



Contents lists available at ScienceDirect

## The American Journal of Surgery

journal homepage: [www.americanjournalofsurgery.com](http://www.americanjournalofsurgery.com)

## Glass table injuries: A silent public health problem

Usha Trivedi <sup>a,\*</sup>, Dhaval Chauhan <sup>b</sup>, Christine Villegas <sup>b</sup>, Riza Bueser <sup>b</sup>, David Livingston <sup>b</sup>, Stephanie Bonne <sup>b</sup><sup>a</sup> Rutgers New Jersey Medical School, Newark, NJ, USA<sup>b</sup> Department of Surgery, Rutgers New Jersey Medical School, Newark, NJ, USA

## ARTICLE INFO

## Article history:

Received 14 February 2020

Received in revised form

7 May 2020

Accepted 6 July 2020

## Keywords:

Glass

Table

Preventable injuries

Public legislation

## ABSTRACT

**Background:** Glass tables can break and cause traumatic injury. This public health issue is avoidable by adequate regulatory measures. We describe the burden and characteristics of these injuries using the National Electronic Injury Surveillance System (NEISS) database and data from a level 1 trauma center. **Methods:** NEISS data was extracted from 2009 to 2015. Injuries were classified by type, severity, and involvement of faulty glass using predetermined criteria. A retrospective chart review of a level 1 trauma center data was performed. Epidemiologic and outcomes data are reported.

**Results:** 3241 cases were reviewed from NEISS. 56% of injuries were attributable to faulty tables. 15% were severe. A bimodal age distribution of age under 7 and early 20s was observed. Commonly injured areas were the upper extremity and forehead.

24 trauma center cases were reviewed. 21% presented with hemodynamic instability, 34% had major organ, body cavity or joint space injuries, and 58% required surgical intervention. 30-day mortality rate was 8%. More than 54% required inpatient care.

**Conclusion:** Glass table injuries are common, estimated at over 2.5 million per year. Regulation of glass quality may prevent injury.

**Summary:** Glass table injuries are more common than may be recognized and represent a public health problem that can be mitigated through proper regulatory measures.

© 2020 Elsevier Inc. All rights reserved.

## Introduction

The commonplace glass table can cause life-threatening injuries, prompting presentation to an emergency department or trauma center. This common problem is often overlooked in lay literature and among the general public. As a result, trauma centers and emergency departments see patients with a variety of injuries inflicted from glass tables, whether secondary to breaking glass or from a strike against the table. This mechanism of injury is widely variable and injury severity can range from minor abrasions to as extreme as evisceration, injury to major organs, vessels and eventual death.<sup>1,2</sup>

The impact of glass table injuries has been described in children in both academic publications and lay press.<sup>1,3–6</sup> A recent retrospective cohort analysis of patients in an urban pediatric

department found that more than half of trauma injuries involving glass tables could have been prevented by usage of strengthened tempered glass.<sup>1</sup> This is a public health issue which should be easily avoidable by adequate legislation and regulatory measures, but current guidelines are more suggestive than regulatory.<sup>7</sup>

In order to more adequately define this problem and draw attention to our concern, this study aimed to identify the patterns and epidemiology of this problem. A retrospective case series was performed and supplemented with a descriptive query to national dataset providing injury surveillance to further define the national scope of this issue. The National Electronic Injury Surveillance System (NEISS) database was selected to for the national dataset, due to its relative ease of use, online access, low cost, and ability to query a nationwide sample. This dataset is an expansion of the Consumer Product Safety Commission's dataset used to monitor consumer product related injuries. It collects registrar-inputted data from a nationally representative sample of United States emergency departments, with specific weighted selection criteria for participating hospitals.<sup>8</sup> The aim of this was to study describes the burden and characteristics of glass table injuries using the

\* Corresponding author. Rutgers New Jersey Medical School Class of 2022, 185 S Orange Ave, Newark, NJ, 07103, USA.

E-mail address: [ukt1@njms.rutgers.edu](mailto:ukt1@njms.rutgers.edu) (U. Trivedi).

National Electronic Injury Surveillance System (NEISS) database and data from an urban level 1 trauma center.

