FLIGHT SAFETY FOUNDATION
HUMAN FACTORS & AVIATION MEDICINE
Vol. 45 No. 3 *For Everyone Concerned with the Safety of Flight* May–June 1998

Sporting Goods, Oddly Shaped Items Have Highest Injury Rates in Study of Falling Overhead Baggage

Minimal traumatic brain injury is one serious consequence of injury caused by baggage falling from overhead compartments. Between 20 percent and 60 percent of such patients have symptoms three months after being injured.

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Baggage stored in the overhead compartments of airliners can be a source of injury for passengers and flight attendants.[1] These injuries occur in two major categories: first, injuries to passengers and flight attendants from falling baggage, where items that differ in shape from standard baggage represent a particular risk; and second, injuries to flight attendants from baggage handling.

Among the 14 largest U.S. carriers, there are an estimated 4,500 incidents annually, or an average of one every two hours. Worldwide, it is estimated that there are 10,000 injuries a year, or an average of one every hour.[2]

Injuries occur to passengers and flight attendants from falling baggage. Many airline passengers do not consider the possibility of injury from baggage stored in overhead compartments. The compartments are perceived as either convenient locations for storing coats and other light articles, or — increasingly in recent years — an opportunity to circumvent checking baggage and claiming the baggage after the flight.

Current designs for overhead compartments or bins maximize carrying capacity, for both bag size and number. Compartments on some airliner types span several seat rows, making it possible for baggage to fall along the entire length of that compartment after the compartment door is opened manually or spontaneously. Most bins have no built-in impediment to prevent baggage from shifting while the bins are closed, or to prevent baggage from falling after the compartments are opened.

The bags themselves pose a major problem. Despite a U.S. Federal Aviation Administration (FAA) advisory circular (AC) requiring airlines to develop individual programs to limit carry-on baggage, the demands placed on compartments continue to exceed their capacity. Many suitcases today feature integral wheels and telescoping handles, and "wheelies" — wheel-fitted luggage carts that fold up when not in use — enhance the mobility of other suitcases. Because of these changes in luggage design and handling, passengers arrive at the departure gate with larger and more numerous bags.

Passengers who prefer to carry their baggage aboard the aircraft do so not only to avoid having to wait to retrieve their baggage on arrival, but to avoid the possibility of loss, theft or damage.

[According to the U.S. Department of Transportation, passenger complaints about "mishandled baggage" — a category that includes lost, damaged, delayed or pilfered baggage — occurred at a rate of 5.40 per 1,000 passengers in the U.S. domestic aviation system in the first quarter of 1998. The corresponding figure for April 1998 was 4.56 complaints per 1,000 passengers.

[The Air Transport Association of America reports that in the U.S. domestic system the vast majority of mishandled bags are delivered to their owners within 24 hours, and that only 1 percent of all mishandled bags are permanently lost or are stolen.]

The original intent in creating overhead compartments was that passengers would be able to bring aboard small items that they might need during flight. But today, passengers bring aboard full-size folding suitcases, cardboard boxes, sports equipment, laptop computers and other items that are too large, too heavy or improperly packed because the passengers are exclusively focused on their personal convenience or security. They do not consider what the effect might be if the compartment opens inadvertently and the baggage falls from the compartment.

The baggage can emerge uncontrolled from the overhead compartments for two reasons. First, articles that may have been balanced or tightly wedged at the beginning of a flight can shift because of normal in-flight acceleration, deceleration and turbulence. That hardly matters if the articles are small, light and soft, but can be a problem if the compartment contains bulky or heavy items.

Second, even the relatively large overhead compartments in the latest generation of airliners were not designed as cargo holds. As passengers board the aircraft, the compartments fill quickly. Succeeding passengers continue to fill the compartments until, on full flights, compartments can be loaded beyond their design capacity.

This can exceed the ability of the compartment door latches to contain the contents, even if the latches have been secured according to specifications. Under strain, the latches can unlatch spontaneously when subjected to a sudden jarring motion, such as during takeoff, landing or in-flight turbulence. Nevertheless, the data suggest that these spontaneous compartment-door openings are rare, and that bags most often fall out when the doors are opened manually by passengers or flight attendants.

