ORIGINAL ARTICLE

The Function of Computerized Tomography Head Scans in the Assessment of Patients Who Present with Drug Overdose and a Low Glasgow Coma Scale

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ABSTRACT

Background: Drug overdose is a common emergency medical presentation, with most patients presenting with reduced consciousness and a low Glasgow Coma Scale (GCS). Despite there are no guidelines, anecdotal evidence suggests that clinicians often perform computerized tomography (CT) head scans on these patients. While CT imaging is readily available and gives immediate information, we question the functionality of this test and aim to evaluate its place in the management of overdose patients presenting with a low GCS. **Methods:** We conducted a retrospective database search at the Northern General Hospital, of a 25-month period, to identify patients attending the emergency department with a reduced GCS due to a drug overdose. Data were subsequently collected and analyzed. **Results:** Our study cohort numbered 114 patients, 48 males and 66 females, with a mean age of 40 years (SD±15). The median GCS on admission was 3 (interquartile range [IQR] 3–10) and 63 (55%) received a CT head scan. However, only 4 (6%) scans were reported as abnormal. Previous overdose attempts were noted for 57 (50%) patients and 90 (79%) had a history of mental health disorder. The most frequently used drugs were amitriptyline in 21 (18%) cases, diazepam in 17 (15%), and paracetamol in 13 (11%). Further, 37 (32%) involved alcohol and 72 (63%) patients took a mixed overdose. Median inpatient length of stay was 2 days (IQR 1–5) and 5 (4%) patients died in hospital. **Conclusion:** Our data demonstrate a low diagnostic yield from CT head scans in this patient population, and therefore, we suggest that clinicians consider the risk versus benefit of conducting this scan. While management decisions are multifactorial, it appears that CT head scans are of limited value when performed routinely. These findings warrant further studies with the aim of providing definitive guidelines for the management of this patient's population.

Key words: "Drug Overdose"[MeSH], "Tomography, X-Ray Computed"[MeSH], "Glasgow Coma Scale"[MeSH], "Critical Care"[MeSH]

INTRODUCTION

Mental health problems are well recognized as being a major factor that can increase a person's vulnerability to taking drug overdoses, and around 25% of the UK population suffer from a mental health issue at some point over their lifetime.[1] One study from the USA showed that 1% increase in depression diagnoses at the state level was associated with a 26% increase in opioid-related deaths.[2] However, patients who overdose do not always

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intend to complete suicide. When recovered overdose patients were interviewed by Bancroft *et al*., only 44% said that they had wanted to die. The reasons they selected for taking the overdose were "seeking help" in 33%, "escaping from the situation" in 42%, and "obtaining relief from a terrible state of mind" in 52%.[3]

A recent government report showed that 3756 drug overdose deaths were registered in England and Wales, in 2017, with likely many more non-fatal attempts, giving an incidence rate of 66.1 deaths/1,000,000 population.[4] Further, intentional drug overdoses are the most commonly treated form of self-harm in hospital, accounting for 65–85% of cases in a UK multicenter study.[5] It can be seen that there are a significant individual and societal impact from drug overdose, especially on the families of the patients.[6]

Anecdotal evidence from discussion with emergency clinicians and anesthetists brought to light that this group of patients often receives computerized tomography (CT) head scan when presenting to the emergency department (ED). As patients who have taken an overdose typically have a reduced Glasgow Coma Scale (GCS) at presentation, which can continue to fall, the reason for CT was most commonly due to fear of missing intracranial pathology.[7] However, their experiences showed that rarely, if ever, did this have an impact on treatment decisions.

CT scans deliver high doses of radiation to the brain, increasing a person's lifetime risk of developing cancer and thus, in cases of clear overdose with no risk of intracranial pathology, potentially doing more harm than good.[8] Further, these scans are both financially costly and time consuming, thus putting strain on National Health Service (NHS) resources.[9] If, therefore, a scan is not needed, there would be benefits to both patient, doctors, and the NHS.

Despite overdose being a sadly relatively common presentation in the ED, to date, no research or guidance has been published to direct clinicians as to whether or not they should conduct a CT head scan in the work-up of these patients. In this paper, we present single-center, retrospective data with the aim of evaluating the function of CT head scan in the assessment of patients who present with drug overdose and a low GCS score. To the best of our knowledge, this is the first such work to be conducted.

