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Circumstances

A 1984 Ford Econoline van, configured for 19 passengers, struck a 1984 Lincoln Town Car. The collision destroyed the front structure of both vehicles, with rearward structural collapse 20 inches at the right front of the van and 28 inches at the left front of tne Lincoln.

The impact resulted in fatal injuries to the unrestrained 55-year-old woman driving the Lincoln and serious injuries to the unrestrained 24-year-old woman van driver. One of the correctly lap belted van passengers, a 6-year-old girl seated at the extreme left rear position, sustained cervical fractures, head injuries, and massive internal injuries which proved fatal. Five of the remaining 6 correctly lap belted van passengers, all 6- or 7-year-olds, sustained serious to critical injuries which varied from pelvic fractures with abdominal injuries to head injuries. The 5 children who were not wearing lap belts received only minor injuries. This was not a severe impact for the van.

This case should be compared with No. 4 involving a van occupied by lap belted and unrestrained teenagers, with similar results.

To the extent that the lower framework of the bench seats in this van deformed forward, it probably greatly helped to reduce the injury of the children, due to energy dissipation over a much greater distance than would have been allowed with rigid, non-deforming framework.

It is possible that if the lap belt webbing anchors had been mounted on the seat framework, rather than on the floor, the belted children's injuries might have been less severe. By allowing the occupant to "ride down" the impulse as the seats deformed without the floor-anchored webbing pulling the lower body downward, lower forces might have been transmitted to these children's bodies.

Restraint and Injury

Seating location: Driver
Sex: F
Age: 24
Height: 5 feet 5 inches
Weight: 125
Restraint used: None
Proper use? NA

The van driver was not wearing the 3-point lap/shoulder belt provided at her position. Witnesses said that, just before the van went out of control and crashed, the van driver apparently "passed out" and leaned over toward the right side of the van's front passenger compartment. This action would have placed her upper torso rearward of the van's engine cover which was located center front, between the driver's seat and right front passenger's seat. There was extensive forward displacement of the steering wheel rim, at the 12 to 5 o'clock area, along with substantial damage and distortion to the left rear surface of the engine cover. There were depressions in the instrument panel surface at the top center and at the lower left, between the steering column and left side door. The driver's seat was found at its forwardmost adjustment, and the seatback was displaced forward several inches at the top right.

Injuries	AIS	Probable Source
Multiple facial contusions	2	Instrument panel
Multiple small facial lacerations	1	Engine cover
Fractures, left side 1 and 2 ribs	1	Steering assembly
Contusion, left upper chest	2	Steering assembly
Bilatera ulmonary contusions	4	Engine cover and steering assembly
Avulsion fracture, right elbow	3	Engine cover
Contusion, right clavicular area	1	Engine cover
Large laceration, left thigh	2	Engine cover
Multiple contusions, left leg	1	Engine cover, instrument panel
Multiple contusions, right leg	1	Engine cover, instrument panel
Concussion with amnesia	3	Instrument panel
Abrasions, right hand	1	Frontal interior
Abrasions, left hand	1	Frontal interior

This woman required 14 days of hospitalization.

Her injury level would probably not have changed had she been wearing the available 3-point lap/shoulder belt. If she did indeed "pass out" and lean toward the right, the leaning action would have taken her from behind the shoulder strap. Even the amount of pre-impact inboard leaning shown by her contact points would have negated the value of the shoulder strap, leaving only a lap belt to decelerate into. Her head and upper torso would have contacted the steering assembly and instrument panel, while her lower abdomen would have been at the mercy of the lap belt. All things considered, this driver probably rode down the impact as well as could be hoped for in this accident.

Seating location: Bench 1, extreme left
Sex: M
Age: 6
Height: 47 inches
Weight: 48
Restraint used: None
Proper use? NA

There were several inches of forward displacement at the upper right side of the driver's seat back, directly forward of this seating position.

Injuries	AIS	Probable Source
Laceration, right side lower lip	1	Driver's seatback
Abrasion, right side forehead	1	Driver's seatback
Abrasion, right side face	1	Driver's seatback
Abrasion, inner right thigh	1	Driver's seatback

This child was admitted to a local hospital for an unspecified period.

Although this child said that he was wearing the static lap belt provided, the evidence is that he was unrestrained. This child's size would not have allowed him, if belted, to make the contacts which were apparent in the area of his position. Being unrestrained, he was in fact allowed to decelerate into the relatively forgiving rear surface of the driver's seat.

Seating location: Bench 1, inside left
Sex: M
Age: 7
Height: 42 inches
Weight: 61
Restraint used: Lap belt (static)
Proper use? Yes

This boy was wearing a static lap belt at the time of the collision. The system used incorporated a lift-release type of buckle, adjustable on a 37-inch length of webbing, and a latchplate sewn onto a 30-inch length of webbing. Both webbing components were floor anchored and entered the seating area by passing between the junction of the upper and lower cushions. The child related that his lap belt was "snug," positioned low across his hips.

Injuries	AIS	Probable Source
Bilateral pelvic fracture	2	Lap belt
Abrasion, left flank	1	Lap belt
Abrasion, right flank	1	Lap belt
Closed head injury with neurologic defect	3	Driver's seatbase
Contusion/abrasion, bridge of nose and above	2	Driver's seatbase

This child spent 7 days at an area hospital.

This child's injuries can be attributed directly to the lap belt he was wearing. It appears, considering the area and type of pelvic injuries, that the lap belt was worn in what is normally considered to be a proper manner. He sustained a bilateral pelvic fracture caused by decelerating into the belt webbing while his upper torso jackknifed over into a head contact with the rigid base of the driver's seat. Had a lap belt not been worn, this child's deceleration would have been into the rear cushion of the driver's seat, the driver's body, and the surface of the engine cover, and some level of moderate to serious injury could have occurred.

Seating location: Bench 1, extreme right
Sex: M
Age: 7
Height: 4 feet 6 inches
Weight: 60
Restraint used: Lap belt (static)
Proper use? Yes

This boy was wearing the lap belt at his seat. It was similar to the other lap belts in the van. The webbing was floor-anchored. There was substantial forward deformation of the right front seatback, directly in front of this boy's seat.

Injuries	AIS	Probable Source
Comminuted fracture, left iliac wing	3	Lap belt
Contusion, lower abdomen from right pelvic area to left pelvic area	1	Lap belt
Contusion, upper forehead	1	Right front seatback
Abrasion, lower left leg	1	Right front seatback
Abrasion, left calf	1	Right front seatback

This boy was in a hospital for 5 days.

Although the seatback of the bench occupied by this boy and the boy to his left was loaded by the two unrestrained outboard occupants of the second bench, it is not likely that this loading contributed to the injuries sustained by the two boys on the first bench. First, another boy on the first bench, unrestrained, was also subject to this loading but remained largely unhurt. More significantly, three of the four children lap belted on the last bench sustained critical and fatal injuries, yet their seatback was not loaded from behind at all.

This child's serious pelvic injury was the result of the lap belt being worn at the time of impact. Because his height was much greater then that of the child at left position on this bench, his head contact was directed into the upper area of the seatback in front of him (the right front seatback). This area of contact was much more forgiving than the area struck by the lap belted boy to his left. Consequently, this boy on the extreme right suffered no serious head injury. The seatback in front of him deformed forward, allowing a controlled or contained deceleration.

Seating location: Bench 2, extreme left
Sex: M
Age: 7
Height: 45 inches
Weight: 50
Restraint used: None
Proper use? NA

This child was not wearing the static lap belt available at his position. There was extensive forward displacement of the first bench seatback directly in front of this position, along with multiple scuffed areas. Also noted was forward deformation of the lower framework and seatback framework of this occupant's bench (second bench).

Injuries	AIS	Probable Source
Contusion, lower left leg	1	Bench rear framework

This child did not require medical attention. He was fully contained by the bench seat directly in front of him (Bench 1). His single injury, a contusion to his lower left leg, did not require medical attention.

Seating location: Bench 2, extreme right
Sex: M
Age: 7
Height: 47 inches
Weight: 52
Restraint used: None
Proper use? NA

This boy was not wearing the lap belt at his seating position. There was extensive forward deformation of the second bench's lower framework, along with the seatback, at this position. The seatback of the first bench was pushed forward several inches, with scuffed areas on the upholstered rear surface.

Injuries	AIS	Probable Source
Abrasion, lower left leg	1	Rear of bench 1
Contusion, left shoulder	1	Rear of bench 1
Contusion, right thigh	1	Rear of bench 1
Contusion, lower right leg	1	Rear of bench 1
Contusion, right knee	1	Rear of bench 1
Contusion, left knee	1	Rear of bench 1

This child was treated and released at a local hospital.

Seating location: Bench 3, extreme left
Sex: F
Age: 6
Height: 47 inches
Weight: 60
Restraint used: Lap belt (static)
Proper use? Yes

This child was wearing a static lap belt similar to those elsewhere in the van. The bench seat directly in front of this girl was extensively deformed: the lower framework was displaced forward several inches, and the back cushion was pushed forward into contact with the lower cushion. Also, scuffed areas were noted on the upholstered rear surface of the back cushion of the second bench.

Injuries	AIS	Probable Source
Head injury	3	Bench 2 rear framework
Fracture, left iliac crest	2	Lap belt
Contusion, bladder	3	Lap belt
Contusion, right hip	1	Lap belt
Contusion, left iliac crest	1	Lap belt
Abrasion/contusions, lower right leg	1	Bench 2 rear framework
Contusions, lower left leg	1	Bench 2 rear framework
Contusions, right hand	1	Rear surface of bench 2
Contusions, left hand	1	Rear surface of bench 2

This girl was hospitalized for 4 days. Her serious injuries can be attributed to the lap belt. The pelvic injuries strongly suggest proper belt placement.

Seating location: Bench 3, inside left
Sex: F
Age: 6
Height: 46 inches
Weight: 53
Restraint used: None
Proper use? NA

This girl was not wearing the static lap belt at her position. (For discussion of compartment, see bench 3, extreme left.)

Injuries	AIS	Probable Source
Contusion, forehead	1	Bench 2 seatback
Contusion, left thigh	1	Bench 2 lower frame
Contusion, right thigh	1	Bench 2 lower frame

This child was treated and released at an area hospital. This child's deceleration, and that of the small boy on the extreme right, were fully contained by the rear surface of the second bench seatback and only minor abrasions and contusions were sustained by them.

Seating location: Bench 3, extreme right
Sex: M
Age: 6
Height: 45 inches
Weight: 45
Restraint used: None
Proper use? NA

This child was not secured within the static lap belt available at his seating position. He said he had used the belt but that it came unlatched during the impact. The condition of the third bench compartment has been described.

Injuries	AIS	Probable Source
Abrasion, top of scalp	1	Rear of bench 2
Contusion, lower left leg	1	Rear of bench 2
Contusion, right knee	2	Rear of bench 2

This boy was treated and released at a local hospital. See comments on previous child's experience.

Seating location: Bench 4, extreme left
Sex: F
Age: 6
Height: 4 feet 1 inch
Weight: 55
Restraint used: Lap belt (static)
Proper use? Yes

This child was wearing a static lap belt with a lift release type of buckle, adjustable on a 37-inch length of webbing, and a latchplate sewn into a 30-inch length of webbing. Both webbing components entered the seating area from between the junction of the upper and lower seat cushions. The anchor points for both the latchplate and buckle webbing were located almost directly behind the longitudinal centerline of the seating position.