## Methods

### Single center review

An IRB-approved retrospective chart review was conducted from September 2001 to March 2016 the institutional trauma registry at University Hospital in Newark, New Jersey. The registry was queried for “glass” AND “table” in all injury mechanism data fields, across all trauma activations in the registry. University Hospital is a level 1 trauma center located in Newark, New Jersey and is the referral center for severe trauma in northern New Jersey with a wide catchment area. Patient demographics, comorbidities, mechanism, injury description and subsequent hospital course and disposition, including mortality were collected from the narratives in chart review. Case counts of age, race, anatomic location of injury, and disposition were recorded. SASS software was used to perform descriptive statistics.

### NEISS review

The National Electronic Injury Surveillance System (NEISS) dataset was queried from 2009 to 2015 for the terms “glass” AND “table.” Demographic data was extracted for each matching data entry. A narrative field is included with each entry in the dataset, with variable degrees of detail dependent on registrar input. Each narrative was reviewed in by a single investigator to maintain internal validity. This investigator abstracted data into three fields including<sup>1</sup> injury type,<sup>2</sup> severe and<sup>3</sup> if a “faulty” table was involved. Injury types were classified as laceration, contusion or other, and severity of injury were classified as minor or severe. In cases with multiple injuries, the most severe injury was quantified. Severity were determined by documentation of laceration greater than 6 cm, injury to the trunk or neck, closed head injury, shock, hypotension or severe bleeding, vascular injury, complex laceration, open fracture or open joint space.

Injuries were reported as due to a “faulty” table if there was broken glass resulting in direct injury from glass shards, or if the patient went “through” the table. These typically resulted in penetrating trauma and were described as such in the narrative. Injuries were listed as “probable” if the narrative did not explicitly report a broken table, but the injury pattern and description of mechanism suggested the injury was due to shattered glass, such as limb lacerations, finger lacerations, or mention of impalements of any kind. Tables were “not faulty” if the narrative reported that the glass did not break or if injuries were from blunt trauma. “Not faulty” cases included narratives where patients fell into the table and sustained minor injuries such as forehead or lip lacerations, or traumatic brain injuries without a penetrating mechanism.

## Results

### Institutional data

In the single center chart review, 24 patients sustained injuries due to glass tables. They were predominantly (70%) male, and had a wide age distribution with bimodal peaks in childhood and in the early twenties. Race was representative of the hospital patient population (Table 2). Twenty five percent<sup>6</sup> patients had documented medical comorbidities, most commonly asthma, in 2 patients, and hypertension in another two patients.

All injuries were associated with breakage of faulty glass tables

(Table 2). Our institution showed a higher rate of admission than the national average. Hemodynamic instability, especially hypotension and tachycardia, defined as a blood pressure less than 80 systolic and heart rate greater than 120 bpm, were present in 21% of patients. Torso injuries were present in 34% patients. Injuries involving deep organs, body cavity (intrathoracic or abdominal) and/or joint cavity were present in 50% of patients. Significant blood loss was reported in 29% of patients. Surgical intervention was required for 58% of patients for reasons ranging from complex repair of a laceration to major laparotomies or thoracotomies. The overall 30-day mortality rate was 8%.

Twelve patients with deep organ space injuries or joint injuries. These included one complex lung and cardiac laceration resulting in an emergency thoracotomy and subsequent death. There were seven major abdominal injuries requiring laparotomy and including visceral injuries such as bowel laceration, colon laceration, bladder laceration, liver laceration and renal laceration. One injury resulted in complete laceration of the right renal pedicle resulting in exsanguination from the site. There were two deep joint injuries, one to the hip and one to the elbow, and one deep buttock laceration with associated anal lacerations.

### NEISS data

In total, the NEISS query resulted in 3241 cases. Of these, 1151 cases were determined by narrative review to be “faulty”, and another 665 were classified as “probably”, such that 56% of injuries were definitely or likely attributable to faulty tables. 265 (14.6%) of the “faulty” cases were classified as severe. 1792 of the faulty table injuries were lacerations and 24 were blunt injuries sustained by a table breaking and the subsequent injury occurring from a fall when the glass broke.

Median age in the “faulty” cohort was 20.0 years (St. Dev 18.1 years) with bimodal distribution in children under 7 and a second peak of adults in their 20’s (Fig. 1). The median age for the “definitely faulty” group was 21 (St. Dev 17.43) and 20 for the “probably faulty” group (St. Dev 19.3). Males were significantly more commonly injured than females, with 1050 patients being male and 766 female ( $p < 0.05$ ), breaking down to 668 males and 482 females in the definitely faulty group and 382 males and 284 females in the probably faulty group. This is similar to non-faulty gender distribution, in which 800 injuries were male and 624 female ( $p < 0.05$ ). Overall, the percentage of males injured due regardless of whether the table is faulty, probably faulty or non-faulty is 56–58%, which is significantly higher than women but not significantly different across the groups.