Some data concerning the incidence of injuries from falling baggage suggest the scope of the problem.

In the mid-1990s, one major U.S. airline carefully documented 462 occurrences of falling baggage in one type of airplane (the Boeing 757) only.[3] The occurrences included 397 incidents in which a person was struck and 65 incidents in which no one was struck. More than 90 percent of the resulting injuries were head injuries to aisle-seat passengers. Based on the documentation from this airline, the author has analyzed the results of the occurrences.

Objects that fell from the overhead-baggage compartments were divided into five classes:

- Briefcases/baggage/luggage;
- Portable computers;
- Wheels (a category including wheel-fitted carts, strollers and wheelchair parts);
- Sporting goods; and,
- Boxes, picture frames and oddly shaped items.

Injuries were divided into two types: bruising and laceration (cutting of the skin with bleeding).

The overall injury rate from falling baggage was 30 percent across the five classes of objects. Table 1 shows the numbers and types of injury caused by each class of object. Table 2 (page 3) shows the percentages and types of injuries.

In these data, for briefcases/baggage/luggage, computers and wheels, the injury rates hover around 25 percent to 40 percent and show that wheels pose a special risk for producing bleeding lacerations. When sporting goods or unusually shaped items such as picture frames are involved, the injury rates rise to 50 percent and 82 percent, respectively. Computers, with an injury rate of 26 percent, are small but they can be heavy.

Table 1
Consequences of Falling Baggage, By Numbers, in 462 Occurrences

	Numbers of Occurrences			
	Bruising	Laceration	No Injury	Total
Briefcase/Baggage/ Luggage	43	27	223	293
Computer	3	3	16	22
Wheels*	5	9	23	37
Sporting Goods	7	4	11	22
Boxes, Picture Frames	9	10	4	23
Total	**67**	**53**	**277**	**397**

* Comprising wheel-fitted carts, strollers and wheelchair parts.

Note: In 65 of the 462 occurrences analyzed, no one was struck by the falling object.

Source: Leo M. Rozmaryn, M.D.

Table 2
Consequences of Falling Baggage, by Percentages, in 462 Occurrences

	Percentages of Occurrences			
	Bruising	**Laceration**	**No Injury**	**Total**
Briefcase/Baggage/Luggage	14.68%	9.22%	76.11%	100%
Computer	13.64%	13.64%	72.73%	100%
Wheels*	13.51%	24.32%	62.16%	100%
Sporting Goods	31.82%	18.18%	50.00%	100%
Boxes, Picture Frames	39.13%	43.48%	17.39%	100%
Average	**16.88%**	**13.35%**	**69.77%**	**100%**

* Comprising wheel-fitted carts, strollers and wheelchair parts.

Source: Leo M. Rozmaryn, M.D.

Table 3 shows the numbers of strikes by objects on various locations on the body. Table 4 (page 4) shows the forms of attention or treatment that resulted from the strikes.

The most serious medical consequence of these accidents can be minimal traumatic brain injury (MTBI). Until recently, this clinical constellation of symptoms has been under-recognized,[4] but is now being seen to cause long-term morbidity and dysfunction in a significant percentage of patients.[5]

The medical literature about MTBI symptoms and consequences indicates what can happen to passengers who receive this type of injury caused by baggage falling from overhead compartments.

After a heavy item falls on a person's head there may be a brief period of loss of consciousness.[6] The data indicate that many patients suffering from head trauma complain of headache, dizziness, scalp hematoma (clotted blood confined within the scalp tissue), laceration, contusion (bleeding beneath the skin) and abrasion (scraping of the skin).[7]

Passengers who have been subjected to MTBI might be treated with an ice pack. Although this treatment might be sufficient in many cases, as many as 50 percent of MTBI victims develop postconcussive symptoms.[8] Those symptoms include persistent headaches, dizziness, fatigue, irritability, tinnitus (ringing in the ears), reduced concentration, frustration, slowed thinking, sleep disturbance, memory dysfunction, anxiety, sensitivity to noise, double vision or blurred vision, sensitivity to light, and depression.[9]

