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Original Article

Characteristics and Costs of Ladder Fall Injuries: A Report from a Single Emergency Center in Okayama

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We sought to identify the incidence, injury patterns, and financial burden of ladder fall injuries to provide a reference for reinforcing guidelines on the prevention of such injuries. We enrolled the patients who were injured in a ladder-related fall and required intensive care between April 2012 and March 2014 at Okayama University Hospital, a tertiary care hospital in Okayama City: 9 patients injured in 7 stepladder falls and 2 straight ladder falls. The median patient age was 69 years, and 8 were males. Six falls occurred in non-occupational settings. Head injuries predominated, and the injury severity score ranged from 2 to 35 (mean = 21 ± 12). At the time of discharge from the intensive care unit, one patient had died and 5 patients had some neurological disabilities. The case fatality rate was 11%. The total cost of care during the review period was ¥16,705,794, with a mean cost of ¥1,856,199 per patient. Ladder fall injuries are associated with a high rate of neurological sequelae and pose a financial burden on the health insurance system. A prevention education campaign targeting at older-aged males in non-occupational settings may be a worthwhile health service investment in this community.

Key words: accidental falls, accident prevention, hospital costs, injuries, ladder

In recent years, the number of ladder fall accidents in Japan has been increasing, despite a safety guidance and education campaign for prevention provided by the Japanese government [1]. Ladders are frequently used in non-occupational settings such as when cleaning windows, decorating, painting or repairing houses, and cutting branches off trees [2]. Studies from outside of Japan reported that between one-half and two-thirds of all ladder fall accidents are non-occupational [3, 4]. Falls are the leading cause of injury and the second leading cause of injury-related death in Japan according to Japan Trauma Data Bank Report 2012 (2007–2011) (available from http://www.jtcr-jatec.org/traumabank/dataroom/data/JTDB2012e.pdf, accessed May 2015); however, medical reports on ladder fall injuries in Japan are scarce. In the present study we examined the characteristics of ladder fall injuries treated at a tertiary care hospital in Okayama, a medium-sized city in Japan, to provide a reference for reinforcing guidelines on the prevention of such injuries.

Methods

The clinical records of patients admitted to the

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emergency intensive care unit (ICU) at Okayama University Hospital from April 1, 2012 through March 31, 2014 (24 months) were retrospectively reviewed. This hospital provides only tertiary care. There are currently 2 tertiary care hospitals in Okayama City serving a population of approximately 700,000. Any patient admitted to our emergency ICU following a ladder fall was included in this study. Cases were excluded if they involved multiple mechanisms of injury, such as a fall when escaping a fire using a ladder. The types of ladders were defined as follows: (1) Straight ladder: a single or extension ladder in one or 2 parts that leans against an object for support. (2) Stepladder: a folding ladder of any kind that unfolds to stand unsupported [5]. The study was approved by the Ethics Committee of Okayama University Hospital.

We collected the following information from the patients' charts: age, sex, accident history, diagnosis, Abbreviated Injury Scale (AIS), Injury Severity Score (ISS), probability of survival based on the Trauma-Related Injury Severity Score (TRISS Ps), length of ICU stay, Glasgow Outcome Scale (GOS) at ICU discharge, and mortality. The GOS is read as follows: 1 point, dead; 2, vegetative state; 3, severely disabled; 4, moderately disabled; 5, good recovery. For each case, The finance department at Okayama University Hospital provided the hospital costs and the Fire Department of Okayama City provided the ambulance transportation data. The data are presented as proportions, means ± standard deviations, or medians and ranges as appropriate.

Results

During the 24-month review period, 16,246 injured patients were transported by ambulance in Okayama (29.4% of all transported cases). During the same period, 344 patients were admitted to our emergency ICU with injuries, of which 9 (2.6%) resulted from ladder falls. The clinical characteristics and outcomes for these 9 patients are described in Table 1 and 2. The patients were 8 males and 1 female, with a median age of 69 years (range, 39–84 years). Six falls occurred in non-occupational settings. We registered 7 stepladder falls and 2 straight ladder falls. Four patients were pruning a tree in their gardens and 2 were fixing a roof at the time of the accident. The median height fallen was 2 m with a range of 1.5–4 m. Most of the falls occurred in the spring or summer.

