

## Mini Review Article

# An analysis of reports concerning overdose evaluated by abdominal computed tomography

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Recently, there have been a number of reports concerning the utility of abdominal computed tomography (CT) for diagnosing overdose (OD). We herein report the summary and results of an analysis of these reports to assess the significance of CT for patients with OD. Searches of Ichushi (Japan Centra Revuo Medicine) and PubMed were carried out to identify articles from 1983 to 2019 using the key words “poisoning” and “abdominal computed tomography”. Forty-eight cases across 15 articles were defined as subjects in this report. The average age of subjects was 46 years old, and there were 28 women. Forty-five of the 48 subjects (93.8%) had positive findings of residual drugs on CT. The finding of a high-density fluid level in the stomach was the most frequent (60.4%), followed by ill-defined high-density material in the stomach (12.5%) and high-density tablets in the stomach (10.4%). One prospective study suggested the merits of decontamination for patients with positive findings on CT even if more than 60 min had elapsed since the ingestion of drugs. Computed tomography could aid in the diagnosis of OD in comatose patients who cannot talk or who present without any other evidence of OD. In addition, a recent study revealed the merits of decontamination for patients with positive findings on the CT even if more than 60 min had elapsed since the ingestion of drugs.

**Key words:** Computed tomography, decontamination, overdose

## INTRODUCTION

PATIENTS WHO PRESENT with an overdose (OD) often ingest large amounts of psychotropic drugs. The diagnosis of an OD is usually based on a patient’s complaint or the situation with scattered multiple empty charts as around a comatose patient. Drug urinary screening tests can be useful for detecting OD in unconscious patients. However, patients with OD often take psychotropic drugs regularly, so it can be difficult to diagnose OD correctly based solely on the results of screening tests.<sup>1</sup> In addition, drug screening tests cannot identify patients with OD of major tranquilizers and/or selective serotonin reuptake inhibitors. Although a definitive diagnosis can be obtained by measuring the serum drug level, standard hospitals cannot easily

measure the serum drug level at their facilities. Overdose is also difficult to diagnose in comatose patients who cannot talk or in patients who present without any remarkable evidence of OD.

Recently, there have been a number of reports concerning the utility of abdominal computed tomography (CT) for diagnosing OD.<sup>1–16</sup> We herein report the summary and results of an analysis of these reports to assess the significance of CT for patients with OD.

## METHODS

THIS STUDY WAS approved by the Institutional Review Board of Juntendo Shizuoka Hospital (Izunokuni, Japan).

Searches of Ichushi (Japan Centra Revuo Medicine), which collects summaries of Japanese medical articles, and PubMed were undertaken on 20 February, 2019, to identify articles from 1983 to 2019 using the key words “poisoning” and “abdominal computed tomography”. Additional articles were identified by a manual search of the references from the key articles. The inclusion criteria were reports describing cases of OD due to medical drugs and including data on patients and abdominal CT findings concerning drugs.

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Reports of body packers or stuffers and reports that did not describe an individual patients' data were excluded.

We collected patient data including sex, age, reason for poisoning, name of drug(s) involved, volume or serum level of drug(s), findings of abdominal CT concerning the drug (s), abdominal X-ray findings (if relevant), duration from ingestion of drug(s) to CT, treatment, and final outcome.

Statistical analyses were carried out using the  $\chi^2$ -test, if appropriate. Differences with  $P$ -values of  $<0.05$  were considered to be statistically significant.

## RESULTS

**WE FOUND** 16 articles concerning OD including abdominal CT findings, excluding seven articles of body packers.<sup>1–16</sup> Of these, one report by Cha *et al.*<sup>16</sup> did not describe the individual patients' data, so this report was excluded from the data analysis. Accordingly, 48 cases across 15 articles were defined as subjects in this report.

