

TRENDS IN *AMANITA PHALLOIDES* INTOXICATIONS IN THE CZECH REPUBLIC: HOW MANY ANTIDOTES ARE NEEDED?

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SUMMARY

Objectives: In Central Europe, mushroom poisoning is a public health problem as the Czech Republic belongs to the countries with the highest proportion of mushroom pickers. The trends in *A. phalloides* intoxications, their treatment and outcome were investigated in verified cases, as several antidotes are recommended and their effect is still under discussion.

Methods: Mushroom intoxications in 2010–2024 were searched in the database of the Czech Toxicological Information Centre (TIC) and the Institute of Health Information and Statistics. Intoxications with amatoxins in 2019–2024 were analysed.

Results: Mushroom-related consultations of TIC reached an average of 490 calls/year (SD = 130), and 190 subjects/year (SD = 36) were hospitalized. A total of 1,248 mycological identifications and laboratory analyses were performed in 2019–2024; in 45 proven intoxications with amatoxins, lethality was 4.4%. The amount of ingested mushrooms (0.3–8 pieces) was negatively correlated ($r = -0.358$, $p = 0.041$) with the latency to symptoms (10.4 ± 1.3 hours), and positively with the duration of hospital stay (7.8 ± 2.3 days, $r = 0.356$, $p = 0.042$), peak international normalized ratio ($r = 0.445$, $p = 0.010$), and use of elimination methods ($r = 0.451$, $p = 0.008$). Later admission correlated with alanine aminotransferase activity ($r = 0.318$, $p = 0.033$) and creatinine level ($r = 0.447$, $p = 0.002$). Patients with simultaneous amatoxin positivity of blood and urine had a longer hospital stay than those with only one positive sample (14.0 ± 6.6 vs. 7.4 ± 2.1 days, $p = 0.018$). Of 45 patients, 32 patients were treated with 2 or 3 antidotes; two patients died; an additional critical factor for lethal intoxications was preceding liver or psychic disorders. Eight patients received one antidote and recovered; there was no difference between N-acetylcysteine and silibinin ($p > 0.05$). Five patients with early admission were treated without antidotes and did not develop hepatotoxicity.

Conclusions: Deaths from unintentional poisoning with amatoxins can be averted. Amount of mushrooms ingested, early treatment with N-acetylcysteine or silibinin, and evidence of amatoxins in blood and urine are key factors. Timely mycological consultations and information for safe mushroom collection, including for immigrants, are crucial.

Key words: mushrooms, *A. phalloides*, amatoxins, treatment, survival, prevention, antidotes

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INTRODUCTION

According to the Ministry of Agriculture and the data from the Faculty of Forestry and Wood Sciences of the Czech University of Life Sciences Prague, the Czech Republic belongs to the countries with the highest proportion of mushroom pickers (1). The treatment of fungal poisonings is commonly consulted with

the Czech Toxicological Information Centre (TIC), which also maintains a stock of antidotes.

Amanita phalloides is one of the most toxic mushrooms worldwide, as one mushroom cap can cause fulminant hepatic failure and death in an adult. This mushroom is predominant in Central and Western Europe and may account for 90–95% deaths due to mushroom ingestion. Rarely, other bicyclic

octapeptides containing mushrooms, such as some *Lepiota* or *Leucoagaricus americanus*, may be found. Like in other mushrooms, its growth and quantity vary depending on the weather conditions.

Amatoxins (bicyclic octapeptides, including especially alpha, beta, and gamma amanitins) play the main role in *Amanita phalloides* ingestion, as they are resistant to drying, freezing, or cooking at 250–280 °C. Less toxic phallotoxins and virotoxins are not absorbed in the gastrointestinal tract and do not exert toxicity after ingestion (2, 3).