There was structural distortion of this seat's upper and lower framework, along with forward displacement of the back cushion of the third bench. Tubular framework components of both seats (benches 3 and 4) were bent forward several inches; however, the forward displacement of the fourth bench was limited by a spare tire carried unsecured beneath the seat. This spare tire and wheel moved forward during the collision--in effect, supporting the leading edge of the lower cushion and preventing further forward deformation of the framework. The postcrash location of the spare tire was directly beneath the inside left and extreme left positions. Also noted forward of the extreme left position was the inner fender over the left rear tire of the van.

Injuries	AIS	Probable Source
Subdural hematoma	4	Spare tire, inner fender, bench 2 lower frame
Subarachnoid hemorrhage	3	Spare tire, inner fender, bench 2 lower frame
Loss of consciousness	5	Spare tire, inner fender, bench 2 lower frame
Laceration, small bowel	5	Lap belt
Laceration, colon	5	Lap belt
Torn mesentery	4	Lap belt
Serosal tear	4	Lap belt
Retroperitoneum hematoma	3	Lap belt
Bilateral pulmonary contusions	3	Lower cushion frame, spare tire, inner fender
Cervical axial dislocation (quadriplegic)	5	Lower cushion frame, spare tire, inner fender
Small contusion, left cheek	1	Lower cushion frame, spare tire, inner fender
Contusion (6 inch x 6 inch) left hip	2	Lap belt
Contusion, left arm	1	Undetermined
Contusion, lower right leg	1	Bench 3 lower frame
Abrasion, lower right leg	1	Bench 3 lower frame
Contusions, lower pelvis	1	Lap belt

This child never regained consciousness. She was treated, with the aid of life-support equipment, for 3 days before being pronounced dead.

The injuries sustained as a result of lap belt usage by this child proved fatal. The injury severity was increased by the presence of an unsecured spare tire and wheel, which moved forward at impact to a position beneath and forward of this occupant. The jackknifing action over the lap belt accelerated the child's head into violent contact with the tire and wheel, resulting in brain and spinal injury. The lap belt itself penetrated her abdomen, resulting in massive internal trauma. The movement of the spare tire blocked the downward collapse of the lower seat cushion, presenting a rigid surface which resulted in compression of the child's chest and pulmonary contusions.

The location and type of abrasions and contusions to this child's pelvic area seem to indicate that the lap belt was positioned in an area generally considered to be proper. The type and location of her internal injury reinforce that indication. Insufficient evidence prevents an adequate assessment of belt tension.

Seating location: Bench 3, inside left
Sex: M
Age: 6
Height: 4 feet 2 inches
Weight: 50
Restraint used: Lap belt (static)
Proper use? Yes

This child was restrained by a static lap belt similar to others in the van. For compartment description, see previous occupant.

Injuries	AIS	Probable Source
Contusion w/hematoma, forehead	1	Bench 3, spare tire
Subarachnoid hemorrhage	3	Bench 3, spare tire
Severe brain stem injury	5	Bench 3, spare tire
Bilateral fractures of iliac crests	2	Lap belt
Contusion, left lower abdomen	1	Lap belt
Contusion, right lower abdomen	1	Lap belt
Contusion, right ankle	1	Bench 3
Abrasion, right tibia area	1	Bench 3
Abrasion, left tibia area	1	Bench 3

This boy received initial care for 2 days at an area hospital before being transferred for long term care.

His injuries can also be attributed directly to the lap belt worn at the time of impact. Without the lap belt, there would have been no downward acceleration of his head into the spare tire and wheel or the lower framework of the third bench seat.

The nature of the child's pelvic injuries seems to indicate proper belt placement. Evaluation of belt tension was not possible, due to lack of evidence.

Seating location: Bench 4, inside right
Sex: M
Age: 6
Height: 4 feet 9 inches
Weight: 54
Restraint used: Lap belt (static)
Proper use? Yes

This child was restrained by a static lap belt similar to others in the van. For compartment description, see previous occupant.

Injuries	AIS	Probable Source
Subarachnoid hemorrhage, posterior fossa	3	Rear of bench 3
Subarachnoid hemorrhage, cranial/ cervical junction	3	Rear of bench 3
Spinal cord contusion (quadriplegic)	5	Rear of bench 3
Perforation of small bowel	5	Lap belt
Contusion w/hematoma, cecum	3	Lap belt
Abrasion/contusion, lower abdomen	3	Lap belt
Contusion w/hematoma, forehead	2	Rear of bench 3

This boy spent an extended period at a local hospital and then he was transferred to an extended care facility.

The location of the boy's intra-abdominal injuries are approximately in line with the top of the iliac crests, as could be expected due to loading if the belt rode up over the crests. If the belt had been improperly positioned prior to the force loading, the intra-abdominal injuries would have been to organs located higher up in the abdominal cavity. Thus, it appears the boy was wearing the lap belt correctly and that his serious to critical injuries were induced by it.

This child's height allowed his head, during a violent jackknifing induced by the lap belt, to make violent contact with the lower framework of the third bench seat and resulted in serious head injury along with spinal cord damage that rendered him quadriplegic.

Seating location: Bench 4, extreme right
Sex: F
Age: 6
Height: 4 feet 2 inches
Weight: 50
Restraint used: Lap belt (static)
Proper use? Yes

This child was wearing a static lap belt similar to others in the van. There were several inches of forward deformation at the right side lower framework of the fourth bench. The tubular frame members were bent forward to a point of contact between the bench's leading edge frame and the inner fender of the right rear tire. The back cushion of this bench was displaced forward by several inches at its top.

Injuries	AIS	Probable Source
Abrasion, right side forehead	1	Right side inner fender
Abrasion, right side face	1	Right side inner fender
Full depth laceration of tongue	2	Right side inner fender
Contusion, right side pelvis	1	Lap belt
Contusion, left side pelvis	1	Lap belt
Unspecified leg injury	7	Undetermined

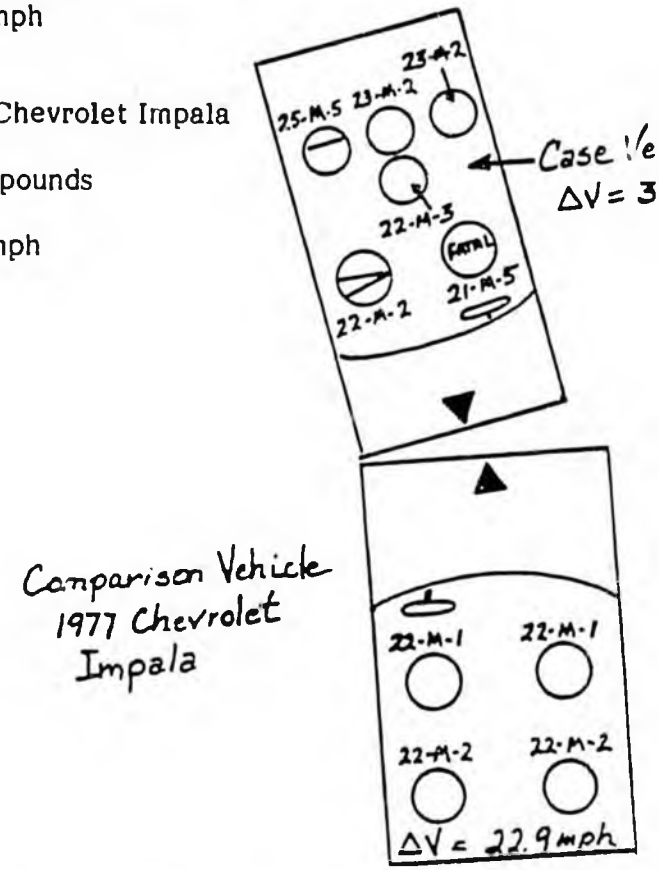
This girl was hospitalized for 2 or 3 days.

She was afforded some degree of deceleration by the interior sidewall of the van and did not sustain serious to critical injuries comparable to the other lap belted children in the van. Had she been unbelted, she probably would have sustained a moderate to serious level of injury, since the van's seating configuration did not provide containment for the position.

The Safety Board concludes that if the unbelted children in this case had been wearing the available lap belts, they probably would have sustained injuries similar to those sustained by the lap belted children. Considering the injuries sustained by the lap belted children (head, spine, and intra-abdominal), the Board concludes they would have fared much better if they had been restrained by lap/shoulder belts.

CASE 24 (ATL-85-H-OR21)

Case vehicle:	1979 VW Rabbit, 4-door
Case vehicle weight:	2,900 pounds
Case vehicle Delta V:	35.5 mph
Comparison vehicle:	1977 Chevrolet Impala
Comparison vehicle weight:	4,500 pounds
Comparison vehicle Delta V:	22.9 mph



Circumstances

A 1979 VW Rabbit struck a 1977 Chevrolet Impala head-on. The Delta V for the VW was 35.5 mph, and for the Impala, about 23 mph. Both vehicles were substantially damaged, with rearward structural collapse reaching depths of 26 inches on the VW and 34 inches on the Chevrolet.

The small 5-passenger Rabbit was occupied by six men, with restraints in use by the right front and right rear passenger. None of the four 22-year-old men in the Chevrolet were restrained.

The unrestrained driver of the VW sustained fatal injuries. His lap/shoulder belted right front passenger escaped with only minor 1/ injuries. The lap belted right rear passenger received critical internal injuries, including ruptures of the aorta and colon, along with a fracture of his 3rd lumbar vertebra. The aorta damage required a 3-inch graft repair and the colon injury necessitated removal of more than 1 1/2 feet of damaged intestine. Injuries to the remaining three occupants of the VW's rear seat, all unbelted, were minor to moderate.

The four unrestrained male occupants of the Chevrolet sustained minor to moderate injuries. All were treated and released from a local hospital without further treatment.

Restraint and Injury

Seating location: Driver (VW)
Sex: M
Age: 21
Height: 5 feet 10 inches
Weight: 170
Restraint used: None
Proper use? NA

This driver was not wearing the available 3-point lap/shoulder belt. There was substantial rearward deformation of the instrument panel and steering assembly forward of the driver's seat. While the entire frontal area was compressed rearward, the steering wheel and column were pushed upward, with the lower rim circumference displaced forward by several inches. The driver's seatback showed massive structural distortion, primarily confined to the left side of the framework.

Injuries	AIS	Probable Source
Multiple head injury	5	Head liner above windshield
Open fracture, right femur	3	Compressed frontal interior
Fractured pelvis	2	Compressed frontal interior
Cervical injury (unspecified)	7	Force through head impact
Chest injury (unspecified)	7	Steering assembly

1/ This man had one AIS 2 (moderate) injury--a chest contusion from the shoulder belt. However, it is classified as AIS 2, rather than AIS 1 (minor) only because of its size (greater than 50-square cm). All his other injuries were minor.

This man was found without vital signs at the accident scene. He probably would have survived if he had been properly restrained by the available lap/shoulder belt. There was sufficient survivable space at his position to make this possible. Although some level of moderate to serious injuries would have been expected, partially due to seatback loading, they probably would have been similar to those of his restrained right front passenger.

Seating location: Right front (VW)
Sex: M
Age: 22
Height: 5 feet 7 inches
Weight: 160
Restraint used: Lap/shoulder belt (ELR)
Proper use? Yes

This occupant was wearing a 3-point, continuous loop, lap/shoulder belt with an ELR sensitive to webbing motion, a free-sliding latchplate, and a push-to-release type of buckle mounted to a rigid stalk. There was extensive rearward displacement of the frontal interior at this seat position. The extreme right side instrument panel, along with the right side A pillar, was compressed rearward several inches due to the impact force. There was also substantial distortion of this seat's lower and back framework, with forward displacement of the upper left side of the back cushion, due to loading by the rear seat passengers.