[Candace Kolander, coordinator of air safety and health for the U.S. Association of Flight Attendants (AFA), said, "The medical training given to flight attendants should enable them to understand that in falling-baggage situations, the lack of visible lacerations or immediate symptoms does not necessarily mean that no injury has occurred. (Flight attendants) need to

Table 3
Numbers and Locations of Strikes by Falling Baggage in 462 Occurrences

	Location of Strike				
	Head	**Neck/Back**	**Shoulder**	**Arm/Hand**	**Unknown**
No Injury	139	8	5	7	25
Laceration	64	0	0	1	0
Bruising	127	16	12	12*	3
Totals	**330**	**24**	**17**	**20**	**28**

* Includes one flight attendant injury.

Note: Totals add up to more than 397 because some passengers were struck at more than one location. In 65 occurrences no one was struck.

Source: Leo M. Rozmaryn, M.D.

Table 4
Attention or Treatment Required for Passengers Following Strikes By Falling Baggage in 462 Occurrences

	Location of Strike				
	Head	**Neck/Back**	**Shoulder**	**Arm/Hand**	**Unknown Site**
Flight Attendant Medical Attention/ Ice/Paramedic Attention	136	12	3	7	2
Flight Attendant Reassurance	28	2	9	2	2
Physician or Other Medical Attention*	15	1	0	1	1

* Includes one injury with no physician on board.

Note: These data represent 221 occurences. In 241 occurrences no treatment was provided.

Source: Leo M. Rozmaryn, M.D.

have enough knowledge to warn the passenger that symptoms may develop later, and to suggest consulting a physician."]

Many studies have revealed that between 20 percent and 60 percent of patients have persisting symptoms three months following their injuries.[10] These symptoms can cause significant deficits in psychosocial and interpersonal functioning.[11]

Everyday life involves many tasks — for example, shopping in busy supermarkets, driving, consulting with clients and meeting deadlines — that require divided attention, sustained attention or intact speed of information processing. Such activities are particularly troublesome and frustrating to one recovering from MTBI, and the problems are compounded by poor concentration and fatigue.[12] One year following injury, persistent symptoms are more likely to occur in patients who are in one or more of the following categories: female; low socioeconomic status; older age group; involved in litigation; drug or alcohol abusers; or those who had a prior head injury.[13]

Mild head trauma results when the blow to the head causes a sudden shearing force within the brain. This force can disrupt small blood vessels as well as axons (the long parts of neurons — nerve cells — that conduct nerve impulses toward or away from the cell bodies) at the interface between the gray and white matter. (White matter is brain tissue containing densely concentrated axons having myelin sheaths, which are thought to protect the axons and help them transmit nerve impulses. Gray matter is brain tissue consisting largely of nerve-cell bodies and fewer axons with myelin sheaths.) Depth of injury is related to the energy transferred to the head during the trauma.

Injury to blood vessels in the substance of the brain causes microhemorrhages or localized edema (an accumulation of excess watery fluid in cells, tissues or cavities). Disruption of the surface veins causes subdural (situated under the outer covering of the brain) hematomas. The trauma does not by itself tear the neurons, but disrupts the flow of axonal transport, causing neural degeneration and eventually destruction. This can progress over six hours to 12 hours with disruption of intracellular ion transport and precipitation of inflammation.[14]

The classic method of determining the severity of head injury, the Glasgow Coma Scale, is not helpful in this situation because in most cases the injury would be categorized as "mild or minimal." In addition, a significant number of patients, because of the mechanisms described above, seem completely asymptomatic at first, and only worsen during the 48 hours following,[l5] well after their flights when they are no longer in contact with the air carrier. This is typical of the older person who has developed a subdural hematoma. Persons with no history of head trauma are more likely to be misdiagnosed at first than those who have had a previous injury.[16]

Accurate diagnosis can be made clinically and with the help of imaging techniques such as computed tomography (CT) scanning or magnetic resonance imaging (MRI).[17] Treatment includes psychotherapy, psychoactive medications such as antidepressants, neuropsychological exercises and physical therapy.[18]

Education and close follow-up are critical to therapeutic success. Contrary to popular belief, patients with litigation or worker's compensation claims are not "cured by the verdict."[19] Outcomes six months following injury indicated that those patients who were aggressively treated had fewer and less severe symptoms than those who remained untreated, although there was no difference between the groups in the time required for patients to return to work.[20]

Injuries occur to flight attendants from baggage handling. Wheeled suitcases and folding carts make it relatively easy to bring baggage onto an airliner. Then the devices lose their utility, and only human muscle power can lift the baggage into an overhead compartment. At that point, it is not unusual for a passenger to realize for the first time how heavy the baggage is. A flight attendant is frequently called on to lift the bag, which may result in an injury to the flight attendant.

