Hypothesis: Methamphetamine use affects length of hospital stay in the minimally injured patient.

Design: Case series.

Setting: The only tertiary trauma center serving Hawaii.

Patients: Trauma patients examined during a 12-month period with an Injury Severity Score of 1 to 5 and an age of 18 to 55 years undergoing urine toxicology screen for suspected suicide attempt or altered sensorium.

Main Outcome Measures: Presence or absence of amphetamine or methamphetamine on urine toxicology screen, intention of injury, hospital admission rate, length of stay, and hospital charges.

Results: During the study period, 1650 trauma patients were examined, with 544 meeting study criteria. Urine toxicology screens were performed in 212 patients, with 57 positive and 155 negative for amphetamine or methamphetamine. There was no difference in sex (77% vs 73% male; P = .53), Injury Severity Score (3.2 for both groups), or total number of computed tomographic scans performed (mean ± SEM, 3.0 ± 0.3 vs 4.0 ± 0.3; P = .07). Patients in the positive group were more likely to have intentional self-inflicted injury or intentional assaults than patients in the negative group (37% vs 22%; P = .04). The positive group was older than the negative group (33.6 ± 1.3 vs 29.9 ± 0.8 years; P = .02), had a significantly longer hospital stay (2.7 ± 0.4 vs 1.7 ± 0.1 days; P = .003), had significantly higher hospital charges ($15617 ± $1866 vs $11600 ± $648; P = .01), and was more likely admitted to the hospital (91% vs 70%; P = .001) despite the low Injury Severity Score.

Conclusion: Methamphetamine use results in trauma center resource utilization out of proportion to injury severity.

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Methamphetamine use has become a major health care problem in the United States, with Hawaii leading the nation in methamphetamine use. Crystal methamphetamine, known as “ice,” is a freebase form of amphetamine and is the smokable form. Methamphetamine, like cocaine, is a potent stimulator of the central nervous system that induces the feeling of euphoria, increases alertness, reduces fatigue, intensifies emotions, increases aggression, and increases libido. Unfortunately, its use also causes diaphoresis, increases blood pressure and heart rate, and can cause anxiety, irritability, insomnia, paranoia, and sometimes psychosis. Once the drug wears off, mental and physical exhaustion occurs, often with deep depression. Unlike cocaine, the effect of methamphetamine lasts for 6 to 12 hours or more, depending on the dose and urine pH. Methamphetamine is abused because of its long-lasting euphoric effects and rapid absorption from the lungs, resulting in almost instant clinical effects from inhalation of the smokable form. In addition, “ice” is relatively easy to produce, with the main ingredients being ephedrine and pseudoephedrine.

Methamphetamine has become a major social problem, with 40% of people arrested in Honolulu, Hawaii, testing positive for methamphetamine, the highest rate in the country. According to the Honolulu Medical Examiner’s Office, deaths associated with crystal methamphetamine use have nearly doubled in 2 years. The Treatment Episode System and the State Department of Health’s Alcohol and Drug Abuse Division show treatment program admissions for methamphetamine abuse quadrupled between 1994 and 2002. For the first time, in 2003, methamphetamine was the leading drug of abuse in those seeking drug treatment in our state. Methamphetamine abuse is not a problem unique to Hawaii. According to the 2000 National Household Survey on Drug Abuse, an estimated 8.8 million people (4.0% of the population) have tried methamphetamine at some time in their lives. The National Institute on Drug Abuse’s Community Epidemiology Work Group reported in 2001 that methamphetamine continues to be a problem in Hi-
Methamphetamine is a psychostimulant and, because of its effects, can cause aggressive and erratic behavior. This may account for the higher incidence of intentional injury associated with methamphetamine use reported by Loiselle et al. In addition, psychomotor performance is impaired at high doses by methamphetamine. Methamphetamine use in the trauma patient may make it difficult to clearly diagnose injuries, because there is an incomplete or unreliable history as a result of the psychological effects of the drug, and the physiological effects of methamphetamine may influence the physical presentation. In addition, the clinical course may be influenced by the exhaustion and depression that sets in as the effects of the drug subside.

This study was undertaken to determine whether the use of methamphetamine impacts hospital length of stay (LOS) and hospital resource utilization in the minimally injured trauma patient.

METHODS

All trauma patients admitted to one regional tertiary trauma center from January 1, 2002, through December 31, 2002, were identified from a prospectively maintained trauma registry. This retrospective study was approved by the institutional review board. Data obtained from the registry included age, sex, mechanism of injury, Injury Severity Score (ISS), admission to the hospital, hospital LOS, intensive care unit (ICU) admission, ICU LOS, charges billed, and outcome. Length of stay was defined as 1 day if the patient was discharged on the same day as emergency department admission. Otherwise, LOS was equal to the day of discharge minus the day of admission.