Injuries	AIS	Probable Source
Abrasion/contusion, extending from right neck to left chest	2 (size)	Shoulder belt
Laceration, left elbow	1	Instrument panel
Laceration, left wrist	1	Instrument panel
Laceration, left hand	1	Instrument panel
Contusion, abdominal area	1	Lap belt
Contusion, right knee	1	Lower instrument panel
Contusion, left knee	1	Lower instrument panel
Sprain, right foot	1	Below instrument panel

This fully restrained passenger rode down the impact forces with a much lower level of injuries than could be expected in a collision of this severity. His major injury was an AIS 2 contusion which resulted from the restraint shoulder strap. Had he been unrestrained, the expected injury from violent impacts with the A pillar and other frontal interior components could have been fatal. The restraint system's performance at the right front position was excellent.

Seating location: Left rear (VW)
Sex: M
Age: 23
Height: 6 feet
Weight: 175
Restraint used: None
Proper use? NA

This man was not wearing the available lap belt. There was extensive compartmental distortion which included several inches of forward displacement of the driver's seat framework. Both the upper and lower bench cushions of the rear seat were substantially deformed, at least partially due to impact from cargo stored behind the rear seat.

Injuries	AIS	Probable Source
Fractured right foot	2	Driver's seat framework
Laceration (3 inch), right knee	1	Driver's seat framework
Laceration, right foot	1	Driver's seat framework
Contusion, right foot	1	Driver's seat framework
Multiple unspecified abrasions	1	Driver's seat framework
Contusion, lip	1	Driver's seat framework
Contusion, left foot	1	Driver's seat framework

This passenger was treated and released at a local hospital emergency room. His forward reactive travel was contained by the rear surface of the driver's bucket seat. While it cannot be determined how much this contact contributed to the driver's injuries, it can be stated that it prevented serious injury to the subject passenger.

Had this passenger been restrained by the lap belt, his injury level could have reached comparable severity to that of the lap belted right rear passenger and to that of other young men lap belted in a Delta V 35-40 mph crash (Case 4).

Seating location: Center rear, on lap (VW)
Sex: M
Age: 22
Height: 5 feet 8 inches
Weight: 160
Restraint used: None
Proper use? NA

This man was seated on the lap of another man at the center rear and, consequently, had no restraint available. Inspection of this compartment area revealed extensive distortion to both the rear seat cushions and the framework of the front seats. The back cushion of the rear seat was deformed forward several inches, due to displaced cargo positioned behind it prior to the crash, and the inboard side of the left front seatback was pushed forward.

Injuries	AIS	Probable Source
Abrasion, forehead	1	Left front seat framework
Closed head injury with defect	3	Left front seat framework
Laceration, right hand	1	Left front seat framework
Unspecified intra-abdominal injury	7	Left front seat framework

This man required more than 2 weeks of hospitalization and lost more than 5 weeks of work. His injuries were undoubtedly made worse by loading from the man whose lap he was sitting on. Furthermore, his forward reactive travel could be only partially contained by the front bucket seats, due to the open space between the seatbacks. Consequently, his head was free to move between the seatbacks to a point of violent deceleration.

Seating location: Center rear (VW)
Sex: M
Age: 23
Height: 5 feet 10 inches
Weight: 175
Restraint used: None
Proper use? NA

This passenger was riding unrestrained with an adult male sitting on his lap. Substantial compartmental distortion was noted at this seat position, with both the back cushion of the rear seat and back framework at the front seats deformed forward several inches.

Injuries	AIS	Probable Source
Displaced fracture, left mandible	2	Front seat framework or man on lap
Large contusion, left face	2	Front seat framework or man on lap
Contusion, left forehead	1	Front seat framework or man on lap
Abrasion, left cheek	1	Front seat framework or man on lap
Contusion, nose	1	Front seat framework or man on lap
Contusion, left ribs	1	Front seat framework or man on lap
Contusion, left knee	1	Front seat framework or man on lap
Contusion, right knee		Front seat framework or man on lap

This man spent an unspecified period in the hospital. He lost approximately 30 days of work. His forward reactive travel was contained and cushioned by the occupant seated on his lap; therefore, use of the available static lap belt would probably not have increased nor reduced his minor to moderate injuries.

Seating location: Right rear (VW)
Sex: M
Age: 25
Height: 5 feet 8 inches
Weight: 185
Restraint used: Lap belt (ALR)
Proper use? Yes

This man was restrained by a lap belt that incorporated an ALR, a sewn-in latchplate attached to the retractable webbing, and a pushbutton release type of buckle. The buckle webbing entered the seating area by passing between the junction of the upper and lower seat cushions, at a point 17 inches inboard from the right interior sidewall, while the latchplate webbing entered from between the right interior sidewall and the lower bench. The buckle webbing was 13 inches long, and the latchplate webbing was 30 inches long. There was extensive deformation of the bench seat framework at this position. The rearmost framework of the lower cushion was distorted forward and up, resulting in the seat cushion angling downward at the front edge. The framework of the right front bucket seat was also extensively deformed directly forward of this seating area. Lower framework components of that seat were displaced forward and up, while the back cushion was pushed forward several inches.

Injuries	AIS	Probable Source
Small contusion, left side head	1	Right front seatback
Ruptured aorta (common iliac, 3-inch graft required)	5	Lap belt
Ruptured colon (18 inches removed)	5	Lap belt
Fracture, 3rd lumbar vertebra	3	Lap belt
Laceration, from behind left kidney around to left side of abdomen	2	Lap belt
Contusion across abdomen	2	Lap belt
Head injury, with amnesia, 6-7 days unconscious	5	Impact force

This man spent an extended period in area hospitals; as of 5 1/2 months after the crash, he had not returned to service with the armed forces.

His critical internal injuries can be attributed directly to the lap belt. While medical records were not obtained for detailed injury location description, the verbal descriptions given by the victim and family members seem to indicate that the lap belt penetrated his abdominal cavity above that area which is generally considered as proper lap belt placement. This location of penetration does not necessarily mean that the lap belt's preimpact placement was improper. His lower pelvic area was forced forward, due to rear compartment cargo deforming the bench seat lower framework at the cushion junction. The forward edge of the lower cushion was also deformed downward. The combined effects of the seat framework distortion would contribute to some degree of submarining by the occupant. This analysis is reinforced by consideration of his injuries, which appear to start low at the frontal abdominal area and rise to the level of the 3rd lumbar vertebra at the rear.

It is not known whether his loss of consciousness was due to a forceful head impact or was the result of hypoxia.

Had this passenger not been restrained by the lap belt, but by a properly fitted lap/shoulder belt, the life-threatening internal injuries would not have occurred.

Seating location: Driver (Chevrolet)
Sex: M
Age: 22
Height: 6 feet
Weight: 170
Restraint used: None
Proper use? NA

This driver was not wearing the available lap/shoulder belt at his position. There was no compartment compression at this position, but extensive forward deformation occurred to the instrument panel and steering assembly. The steering wheel rim and hub were displaced forward and toward the left interior, in line with the impact force. The plastic and vinyl instrument panel components were broken and deformed.

Injuries	AIS	Probable Source
Abrasion, left eyebrow area	1	Windshield
Small laceration, left eyebrow area	1	Windshield
Abrasion, left elbow	1	Instrument panel
Abrasion, left knee	1	Instrument panel
Abrasion, right knee	1	Instrument panel
Sprained right wrist	1	Instrument panel
Numerous contusions, chest area	1	Steering assembly
Small laceration, right neck	1	Broken panel component
Contusion, center forehead	1	Windshield

He was treated and released at a local hospital emergency room. There was no work loss as a result of his injuries.

(See comments at the end of this case summary.)

Seating location: Right front (Chevrolet)
Sex: M
Age: 22
Height: 6 feet 5 inches
Weight: 175
Restraint used: None
Proper use? NA

This man was not wearing the 3-point lap/shoulder belt provided at his position. There was extensive forward deformation of the instrument panel forward of and inboard from this seat position. An area of windshield damage, broken with a "spiderweb" effect, was found slightly inboard and forward of the approximate centerline of this position.

Injuries	AIS	Probable Source
Multiple abrasions/lacerations, face	1	Windshield
Sprained right shoulder	1	Instrument panel
Abrasions, left arm	1	Instrument panel
Small laceration, left hand	1	Instrument panel
Abrasion, right wrist	1	Instrument panel
Small lacerations, left knee	1	Instrument panel
Abrasion, left knee	1	Instrument panel
Small laceration, right knee	1	Instrument panel

He was treated and released at a local hospital and returned to work immediately.

(See comments at the end of this case summary.)

Seating location: Left rear (Chevrolet)
Sex: M
Age: 22
Height: 6 feet
Weight: 180
Restraint used: None
Proper use? NA

This man was not wearing the lap belt provided at his position. The front bench seatback was across its entire width. In addition, scuffs were noted on the vinyl material covering the B pillar forward and left of this position.

Injuries	AIS	Probable Source
Small laceration, right eyebrow	1	Rear of front seat
Abrasions to forehead	1	B pillar
Unspecified head injury	2	B pillar
Laceration, left elbow	1	Interior sidewall
Fracture, left radius	2	Interior sidewall and B pillar
Fracture, left ulnar	2	Interior sidewall and B pillar
Small laceration on scalp	1	Interior sidewall and B pillar
Four fractured teeth	1	Interior sidewall and B pillar

He was treated and released at an area hospital and stayed home from work for 1 day.

(See comments at the end of this case summary.)

Seating location: Right rear (Chevrolet)
Sex: M
Age: 22
Height: 6 feet 5 inches
Weight: 190
Restraint used: None
Proper use? NA

This man was not wearing the lap belt provided at his seat position. There was extensive forward deformation of the front seatback framework across its entire width. Numerous scuffs were also noted on the vinyl upholstery covering the rear of the front seatback.

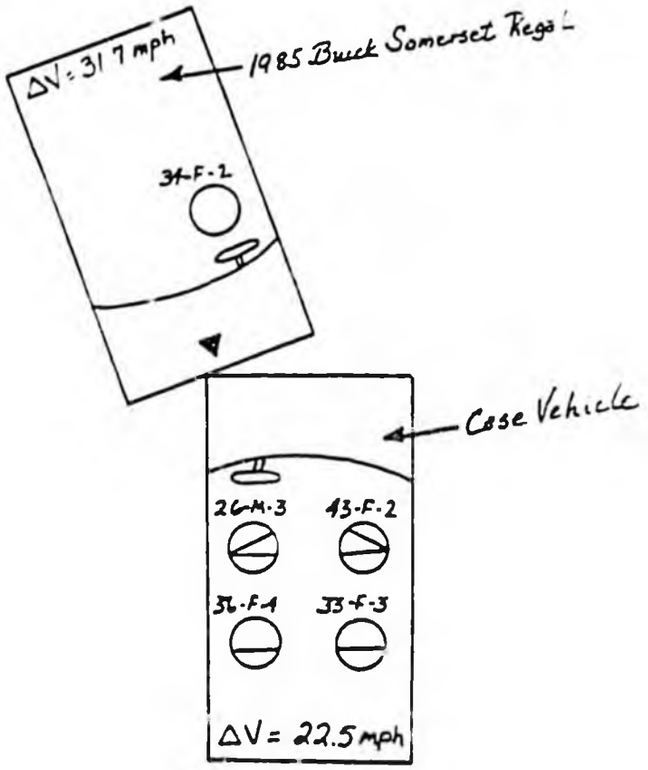
Injuries	AIS	Probable Source
Abrasion, mid-forehead	1	Rear of front seat
Contusion, left wrist	2	Rear of front seat
Comminuted fracture, left radius	2	Rear of front seat
Fracture, left ulnar styloid process	2	Rear of front seat
Laceration, right hand	1	Interior objects
Contusions, left arm	1	Rear of front seat
Contusion, left knee	1	Rear of front seat
Laceration, left foot	1	Front seat lower framework
Laceration, left cheek	1	Front seat framework

He was treated and released at a local hospital and was able to return to work.