Toxic Effects of Amatoxins

Amatoxins are rapidly absorbed from the intestine and transported into the liver and kidney cells. Their absorption is enabled especially by organic-anion-transporting polypeptides (OATP), i.e., membrane transport proteins to the liver (4). Due to the inhibition of RNA polymerase, hepatocytes cannot synthesize proteins, and centrilobular liver necrosis occurs. Amatoxins are excreted in the urine during the first days. Their high concentration in kidney cells and dehydration due to gastrointestinal losses lead to kidney injury (5, 6). Animal studies have shown that amatoxins also increase apoptosis and oxidative stress, as well as deplete hepatic glutathione content (7).

However, after survival, hepatocyte damage that does not affect periportal stem cells usually improves with complete healing within a few months (8, 9).

Features of Intoxication

A. phalloides intoxication is characterized by a long latent period, usually 8–12 hours to the onset of gastrointestinal symptoms, unlike mushrooms with mild toxicity or insufficiently cooked, which usually starts within 0.5–2 hours. In this phase, loss of fluids and oliguria can occur. On day 2, the condition of the patient subjectively improves; however, after a latent period of 24–48 hours, liver necrosis and potentially renal and/or multiorgan failure may appear. Without treatment, death occurs within 3–14 days.

The amatoxins appear in the blood and urine within tens of minutes after ingestion, and depending especially on the amount of mushrooms, can be detected up to 48 hours in the blood, and up to 96 hours in the urine (3, 10).

Effect of Antidotes

Animal and *in vitro* studies describe several mechanisms that may reduce amatoxin toxicity:

- Blocking the uptake of amatoxins by OATP to hepatocytes, especially cyclosporin, rifampicine, silibinin, benzylpenicillin, ceftazidime (4, 5), and potentially N-acetylcysteine (11, 12).
- Silibinin, the component of the hepatoprotective complex silymarine (including also silydianin and silychristin) from *Silybum marianum*, stimulates RNA polymerase to unblock RNA synthesis, reduces enterohepatic circulation of amatoxins, and increases renal elimination (13).
- N-acetylcysteine, silibinin, and benzylpenicillin lower apoptosis caused by amatoxins; the first two drugs also have strong antioxidant properties (7, 14).

Still, their clinical effect in humans is discussed, as other experimental studies did not find efficiency of these pharmaceuticals, and human data bring controversial results (15).

Silibinin, N-acetylcysteine, and their combination reportedly improved patients' survival in several recent studies (5, 16, 17). In contrast, a study focused on silibinin treatment in 2008–2018 did not find any effect. However, it did not differentiate silibinin from silymarin (18). Benzylpenicillin treatment was also efficient (19, 20). However, it resulted in a higher lethality when used alone, as compared to combination with N-acetylcysteine (13).

Importantly, controlled double blind human studies have not been performed due to ethical reasons. Therefore, only retrospective data are available, and the results are contradictory (21).

Most studies did not focus on the quantity of mushrooms ingested. Only rarely, the mycological and/or toxicological proof was done to exclude other poisoning by mushrooms or diseases, such as cholecystitis (18).

Elimination Methods

Removing amatoxins after 24–48 hours after ingestion using extracorporeal elimination methods is unlikely, but plasmapheresis can remove metabolic wastes from the blood, as well as supply albumin, immunoglobulins, coagulation factors, and proteins, and support hepatocyte regeneration.

In kidney failure, haemodialysis is used, especially in oliguria, fluid overload, metabolic derangement, acidosis, high lactate, and/or ammonia (22).

In the setting of acute liver injury or failure, extracorporeal therapies, including plasma exchange, double plasma molecular adsorption system (DPMAS), and continuous renal replacement therapy (CRRT), as well as their combinations, may be employed to support hepatic regeneration until functional recovery is achieved or as a bridge to liver transplantation.

This study focused on the trends in mushroom intoxications in the past 16 years, and it compared the outcome of treatment with different antidotes in the past 6 years in verified amatoxin poisonings.