METHODS

A retrospective database search of the Northern General Hospital's records was conducted for a 25-month period from April 2016 to May 2018. This time period was decided upon based on a clinical estimation that one overdose case presented each week, thus giving us a cohort of over 100 patients. The search strategy used multiple International Statistical Classification of Diseases and Related Health Problems 10th Edition (ICD-10) and Systematized Nomenclature of Medicine Clinical Terms codes for self-harm/overdose as a presenting complaint in ED or as a primary or secondary coding on the inpatient admission in the intensive care unit (ICU). All patients had to be admitted to the ICU. Duplicate entries were manually removed, but multiple admissions of the same patient were allowed.

Data were then extracted from patient records by one reviewer (TF) and checked for errors by two others (MW and SM). Items to be recorded included age; sex; overdose substance/s; history of previous overdose attempts; medical and drug history; admission GCS; requirement for tracheal intubation; duration of ICU and hospital stay; whether a CT was performed; reason for CT request; CT result; CT radiation dose; and in-hospital mortality status. The HM Coroner for South Yorkshire West District was contacted to obtain causes of death for any patient who died in hospital.

The data points we were most interested in were whether the CT head scans showed findings that had an impact on the management of that patient.

RESULTS

Our database search found that 114 patients had presented to ED and, subsequently, the ICU due to a drug overdose over the 25-month period. Of these, the mean age was 40 years (SD±15) and 66 (58%) were female. The age range was wider than expected, stretching from 16 to 86 years. History of the previous overdose attempts was also high at 57 (50%), with 35 (53%) of the females and 22 (46%) of the males having been treated previously. Further, 90 (79%) patients had a background of mental health issues and 9 (8%) had unknown medical history, which may also include mental health problems. A summary of the patient characteristics is available in Table 1.

While 42 (37%) patients in our series took a single-drug overdose, the remaining 72 (63%) took a mixed overdose of between 2 and 18 substances. Further, just under a third of patients, 37 (32%) ingested alcohol as part of the overdose attempt. Patients took a range of prescription medications, illicit drugs, and other substances, ranging from paracetamol to cocaine to brake fluid. The five most prevalent medications used were amitriptyline in 21 (18%) cases, diazepam in 17 (15%), paracetamol in 13 (11%), tramadol in 10 (9%), and zopiclone in 10 (9%). A summary of drugs used, number taken, and alcohol involvement is available in Figure 1.

Over half of the patients, 60 (53%), presented with the lowest possible GCS score, meaning the median was 3 (interquartile range [IQR] 3–10), and scores ranged from 3 to 14. In total, 70 (61%) patients had their tracheas intubated for airway

Table 1: Cohort demographics

Number	Total	114
	Male	48 (42%)
	Female	66 (58%)
Age (years)	Average	40
	Male	39
	Female	41
	Range	16–86
	<18	4 (3.5%)
	18–35	44 (38.6%)
	36–65	58 (50.9%)
	>65	8 (7%)
Previous overdose	Total	57 (50%)
	Male	22 (39%)
	Female	35 (61%)
History of mental illness	Total	90 (79%)
	Male	33 (37%)
	Female	57 (63%)

Patient characteristics on age, sex and whether they had any previous overdose attempts

protection and of these, the vast majority, 54 (86%), were CT scan. There were, however, 9 (14%) patients who received a CT without tracheal intubation and 16 (14%) patients had their tracheas intubated but did not receive a scan. Interestingly, while most of the 79 patients who presented with a GCS ≤8 were intubated (87%), a small group of 10 (13%) was not.

Overall, 63 (55%) patients received a CT scan as part of their work-up, with 58 (92%) of these occurring at the point of transfer from ED to ICU. The remaining 5 (8%) CT scans occurred between 2 and 19 days after admission. The reason for requesting a CT was most commonly to exclude intracranial bleed or skull injury, 53 (84%), and rarely due to the patient experiencing seizures, 3 (5%). The remaining 7 (11%) scans were requested looking for various other pathologies. Moreover, we found that 55 (87%) of scans performed were on patients who had a motor component score of their GCS at least 2 points below normal; 4 or less. Of the 63 scans conducted, 59 (94%) were reported as being normal. Only 4 (6%) had abnormal reports: One showed acute nasal fractures due to an assault on the day of overdose; one showed a small bleed likely caused by a car crash a few days before overdose; one had appearance of diffuse hypoxic brain injury, which on later magnetic resonance imagining showed "restricted diffusion in keeping with hyperammonemic injury which has been reported in the literature with valproate toxicity" (this patient overdosed on sodium valproate); and one showed a possible thrombus (discussed in more detail below). While we cannot definitively state that none of these scans had an impact on overdose treatment, it is, however,