Commonly injured areas in “faulty” cases were the wrist (347), hand (252), and finger (204) (Table 1). Among the 265 severe “faulty” cases, the median age was 23.8 years (St. Dev 17.25) with similar bimodal distribution in children under age 5 and adults in their 20s. Among these, common body parts injured were the lower trunk (85), upper trunk (31), and wrist (23) (Table 1).

Injuries that were not due to faulty glass, such as striking against a glass table or falling from a glass table, showed a different age distribution, with a median age of 4 (St. Dev 0.54) and skew to children under age 10 (Table 1). These injuries most commonly involved the face (555) and head (401), and mouth (88), indicating slip/trip and fall to be a much higher proportion of the injuries.

## Discussion

An alarming number glass tables injuries occur annually in the United States, some of which are severe. NEISS data, while robust, represents a sampling of just 96 US hospitals and emergency rooms. With over five thousand emergency rooms in the United

**Table 1**

Description of patients with glass table injuries from NEISS data.

Variable	Injured by glass table (Definite ± probable) (n = 1810) Mean ± Standard Deviation (SD) or frequency (%)	Patients with severe injuries in NEISS database (n = 265) Mean ± SD or frequency (%)
Median Age (years)	20 ± 0.4	24 ± 1
Male gender	1051 (58%)	135 (49%)
Inpatient admission	56 (3%)	25 (9%)
<i>Anatomic location of injury</i>		
Wrist	347 (19%)	23 (9%)
Hand	252 (14%)	17 (6%)
Finger	204 (11%)	8 (3%)
Upper trunk	38 (2%)	31 (12%)
Lower trunk	109 (6%)	85 (32%)

**Table 2**

Description of institutional data.

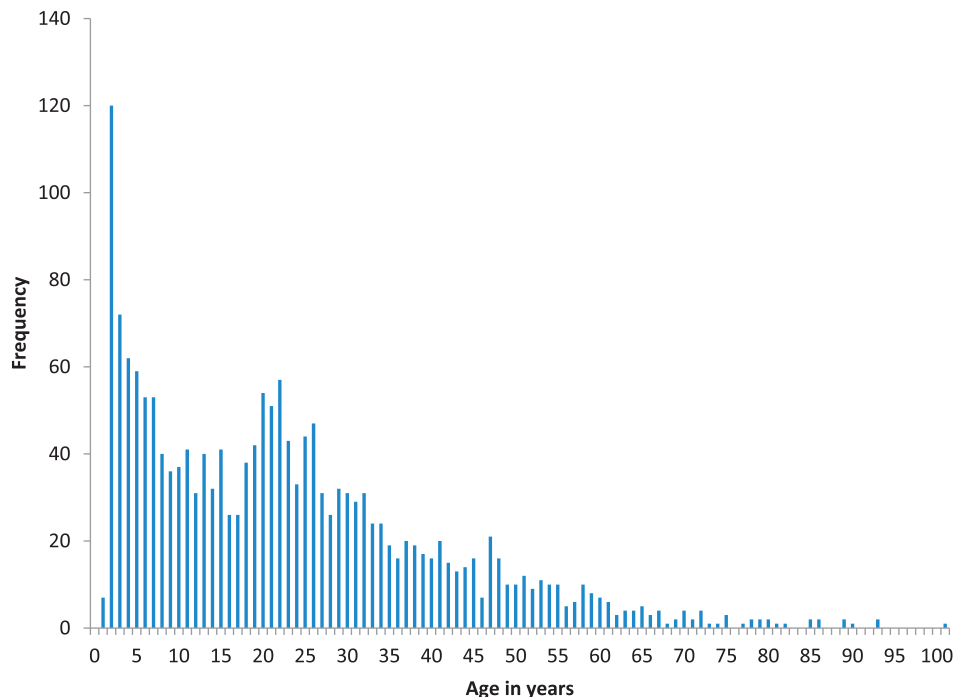
Variable	Mean +SD or Frequency (percentage) N = 24
Median Age (years)	24.13 + 17.61
Male gender	17 (70.83%)
Hemodynamic instability at presentation	5 (20.83%)
Significant blood loss on site	7 (29.17%)
Inpatient admission	13 (54.17%)
Trauma team activation	17 (70.83%)
OR visit	14 (58.33%)
Skin and soft tissue involvement only	12 (50%)
Deep organ/body cavity/joint involvement	12 (50%)
Mortality	2 (8.33%)

States, the burden of glass table injuries may be far greater<sup>7</sup>. The 3241 cases over six years in NEISS, amounts to 540 injuries in NEISS per year hospitals alone. As NEISS is a representative sample of US emergency departments, the estimate can be extrapolated to a conservative estimate of over 2.5 million annual injuries occur in the United States. Notably, some of these injuries are the result of striking a table in general, and are not specific to the glass material; however, many injuries were reported due to faulty glass.