MATERIALS AND METHODS

Mushroom Intoxications

The inquiries of TIC concerning mushrooms and data from the Institute of Health Information and Statistics with the diagnostic code ICD-10 T62.0 “Toxic effect of ingested mushrooms”, including the National Register of Covered Healthcare Services and the main cause of death according to the Death Certificate Information System, were searched in the years 2010–2024.

Mushroom Laboratory Analyses

Qualitative analyses of amatoxins in blood serum and urine, using the LC-MS method (solid-phase extraction and ultra-high-performance liquid chromatography coupled with ultra-high-resolution mass spectrometry) (23) or amanitin ELISA (Enzyme-Linked Immunosorbent Assay) kit (10). Spores were

microscopically detected in the mushrooms, meal residues, gastric and/or gut content (24).

Patients with Poisonings Caused by Amatoxins

The consultations to the Czech TIC in the years 2019–2024 and the results of laboratory analyses in blood and/or urine were recorded continuously, and the discharge reports were collected.

The authors have followed the principles outlined in the Declaration of Helsinki.

Statistical Analysis

The statistical calculations were realized using QC Expert software 3.3 (Trilobite, Czech Republic) and MS Excel 365 (Microsoft, USA).

The results were characterized using standard descriptive statistics (normality, arithmetic mean, standard deviations, confidence intervals, etc.). The strength and direction of a power relationship were evaluated by the correlation coefficient. The data were compared and the differences were evaluated using one-factor ANOVA, F-tests, and t-tests (calculated using the above-mentioned software).

RESULTS

Poisonings with Mushrooms in the Country

There were an average of 490 consultations/year (SD = 130) of the Czech TIC related to mushrooms and 190 patients/year (SD = 36) hospitalized for mushroom intoxications, 151 (SD = 27) as main diagnosis, according to the National Registry of Health Insurances (Fig. 1). The number of hospitalizations for mushroom intoxications correlated with hospitalization, where mushroom intoxication was the main diagnosis ($r = 0.970$, $p < 0.001$).

The counts of liver transplantations correlated with the number of deceased patients due to mushroom intoxication ($r = 0.559$, $p = 0.030$). In 2013, two patients from Moldavia, living and working in the Czech Republic, had a liver transplant here. The data are shown in Table 1.

Identification of *A. phalloides*

In the past six years 2019–2024, an average of 208 (SD = 57) mycological analyses/year were performed in four toxicological laboratories (Prague, Olomouc, Ostrava, and Brno), i.e., 197, 135, 154, 249, 228, and 285 in the individual years. The most frequent proof was the analysis of the biological sample, as shown in Table 2.

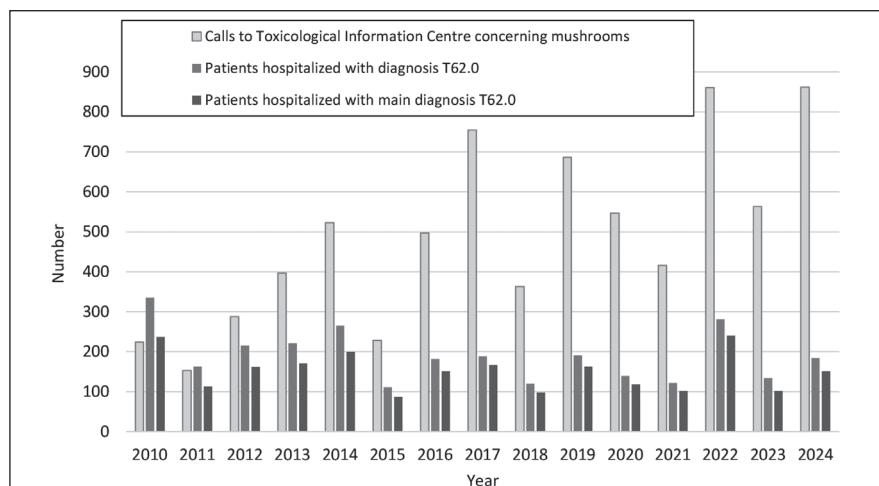


Fig. 1. Consultations of the Czech TIC concerning mushroom exposures and hospital treatments for mushroom poisoning.