The unrestrained occupants of the Chevrolet did not suffer any life-threatening injuries. All were treated and released at a local hospital; the major injuries were AIS 2 fractures to the rear seated passengers. Forward reactive travel was contained well by the vehicle interior. It would be difficult to say that the front seat occupants could have come out any better if they had been restrained by the available lap/shoulder belts. Given the experience of other rear seat occupants in this study, the Safety Board thinks that the rear seated passengers could have sustained serious restraint-related injuries had they been wearing the available lap belts. This is a more difficult assessment in this case than in some others, since the Delta V of approximately 23 mph places the expected crash force injury in an area of ambiguity. Especially for large cars, the crash injury level for 20 to 25 mph collisions is more unpredictable. However, in this case it can be stated with certainty that the rear seat occupants rode down the crash forces very well by containment only.

CASE 25 (MKC-86-H-OR01)

Case vehicle: 1981 Ford Fairmont station wagon
Case vehicle weight: 3,583 pounds
Case vehicle Delta V: 22.5 mph



Circumstances

A 1981 Ford Fairmont station wagon was struck on the left front corner by the center front of a 1985 Buick Somerset Regal. Both vehicles received substantial front structural damage, with rearward collapse reaching over 30 inches at the Ford's left front and over 23 inches at the left side front of the Buick.

The Ford station wagon was being driven by a 26-year-old man who was wearing the lap/shoulder belt provided at his position. Occupants of the Ford included a 40-year-old female right front passenger, also fully restrained by a lap/shoulder belt, along with a 36-year-old female left rear and 33-year-old female right rear passengers. Both rear seat passengers were wearing the available lap belt restraints. The 34-year-old woman driving the Buick was unrestrained.

The collision resulted in moderate injuries to the Ford's driver and right front passenger. The lap belted left rear Ford occupant sustained serious injuries, including a severely avulsed small bowel mesentery which required a resection of more than 30 inches, due to multiple areas of torn mesentery. The right rear occupant suffered multiple fractures of the lumbar vertebrae. Injuries sustained by the Buick driver were moderate.

Restraint and Injury

Seating location: Driver
Sex: M
Age: 26
Height: 5 feet 10 inches
Weight: 205
Restraint used: Lap/shoulder belt (ELR)
Proper use? Yes

This man was wearing the 3-point, continuous loop, lap/shoulder belt with an ELR, a free-sliding latchplate, and a pushbutton release type of buckle attached to a flexible stalk. The ELR was sensitive to vehicle motion and did not have a tension relief mechanism. The steering assembly was deformed outboard due to front structural collapse, and the lower instrument panel was distorted.

Injuries	AIS	Probable Source
Laceration (4 cm), right knee	1	Lower instrument panel
Fracture, right tibial plateau	2	Lower instrument panel
Comminuted fracture, right radius	3	Steering assembly
Contusion, central chest area	1	Shoulder strap
Contusion, lower left leg	1	Lower instrument panel

This man spent 3 1/2 days in an area hospital and lost 6 1/2 days of work.

(See comments at the end of this case summary.)

Seating location: Right front
Sex: F
Age: 40
Height: 5 feet 6 inches
Weight: 170
Restraint used: Lap/shoulder belt
Proper use? Yes

This woman was wearing a lap/shoulder belt similar to the driver's. The lower instrument panel was distorted forward of her seat position.

Injuries	AIS	Probable Source
Contusion, left lower chest	1	Shoulder strap
Contusion, across entire abdomen	2	Lap belt
Abrasion, left flank	1	Lap belt buckle
Contusion, left mid forearm	1	Steering wheel
Contusions and abrasions, right knee	1	Lower instrument panel
Contusions and abrasions, left knee	1	Lower instrument panel
Contusion, right side neck	1	Shoulder strap

This woman was treated at the emergency room of a local hospital for several hours before being released. She was unable to work for 9 days.

Seating location: Left rear
Sex: F
Age: 36
Height: 5 feet
Weight: 160
Restraint used: Lap belt (ALR)
Proper use? Yes

This woman was wearing a lap belt with an ALR, a sewn-in latchplate attached to a 35-inch length of retractable webbing, and a pushbutton release type of buckle attached to a length of webbing extending 8 inches through the junction of the bench seat cushions. There was no deformation of the passenger compartment at this position. The plastic covering of the lap belt retractor was broken, due to force loading. This woman said her belt was about her abdomen with a "snug" tension.

Injuries	AIS	Probable Source
Contusion, left triceps	1	Left sidewall
Abrasion, distal right tibia	1	Rear surface driver's seat
Abrasion/contusion, lower abdomen	2	Lap belt
Avulsion injury, abdominal wall	2	Lap belt
Avulsion injury, abdominal fascia	2	Lap belt
Avulsion injury, small bowel mesentery	4	Lap belt
Abrasion, left iliac crest	1	Lap belt
Abrasion, right iliac crest	1	Lap belt
Large bruise, lower right leg	2	Driver's seat lower frame
Laceration, lower right leg	1	Driver's seat lower frame
Contusion, posterior right thigh	1	Rear seat frame
Contusion, posterior left thigh	1	Rear seat frame

This woman spent 11 days in an area hospital and lost an unspecified number of days' work

(See discussion at the end of this case summary.)

Seating location: Right rear
Sex: F
Age: 33
Height: 5 feet 4 inches
Weight: 118
Restraint used: Lap belt (ALR)
Proper use? Yes

This woman was wearing a lap belt similar to the left rear passenger's. There was no permanent compartment deformation at this seat position. Again, the plastic retractor covering was broken, due to force loading. This woman said she had her lap belt low across her hips and snug.

Injuries	AIS	Probable Source
Fracture, second and third lumbar vertebrae	3	Force through lap belt
Contusion, lower abdomen	1	Lap belt
Contusion, upper left arm	1	Contact with lower extremities
Contusions, lower right leg	1	Rear of front seatback
Contusion, lower back	1	Impact forces

This woman spent 10 days in a hospital before release in a body cast. At the time of the Safety Board investigation (late 1985), she expected the body cast to be necessary for 2 to 6 months.

This crash cannot be considered a severe collision for the Ford occupants. A much higher level of injuries was sustained by each of them than would be expected with a Delta V of approximately 22.5 mph.

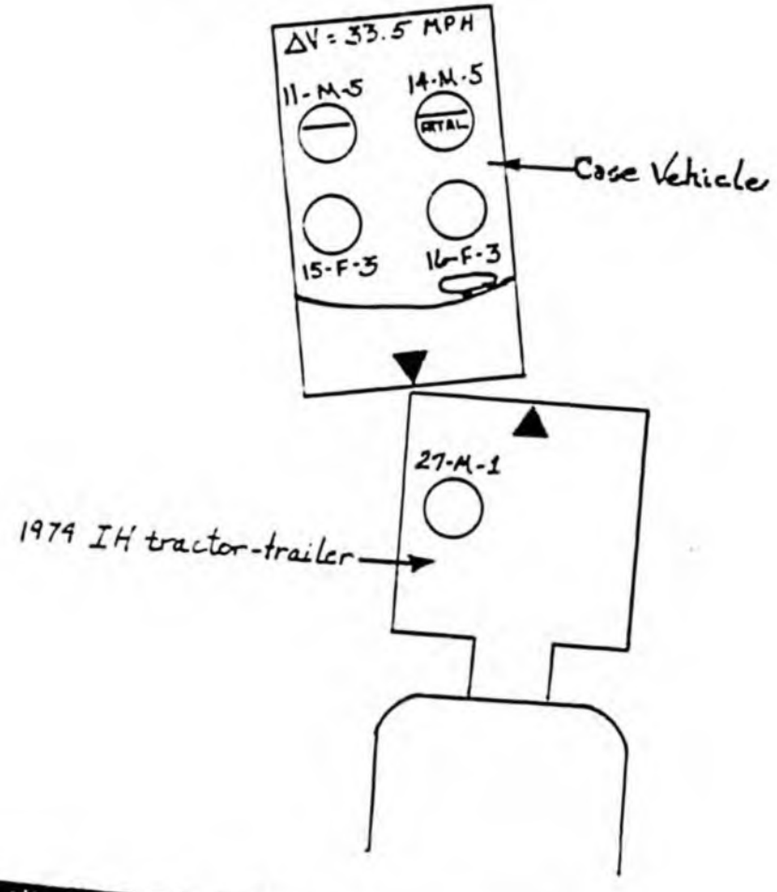
There were no indications of improper belt use. The nature of the Ford's belt systems, both front and rear, should provide a snug tension, with automatic tensioning of the front belts and ALRs on the rear lap belts. The most seriously injured of the Ford's occupants, the woman wearing a lap belt in the left rear, had abrasions on both the right and left iliac crests, indicating a lap belt positioning in the area generally considered to be proper. Yet she sustained an intra-abdominal injury severe enough to require removal of more than 30 inches of small intestine. In addition, a large area of her abdominal subcutaneous tissue was avulsed by the lap belt's penetration.

The other lap belted woman in the rear said she had the belt positioned low and snug. Medical record description of her abdominal contusions and abrasions were not sufficient to make an independent evaluation of proper or improper fit. She received multiple fractures of the mid-lumbar vertebrae, necessitating 10 days hospitalization and the fitting of a body cast for an extended period.

All the documented serious injuries sustained by the rear seated Ford passengers can be attributed directly to the lap belts in use. All but one of the documented injuries not attributed to the lap belts were minor. The non-use of lap belts by these two women might have resulted in a few additional contusions, as the impact forces were contained by the rear surface of the front bench seat. The serious internal and spinal injuries would not have occurred, however. Properly fitted lap/shoulder belts also would have prevented these injuries.

CASE 26 (NYC-85-H-OR16)

Case vehicle: 1985 Ford Escort, 2-door
Case vehicle weight: 2,824 pounds
Case vehicle Delta V: 33.5 mph



Circumstances

A 1985 Ford Escort struck, center front to left front corner, a 1974 International Harvester semi-truck and trailer. The collision forces completely destroyed the front structure of the Escort, with rearward structural collapse reaching 29 inches at the left front.

The Ford Escort was driven by an unrestrained 16-year-old girl. An unrestrained 15-year-old girl was the right front passenger, a 14-year-old boy was lap belted left rear, and an 11-year-old boy was lap belted in the right rear position. The driver sustained minor abrasions, lacerations, and contusions, deep lacerations of the lower extremities, and an open fracture of the left femur. The right front occupant sustained similar injuries. Both lap belted rear seat passengers sustained massive internal injuries, including torn and avulsed mesentery, avulsed and ruptured intestines, and substantial blood loss. In addition, the 11-year-old boy in the right rear received a lap belt induced fracture of the spinal column, which rendered him paraplegic. The 14-year-old boy in the left rear seat died as a result of his lap belt induced internal injuries before medical treatment could provide repair.

Restraint and Injury

Seating location: Driver
Sex: F
Age: 16
Height: unknown
Weight: 180
Restraint used: None
Proper use? NA

This driver was not using the available lap/shoulder restraint provided at her seat position. There was substantial compartmental compression at this position. Extensive distortion was found, with forward displacement of the steering assembly and rearward displacement of the instrument panel, A pillar, and lower floor components.