Table 1 shows a summary of each subject's sex, age, reason for poisoning, findings of abdominal CT concerning the drug(s), abdominal X-ray findings (if relevant), duration from ingestion of drug(s) to CT, treatment, and final outcome (Table S1). There were 14 subjects who underwent both abdominal CT and X-ray. Only one of the 14 subjects who underwent X-ray were suggested to have ingested drugs; however, the CT findings in all 14 subjects suggested residual drugs in the stomach, which was a statistically significant difference ( $P < 0.0001$ ). All fatal cases underwent postmortem abdominal CT, and the subjects who were transported to the hospital not in cardiac arrest obtained a survival outcome.

Table 2 describes which drugs each subject took, volume or serum level of drug, and duration from ingestion of drugs to examination of CT. Thirty-one of 48 subjects ingested multiple drugs, and 45 of 48 subjects ingested psychotropic drugs.

Table 3 shows a summary of the abdominal CT findings concerning drugs. Forty-five of the 48 subjects (93.8%) had positive findings of residual drugs on CT. The finding of a high-density fluid level in the stomach was the most frequent (60.4%), followed by ill-defined high-density material in the stomach (12.5%) and high-density tablets in the stomach (10.4%).

## DISCUSSION

**THIS MINI REVIEW** revealed that 93.8% patients with OD had positive findings of residual drugs on abdominal CT, suggesting that CT is more sensitive for detecting residual drugs in the stomach than X-ray. Of note, a high-density fluid level in the stomach was the most frequent finding on CT.

**Table 1.** Summary of background characteristics of subjects who underwent abdominal computed tomography (CT) for diagnosing overdose of ingested drugs ( $n = 48$ )

Age (years)	16–91, average 46.8 ± 17.8
Sex (male/female)	20/28
Reason for intoxication	
Suicide	24
Accident	2 (dementia)
Unknown	22 (discovered after death)
CT findings, positive/negative	45/3
Abdominal X-ray	
Positive	1
Negative	13
Not performed	33
Treatment	
Gastric lavage, laxative, charcoal	12
Gastric lavage	2
Infusion only	5
Gastric lavage, laxative, charcoal, endoscopy	1
Gastric aspiration, charcoal	1
Charcoal, sodium bicarbonate	1
None (post-mortem CT)	26
Outcome	
Survival	22
Death	26

Cha *et al.* reported the results of a prospective cohort study of patients with OD who were admitted to the emergency department between March 2017 and February 2018. They evaluated the prevalence of drugs in the gastric lumen using abdominal plain CT. Among 140 subjects, residual drugs, defined as a round-shaped lesion with a higher density than the gastric mucosa on CT, were detected in 36 patients (25.7%). In addition, 58 patients (41.4%) showed a positive radiodense image in the stomach, defined as an artifact with a higher density than the gastric mucosa on CT. One reason for the difference in the ratio of positive findings on CT between the study of Cha *et al.*<sup>16</sup> and the present study could be the severity of the patients with OD. Their study included patients encountered between 1 and 12 h after ingesting drugs and who met the following criteria: (i) ingestion of more than three times the therapeutic dose of a drug with signs and symptoms, (ii) known or reported life-threatening drugs, (iii) overdose of multiple classification drugs or sustained-release drugs, (iv) unknown type of ingested drug, (v) known type of drug but no information about amount ingested, with symptoms and/or signs of OD.