Source: National Registry of Reimbursed Health Services

Table 1. Counts of liver transplants and deaths due to mushroom poisonings

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Patients with liver transplant due to diagnosis T62.0 mushroom poisoning	0	0	0	3	1	0	1	0	0	0	0	0	0	0	1
Deaths due to diagnosis T62.0 mushroom poisoning	0	0	0	1	1	0	0	0	1	0	0	0	0	0	2

Source: National Registry of Health Insurances and Death Certificate Information System

Table 2. Identifications of mushrooms by mycologists/toxicologists in the years 2019–2024

Analysis method	n	%
Toxins in blood and in urine	703	56.3
Analyses of spores in mushrooms, meal residues, or gastrointestinal content	392	31.4
Mushrooms or photos of mushrooms	153	12.3
Total	1,248	100.0

Table 3. Findings in 45 patients intoxicated with amatoxins in the years 2019–2024 in the Czech Republic

Number of antidotes	Patients	Mean age	Mushrooms	Mushrooms	Unknown amount	Symptoms latency	Admission before symptoms	Admission lag	High AST	High ALT	High INR	High crea	Hospital days	Extracorp treated patients	Waiting list/liver transplant	Patients exitus
	n	Years (SD)	n/amount (SD)	kg/b.wt. (SD)	%	Hours (SD)	n	Hours (SD)	%	%	%	%	Days (SD)	n (%)	n	n (%)
0	4	18 (26.0)	Small	Unknown	100.0	N.A.	3	13 (12.0)	0.0	0.0	0.0	0.0	2.0 (0.0)	0 (0.0)	0	0 (0.0)
1	8	50 (14.0)	2.0 (1.3)	0.023 (0.015)	25.0	10.5 (2.6)	1	35 (22.0)	62.5	62.5	62.5	37.5	6.1 (3.5)	1 (12.5)	0	0 (0.0)
2	29	51 (7.4)	2.9 (1.0)	0.037 (0.012)	17.2	10.3 (1.6)	2	32.0 (9.0)	65.5	65.5	34.5	34.5	9.3 (3.4)	9 (27.6)	5/1	2 (6.9)
3	3	71.3 (7.6)	2.7 (1.4)	0.041 (0.057)	27.0	N.A.	2	10 (29.0)	67.0	67.0	67.0	0.0	7.0 (2.5)	0 (0.0)	0	0 (0.0)
Total	45	48.7 (6.5)	2.69 (0.72)	0.035 (0.009)	26.7	10.4 (1.3)	7	29.1 (7.1)	55.6	55.6	24.4	24.4	7.8 (2.3)	10 (22.2)	5/1	2 (4.4)

SD – standard deviation; N.A. – not applicable; N – within reference values: extracorp – extracorporeal; high AST – aspartate aminotransferase exceeding 5.8 µkat/l; high ALT – alanine aminotransferase exceeding 6.0 µkat/l; high INR – international normalized ratio exceeding 1.8; high crea – creatinine exceeding 156 µmol/l (males); 135 µmol/l (females)
Significant probabilities of differences in groups of mean ages sorted by number of antidotes: p (0 vs. 1) = 0.017; p (0 vs. 2) = 0.002; p (0 vs. 3) = 0.004; p (2 vs. 3) < 0.001 and probabilities of differences in groups of admission lag sorted by number of antidotes p (0 vs. 2) = 0.014.

In the group of 45 amatoxin-intoxicated subjects, a total of 60 biological samples were collected (29 blood and 31 urine samples); both samples were collected simultaneously in 21 subjects.

Eleven blood samples and 23 urine samples were positive for amatoxins (all LC/MS). Their time of collection since ingestion was 18 ± 11 (range 5–42) hours for blood and 42 ± 22 (range 2–73) hours for urine samples. Photos (7 cases) or microscopic spores (5 cases) enabled further identification.