Injuries	AIS	Probable Source
Superficial abrasion, left forehead	1	A pillar
Small laceration, bridge of nose	1	A pillar
Unspecified contusion, chest	1	Steering assembly
Unspecified abrasion, chest	1	Steering assembly
Contusion/abrasion, abdomen	1	Steering assembly
Unspecified contusion/abrasion, both hands	1	Instrument panel
Avulsion, right leg below knee	2	Instrument panel
Open fracture, left femur	3	Instrument panel

She was admitted to a local hospital for an unspecified period. Although the fractured femur is classified as a serious injury (AIS 3), it was not life-threatening.

Seating location: Right front
Sex: F
Age: 15
Height: 5 feet 3 inches
Weight: 150
Restraint used: None
Proper use? NA

This girl was not wearing the available lap/shoulder restraint provided at her seat position. An inspection of the Escort's right frontal interior revealed extensive distortion of the instrument panel.

Injuries	AIS	Probable Source
Small lacerations, forehead	1	Windshield
Abrasion, left chest wall	1	Instrument panel
Laceration, left elbow	1	Instrument panel
Laceration, right elbow	1	Instrument panel
Abrasion, right leg tibia area	1	Instrument panel
Abrasion, left arm	1	Instrument panel
Abrasion, left flank	1	Instrument panel
Abrasion/contusion, left knee	1	Instrument panel
Fracture, right fibula	2	Instrument panel and below
Fracture, left femur	3	Instrument panel and below

This passenger was in a hospital for 13 days. Although an AIS 3 injury was sustained, it was not life-threatening.

Seating location: Left rear
Sex: M
Age: 14
Height: 5 feet 10 inches
Weight: 175
Restraint used: Lap belt (ALR)
Proper use? Yes

This boy was wearing a lap belt with an ALR, a sewn-in latchplate fixed to the retractable webbing, and a pushbutton release type of buckle attached to a short length of webbing. Both webbing components entered the seating area from between the junction of the upper and lower seat cushion. The only compartmental deformation noted was to the lower bench seat cushion, found to be displaced forward approximately 2 inches.

Injuries	AIS	Probable Source
Major abdominal contusion (3 inch x 20 inch)	2	Lap belt
Abrasions, right side abdomen	1	Lap belt
Contusions, lateral left thigh	1	Lap belt
Multiple avulsions, superior mesentery veins	4	Lap belt
Avulsion, superior mesenteric artery	4	Lap belt
Avulsed root of mesentery	4	Lap belt
Avulsion, two sections of small bowel	5	Lap belt
Contusion, scrotum	1	Impact force
Contusions, left hand	1	Compartment sidewall

He survived for approximately 5 hours but died before his internal bleeding could be stabilized. All his injuries, with the exception of a contused left hand, were the result of the lap belt.

Seating location: Right rear
Sex: M
Age: 11
Height: 5 feet 2 inches
Weight: 128
Restraint used: Lap belt (ALR)
Proper use? Yes

This boy was wearing a lap belt with an ALR, a sewn-in latchplate fixed to the retractable webbing, and a pushbutton release type of buckle. Inspection of the interior compartment revealed the lower seat cushion to be displaced forward approximately 2 inches. No other compartmental deformation was noted.

Injuries	AIS	Probable Source
Contusion, nose (septal hematoma)	1	Lower extremities
Bilateral contusions, anterior ribline	1	Lower extremities
Major contusion, lower abdomen	2	Lap belt
Gaping laceration of abdominal muscle	3	Lap belt
Complete avulsion of ileum mesentery	4	Lap belt
Complete avulsion of right colon mesentery	4	Lap belt
Perforation of ileum	5	Lap belt
Perforation of cecum	5	Lap belt
Transection of ileum	5	Lap belt
Transection of cecum	5	Lap belt
Avulsion of mid-sigmoid colon mesentery	4	Lap belt
Serosal degloving of mid-sigmoid colon	4	Lap belt
Fracture, third lumbar vertebra with complete paraplegia	5	Lap belt
Fracture, right thumb	1	Compartment interior

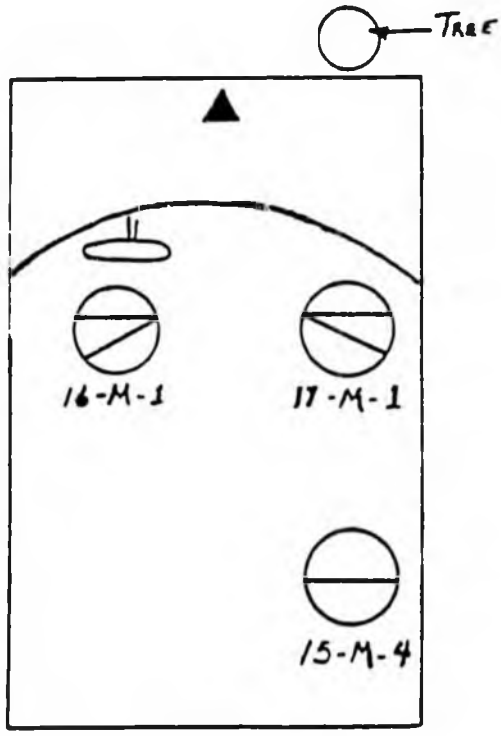
He required 2 months of hospitalization before transfer to an extended care facility for rehabilitation due to the paraplegia.

Both boys lap belted in the rear seat sustained intra-abdominal injuries due to the penetration of that cavity by the lap belts at impact. Descriptive terminology in the left rear passenger's medical records seem to indicate that the lap belt was positioned in the area considered proper. This description places the major belt-related contusion in the lower abdominal region, with related abrasions on lateral aspects of each thigh. The positioning of the right rear passenger's belt, while not as well defined as that of the left rear, also appears to have been proper. The medical description, a transverse contusion, 7-cm wide, at the level of the anterior superior iliac spine, places the belt well within the area considered proper.

Both of the Ford's rear seat passengers underwent their entire deceleration into the 2-inch-wide lap belt. If the crash forces had not been concentrated in this way, but had been spread over a larger area of the body, the severity of these boys' injuries would have been greatly reduced. Lap/shoulder belts would have distributed the crash forces over a wider area of the body.

CASE 27 (SEA-85-H-OR23)

Case vehicle: 1980 Dodge Colt, 2-door
Case vehicle weight: 2,311 pounds
Case vehicle Delta V: 27.7 mph



Circumstances

A 1980 Dodge Colt 2-door sedan struck a tree head-on. The driver was a 16-year-old boy wearing a lap/shoulder belt; the right front passenger was a 17-year-old boy also wearing a lap/shoulder belt; the right rear passenger was a 15-year-old boy wearing a lap belt.

The driver did not receive, nor did he require, any on-scene medical attention. The only injury he reported was a belt abrasion on his left shoulder. However, the two passengers were transported to a hospital. The lap/shoulder belted boy in the right front seat had only minor bruises and was not admitted to the hospital; he was examined and released. The lap belted boy in the right rear seat, however, was admitted with severe injuries; he was hospitalized for 33 days.

Restraint and Injury

Seating Location: Driver
Sex: M
Age: 16
Height: 5 feet 7 inches
Weight: 160
Restraint used: Lap/shoulder belt
Proper use? Yes

This boy was using a continuous loop, lap/shoulder belt with a free-sliding latchplate. There was no evidence of belt malfunction, improper fit, or improper use. He described the fit as "snug." Although the steering wheel was deformed about 2 1/2 inches at the 4 o'clock position, there were no driver injuries that could be related to that deformation. The driver said he had been using seat belts for about 15 months.

Injuries	AIS	Probable Source
Abrasion, left shoulder	1	Shoulder belt

Seating Location: Right front
Sex: M
Age: 17
Height: 5 feet 10 inches
Weight: 135
Restraint used: Lap/shoulder belt
Proper use? Yes

This boy was also using the continuous loop, lap/shoulder belt with a free-sliding latchplate that was provided at his seat. There was no evidence of malfunction, improper fit, or improper use. This boy said that he never wears a seat belt, but that he was "talked into" it on this trip by the rear seat passenger. He was not admitted to a hospital.

Injuries	AIS	Probable Source
Bruise, forehead	1	Instrument panel or A pillar
Strained ankle	1	Floor
Bruise, right shoulder	1	Shoulder belt
Bruise, chest	1	Shoulder belt
Bruise, abdomen (below umbilicus)	1	Lap belt

Seating Location: Right rear
Sex: M
Age: 15
Height: 5 feet 8 inches
Weight: 135
Restraint used: Lap belt (locking latchplate, webbing retractor one unit)
Proper use? Yes

This boy was using a lap belt that has the locking latchplate combined with the webbing retractor in one unit. The retractor automatically takes up webbing slack and the latchplate locks the webbing in place when buckled. There were no defects found in the system. The boy said he was wearing the belt "snug" and that it was routed across the waist but below the navel. He said he had been using seat belts for 12 months before this crash.

Injuries	AIS	Probable Source
Fractured vertebrae (L2, L3)	3	Flexion over lap belt
Perforations (two), small bowel	4	Lap belt and/or retractor
Ruptured spleen	4	Lap belt retractor
Bruise, left hip	1	Lap belt
Bruise, right hip	1	Lap belt
Abrasion, about 1 inch below umbilicus	1	Lap belt

The performance of the front seat lap/shoulder restraints was exceptionally good in this Delta V 27.7 mph crash, especially when compared to the rear seat lap belt. Forces acting at the right front were very similar to those acting at the right rear, allowing a direct comparison of lap/shoulder belt performance to lap-only belt performance. The crash resulted in AIS level 1 injuries at the right front, which required only 1 hour 15 minutes of observation and treatment before that boy was released from medical care. In comparison, the crash induced injuries sustained by the lap belted boy in the right rear position were at an AIS 4 level and required two operations during the course of more than 1 month's hospitalization.

Prompt initial diagnosis and treatment probably would have reduced the period of hospitalization required for the lap belted boy. It appears that, at initial injury evaluation, the attending physician "ruled out" all of the serious injuries that were, in

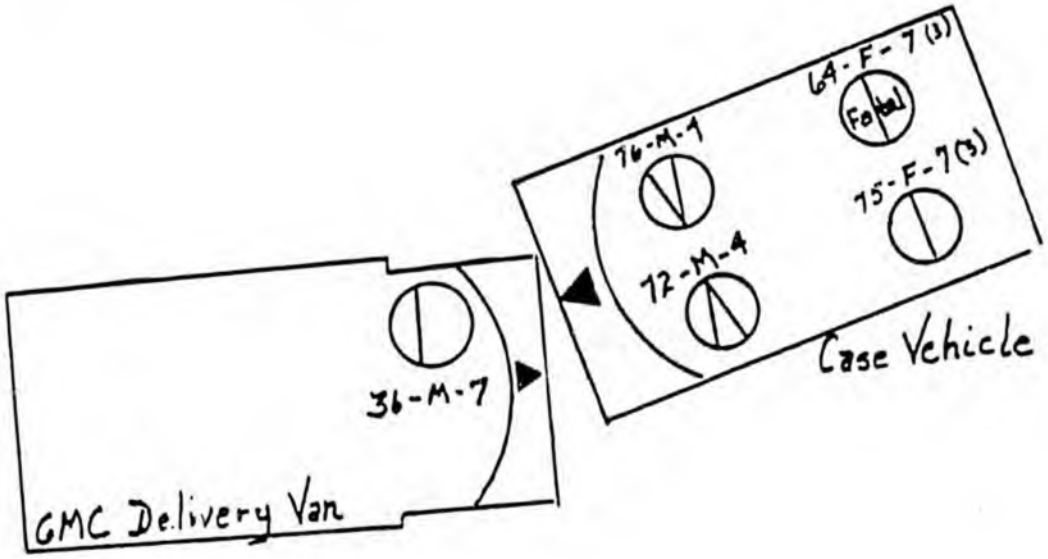
fact, present. As a result, the fractures of two lumbar vertebrae were not identified for at least a day and the major internal organ damage was not identified for nearly 2 weeks following admission to the hospital. From that point, two major operations were required for repair of perforated intestines, severe abscessing, and finally, removal of the damaged spleen.