One airline studied injury rates to flight attendants caused by handling of baggage during an 18-month period (Table 5).[21]

Table 5
Flight-attendant Baggage-related Injuries, One Airline, During 18 Months

	Number of Injuries	Number of Work Days Lost
Assisting Passengers	17	394
Flight Attendant Loading Bags Overhead	68	1,923
Object Falling from Overhead Compartment	6	66
Baggage Dropped on Flight Attendant by Passenger	3	6
Tripped on Bag	3	77
Struck by Bag Carried or Lifted by Passenger	3	238
Total	**100**	**2,704**

Source: Leo M. Rozmaryn, M.D.

"Assisting passengers" and "loading bags overhead" were the most common causes of flight-attendant injuries, frequently to the neck and back. The average number of work days lost was lowest — two — for the category "baggage dropped on flight attendant by passenger"; the average number of work days lost was highest — 79 — for the category "struck by bag carried or lifted by passenger."

Another airline, a small national carrier, during 1996 examined its flight-attendant injury rate.[22] There were 66 injuries, 10 related to baggage handling, with 242 work days lost in the baggage-handling injuries. The neck and back were most frequently involved.

The 1989 average cost of treatment of low-back pain was estimated to be US$8,300 per case. Only 34 percent of the cost was direct medical expenses; 66 percent was indemnity (lost time and wages).[23]

Low-back-pain disability affects the suffering individual in every aspect of daily living, and leaves him or her virtually incapacitated. Despite three decades of intensive research into the prevention and treatment of low-back pain, medical science seems to be no closer to a broad solution to this problem.[24] There appears to be no difference in long-term outcome between conservative and operative treatment, and no means has been found to affect in any material way the incidence and severity of low-back pain.

It is of utmost importance, therefore, to focus on workplace adaptation to reduce the risks. The risks include exposures in activities such as pushing, pulling, holding, carrying and lifting. Principles concerning risk in the activities cited include:

- The capacity for pushing an object is much greater than for pulling;
- For pushing and pulling, two hands are better than one;
- Pushing at waist level permits exertion of much more force than pushing at shoulder or knee level;
- The friction between footwear, baggage and the floor surface influences the ability to push or pull;[25]
- Carrying and holding baggage in confined spaces or up and down stairs without a hand-hold is deemed hazardous;
- Lifting capacity is a complex issue and is the subject of an algorithm set forth by the U.S. National Institute of Occupational Safety and Health (NIOSH): the NIOSH lifting equation. This algorithm considers the weight lifted, the vertical and horizontal distance lifted, the degree of symmetry of the lift and the frequency of the lifting activity;[26]
- Despite years of research and worker education it is not clear that lifting with bent knees is really any better for the back than lifting with bent back.[27] It depends on the circumstance. For example, the "freestyle lift" (in which, beginning from a crouching position, both the knees and the lower back are used) has been shown to be biomechanically the most efficient;[28]
- Sudden and ballistic pushing movements such as those necessary to lift a heavy bag into an overhead bin at a distance (over the aisle seat) can place a large inertial moment on the lumbar spine and may exceed its limit of tolerance;
- Twisting movements while carrying or lifting increase the shear forces on the structures of the low back; and,
- Big and bulky packaging will also markedly increase the stresses on the lumbar spine, especially in women.[29]

Inconsistencies in Carry-on Baggage Allowance Create Problems

Not only is there controversy about how much and what kind of carry-on baggage *should be* permitted in airplane cabins, but passengers are also confused about what carry-on baggage they *are* allowed.