Trauma patients between the ages of 18 and 55 years with an ISS of 1 to 5 were eligible for inclusion in the study. Toxicology screens were obtained for suspected suicide attempt or altered sensorium with attending physician suspicion of illicit drug use. Urine toxicology screens were qualitative and performed by means of enzyme multiplied immunoassay (EMIT; Syva Co, San Jose, Calif). All positive test results were confirmed by gas chromatography–mass spectrometry. Comparisons were made between the group of study patients with urine toxicology screens positive for amphetamine or methamphetamine and those with screens negative for amphetamine or methamphetamine.

Statistical analysis was performed with SPSS 10.0 for Windows (SPSS Inc, Chicago, Ill). Continuous variables were compared by 2-tailed t tests for independent means, and the results are given as mean ± SEM. Nominal variables were compared by χ² analysis. P < .05 was considered significant.

RESULTS

During the study period, 1650 trauma patients were examined, with 544 meeting study inclusion criteria. Excluded from analysis was 1 patient who attempted suicide by hanging, as the ISS does not capture the severity of that type of injury. Three hundred thirty-one patients did not have a urine toxicology screen performed and were excluded from further analysis, leaving a total of 212 patients for analysis.

Of the 212 patients, 157 (74.1%) were male; the mean age was 30.9 ± 0.7 years and the mean ISS was 3.2 ± 0.1. The mean LOS for all patients was 2.0 ± 0.2 days. There were 151 accidental injuries (71.2%), 43 injuries by assault (20.3%), 12 attempted suicides (5.7%), and 6 (2.8%) were “found down.” Mechanism of injury was predominantly motor vehicle related (101 [47.6%]), followed by blunt assault (27 [12.7%]) and stab wounds (22 [10.4%]) (Table 1). There were no deaths.

Results of urine toxicology screens for amphetamine and methamphetamine were positive in 57 patients and negative in 155. There was no significant difference between groups in sex (77% male in the positive group vs 73% male in the negative group; P = .53), Glasgow Coma Scale score (14.6 vs 14.4; P = .16), or ISS (mean ISS, 3.2 for both groups) (Table 2). The positive group was more likely than the negative group to have intentional injury (37% vs 22%; P = .04) (Table 3). The positive group was slightly older than the negative group (mean age, 33.6 ± 1.3 years vs 29.9 ± 0.8 years; P = .02) and more likely to be admitted to the hospital (91% vs 70%; P = .01). A slightly higher percentage of patients in the screen-positive group were admitted to the ICU compared with those whose screens were negative (14% vs 9%), but this was not statistically significant (P = .29). Likewise, ICU LOS was not significantly different between the 2 groups (P = .18). The mean number of head computed tomographic scans performed and the mean total number of computed tomographic scans performed were not significantly different between the 2 groups. However, there was a significant difference in the charges billed...
Our study demonstrated an increased use of hospital resources, measured by hospital LOS and charges, in the minimally injured adult trauma patients who tested positive for methamphetamine. This can be explained by the physiological and psychological effects of the drug.

Methamphetamine is a sympathomimetic amine that enhances the release of catecholamines centrally and peripherally.\textsuperscript{13} Methamphetamine has greater central nervous system effects than amphetamines, possibly because of its increased half-life and better central nervous system penetration.\textsuperscript{3} Animal models indicate that methamphetamine is twice as potent as amphetamine.\textsuperscript{11} Both the short- and long-term toxic effects of methamphetamine mirror those of all other amphetamine-related compounds. They have significant cardiopulmonary, neurologic, and systemic effects, all of which may confuse the picture when a patient is examined after acute trauma. Cardiopulmonary symptoms include chest pain, palpitations, and dyspnea.\textsuperscript{3} Methamphetamine-related pulmonary hypertension,\textsuperscript{2} myocardial infarction,\textsuperscript{11} and acute pulmonary edema develop 24 to 36 hours after the use of smokable methamphetamine\textsuperscript{16} have also been reported.

The initial feeling of increased mental and physical powers after methamphetamine use quickly evaporates with prolonged use and high doses. In toxic doses, methamphetamine produces severe central nervous system symptoms such as agitation, anxiety, hallucinations, delirium, psychosis, seizures, and death.\textsuperscript{2} In Hawaii, the most common presentation in chronic users is acute psychosis with auditory hallucinations and paranoia.\textsuperscript{14} In addition, the use of methamphetamine with alcohol increases the psychological and cardiac effects,\textsuperscript{2} and the combination of methamphetamine and nicotine results in the production of cyanomethylmethamphetamine, which has been demonstrated to have a greater psychostimulant effect than methamphetamine alone.\textsuperscript{15} Reports of severe systemic toxicity among methamphetamine users is common. These presentations vary but can include severe hyperpyrexia, convulsion, rhabdomyolysis, acute renal failure, hepatic failure, disseminated intravascular coagulation, and refractory hypotension.\textsuperscript{18,19}

Do any of these effects translate into prolonged hospital stay or consumption of resources among trauma patients? In a 6-month review of 461 methamphetamine-positive patients presenting to the emergency department for both medical and traumatic reasons, Richards et al\textsuperscript{20} reported that there was a significantly higher use of ambulance transport and admission rates for methamphetamine-positive patients vs those not using methamphetamine. However, this study considered all methamphetamine-positive patients, including medical patients.