Patients with Amatoxin Intoxication

Whole Group of Patients

Of 45 patients (27 males, 18 females), aged 5–84 years with proven amatoxin intoxication, 43 patients survived. In 2024, two patients died (4.4%), and one female survived with a liver transplant. A total of 15.5% patients were immigrants from Ukraine.

The estimated number of ingested mushrooms, if known, ranged from 0.3 to 8 pieces. The patients' data are presented in Table 3.

Mean latency to first symptoms (10.4 ± 1.3 hours) negatively correlated with the amount of mushrooms ingested ($r = -0.358$, $p = 0.041$) and with mushrooms/kg body weight ($r = -0.358$, $p = 0.041$).

The amount of mushrooms also correlated with the length of hospital stay (7.8 ± 2.3 , $r = 0.356$, $p = 0.042$), with peak international normalized ratio (INR) ($r = 0.445$, $p = 0.010$), and use of elimination methods ($r = 0.451$, $p = 0.008$).

The age correlated with the time lag to admission ($r = 0.378$, $p = 0.010$); younger patients were admitted to the hospital sooner. Later admission correlated with higher alanine aminotransferase (ALT: $r = 0.318$, $p = 0.033$) and creatinine ($r = 0.447$, $p = 0.002$). Similarly, the length of hospital stay correlated with peak activity of liver enzymes (ALT: $r = 0.565$, $p < 0.001$; AST: $r = 0.553$, $p < 0.001$), INR ($r = 0.624$, $p < 0.001$), creatinine ($r = 0.596$, $p < 0.001$), and use of elimination methods ($r = 0.47$, $p < 0.001$).

In 21 patients, the samples of both blood and urine were simultaneously collected for analysis; in the rest of the patients, only one sample was sent. As shown in Table 4, hospitalization was longer in subjects with both samples positive for amatoxin than in those with one positive and one negative sample. All had severe hepatotoxicity. In addition, one patient died.

Group Treated without Any Antidote

Five patients recovered quickly thanks to a small amount of mushrooms ingested, early presentation to the hospital, and charcoal treatment.

Group Treated with One Antidote

Eight patients (19.0%) were treated with N-acetylcysteine or silibinin, and all recovered (Table 5). One patient needed plasmapheresis and haemodialysis.

No differences were found between the subgroups of patients treated with N-acetylcysteine and silibinin, as to the amount of mushrooms, symptoms, length, and outcome of hospital treatment (all $p > 0.05$). There was no correlation of any parameter with a specific antidote used.

Also here, the amount of mushrooms ingested correlated with the age of patients ($p = 0.05$) and time lag to hospital admission ($r = -0.358$, $p = 0.041$); and AST correlated with ALT ($r = 0.920$, $p < 0.001$).

Table 4. Positivity for amatoxins in two simultaneously collected biological samples and length of hospital stay

Amatoxin positivity in two simultaneous samples	Subjects n	Ingest lag Hours, mean (SD)	Hospital stay Days, mean (SD)	p-value
1 sample positive and 1 sample negative (blood/urine)	18	33.7 (9.7)	7.4 (2.1)	0.018
2 samples positive (blood and urine)	3	22 (46.0)	14.0 (6.6)	

Group Treated with Two Antidotes

The majority of subjects (76.2%) were treated with N-acetylcysteine and silibinin, including two deceased patients (Table 5).

One was a 60-year-old man with haemochromatosis, who, despite the warning of both the internet application and of his family, ate 8 mushrooms, i.e., the highest amount in the study. He developed symptoms within 4 hours and was admitted to the hospital 24 hours later. Despite haemodialysis and plasma exchange, he died on day 4, while on the waiting list for a liver transplant.