A U.S. newspaper carried out a "random and unscientific telephone survey" of airlines' policies. It found that one airline allowed two pieces of carry-on baggage, including laptop computers and briefcases, but not purses; another airline permitted a total of three bags to be checked or carried aboard, in addition to purses, briefcases and laptop computers; a third airline counted computers, but only "real big" purses, as bags in its two-bag carry-on restriction; two reservations agents for a fourth airline gave conflicting answers about whether purses were considered carry-on baggage.

In an editorial, the newspaper said, "The best course would be for airlines to agree on a common standard. But that approach has already failed. By failing to take action, the FAA has once again shown that it is more inclined to follow the industry it is supposed to regulate than to lead it."

Invited to respond, Jane F. Garvey, U.S. Federal Aviation Administration (FAA) administrator, said, "Airlines were told [in FAA guidelines issued on July 22, 1998, that] their carry-on policies should make clear to passengers what constitutes carry-on baggage, offer guidance about allowable bag sizes and how many bags can be brought safely on board, and indicate how child-safety seats should be treated.

"Carry-on baggage is not a one-size-fits-all issue that lends itself to across-the-board regulations. Rather, it is an issue in which flexibility to adjust to wide differences in the industry is the most logical course — for now.

"Regular travelers know that airlines operate a wide variety of aircraft and there are widely differing interior configurations [of the same type of aircraft]. Moreover, passenger loads vary from season to season, another argument against a rigid, inflexible approach dictated from Washington."♦

Source: *USA Today*, July 27, 1998

To help control the problem of injuries caused by carry-on baggage, there must be a two-pronged approach, including engineering and administrative controls.

For example, redesigning the latch mechanism, to provide a visual indication when the latch is closed correctly, would help prevent some spontaneous openings of overhead compartments.

Administrative controls include limiting the size, weight and number of baggage pieces carried into the cabin by passengers. Recently, some airlines have begun to impose such limitations.

Delta Air Lines, for example, permits two items of carry-on baggage, each of which must fit into a container about 22 inches by 14 inches by nine inches (56 centimeters by 36 centimeters by 23 centimeters). Northwest Airlines policy allows one piece of carry-on baggage, whose size requirement is the same as Delta's and whose maximum weight is 40 pounds (18 kilograms). British Airways permits various sizes and numbers of bags to be brought into the cabin, depending on the class of service; permissible total weight ranges from 13 pounds (six kilograms) in coach, U.K. domestic service and shuttle service to 26 pounds (12 kilograms) for Concorde flights.

The effect of varying any one of the ameliorative factors has yet to be prospectively studied. All the data so far are retrospective and anecdotal. It would be unrealistic to make major and potentially expensive changes in policy without an objective study to determine the most effective controls. But after the study has been performed and conclusions reached, the resulting controls must be enforced without exception at the ticket counter and at the boarding gate. The laissez-faire era, in which many passengers believe that they have the right to bring into the cabin anything they wish, must end.

As part of the training of flight attendants, ergonomically correct methods of lifting and carrying in confined spaces must be taught. Organized efforts should be made to encourage flight attendants to attain and maintain a minimal level of fitness, which would help prevent injuries on the job.

Another issue emerges from the airline-collected data shown in Table 4 (page 4). In the sample evaluated, there were 18 instances in which a passenger-physician volunteer was enlisted to help in an on-board medical emergency. Such situations put a physician at some legal risk, because he or she is licensed to practice medicine in a specific locality and jurisdiction. Practicing medicine during cruise flight over the Atlantic Ocean might not be covered under the terms of the physician's license or malpractice insurance if there were an adverse effect on the patient following treatment.

On April 24, 1998, the Aviation Medical Assistance Act of 1998 was signed into U.S. law. Under the law's Good Samaritan provision, a medically qualified person such as a doctor, nurse or paramedic is protected from liability arising out of assistance in an in-flight emergency (except for gross negligence or willful misconduct).

[David Schaffer, counsel to the U.S. House of Representatives Aviation Subcommittee, said that the Good Samaritan provision would also protect flight attendants.[30]]

This law appears to provide a large measure of protection to U.S. medical personnel against being sued in U.S. courts, but it does not shield non-U.S. medical personnel from litigation in their respective countries.♦

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HUMAN FACTORS & AVIATION MEDICINE

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