Most reports of the effect of drug use on trauma patients focus on patients with life-threatening injuries. Cornwell et al\textsuperscript{21} reported on 516 critically injured patients who had urine toxicology screens performed and were admitted to one urban level I trauma center during a 9-month period. Three hundred seventy-one patients tested positive for drugs, alcohol, or both and were compared with a control group matched for injury severity and age. They found that patterns of drug use or nonuse did not correlate with severity of injury, mode of transport (emergency medical service vs civilian), presence of shock on admission, need for surgery, ICU admission, LOS, or hospital course. However, they included all positive drug screens regardless of which substance tested positive. Cocaine was the most prevalent drug that tested positive. Although methamphetamine has a clinical effect similar to that of cocaine, there are major differences in their basic mechanisms of action.

Likewise, Madan et al\textsuperscript{11} reported on a 6-month review of 557 patients sustaining life-threatening injuries seen in a large level I trauma center. Urine toxicology screening was performed on 450 patients, with 70% testing positive. They found no difference in hospital days or mortality between patients with positive and negative screens.

In a prospective, age-matched, controlled study during a 20-month period, Loiselle et al\textsuperscript{10} reviewed data from 134 adolescent trauma patients admitted to a level I pediatric trauma center. Sixty-five patients had urine toxicology screens performed and 22 (34%) tested positive for drugs of abuse. Similar to the study by Cornwell et al,\textsuperscript{21} co-
caine was the most prevalent drug found. There were no significant differences between patients with positive and negative toxicology screen results with regard to sex, Glasgow Coma Scale score, trauma score, mean hospital stay, time of arrival, or need for operative intervention.

Few studies have specifically addressed the problem of methamphetamine toxicity. In a 5-year review of patients admitted to one level I trauma center, Schermer and Wisner* reported on trauma patients who tested positive for methamphetamine. Similar to our study, they found that patients positive for methamphetamine were most likely to be injured in motor vehicle collisions (Table 1). In contrast to our study, they found that hospital resources were not increased on the basis of the use of methamphetamine. However, to assess the use of hospital resources, they looked at the need for emergency surgery and ICU admission. In our study, we looked at hospital LOS and hospital charges as surrogates for hospital resources used and found a significant difference in those testing positive for methamphetamine.

Most studies reviewed failed to show a difference in LOS or ICU admission between patients with positive vs negative urine toxicology screen results. However, most, if not all, of the studies addressing this question focused on seriously injured patients. It stands to reason that in this population, the severity of injury will dictate the LOS, ICU utilization, and need for emergency surgery, as well as mortality and complication rates. In fact, Bast et al reported the results of a 5-year review of 2768 trauma patients who underwent drug screening. Of those patients, 414 (15.0%) had positive screens. Review of all available charts (n = 401) failed to identify any cases in which treatment was altered by a positive toxicology screen result.

Our study focused on patients who were minimally injured and would, therefore, normally require little, if any, care. Furthermore, we limited our analysis to patients who tested positive for methamphetamine because of the overwhelming prevalence of this drug in our state and its increasing prevalence in the United States as a whole. In this population, we found that there was significantly longer LOS and increased hospital charges (Table 2). There was also a slightly higher rate of ICU admission and ICU LOS, although these failed to reach statistical significance (Table 2).

We believe that these results reflect the effect of the drug on these patients as opposed to patients who are seriously injured. In the critically injured, care is dictated by the location and severity of the injury, while the drug effect is likely of secondary concern, if it is a concern at all. However, in the minimally injured patient, the drug effect becomes more important. The treating physician must now search for and rule out other causes of, for instance, tachycardia, diaphoresis, or altered sensorium. Likewise, in the presence of drug use, the physical examination findings are unreliable, making radiographic studies and/or additional observation necessary. These patients must often be admitted for no other reason than to allow clearance of the cervical spine after the drug’s “high” or “low” has worn off. This results in an increased burden on the resources of the trauma system. In our state, there has recently been an aggressive campaign aimed at raising the public awareness of the effects of methamphetamine. Additional resources need to be allocated to prevention of methamphetamine use and to drug rehabilitation. It remains to be seen whether this will have any effect. We believe that efforts like this are an important part of decreasing the use of methamphetamine and, if successful, should relieve some of the burden that these drugs are placing on our trauma system and, undoubtedly, other trauma systems around the country.

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