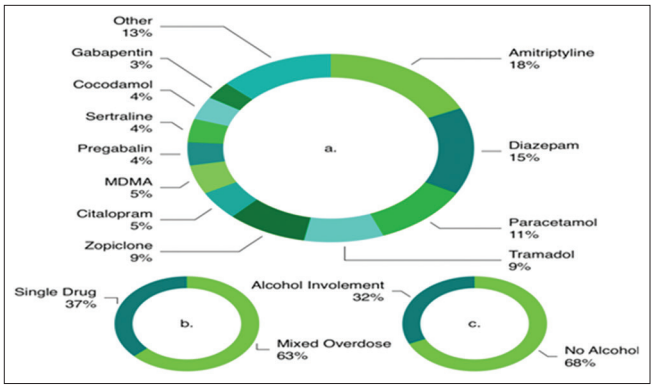

Figure 1: Overdose mechanisms. Characteristics of overdose mechanism showing (a) prevalence of drugs used, (b) number of drugs used, (c) alcohol involvement

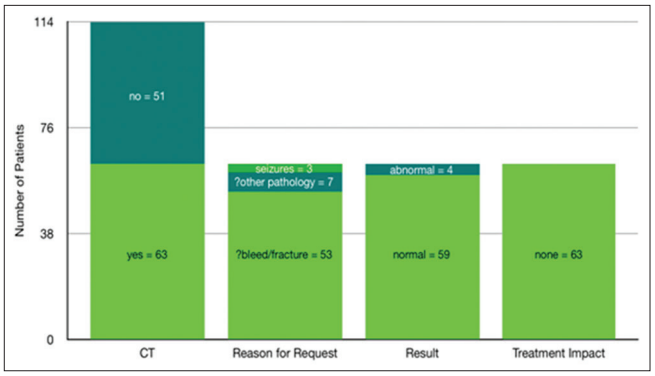

Figure 2: Impact of computerized tomography scans. Summary of the number of computerized tomography requests, the reason for them, the outcomes, and the direct treatment impact

apparent that apart from cases where there was indication for CT head due to obvious physical injury, there is a very low rate of positive findings from routine head scans. Further, the rate of treatment consequence is likely also low, and while retrospective, we did not find any direct treatment influence from the scans. A summary of the CT head scan data is available in Figure 2.

Radiation dose from the CT head scans was also recorded, in dose length product (DLP). The median DLP delivered to patients' heads was 588 mGy-cm (SD±224).

All patients presented to ED and were then subsequently transferred to ICU. Once stable they were either directly discharged or transferred to another ward until further improved. The length of stay for patients in ICU ranged from <1 to 19 days, with a median of 1 (IQR 1–3), and a total of 335 days were spent in ICU beds. Overall, inpatient stays were longer, ranging from <1 to 288 days, with a median of 2 (IQR 1–5). Patients occupied hospital beds for a total of 936 days over the 25 months.

In total, five patients died while in hospital; 4% of the cohort. Mean age was 38 years (SD±15) and all were female. A summary of their details including causes of death is available in Table 2. The CT head report of Patient 1 showed diffuse hypoxic brain injury possibly related to valproate toxicity, but there was strong clinical suspicion that the cause might be a long downtime cardiac arrest. The report for Patient 3 read "the basilar tip appears dense and there is a suspicion of thrombus. While likely a spurious finding, a repeat CT scan and cerebral angiogram are advised." Basilar thrombus is a significant pathology that CT scans are performed for, but the patient died before the repeat scan.

DISCUSSION

The average age of overdose in our patient population was 40 and females made up 58% of the cohort. A recent study conducted in the USA closely mirrors our findings, reporting an average age of 35 and 52% of female predominance.[10] Another study from Ireland also reflects these findings, with an average age of 33 and 58% proportion of females.[11] Further, the latter study reports 40% alcohol involvement and 47% mixed overdose rate, compared to our 32% and 63%, respectively. In comparison to a study on the epidemiology of self-poisoning in the UK, five of the top seven drugs listed can be found in the top seven drugs used by our cohort; amitriptyline, diazepam, paracetamol, zopiclone, and MDMA.[12]

While the aim of this study is to investigate the value of CT head scan, it was obvious from our dataset that there were noticeable differences, in which patient's tracheas were intubated, likely due to circumstantial variation. One well-described trend regarding time to intubate suggests that a GCS score of 8 or less is a reasonable cut-off guide in poisoned patients.[13] The decreased levels of consciousness associated with a low GCS as well as the subsequent loss of airway reflexes may lead to respiratory failure and increase the risk of aspiration, potentially progressing to secondary hypoxic brain injury.[14] In our patient set, 87% of patients with a GCS of 8 or less were intubated, roughly obeying this guide.