**Table 2.** Detailed data of overdose for each subject who underwent abdominal computed tomography (CT)

No.	Drug	Number or serum concentration	Duration from ingestion to CT examination	Primary reporter
1	Bromovaleryl urea	40	?	Sagishima
2	Antidiarrheal drug, Seirogan	Large number	5	Kimura
3	Sulpiride, maprotiline, biperiden, quetiapine	?	2	Kimura
4	Zopiclone	60	?	Shikama
5	Chlorpromazine, nitrazepam	?	?	
6	Quetiapine, flunitrazepam	?	?	Terazumi
7	Fenobarbital, chlorpromazine, promethazine, etizolam	840	8	Yanagawa
8	Zopiclone, mirtazapine	420	10	Yanagawa
9	Brotizolam	12	8	Yanagawa
10	Olanzapine, clonazepam, valproate, paroxetine	3,482	6	Yanagawa
11	Etizolam, loflazepate, paroxetine, haloperidol, flunitrazepam, lithium	40	12	Yanagawa
12	Triazolam	7	?	Yanagawa
13	Amobarbital, loflazepate	1,122	8	Yanagawa
14	Biperiden, loflazepate, risperidone, promethazine, levomepromazine	82	9	Yanagawa
15	Nitrazepam, quazepam, flunitrazepam, promethazine	2,911	12	Yanagawa
16	Nitrazepam, triazolam	130	4	Yanagawa
17	Valproate	?	?	Yanagawa
18	Fluvoxamine, carbamazepine, zolpidem	3.0 µg/mL fluvoxamine, 8.7 µg/mL carbamazepine, 50 ng/mL zolpidem	1 day	Sano
19	Chlorpromazine, phenobarbital	?	1 and 3 days	Miyamoto
20	Calcium supplement	30	?	Kato
21	Acetylsalicylic acid, triazolam, nitrazepam, imipramine, etizolam	746 µg/mL acetylsalicylic acid, 13.5 mg triazolam, 110 mg nitrazepam, 1 g imipramine, 68 mg etizolam	?	Tominaga
22	Imipramine	?	24	Nishikata
23	Nifedipine, lisinopril, loxoprofen	180	3	Sakamoto
24	Amobarbital, phenobarbital, pentobarbital	13 µg/mL amobarbital, 122 µg/mL phenobarbital, 11 µg/mL pentobarbital	Several weeks	Usui
25	Triazolam	100 ng/mL triazolam	2 days	Usui
26	Levomepromazine	3 µg/mL levomepromazine	A few days	Usui
27	Diphenhydramine, mianserin, zolpidem	10 µg/mL diphenhydramine, 443 ng/mL mianserin, 199 ng/mL zolpidem	A few days	Usui
28	Amobarbital	87 µg/mL amobarbital	1 day	Usui
29	Pentobarbital	414 µg/mL pentobarbital	Several days	Usui
30	Zolpidem	917 µg/mL zolpidem	1 day	Usui
31	Pentobarbital, levomepromazine, nitrazepam	33 µg/mL pentobarbital, 631 ng/mL levomepromazine, 225 ng/mL nitrazepam	A few days	Usui
32	Zolpidem	1,720 ng/mL zolpidem	?	Usui
33	Milnacipran, zolpidem, paroxetine	19 µg/mL milnacipran, 1,180 ng/mL zolpidem, 904 ng/mL paroxetine	2 days	Usui

Table 2. (Continued)

No.	Drug	Number or serum concentration	Duration from ingestion to CT examination	Primary reporter
34	Levomepromazine, olanzapine, phenobarbital, zopiclone	2,100 ng/mL levomepromazine, 1,060 ng/mL olanzapine, 80 µg/mL phenobarbital, 659 ng/mL zopiclone	A few days	Usui
35	Olanzapine	1,020 ng/mL olanzapine	A few days	Usui
36	Salicyclic acid	429 µg/mL salicyclic acid	A few days	Usui
37	Olanzapine, zolpidem	247 ng/mL olanzapine, 330 ng/mL zolpidem	A few days	Usui
38	Amobarbital, pentobarbital, triazolam	14 µg/mL amobarbital, 17 µg/mL pentobarbital, 7 ng/mL triazolam	A few days	Usui
39	Levomepromazine, haloperidol	949 ng/mL levomepromazine, 59 ng/mL haloperidol	A few days	Usui
40	Flunitrazepam	106 ng/mL flunitrazepam	1 day	Usui
41	Amitriptyline, nortriptyline	6,060 ng/mL amitriptyline, 902 ng/mL nortriptyline	A few days	Usui
42	Olanzapin, phenobarbital, promethazine	406 ng/mL olanzapin, 154 µg/mL phenobarbital, 997 ng/mL promethazine	A few days	Usui
43	Levomepromazine, mirtazapine, zolpidem	3,890 ng/mL levomepromazine, 6,020 ng/mL mirtazapine, 332 ng/mL zolpidem	1 day	Usui
44	Promethazine, sulpride	245 ng/mL promethazine, 2,170 ng/mL sulpride	A few days	Usui
45	Levomepromazine, promethazine, zopiclone	1,880 ng/mL levomepromazine, 919 ng/mL promethazine, 445 ng/mL zopiclone	A few days	Usui
46	Olanzapine	1,100 ng/mL olanzapine	A few days	Usui
47	?	?	?	Garetier
48	Mirtazapine, eszopiclone	?	?	Nagasawa