Head injuries predominated, with 6 intracranial hemorrhages, 4 brain contusions and 1 diffuse axonal injury. None of the 6 patients who were injured in a non-occupational setting wore protective equipment such as a helmet. One patient suffered from dislocation fractures of the thoracic spine that resulted in complete paralysis of the lower extremities. Another patient suffered from traumatic spleen injury requiring a splenectomy and massive blood transfusion. The mean ISS was 21.0 ± 12 (median, 29; range, 2–35), with 6 patients scoring greater than 16.

Table 1 Clinical characteristics of patients with ladder fall injuries admitted to the intensive care unit of Okayama University Hospital, April 2012–March 2014

Patient No.	Age (years)	Sex	Date	Height (m)	AIS	ISS	TRISS Ps (%)	Working settings	Activity
1	39	M	August	2	T4 A4	32	93.2	Occupational	At work
2	50	M	May	4	H1 CS2 UE1	6	99.7	Non-Occupational	Fixing a roof
3	61	M	April	NA	H5 LS2 LE1	30	80.3	Non-Occupational	Pruning
4	61	M	June	1.5	H1 UE1	2	98.2	Non-Occupational	Replacing a light bulb
5	69	M	March	2	H5 T2	29	55.2	Non-Occupational	Pruning
6	74	M	April	2	H3 T3 TS5 LE1	35	51.0	Occupational	Pruning
7	79	M	November	2	H3 A1	10	5.0	Occupational	Pruning
8	81	M	May	3	H4 LE1	17	93.8	Non-Occupational	Fixing a roof
9	84	F	December	2	H4 T3 UE2	29	72.5	Non-Occupational	Harvesting

M, male; F, female; NA, not available; AIS, Abbreviated Injury Scale; T, thorax; A, abdomen; H, head; CS, cervical spine; TS, thoracic spine; LS, lumbar spine; UE, upper extremities; LE, lower extremities; ISS, Injury Severity Score; TRISS Ps, probability of survival based on the Trauma-Related Injury Severity Score.

Table 2 Outcomes of ladder fall injuries treated at the intensive care unit of Okayama University Hospital, April 2012–March 2014

Patient No.	ICU stay (day)	GOS	Discharge	Cost (¥)	Breakdown of the cost (%)	
					Operation-related	Facility charge
1	15	5	Rehab	3,047,454	20.0	24.6
2	2	5	Home	231,050	5.1	41.6
3	21	4	Rehab	2,052,800	0	56.8
4	2	5	Rehab	263,210	2.5	41.6
5	25	3	Rehab	2,139,180	1.4	52.1
6	17	3	Rehab	4,966,350	54.6	15.0
7	6	1	Dead	968,680	1.4	60.4
8	28	4	Rehab	1,996,600	0	47.2
9	6	3	Rehab	1,040,470	0	65.1

ICU, intensive care unit; GOS, Glasgow Outcome Scale; Rehab, rehabilitation hospital.

The median length of emergency ICU stay for the surviving patients was 16 days (range, 2–28). One patient required a tracheostomy. At the time of ICU discharge, the GOS scores were as follows: 1, n = 1; 3, n = 3; 4, n = 2; 5, n = 3. The case fatality rate was 11%; one patient died from traumatic subarachnoid hemorrhage. Using a GOS score of 5 to define a good neurological outcome, more than half of the surviving patients (63%) had poor neurological outcomes. One patient was discharged to his home and 7 were discharged to rehabilitation hospitals.

The total cost of treatment in Japanese Yen was ¥16,705,794 (US $170,000), with a mean cost of ¥1,856,199 (US $19,000) per patient. The median cost of hospitalization was ¥1,996,600 (US $20,000) (range, ¥231,050–¥4,966,350). The facility charge is the major breakdown item (¥6,189,320, 37.0%), followed by operation-related costs including technical fees and material costs (¥3,376,650, 20.2%).