Similarly, if severe injury numbers are extrapolated, there are an estimated 2.6 severe injuries per hospital in the United States, annually. This is a total of 13,802 severe injuries in the United States due to glass tables annually. This is actually slightly less than the Consumer Product Safety Commission's estimate of 20,700 annual injuries.<sup>9</sup> However, either number is extremely high. If our case fatality rate of 8% is applied to this number, we can estimate about 400 deaths annually in the United States occur due to individuals sustaining severe injuries from faulty glass tables. When one considers that the choice to purchase a glass table is made essentially for decorative purposes without any real practical advantage over wood or other non-shattering materials, it is especially tragic to consider these individual cases.

In addition to the striking numbers above, the burden of non severe injuries may be underrepresented because this data did include trip and fall incidents. Lacerations associated with these incidents, while not "faulty" in this study, may have been prevented if the fall had occurred in a more forgiving material like wood, instead of the sharp glass.

This problem has been previously described as a pediatric issue, but is not limited to the pediatric population.<sup>10</sup> Single center experience indicates a bimodal distribution of glass table injuries and both pediatric and adult population have suffered remarkable

**Fig. 1.** Bimodal distribution of incidence of glass table injury in NEISS data.

injuries involving glass tables. The bimodal age distribution suggests that both children and adults are at risk for these preventable injuries.

When comparing level 1 trauma center data to NEISS, trauma patients more frequently sustained severe injuries. This is unsurprising and NEISS abstracts data from some emergency departments that are associated with a trauma center, and others that are not, that may be bypassed by emergency medical services in the case of a severe injury. More than 54% of patients brought to a trauma center required inpatient care and operative interventions, while the NEISS data reported inpatient care was needed for 3% of patients with glass table injuries and 9% in severe cases.

Upon web-based review regarding regulations for glass table manufacturing and marketing, the authors were disappointed to find out that there is a serious lack thereof in the United States. Surprisingly, unlike European countries, Consumer Product Safety Commission for the United States does not have any requirements for the glass used in making glass tables. For example, the glass for manufacturing the glass has strict requirement according to the furniture it is going to be used in the United Kingdom.<sup>7</sup> In the United States, however, there is no requirement for either manufacturing or marketing for these tables. The manufacturers are not required to disclose the type of glass used in the glass table. The tables with faulty glass can easily become a health hazard, especially in families with young children and public spaces.

Further review, however, demonstrates that empirical methods can be used to determine if a glass sample is susceptible to fracture. Tensile stress is a significant factor in the strength of glass, and heat-strengthening techniques are employed to reduce this factor of glass breakage.<sup>11</sup> Since 1960, the method of heat soak testing has been the standard to prevent spontaneous breakage. This method reduces the risk of spontaneous breakage by reducing nickel sulfide contamination within the glass, as the nickel sulfide contamination disrupts homogenous glass structure and causes weaker clustering structure during cooling.<sup>12</sup> This restructuring during cooling produces weaker glass that may be more liable to fracture. Manufacturers are aware of these hazards and some offer replacement warranty if the nickel sulfide inclusion levels exceed a threshold of 0.3%.<sup>13</sup> The strength of glass and the internal composition of the material is an important consideration due to the high association of trauma injuries with fractured glass. There are, however, no clear guidelines regarding nickel sulfide content in United States furniture manufacturing guidelines.