?, unknown.

In contrast, our subjects included those with a postmortem study, accounting for 26 of the 48 cases (54.2%), compared with just two fatal cases (1.4%) in Cha *et al.*'s study. Accordingly, the present study included more severely ill patients with OD, suggesting a greater quantity of ingested drugs than in Cha *et al.*'s study. This difference might have resulted in the high frequency of positive findings on CT in the present study. However, the present study less frequently showed round-shaped lesions in the stomach than the study of Cha *et al.*,<sup>16</sup> a finding that indicated high-density tablets. This might be due to the timing of the CT examination, as the present study included subjects in whom CT was carried out several days or weeks after drug ingestion. This delayed timing of CT could have resulted in the drugs being dissolved in the gastric juice.

Undertaking an abdominal CT examination in unconscious patients is important for obtaining clues to aid in the

diagnosis of an OD. Unconscious patients who cannot supply information about a potential OD could die without treatment with an appropriate antagonist and/or decontamination.<sup>17</sup> Abdominal CT can also provide clues to aid identifying OD patients who need decontamination in order to obtain an early recovery. Cha *et al.*<sup>16</sup> undertook decontamination when abdominal CT showed positive findings. As a result, the total duration of the hospital stay was significantly longer in cases of negative CT findings than in those with positive findings.

Several limitations associated with the present study warrant mention. Computed tomography requires patients presenting with OD, whose prognosis is usually favorable, to undergo radiation exposure. In addition, CT is able to detect the contents of the stomach, although the details thereof cannot be determined using CT alone. Accordingly, further studies are required to determine the level of drugs in the

**Table 3.** Summary of computed tomography findings in patients with overdose of ingested drugs ( $n = 48$ )

High-density fluid level in stomach	29
Ill-defined high-density material in the stomach	6
High-density tablets in stomach	5
High-density ball in stomach	1
High-density area in gastric fluid	1
Relatively high-density gastric fluid	1
High-density in stomach	1
High-density in duodenum	1
None	3

gastric juice and/or blood for an accurate diagnosis of OD. Additionally, a large amount of drugs can move into the intestine and thus be absorbed, and therefore such absorbed drugs might no longer be detected by CT examinations. Therefore, it is necessary to determine how long after ingestion CT is effective for indicating high-density areas of residual drugs in the stomach.

## CONCLUSION

THIS MINI-REVIEW SUGGESTED that a high-density fluid level or high-density tablets in the stomach on abdominal CT can be indicative of the presence of an OD of ingested drugs. Accordingly, CT findings could provide a clue to aid in the diagnosis of OD in comatose patients who cannot talk or who present without any other evidence of OD. In addition, a recent study revealed the merits of decontamination for patients with positive findings on the CT even if more than 60 min had elapsed since the ingestion of drugs.

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## DISCLOSURE

Approval of the research protocol: The protocol of this retrospective study was approved by the review board of Shizuoka Hospital, Juntendo University (No. 298).  
Informed consent: N/A.

Registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflict of interest: None declared.

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## SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Table S1** Each subject's sex, age, reason for poisoning, findings on abdominal computed tomography (CT) concerning the drug(s), abdominal X-ray findings (if relevant), duration from ingestion of drug(s) to CT, treatment, and final outcome.