The second deceased case, a 66-year-old woman with depressive disorder, ingested an unknown amount of raw mushrooms. She developed symptoms 8 hours later, arrived at the hospital 80 hours after the ingestion with severe liver and kidney damage, anuria, and bleeding. She died on day 11.

One survivor, thanks to a liver transplant, was a 62-year-old female, symptomatic 8 hours after ingestion of 5 mushrooms, admitted 68 hours after ingestion. Two antidotes and intensive support treatment were started (plasma exchange, DPMAS, and continuous haemodialysis), and five days after ingestion, she had a liver transplant. Due to the primary non-function of the liver graft, this patient was temporarily listed for re-transplantation. However, thanks to intensive supportive therapy, liver graft function gradually improved, along with subsequent renal recovery. The patient's medical history was notable for significant comorbidities, including ischaemic heart disease, hypertension, and diabetes mellitus. Upon admission, hepatitis C was diagnosed, and the patient had a history of hepatitis B. Therefore, hepatitis B prophylaxis was administered, and treatment for hepatitis C was initiated.

Seven further patients from this group needed extracorporeal elimination methods. Four were listed for acute liver transplant and recovered, including one person, who consumed 7 mushrooms, and a 5-year-old boy, who ingested half of a mushroom.

Group Treated with Three Antidotes

Three women, consuming identical mushrooms, received additionally benzylpenicillin. One consumed 2 mushrooms and developed mild liver damage, and two had severe liver damage after 3 mushrooms.

DISCUSSION

The prognosis of *A. phalloides* ingestion was primarily determined by the estimated quantity of mushrooms ingested, correlating with the severity of findings, length of hospital stay, and need for elimination methods.

This study confirmed the shorter latency to the first symptoms after a higher mushroom dose. However, the early transport to the hospital was practiced in children only.

Another new information is the potential negative prognostic value of the simultaneous positivity of both blood and urine amatoxins. It could reflect the high doses of amatoxins in the body and the need for intensive treatment.

In this limited study, no difference in the outcome related to the number of antidotes used, as the two lethal cases were in the largest group with 2 antidotes.

All patients treated with only one antidote recovered. N-acetylcysteine is commonly available in local hospitals, and the treatment can be started early (16, 25). In the Czech Republic, silibinin is also used in the first-line treatment. However, its transport from the stocks of antidotes may take several hours.

Both drugs have low side effects and can reduce hepatotoxicity irrespective of origin (11). It seems that first-line treatment should optimally include blocking the uptake of amatoxin into the hepatocytes. N-acetylcysteine, to the best of our knowledge, has not been tested for OATP1B3. However, human liver OATP1B1 cells also uptake amatoxins (4), and N-acetylcysteine is its potent inhibitor, lowering hepatotoxicity (11, 12).

Anyway, more data are needed as the efficiency of antidotes is still under discussion. More exact data on the dose of amatoxins ingested is needed, and knowledge of all interfering factors is limited.

Historically, lethality in Europe was up to 40% in the early part of the 20th century but decreased to 30% in 1993–2005 and lately under 5% (3, 26). Accordingly, in the Czech Republic, it reached 26% in 1991–1992 (27), and decreased to 6.1% in the years 2000–2004 (8).

The explanation of two lethal outcomes may not be the absence of efficient treatment, but rather ignorance of preventive principles in patients with underlying diseases, and/or the potential suicidal misuse of toxic mushrooms.

The increasing number of consultations and mycological analyses document the increasing awareness of the population. Consultations should also be available for immigrants, not recognizing this danger (28), as the proportion of Ukrainians in the Czech Republic is only about 5% and 15.5% were among the poisoned. Public health campaigns should be done with caution, as some mushrooms can be abused (29) or used for self-harm (30).

Limitations

The main limitation is the number of patients in this 6-year study, due to the population size of the Czech Republic.

The second limitation is the estimated amount of ingested mushrooms and their size. Still, the number of mushrooms showed good correlations with the outcomes and may serve as a basic estimate.