These internal injuries, and the fractures of the lumbar vertebrae, must be attributed directly to the lap belt used by this boy. It is clear that the major intra-abdominal injuries resulted from compression around the bulky retractor mechanism integral to the latchplate on this system. The design of this component places the retractor directly in the area of all the internal injuries described by the boy's medical records.

If this boy had had available to him, and had been properly wearing, a 3-point lap/shoulder belt, he would not have sustained the spinal injuries or the internal injuries induced by the lap belt.

CASE 28 (SEA-86-H-OR04)

Case vehicle: 1984 Buick Century Custom, 2-door
Case vehicle weight: 3,488 pounds
Case vehicle Delta V: 31.7 mph



Circumstances

A 1982 Buick Century struck front first into the left front of a GMC delivery truck. The Buick was driven by a 72-year-old man wearing a lap/shoulder belt. The right front passenger was a 76-year-old man also wearing a lap/shoulder belt; the left rear passenger was a 75-year-old woman wearing a lap belt; and the right passenger was a 64-year-old woman, also wearing a lap belt.

Both vehicles were disabled by the impact; the Buick received front structural collapse of more than 28 inches.

The collision resulted in unspecified injuries to the lap belted driver of the large truck. Both front seat occupants of the Buick sustained serious myocardial contusions, minor to moderate fractures, and numerous abrasions and contusions. The left rear lap belted occupant sustained injuries to her abdomen, spine, and pelvis which required more than 1 1/2 months of hospitalization and care. The lap belted right rear occupant received injuries to her head, thorax, and abdomen which resulted in her death.

Restraint and Injury

Seating location: Driver
Sex: M
Age: 72
Height: 5 feet 10 inches
Weight: 198
Restraint used: Lap/shoulder belt (ELR)
Proper use? Probably excessive slack due to "windowshade" device

This man was restrained by a 3-point, continuous loop, lap/shoulder belt with an ELR sensitive to vehicle motion, a cinching type of latchplate, and a pushbutton release type of buckle attached to a flexible stalk. A windowshade type of tension relief device was also incorporated into the system. The instrument panel was broken and distorted, with the steering assembly collapsed forward and upward.

Injuries	AIS	Probable Source
Myocardial contusion	4	Steering assembly, shoulder strap
Fractured sternum	2	Steering assembly, shoulder strap
Contusion, across chest	2	Shoulder strap
Fractured toe, right	2	Floor pan, controls
Contusion, right knee	1	Instrument panel
Contusion, left knee	1	Instrument panel
Small lacerations, left hand	1	Instrument panel

This man spent 10 days in a hospital and was released to the care of his personal physician.

It is likely that this man was wearing his shoulder strap with excessive slack by means of the windowshade type of tension relief device, based on the degree of deformation to the steering wheel.

Seating location: Right front
Sex: M
Age: 76
Height: 5 feet 11 inches
Weight: 200
Restraint used: Lap/shoulder belt
Proper use? Yes

This man was wearing a lap/shoulder belt similar to the driver's. It appears likely that he was wearing it properly.

Injuries	AIS	Probable Source
Myocardial contusion	4	Shoulder strap
Fracture, 1st rib, left	1	Impact force
Displaced fracture, left wrist	3	Instrument panel

He required 5 days in a hospital and an unspecified period of outpatient care.

The myocardial contusions sustained by these two lap/shoulder belted men are unusual among the cases investigated by the Safety Board. It is possible that their age contributed to this injury.

Both front seat occupants probably would not have survived if they had not been wearing lap/shoulder belts.

Seating location: Left rear
Sex: F
Age: 75
Height: 5 feet 7 inches
Weight: 170
Restraint used: Lap belt (ALR)
Proper use? Yes

This woman was wearing a lap belt with an ALR, a sewn-in latching tongue attached to the retractable webbing, and a pushbutton release type of buckle attached to a short length of webbing. Both webbing components entered the seating area by passing through the junction of the upper and lower cushions. There was no apparent compression or deformation of the compartment at this position.

Injuries	AIS	Probable Source
Comminuted and displaced fracture, right proximal humerus	3	Compression force
Comminuted nasal fracture	2	Right front seatframe
Bilateral fracture, iliac crests	3	Lap belt
Displaced fracture of spine at L4	3	Lap belt
Retroperitoneal hematoma	3	Lap belt
Blunt abdominal trauma	7	Lap belt
Closed auxiliary nerve injury	7	Unknown
Massive contusion/abrasion lower abdomen	2	Lap belt
Laceration, left iliac crest	1	Lap belt

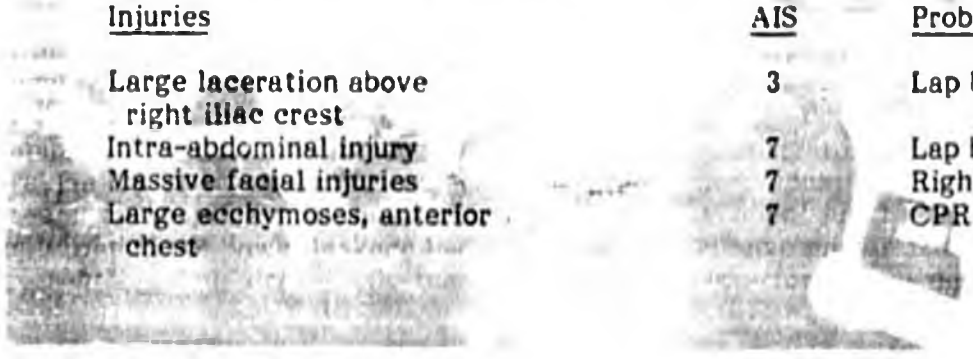
This woman was in the hospital for 20 days before being released to an extended care facility for an additional 3 weeks of treatment.

With the single exception of the upper arm fracture, all of the injuries sustained by this woman can be attributed directly to the lap belt restraint that was worn. These injuries were considered life-threatening by hospital personnel even after 10 days of care, shown by the orders for transfer with life support equipment on board the ambulance. If she had been wearing a properly fitted lap/shoulder belt, she would most likely not have sustained any of these injuries.

Seating location: Right rear
Sex: F
Age: 64
Height: 5 feet 3 inches
Weight: 165
Restraint used: Lap belt (ALR)
Proper use? Probably, with possible belt "ride up"

This woman was wearing a lap belt similar to the one used by the left rear passenger. There were hairs embedded at various points about the rear surface of the right front seat. Body fluids were found on the lap belt webbing.

Injuries	AIS	Probable Source
Large laceration above right iliac crest	3	Lap belt
Intra-abdominal injury	7	Lap belt
Massive facial injuries	7	Right front seatframe
Large ecchymoses, anterior chest	7	CPR



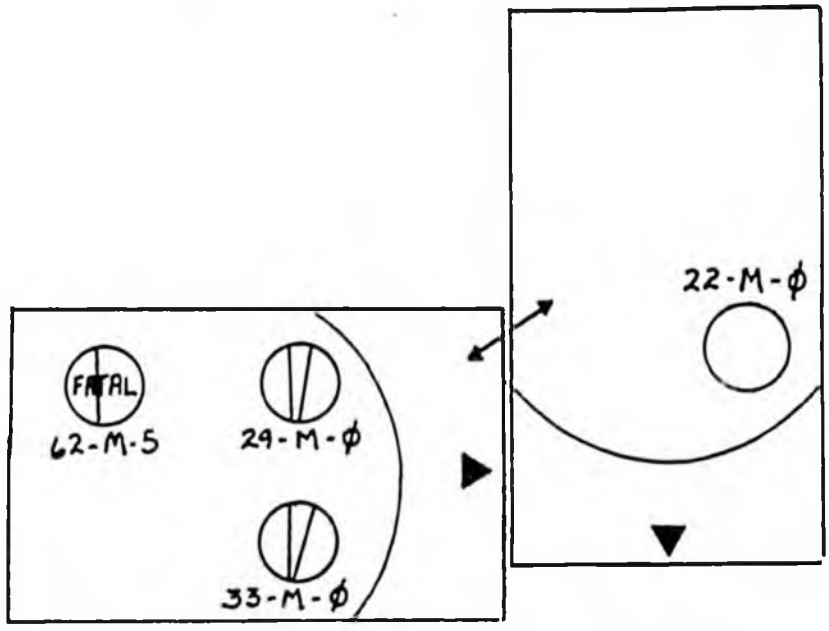
This woman's injuries were evaluated by emergency medical personnel at the accident scene as being "not life-threatening." Her condition deteriorated while enroute to the hospital and she was in full cardiac arrest upon arrival. Revival attempts failed and she was pronounced dead approximately 2 hours after the crash. The medical examiner noted that her death was probably the result of a ruptured great vessel of her heart.

The woman's death probably resulted from injuries sustained as a direct result of the forces transmitted through the lap belt. However, this cannot be stated with certainty, due to the lack of medical information. The forces necessary for fatal intra-abdominal injuries were certainly present, shown by the large gaping laceration completely into her abdominal cavity. Decreasing blood pressure while enroute to the hospital indicates a loss of blood at some point within her system.

This woman almost certainly would have survived if she had been wearing a properly fitted lap/shoulder belt.

CASE 29 (LAX-86-H-OR04)

Case vehicle: 1985 Oldsmobile Firenza, 4-door
Case vehicle weight: 2,968 pounds
Case vehicle Delta V: 25.7 mph



Circumstances

A 1985 Oldsmobile Firenza struck the side of a 1977 Chevrolet Camaro at an intersection. Both vehicles received substantial damage, with rearward structural collapse reaching depths of more than 15 inches at the Oldsmobile front and inward collapse reaching depths of up to 13 inches at the right side of the Camaro.

The unrestrained 22-year-old man driving the Camaro was unhurt, as were the lap/shoulder belted 29-year-old man driving the Firenza and his lap/shoulder belted right front passenger, a 33-year-old man. The 62-year-old man wearing a lap belt in the left rear seat of the Firenza, however, sustained massive intra-abdominal injuries, including multiple lacerations and tears of the small bowel, along with a severe fragmentation fracture of the right iliac wing. This man's injuries proved fatal 39 hours after the crash.

Restraint and Injury

Seating location: Driver
Sex: M
Age: 29
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)
Proper use? Yes

This man was restrained by a 3-point lap/shoulder belt with an ELR sensitive to vehicle motion, a cinching type of latchplate, and a pushbutton type of buckle mounted on a flexible stalk. The system also incorporated a windowshade type of tension relief device.

He sustained no specified injury, other than complaint of "pain."

Seating location: Right front
Sex: M
Age: 33
Height: Unknown
Weight: Unknown
Restraint used: Lap/shoulder belt (ELR)
Proper use? Yes

This man was wearing a lap/shoulder belt similar to that worn by the driver. He also complained only of pain, with no specific injury identified.

Seating location: Left rear
Sex: M
Age: 62
Height: 5 feet 4 inches
Weight: 130
Restraint used: Lap belt (ALR)
Proper use? Yes

This man was wearing a lap belt with an ALR, a sewn-in latchplate attached to the retractable webbing, and a pushbutton type of buckle attached to a short length of webbing. The buckle webbing entered the seating area by passing between the junction of the upper and lower seat cushion, while the latchplate webbing entered from between the lower cushion and interior sidewall. There was no compartment distortion or compression at this seating position.