According to the US Consumer Product Safety Commission, there is a mandatory safety standard for usage of tempered glass in vertical glass doors, but for horizontal surfaces such as tabletops, this safety standard for tempered glass is voluntary.<sup>9</sup> Further voluntary standards are suggested by the American Society for Testing and Materials, and its standard F2813 stipulates usage of safety glass in tables and desks below 44 inches.<sup>14</sup> It is imperative to push for stricter regulation, as consumers of glass tables should not be incurring life-threatening trauma injuries due to neglect of manufacturers to use tempered glass protected from nickel sulfide inclusions. Legislation mandating transparent disclosure quality of the glass and warning labels to be included with non-tempered glass products is a necessary first step in protecting the public from these preventable injuries. Additional public health interventions could include consumer warning labels, information distribution and public awareness campaigns about glass safety, and anticipatory guidance provided by pediatricians, primary care physicians, or other public institutions such as schools and health departments.

There are several limitations to this study, which include are inherent to the sampling method of NEISS, which is a limited sample of United States Emergency Departments. It is, however, rich in its descriptive nature, rather than use of administrative data

that depends on billing codes. In addition, single center analysis demonstrated relatively small numbers more consistent with a case series. Additional subjects, review by a panel of reviewers, and more granular data could be obtained through a multicenter study using individual chart review.

## Conclusion

Glass used in furniture can have variable quality, creating danger to unaware consumers. These hazards lay latent in the structure of the glass itself, with unprotected or untempered glass being at higher risk for breakage with sharp edges. Protective measures are well known and include heat-strengthening and heat soak testing to reduce contamination with nickel sulfide.<sup>9</sup> Nickel sulfide disrupts glass structure during cooling and produces weaker glass that may be more liable to fracture.<sup>10</sup> Manufacturers are aware of these hazards and some offer replacement warranty if the nickel sulfide inclusion levels exceed a threshold of 0.3%.<sup>13</sup>

Glass table breakage can lead to serious injury and death. Public health initiatives, including industry regulatory measures, should be taken to ensure that glass is safe as a material for furniture or suitable alternative materials should be used. The public should be aware of the calculated risk posed by including glass furniture in their homes and public spaces.

## Funding sources

The research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Declaration of competing interest

The authors declare no conflicts of interest related to this work.

## Acknowledgments

Harrison Quijote, MPH, NEISS program manager, University Hospital, Newark.

## References

1. Kimia AA, Waltzman ML, Shannon MW, et al. Glass table-related injuries in children. *Pediatr Emerg Care*. 2009;25(3):145–149.
2. Sullivan AF, Camargo Jr CA. The national emergency department inventory-USA. *Acad Emerg Med*. 2015;22(11):1360.
3. Rosat A, Sanchez JM, Chocarro C, Barrera M. Impalement injury by glass shard with delayed colonic perforation. *Pan Afr Med J*. 2015;21:330.
4. Deramo PJ, Agrawal V, Jefferson HC. Near miss for big red: a unique case of penetrating glass injury of the thoracic spine and posterior mediastinum. *Spinal Cord Ser Cases*. 2017;3:17060.
5. Saraf R, Sharma R, Jaini LV, Mhashal S. External carotid artery pseudoaneurysm with arteriovenous fistula: a rare complication of glass shrapnel injury. *Indian J Radiol Imaging*. 2016;26(4):510–512.
6. Jayadevan R, Weissbart S, Winkler A, Lavery H. A case of penetrating glass foreign body within the renal cortex. *Urology*. 2014;83(6):e13.
7. Shepherd JP. Injury research leads to national glass replacement initiative. *Br J Oral Maxillofac Surg*. 1997;35(6):454.
8. Schroeder TA. The NEISS sample (design and implementation) 1997 to present. Available at: [https://www.wcpsgov/s3fs-public/pdfs/blk\\_media\\_2001d011-6b6pdf](https://www.wcpsgov/s3fs-public/pdfs/blk_media_2001d011-6b6pdf); 2001. Accessed 30 April 2020.
9. Commission CPS. *Tempered Glass Safety Alert Publication # 1801*. 2018. Accessed 14 April 2020.
10. Sonmez A, Kora K, Ozturk N, Ersoy B, Aydin M, Numanoglu A. Injury patterns and psychological traits of patients with self-inflicted wounds produced by punching glass. *J Trauma*. 2010;69(3):691–693.
11. Jacob Leon. Factors that influence spontaneous failure in thermally treated glass – nickel sulfide. *Glass Processing Days*. 1997;1:323–327.
12. Spontaneous AK. Cracking of thermally toughened safety glass, part 1: properties of nickel sulphide inclusions. *Glass Struct Eng*. 2019;4:279–313.
13. Department VGS. Heat Soaked Tempered Glass.
14. International A. *F2813-18 Standard Specification for Glass as a Horizontal Surface in Desks and Tables*. 2018.