The amatoxin blood and urine concentrations could not be quantified. Nevertheless, the positivity of both blood and urine may be a negative prognostic sign if verified in further studies.

Table 5. Findings in 8 patients treated with one antidote (N-acetylcysteine or silibinin)

One antidote	Age	Body weight	Mushrooms	Mushrooms	Symptoms after hours	Admission lag	Hospital stay	Peak AST	Peak ALT	Peak INR	Peak crea	Extracorp treat	Further diagnosis
	Years	Kg	Pieces	Kg/body weight	n	Hours	Days	% elevated	% elevated	% elevated	% elevated	Yes/no	Yes/no
N-acetylcysteine													
1	79	89	3.0	0.034	14	46	7	High	High	N	High	No	Yes
2	64	97	3.0	0.031	10	72	10	High	High	High	Mild	No	No
3	60	90	2.0	0.022	14	18	8	N	N	Mild	N	No	Yes
4	42	75	0.5	0.007	10	7	1	N	N	N	N	No	No
5	32	87	Dried mushrooms	Unknown	6	10	3	N	N	Mild	N	No	No
Subtotal, mean (SD)	55 (23.0)	88 (10.0)	2.1 (1.9)	0.024 (0.019)	10.8 (4.2)	31 (35.0)	5.8 (4.6)	40% elevated	40% elevated	40% elevated	40% elevated	0% yes	40% yes
Silibinin													
1	52	75	3.0	0.040	6	40	13	High	High	High	High	Yes	No
2	36	78	0.5	0.006	12	17	2	Mild	Mild	N	N	No	No
3	34	73	Mushroom goulash	Unknown	12	72	5	High	High	Mild	N	No	Yes
Subtotal, mean (SD)	41 (25.0)	75 (6.0)	1.8 (11.2)	0.023 (0.021)	10.0 (8.6)	43 (69.0)	6.7 (14.1)	66% elevated	66% elevated	33% elevated	33% elevated	33% yes	33% yes
Total, mean (SD)	50 (14.0)	83 (7.4)	2.0 (1.3)	0.023 (0.015)	10.5 (2.6)	35 (22.0)	6.1 (3.5)	62.5% elevated	62.5% elevated	62.5% elevated	37.5% elevated	12.5% yes	37.5% yes

SD – standard deviation; N – within reference values; mild AST – aspartate aminotransferase exceeding the upper limit 0.58 μ kat/l; high AST – aspartate aminotransferase exceeding 5.8 μ kat/l; mild ALT – alanine aminotransferase exceeding the upper limit 0.6 μ kat/l; high ALT – alanine aminotransferase exceeding 6.0 μ kat/l; mild INR – international normalized ratio exceeding the upper limit 1.2; high INR – international normalized ratio exceeding 1.8; mild crea – creatinine exceeding the upper limit (males 104 μ mol/l, females 90 μ mol/l); high crea – creatinine exceeding 156 μ mol/l in males, 135 μ mol/l in females; extracorp treat – extracorporeal treatment

CONCLUSIONS

Lethality in patients ingesting toxic mushrooms is going down, thanks to substantial improvements in treatment possibilities in the past decades. As the amount of mushrooms is not easily determined, we recommend measurement of both blood and urine amatoxins, as their positivity may indicate a high amount and signify a severe prognosis.

One antidote may be sufficient in case of unintentional ingestion of mushrooms containing amatoxin. Therefore, N-acetylcysteine, which is available early in the treatment process, can be administered as a first-line treatment in patients presenting with ingestion of mushrooms containing amatoxins.

Key factors are the amount of mushrooms and the time of admission to the hospital and treatment. If subjects suspect poisoning, they should contact TIC as soon as possible and visit a hospital where treatment can be initiated and intoxication verified.

Nowadays, deaths due to mushroom poisoning can be prevented if basic preventive measures are taken promptly, including preventing intentional ingestion by frail patients.

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Conflicts of Interest

None declared

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