Injuries	AIS	Probable Source
Fragmented fracture, right iliac wing	3	Lap belt
Torn right iliopsoas muscle	2	Lap belt
Retroperitoneal hemorrhage	3	Lap belt
Complete severance, proximal ileum	5	Lap belt
Large laceration/tear, distal ileum	5	Lap belt
Laceration of omentum	4	Lap belt
Multiple large lacerations, mesentery	4	Lap belt
Gaping tear (1.5 cm), small bowel	5	Lap belt
Extensive contusions, mesentery	3	Lap belt
Contusion, ascending colon	3	Lap belt
Contusion, transverse colon	3	Lap belt
Contusion, descending colon	3	Lap belt
Contusion, right iliac crest	2	Lap belt
Contusion, left iliac crest	2	Lap belt
Contusion, right hip to right flank	2	Lap belt
Contusion, left thigh to knee	2	Interior sidewall
Contusion, left occipital region	2	Interior sidewall

This man was in intensive care for 39 hours at two hospitals before he died from his injuries. A laparatomy was performed approximately 4 hours after his initial admission to a hospital; however, no additional surgery was undertaken, even though blood pressure could not be maintained at adequate levels. At autopsy, approximately 4,000 grams of blood clots were found within his abdominal cavity due to intra-abdominal hemorrhaging. In addition, the autopsy noted hemorrhagic material within his stomach and fecal matter within his abdominal cavity. A blood clot of approximately 300 grams was found in the liver area.

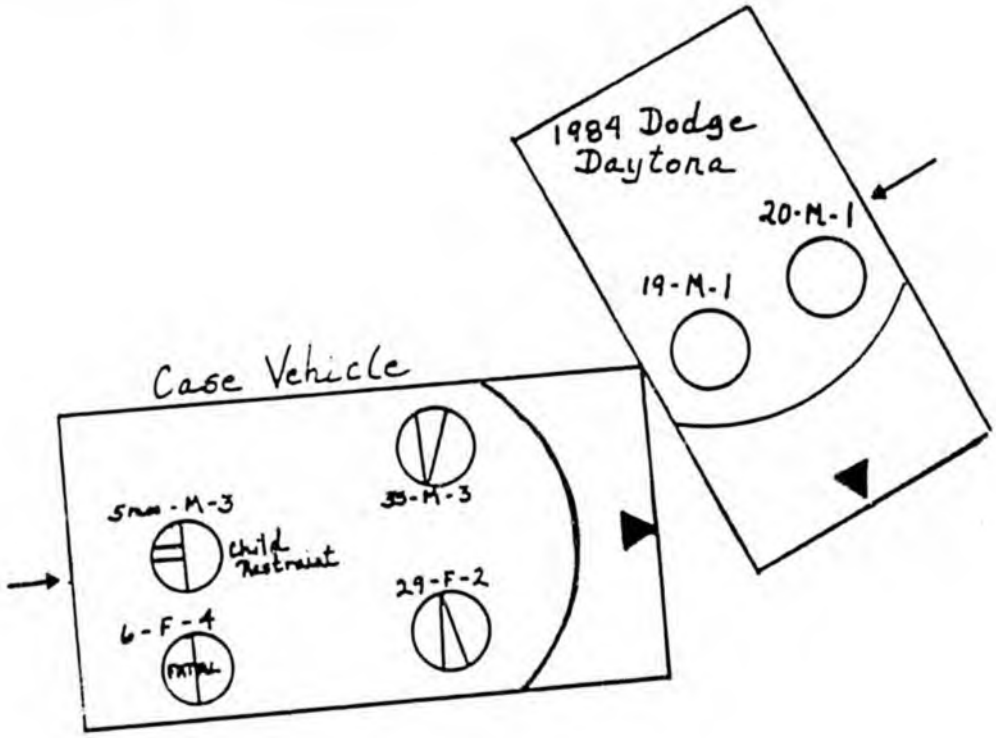
This man might have survived if he had been transported initially to a special trauma center. The physicians attending him did not locate the cause of his post-operative lack of adequate blood pressure and undertake its correction. Furthermore, there is evidence that the surgical measures taken to treat his internal injuries were not appropriate. For example, a consulting surgeon told Safety Board investigators that a physician trained in trauma injury treatment would have operated sooner, would not have repaired the bowel tears by stapling (the bowel leakage may have been due to this inappropriate treatment), and if the bowel leakage had continued, would have performed a second operation to correct it. This doctor said that the "resuscitative effort" expended for this man was "poor."

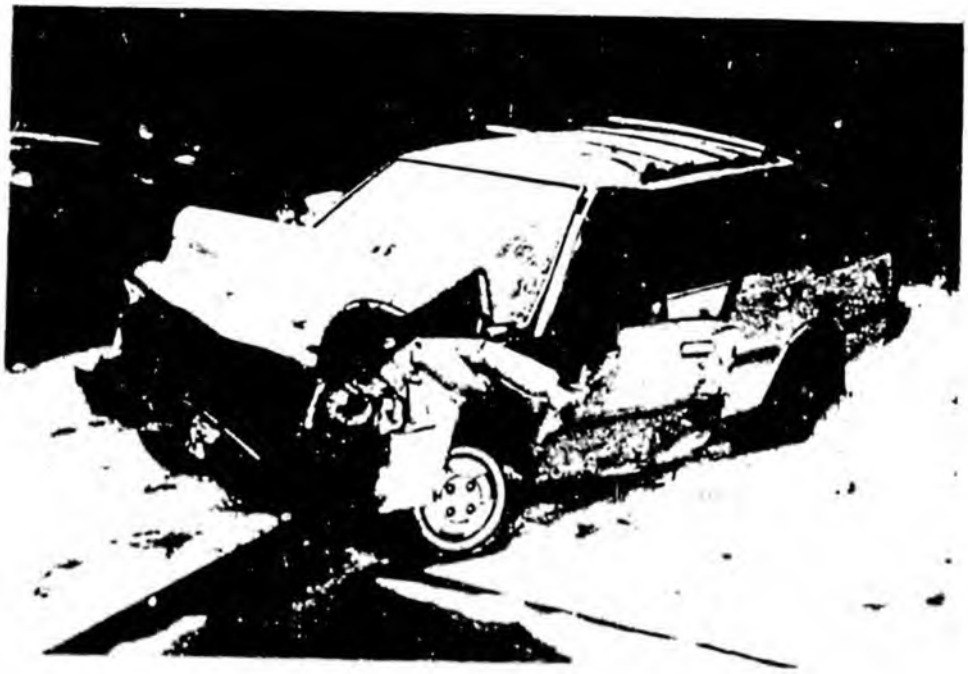
From the injuries indicated in hospital and autopsy records, it seems likely that the lap belt rose above this man's left iliac crest during the crash and penetrated the abdominal cavity from left to right. This interpretation is based on the nature and location of his bowel injuries and the fact that his right iliac crest was displaced rearward and outward. The path of his injuries is consistent with the reactive travel path of his body within the vehicle, given the dynamics of the collision: he would have moved forward and to the left. Evidence suggests that there was a lifting action at the Oldsmobile's left front, which would have induced a downward force at this man's seating position. Thus, the reactive forces at his position would have been directed downward, forward, and to the left--leading to the types of belt induced injuries he sustained.

This man would have survived, with much reduced injuries, if he had been wearing a properly fitted lap/shoulder belt.

CASE 30 (NYC-85-H-OR04)

Case vehicle: 1984 Nissan Sentra station wagon
Case vehicle weight: 2,330 pounds
Case vehicle Delta V: 33.6 mph





Circumstances

A 1985 Dodge Daytona 2-door sedan slid broadside into the front of a 1984 Nissan Sentra station wagon. The Dodge was driven by an unrestrained 20-year-old man; in the right front seat was an unrestrained 19-year-old man. The Nissan was occupied by a 33-year-old male driver and his 29-year-old wife, both of whom were using 3-point lap/shoulder belts; in the rear center seat was their 5-month-old boy in a child safety seat, and in the right rear seat was their 6-year-old daughter, using a lap belt.

After the crash, the occupants of both vehicles were taken by ambulance to a hospital. The unrestrained Dodge occupants were treated and released within a few hours, having sustained only minor injuries. The Nissan driver and his 5-month-old son sustained serious injuries; the children's mother sustained moderate injuries. The 6-year-old child was killed by lap belt induced injuries.

Restraint and Injury

Seating location: Driver
Sex: M
Age: 33
Height: 5 feet 10 inches
Weight: 160
Restraint used: Lap/shoulder belt (ELR)
Proper use? Yes

This man was wearing a continuous loop lap/shoulder belt with a free-sliding latchplate and ELR. There was no evidence that the restraint failed or was defective.

Injuries	AIS	Probable Source
Severe depressed complex fracture of left zygomatic maxillary	3	Left A pillar
Abrasion, left shoulder	1	Shoulder belt
Abrasion, left chest	1	Shoulder belt
Abrasion, sternum	1	Shoulder belt
Hematoma, right ankle	No Code	Unknown

At impact, the vehicle underwent sudden deceleration and counterclockwise rotation. Due to inertia, the occupants tended to continue moving forward, and they also moved leftward in relation to the vehicle's interior. Since all the occupants were restrained, their movement was limited to varying degrees. The adults in the front seat apparently experienced the least movement: their upper torsos and pelvic areas were effectively restrained by their lap/shoulder belts and, except for the left side of the driver's face, there were no other vehicle contact injuries reported. Had the front seat occupants not been properly restrained by lap/shoulder belts, they probably would have been critically injured.

Seating location: Right front
Sex: F
Age: 29
Height: 5 feet 2 inches
Weight: 105
Restraint used: Lap/shoulder belt
Proper use? Yes

This woman was wearing a lap/shoulder belt similar to that of the driver; there was no evidence of restraint failure or defect.

Injuries	AIS	Probable Source
Displaced fracture, right clavicle	2	Shoulder belt
Fractured rib, 1st right side	1	Shoulder belt
Fractured ribs, 5, 6, 7, and 8, left side	2	Shoulder belt
Contusions, left and right iliac crests	1	Lap belt
Contusions, from right clavicle to left mid-sternum	2	Shoulder belt

(See discussion above.)

Seating location: Center rear
Sex: M
Age: 5 months
Height: 23 inches
Weight: 15 lbs. 8 oz.
Restraint used: Child safety seat
Proper use? No

This infant was seated in a child safety seat; however, it was improperly installed, with the car's static lap belt routed through the lower part of the safety seat's tubular frame, rather than around the front of the entire seat, as it was supposed to be.

Injuries	AIS	Probable Source
Depressed skull fracture of left frontal bone	3	Left rear windowframe
Linear fracture, left parietal bone	2	Left rear windowframe
Abrasion, contusion, left cheek and around left eye	1	Left rear windowframe
Hematoma, left orbital area	No Code	Left rear windowframe

Although seated in a child safety seat, this child struck his head on the left left rear window frame because the improper routing of the vehicle's lap belt through the lower part of the safety seat permitted the seat to pitch forward and leftward at impact. Had the child seat been properly installed, its movement would have been considerably reduced and the child would not have contacted the window frame.

Seating location: Right rear
Sex: F
Age: 6
Height: 41 inches
Weight: 50
Restraint used: Lap belt (ALR)
Proper use? Belt routing may have been high

This child was wearing a static lap belt with an ALR. During the crash, the seat cushion was displaced forward about 1 inch.

A photograph of the child's abdomen shows a deep bruise across the area, slightly above the iliac crests but below the umbilicus. These marks indicate that at peak loading, the lap belt was above the iliac crests, above the area considered to be proper fit.

