injuries even when it is used in minimal amounts (20). Metabolic acidosis and erythrocyte haemolysis can result in kidney or liver failure. It is believed that these systemic complications result from the cytotoxic effects of

concentrated acetic acid on erythrocytes (21). In addition, concentrated acetic acid can increase myoglobin concentration due to post-corrosive muscle destruction and can also have a direct toxic effect on the renal tubules, resulting in acute kidney failure (22, 23).

In our study, one third of the patients who developed systemic complications manifested urogenital tract symptoms alone or in combination with liver damage or coagulation status. In another study (24), 74 patients were poisoned with acetic acid; 24 % developed systemic complications and 45 % of them died. One in two patients who ingested acetic acid developed kidney and liver failure (25). Kamijo et al. (26) reported a fatal and massive necrosis of the liver caused by a 90 % acetic acid poisoning. Within 45 min from the ingestion the patient was diagnosed haemolysis and DIC, and liver failure and died within 39 h despite intensive care and immediate treatment. Autopsy showed severe post-corrosive damages to the upper part of the GIT and periportal lesions.

In our study, kidney failure was accompanied by liver failure in one fifth of the patients. Systemic complications were more common among the patients who suffered serious damage to the upper GIT and the death rate among them was as high as 39.28 %.

## CONCLUSION

Due to massive post-corrosive injuries of the upper GIT, acetic acid poisoning presents a great challenge for medical treatment, especially if systemic disorders ensue, as they increase the risk of the fatal outcome. To increase patient's chances of recovery, the treatment should start as soon as possible and involve dialysis and plasmapheresis where appropriate, as well as close monitoring.

Our study suggests that patient age, the amount of ingested acid, and the degree of the post corrosive changes determined by EGD are important for the prognosis of the duration, outcome, and systemic complications of the poisoning.

Unfortunately, the number of poisonings with corrosive chemicals shows a growing tendency, despite public warnings and education. High poisoning rates call for continued research to advance treatment of corrosive acetic acid poisonings.

In terms of prevention, Macedonia has adopted European standards regulating the use, production and import of chemicals containing corrosive elements,

but there is still room for improvement. For one, Macedonian association of toxicologists strongly encourages the ban of concentrated acetic acid from retail.

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**Sažetak****TEŠKO OŠTEĆENJE BUBREŽNE FUNKCIJE U ODRASLIH BOLESNIKA S AKUTNIM TROVANJEM OCTENOM KISELINOM**

Octena kiselina organska je kiselina s korozivnim svojstvima koja ovise o njezinoj koncentraciji. Ako se unese u koncentracijama iznad 30 %, može teško oštetiti gornji dio gastrointestinalnog sustava i izazvati intravaskularnu hemolizu, što može dovesti do teških oštećenja bubrega i jetara te do diseminirane intravaskularne koagulacije.

U ovome retrospektivnom ispitivanju analizirani su slučajevi gutanja octene kiseline prikupljeni u Sveučilišnoj klinici za toksikologiju u Skopju od 1. siječnja 2002. do 31. prosinca 2011. Analize su obuhvatile sistemske komplikacije, oštećenja bubrega i ishode.

Tijekom deset godina, u Kliniku su se javila 84 bolesnika zbog gutanja visokokoncentrirane octene kiseline. Njih 28 dobilo je bolest bubrega, a preostalih 56 nije imalo komplikacije. Smrtni je ishod bio zabilježen u 11 bolesnika, od kojih je sedam imalo sustavne komplikacije, a četiri teške gastrointestinalne komplikacije.

**KLJUČNE RIJEČI:** *ezofagogastroduodenoskopija, korozivna trovanja, postkorozivna stenoza, bubrežna insuficijencija*

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