Non-collision injuries in public buses: a national survey of a neglected problem

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Objectives: This prospective, nationally representative, multi-centre study was undertaken to assess non-collision injuries sustained by public bus passengers in Israel.

Methods: The emergency departments (EDs) of six medical centres, which participated in this eight month study, were chosen to represent both urban and rural catchment areas. All patients diagnosed with injuries sustained on a public bus not involved in a road traffic accident were promptly evaluated for mechanism and nature of injury and demographic parameters.

Results: The study cohort consisted of 120 patients (86 were female, 34 were male, age range 3–89 years). Over half were older than 55 years. The most common injuries were to the limbs, vertebral column, and head. The major mechanism of injury was acceleration/deceleration. Most patients were standing when they sustained the injuries. There were no fatalities, and 17 patients were admitted to hospital (9 of 17, 52% older than 55 years). Extrapolation to yearly national statistics suggests a probable total of 729 such injuries.

Conclusion: The significant injuries inflicted on passengers of public buses not involved in road traffic accidents warrant decisive preventative measures by transportation authorities.

RESULTS
The study cohort consisted of a total of 120 patients, 86 females (71.7%) and 34 males (28.3%) whose ages ranged from 3 to 89 years. Most of the patients (55.8%) were older than 55 years (table 1).

Seventy patients (58.3%) were treated at the ED of the Tel Aviv Sourasky Medical Center. There was no difference in the occurrence of injury between the days of work throughout the week. The low number of incidents during weekends (Friday and Saturday for Israel) probably reflects the fact that only limited public transportation is available in most cities.

Most of the injuries (55.8%) were sustained by passengers who were either standing or moving in the bus (table 3), and the major mechanism of injury was sudden deceleration or acceleration (table 4).

The most common injuries were to the limbs (33.3%), followed by the head (29%) and the spine (22%) (table 5). Seventeen patients (14.2%) were admitted to hospital, of which four were orthopaedic admissions: two for pelvic fractures, one for a calcaneal fracture with subsequent operative correction, and one for radial fracture, (9 of 17, 52% older than 55 years). The mean length of hospital stay was 2.4 days, range 2–5 days. There were no deaths.

DISCUSSION
In our earlier study, we had evaluated non-collision injuries in buses, a mechanism of trauma hitherto unreported in the medical literature although recognised epidemiologically in the road safety literature. These patients had been treated at our ED in Tel Aviv. The alarming level of morbidity that emerged motivated us to extend this investigation to six representative medical centres throughout the country. Together, these centres had provided care to 604 983 patients from a total of 2 444 548 ED visits in the entire country throughout 2000. Extrapolating from these numbers, the probable total yearly injury burden may be as high as 729 (2 444 548/604 983 × 12 months/8 months of the study).
findings from ours. It also interesting that this comprehensive report found that non-collision injuries occurred mostly in urban areas with speed limits of 30 mph (94%), a higher proportion than the average of 83% for all injuries on buses. An Austrian study⁷ showed that 32% of the fatal and serious injuries that were incurred in buses were attributable to non-collision incidents; this figure was 50% in Germany where 70% of cases were attributable to emergency braking and 72% of the casualties were older than 55 years. US data from reports of the American Public Transportation Association (APTA) Report⁵ and the Bureau of Transportation Statistics (BTS)⁶ show an equally alarming number of injuries: there were 3205 in buses and 15 850 in all forms of non-collision public transportation incidents. The BTS report for the year 2000⁶ listed 19 847 non-collision motorbus incidents, including eight fatalities and 20 967 injuries. Relative to the populations of the US and Israel, this number is lower than the extrapolated number for Israel (population ratios of 290 542 869/6 000 000 = 44, injury ratios 20 967/729 = 29).

A study of the Dutch Institute for Road Safety from 1993⁶ found that some 2300 persons are treated in Dutch hospitals because injuries occurring in buses, of which 1200 were not involved in RTAs. DeGraaf and Van Weperen⁷ tested the ability of people to withstand acceleration in buses and trains by producing acceleration forces in four directions (forward, backwards, and laterally) on a treadmill in 22 healthy adults. They used acceleration energies of 0.3–1.6 m/sec² and found that the maximal acceleration at which subjects could still stand declines with age almost linearly. The researchers then looked at the accelerations occurring in public buses in the city of Amsterdam and found values of 1.0–2.0 m/sec². These numbers are significantly higher than the mean values at which most people can remain upright. It seems clear, therefore, that acceleration levels commonly encountered in public buses are greater than those at which an elderly person can keep their balance unless safely seated or holding on to a support. There are over 5000 buses in Israel, with 1900 of them serving municipal Tel Aviv. An average of 1.37 million passengers use public buses daily in the country (personal communication, Chairman of the Road Safety Commission, Ministry of Transportation, Israel). Most of the nation’s buses are comparatively new, they have powerful engines, and they are capable of abrupt starts and stops.

There is also serious overcrowding of metropolitan buses and these vehicles are intentionally designed to have
comparatively few seats and more standing space. This results in a high proportion of passengers who must stand during some or the entire ride, especially during rush hours. Bus drivers’ shifts include a fixed number of “runs”, inevitably motivating them to end a run as fast as possible or, in other words, to drive as fast as possible.

Our data show that there is a need to improve safety of passengers in buses. Improvements have been suggested in several reports, such as that of the UK Department for Transport: that a minimum seat width be specified, that seat spacing be a minimum of 650 mm for all public transport vehicles to meet the needs of accessibility while minimising the reduction in seating capacity, that a minimum separation of 40% of the passenger compartment length of at least two doors be maintained regardless of which side the doors are fitted and whether or not the doors be service or emergency doors, that the emergency door step height be a maximum of 100 mm, that gangway and floor slopes be limited to 8% maximum (thus avoiding the need to restrict the areas in which passengers may stand and assisting with the needs of mobility impaired passengers), that the area in which passengers may stand is no further forward than the rear or centre of the bus, and that handrail provision should be provided throughout the vehicle and not be limited to areas where passengers may stand. The British Vehicle Safety Research Centre report lists further suggestions, for example, texturing floors to prevent slips, prohibiting slopes greater than 3° in the bus, minimising steps, adding visual cues to any floor obstructions, minimising the height of the initial step into and out of the bus, configuring the interior of the bus with minimal hard and sharp protrusions (much like what is already the case with private cars), and ensuring more lenient timetables for drivers that will obviate the need to hurry and thus reduce abrupt accelerations and decelerations. The same report stated that 90% of complaints from injured passengers put the blame on the driver, but it is also important to recognise that drivers are under considerable strain because high levels of traffic congestion, pressure to keep to timetables, and being the single operator of a complex machine. The legislators of the UK are to be congratulated for enacting a Public Service Vehicle Accessibility Regulations law (January 2001), which provides for improved access to buses and better overall design, such as low floors, priority seats, and space for wheelchairs.

A useful way to depict the potential interventions involved in managing this problem, is by using the Haddon injury prevention matrix (available on line http://www.emjonline.com/supplemental).8

Non-collision injuries in public buses cause significant bodily harm that is at least partly preventable with greater attention to bus design and operational details, and the relevant authorities are urged to take appropriate measures. Emergency physicians are urged to regard such injuries as potentially severe, and treat them accordingly, but also to consider reporting them to the relevant authority whenever there seems to be a correctable cause to the incident, such as driver misconduct or mechanical faults in the vehicle.

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The Haddon injury prevention matrix is available on line (http://www.emjonline.com/supplemental).

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