There is no GCS score cut-off for when to conduct CT head scan in overdose patients. From our data, 87% of patients who had a motor component score of 2 or more points below normal, meaning 4 or less, had a scan. Indeed, the motor component is reported as the most reliable component and gives the most information to clinicians, as it can be assessed easily, even in patients whose trachea had been intubated.[15]

A study looking into the UK-wide annual cost of paracetamol poisoning alone estimated the bill to be £51,000,000.[16] Our patient set spent a total of 936 days in hospital beds at rough cost of £440/day.[17] Further, the cost to the NHS of conducting a CT head scan lies around £150.[18] It is clear

Table 2: Overdose deaths

Patient	Age	Sex	History of mental illness	Overdose substance	Glasgow Coma Scale on admission	Days between admission and death	Coroner's death certificate report
Patient 1*	24	F	Yes	Propranolol, sodium valproate	3 (E1V1M1)	15	1a = Hypoxic-ischemic and hypoglycemic brain injury b = Intentional overdose 2 = Epilepsy
Patient 2	34	F	Yes	Ferrous sulfate, fluconazole, omeprazole, citalopram	14 (E4V4M6)	2	1a = Multiorgan failure b = Iron toxicity 2 = /
Patient 3*	22	F	Unknown	MDMA	3 (E1V1M1)	0	1a = Drug toxicity b = / 2 = /
Patient 4	50	F	Yes	Paracetamol	13 (E3V4M6)	0	1a = Multiorgan and acute liver failure b = Paracetamol overdose 2 = /
Patient 5	62	F	Yes	Paracetamol	14 (E4V4M6)	0	1a = Gastrointestinal hemorrhage b = Alcoholic liver disease and paracetamol overdose 2 = /

Details of patients who died post-admission from their overdose, *Patients 1 and 3 received a computerized tomography head scan

that overdoses represent a financial load on NHS resources and that large savings are possible if a scan is not needed. From our 63 scanned patients, a potential saving of almost £10,000 could have been made. However, it could also be argued that a normal CT facilitates management and shortens the duration of stay, thus saving money through reduced bed costs. Aside from cost to the NHS, there are also potential costs to the patient. A CT scan delivers the equivalent radiation dose of a few years background radiation directly to the brain, which may increase a patient's lifetime risk of cancer, with no benefit from the scan.[19]

In instances of obvious or known head trauma, for example, due to a road traffic collision or assault, it is of course still recommended to perform a CT head scan. This follows National Institute for Health and Care Excellence (NICE) guidelines which state that patients with an initial GCS ≤13 or <15, 2 h after the injury should receive a CT head scan.[20] However, based on our above results, in circumstances, where it is known that the patient has taken an isolated overdose with no physical trauma, a scan provides a low incidence of positive pathology. Thus, the clinician should balance the risks and benefits to decide if a scan has any clinical merit and thus whether or not it is indicated.

We acknowledge the limitations of this study. Most significant that we present single-center data making it difficult to extrapolate our results to other centers. Further, our cohort of 114 patients is relatively small, so the incidence of positive pathology on CT head scans that we report may not be representative of the wider patient population. Since this study is retrospective, we rely on accurate record-keeping and cannot uncover the reasoning for each management decision, making it hard to deduce the full impact of each diagnostic test, including CT head scan.

CONCLUSION

We have data from our patient set to demonstrate that there are no clear criteria to help clinicians decide whether or not an overdose patient requires a CT head scan. In our cohort, we established that 63 (55%) patients received a scan but that only 4 (6%) showed any abnormalities (although additional reasons are noted above as to why these patients were scanned) and that none of these had an obvious or direct impact on the treatment of the overdose. This highlights the low diagnostic yield from a routine CT head scan in this patient population and its limited value in the work-up of overdose patients; unless, there are other associated factors such as head injury. There is potential to prevent patients from receiving an unnecessary radiation blast while saving the NHS money, and we suggest that clinicians should consider the risk versus benefit of conducting a scan on their patients. These findings warrant further studies to objectively and definitively evaluate whether CT scans are needed in patients who present with drug overdose and a low GCS score and thus allow for the production of much-needed NICE guidelines.

AUTHORS' CONTRIBUTIONS

TF, MW, and SM: Substantial contribution to conception and design. TF: Acquisition, analysis, and interpretation of data, drafting the article, and revising it. TF, MW, and SM: Critical review for improvement and final approval of the version to be published.

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