Discussion

Information about the medical courses and outcomes of injured patients would contribute to the reinforcement of prevention guidelines for preventable accidents by community governments. We reported the medical consequences of ditch-related injuries, which occur more frequently in Okayama City than do ladder fall injuries [6]. The medical consequences of falls from windows, balconies, and roofs have been reported, and some of this information has contributed to suitable prevention strategies outside of Japan [7]. Falls from ladders have also frequently been reported in industrialized countries [2–5, 8]. However, information about these injuries in Japan is scarce.

To solve the problem of the increasing incidence of ladder fall injuries despite a government prevention educational campaign, information about such injuries specific to Japanese communities should be collected. To our knowledge, this is the first written report to highlight the medical outcomes (including cost) of ladder fall injuries in Japan. We found that elderly males working in non-occupational settings (for example, pruning a tree) were the most common patients, and that there was a high rate of head trauma and poor neurological outcomes.

A high percentage of ladder fall injuries have been reported to occur in male individuals [2–5, 8, 9]. This finding is replicated in the present study, in which 8 out of 9 of the subjects were male. The median age of the present patients was quite high, at 69 years, whereas several previous studies reported that middle-aged (42–53–year-old) individuals suffered the majority of this type of injury [2, 3, 9]. Most of our patients were from rural areas, and being shorthanded due to depopulation or overconfident in their physical strength might have contributed to this result. Studies performed in a town with a predominantly elderly population are more likely to have a preponderance of non-occupational ladder falls [9]. Therefore, in Okayama City, a prevention education campaign targeting elderly males is required to reduce the incidence of severe injuries due to falls from ladders.

Two-thirds of the injuries in this study occurred in non-occupational settings, demonstrating that the majority of accidents occurred in a setting without a

specific safety supervisor. This makes it difficult to promote thorough countermeasures to prevent accidents. A prevention campaign should be planned and promoted through regional mass communication media or at community activities such as summer festivals. Informative posters, with the help of primary care clinics and public transportation facilities, would also be a helpful tool in future educational campaigns to increase the range of citizens reached.

The median ISS in this study was 29. This high score was attributed largely to the high incidence of head injuries resulting in a high rate of neurological sequelae. Working with one's hands full, or the effect of age in reducing one's ability to defend oneself in a fall, may contribute to the mechanism of injury. To date, injuries to the extremities have been reported as the most common injuries in ladder falls [5]. The present findings demonstrated that head injuries in ladder falls are associated with severe outcomes. All of our patients who were not wearing a helmet incurred head injuries, and all would have had a better outcome if they had worn a helmet. We would like to emphasize the importance of protective equipment use every time one works with ladders.

For patients with ladder-fall injuries, the high average financial cost per patient can be directly attributed to the neurological sequelae. As a reference, each day in the ICU costs approximately ¥136,932 (US $1,400). In this study, the total cost during the review period was ¥16,705,794 (US $170,000), with a median cost of ¥1, 996,600 (US $20,000). Despite the small number of patients in our study, their high total cost has a significant impact on the national insurance program of Japan.

This study provides valuable information to reinforce the community government ladder fall prevention campaign. Additionally, it provides a reference cost for ladder fall injuries based on the medical cost of acute intensive care to local governments. Because this reference cost does not include the cost of minor injuries or rehabilitation care after discharge, it is likely that the actual cost to society will be far greater. We assert that the expected cost savings will offset the cost of prevention efforts over time.

This study has several limitations. Notably, it was a retrospective study with a small sample size, carried out over a short duration, and confined to a single tertiary care center. Because our center is specialized only for tertiary care, the study was restricted to events in our emergency ICU and did not consider less severe injuries. Our study did not determine the outcomes of treatment following discharge, and we did not evaluate the contribution of product defects to ladder fall injuries. Therefore, the results are unlikely to reflect the overall characteristics of ladder fall injuries. Further investigation in these areas is required to reveal the factors that contribute to ladder fall injuries.

In conclusion, falls from a ladder can cause severe injuries with neurological sequelae and can create a large financial burden. Our results indicate that a public prevention education campaign targeting elderly males working in non-occupational settings may be a worthwhile health service investment.

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