Injuries	AIS	Probable Source
Contusion, abrasion of forehead	2	Unknown
Linear fracture of frontal bone	2	Unknown
Contusion, right frontal cerebral cortex	3	Unknown
Occipital/cervical dislocation	2	Unknown
Laceration, occipital/cervical ligaments, transection of vertebral arteries	3	Unknown
Contusion, abrasions, anterior abdominal wall	2	Lap belt
Laceration of mesentery	3	Lap belt
Intraperitoneal hemorrhage	No code	
Unconscious	4	Unknown

At impact, the upper torso of this child pitched forward and downward over the lap belt, and the child's head struck the vehicle's interior. Although no evidence identifying the contact point was found, it is suspected, based on the child's head injuries, probable kinematics, the seat cushion softness, and the child's size, that her head struck the forward edge of the metal platform near the floor, on which the rear seat bottom cushion rests.

The pathologist listed the cause of this child's death as the dislocation of the occipital/cervical junction and resulting injuries to the vascular supply to the base of the brain. He believed that these injuries most likely resulted in death within a few minutes. The frontal skull fractures and serious intra-abdominal injuries may have contributed to her death, but he regarded the head/neck separation as the primary cause of death.

CORRECTION

THIS DOCUMENT
HAS BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY

Although seated in a child safety seat, this child struck his head on the left left rear window frame because the improper routing of the vehicle's lap belt through the lower part of the safety seat permitted the seat to pitch forward and leftward at impact. Had the child seat been properly installed, its movement would have been considerably reduced and the child would not have contacted the window frame.

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Sex: F
Age: 6
Height: 41 inches
Weight: 50
Restraint used: Lap belt (ALR)
Proper use? Belt routing may have been high

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Contusion, abrasion of forehead	2	Unknown
Linear fracture of frontal bone	2	Unknown
Contusion, right frontal cerebral cortex	3	Unknown
Occipital/cervical dislocation	2	Unknown
Laceration, occipital/cervical ligaments, transection of vertebral arteries	3	Unknown
Contusion, abrasions, anterior abdominal wall	2	Lap belt
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The pathologist listed the cause of this child's death as the dislocation of the occipital/cervical junction and resulting injuries to the vascular supply to the base of the brain. He believed that these injuries most likely resulted in death within a few minutes. The frontal skull fractures and serious intra-abdominal injuries may have contributed to her death, but he regarded the head/neck separation as the primary cause of death.

Based on a comparison of the injuries to the several occupants, it is clear that the lap belt did not provide the level of protection that the lap/shoulder belts provided. Furthermore, the lap belt in this case probably contributed to the development of the child's fatal head injuries, rather than preventing them. Since the injuries that proved fatal to this child were most likely those to her head and neck, not those to her intra-abdominal viscera (serious as those were), her death cannot be attributed to improper belt placement; the jackknifing motion over the lap belt that resulted in her head strike would have occurred even if the belt had been placed slightly lower on her abdomen.

While there is insufficient evidence to predict what injuries she would have received had she been unrestrained, there is sufficient evidence to conclude that she almost certainly would have survived had she been restrained by a lap/shoulder belt.

APPENDIX B

CANADIAN CASES CONCERNING REAR SEAT LAP BELTS

C 1

A 1978 Pontiac Laurentian hit the side of a 1977 Monte Carlo Landau pulling a small (150 pound) trailer. All four belted occupants of the Pontiac died of their crash injuries.

The 70-year-old man driving the Pontiac weighed 155 pounds and was five feet, 10 inches tall. He was wearing a three-point lap-shoulder belt; it is not recorded whether he wore it correctly. The lap belted woman sitting behind him crashed into the back of his seat. The cause of his death was rupture of the spleen.

The right front passenger was a 65-year-old man, five feet, ten inches tall, 200 pounds. He was wearing a three-point lap-shoulder belt. Again, it is not recorded whether he wore it correctly. The lap-belted woman sitting behind him crashed into the back of his seat. The cause of his death was fracture of his spine. He also sustained head and face injuries.

The left rear passenger was a 57-year-old woman, five feet, three inches tall and weighing 155 pounds. She wore a lap-only belt; it is not recorded whether it fit her properly. She sustained fatal intra-abdominal injuries and injuries to her extremities.

The right rear passenger was also a 57-year-old woman, five feet, two inches tall and weighing 165 pounds. She also wore a lap-only belt and suffered injuries to her extremities and fatal intra-abdominal injuries.

C 2

In this crash, a 1982 Pontiac Phoenix impacted a "large mid-70's sedan" head-on. The Pontiac was reported to be moving forward at about 34 mph at impact; the speed of the other vehicle is not recorded.

The record does not state how many people were traveling in the Pontiac, nor whether they were wearing belts. It does state that the only person injured in the Pontiac was a man, 157 pounds, five feet, eight inches tall, wearing a lap-only belt. His seating location is not recorded. He sustained intra-abdominal injuries and fracture of the third lumbar vertebra.

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* Information on these cases was provided to the Safety Board by Transport Canada. In transmitting this information, the Canadian officials noted that "the extent to which the accident cases which have been compiled are necessarily representative of frontal collisions resulting in abdominal injury to a lap-belted individual is largely unknown."

C 3

On April 25, 1980, a 1978 Plymouth Horizon struck the right front of a "late model, mid-size American vehicle." Three people were traveling in the Plymouth: a 67-year-old man driving (six feet tall, 207 pounds), wearing a three-point lap-shoulder belt; a 65-year-old woman in the rear seat behind him (left rear), five feet, three inches tall, 154 pounds, wearing a lap-only belt; and a 67-year-old woman in the right rear seat (height and weight unrecorded), wearing a lap-only belt.

The driver died three days after the crash, of intra-abdominal injuries; he had also sustained chest injuries. The left rear passenger died of "extensive abdominal injuries." Her fourth lumbar vertebra was also fractured. Although at first the injuries of the right rear passenger were thought to be the most severe, she survived her serious intra-abdominal injuries (she spent 15 days on a respirator, however).

There were no serious head injuries to any of the three occupants. The investigator judged the crash to have been "survivable". The coroner noted in his report that "if /rear/ seat belts were designed in a different fashion to hold either the legs or the pelvis and also the trunk in position, the injuries would be less serious. . . . Having seen the results of the injuries at first hand at the accident site . . . and at the operation of /right rear passenger/, I feel strongly that seat belts can be redesigned."

C 4

On July 24, 1982, a 1979 Plymouth Horizon struck a bridge abutment with the right front of the car. The car was reported to have been traveling at about 40-50 mph when it left the travelway. The car was being driven by a 44-year-old man who was wearing a three-point lap-shoulder belt. He received "minor" injuries, apparently only "small bruises."

In the right front seat was a 30-year-old woman wearing a three-point lap-shoulder belt. She received what are recorded as "minor" injuries, including a "deep cut" to one arm, "loss of teeth," a laceration of the chest.

In the left rear seat (behind the driver) was a 67-year-old woman wearing a lap-only belt. Two of her ribs were fractured in the crash.

In the right rear seat was a 12-year-old boy wearing a lap-only belt. He sustained a "minor skull fracture" and serious intra-abdominal injuries, including perforation of the small bowel and two lacerations of the mesentery.

C 5

In early November 1981, a 1976 Oldsmobile Cutlass with four occupants crashed head-on with a 1978 Ford van. The severity of the crash is not recorded. The Cutlass driver was a 23-year-old man weighing 150 pounds. It is not recorded whether he wore a seat belt. He received "serious" chest injuries, probably from violent contact with the steering system. The lap-belted woman seated behind him crashed into the back of his seat during the impact.

The right front passenger was a 55-year-old man weighing 150 pounds. He was wearing a three-point lap-shoulder belt. He sustained injuries to his head and face and fatal chest injuries. The investigator stated that the "seat belt webbing broke under impact at head rest holding clip level."

The left rear passenger (behind the driver) was a 48-year-old woman, five feet, four inches tall, who weighed 140 pounds. She wore a lap-only belt. She sustained injuries to her face, bilateral fractures of six lower ribs, a fractured spine at the second lumbar vertebra. Her spine also separated 10.5 cm at the fracture point; this separation was deemed the cause of death.

The left rear passenger was a 20-year-old man, five feet, ten inches tall, who weighed 150 pounds. He wore a lap-only belt. His skull was fractured, he sustained multiple bilateral rib fractures, and his distal lumbar spine was displaced to the right by half its diameter. He died of the spine dislocation. The investigator suggested that this man may have "submarined" under the belt during the crash.

C 6

In this crash, the right front of a 1981 Honda Accord hit the left rear tire of a parked 1975 John Deere back hoe. The Accord was said to be traveling at about 18 mph when it hit the parked vehicle.

The driver was a 69-year-old man, five feet, five inches tall, who weighed 240 pounds and who was wearing a three-point lap-shoulder belt. He sustained a minor (AIS 1) sprain of his right hip.

The right front passenger was a 68-year-old man, five feet, four inches tall, who weighed 180 pounds and who was wearing a three-point lap-shoulder belt. He sustained minor (AIS 1) bruising of his right shoulder, chest, and abdomen.

The left rear passenger (behind the driver) was a 58-year-old woman, five feet tall, who weighed 180 pounds and who wore a lap-only belt. She sustained serious (AIS 3) injuries to her abdominal wall.

The right rear passenger was a 64-year-old woman, five feet, one inch tall, who weighed 190 pounds and who wore a lap-only belt. She received head and abdominal injuries: a two-inch laceration of the right temple with "massive resultant hematoma," severe bruising across the abdomen above the iliac crests, and "massive intraperitoneal hemorrhage caused by multiple injuries to the abdomen and contents." The intra-abdominal injuries were fatal.

This was a moderate crash which, according to the investigator, "should have been survivable" for this passenger, especially "considering the /minor/ injuries incurred by the front seat occupants." There was "no evidence to indicate the /rear seat/ occupants submarined the lap belts" in this crash; the investigator concluded from the evidence that the lap belt worn by the right rear passenger was at or above the iliac crests at the time of the impact. Whether it was possible for this passenger to wear the lap belt provided in this car in a lower position is not discussed.

The investigator also stated that if the rear seat occupants had been unrestrained they probably could have survived this crash, although the restrained front seat occupants might have been more seriously injured in that case. The "installation of combination lap and shoulder /belts/ in the rear seat in /all/ likelihood would have reduced the /rear seat occupants'/ injuries to minor ones," the investigator stated. He noted that, beginning with the next year's model, Honda Accord did provide such rear seat lap-shoulder belts.

C 7

This crash was also classified as "moderate." A 1981 Toyota Corona hit a 1952 Ford pickup, left front to left front. The driver (whose seating location was in direct line with the principal point of impact) was a 63-year-old man, five feet, six inches tall, weighing 140 pounds. He was wearing a three-point lap-shoulder belt; his arms and legs were fractured and one hip dislocated.

The right front passenger was a 63-year-old man, of the same height and weight as the driver and also wearing a three-point lap-shoulder belt. He sustained minor (AIS 1) bruises.

The left rear passenger (behind the driver) was a 63-year-old woman, five feet tall, weighing 90 pounds, and wearing a lap-only belt. She sustained minor (AIS 1) bruises and a sprained ankle.

The right rear passenger was a 68-year-old woman, six feet tall, weighing 170 pounds, and wearing a lap-only belt. The investigator said she was wearing the belt correctly, low on the abdomen and snug. She sustained severe bruising across the lower abdomen, abrasions over both the left and right iliac crests, head injuries ("extensive subarachnoid hemorrhage"), fractures of the third and fourth lumbar vertebrae, multiple severe intra-abdominal and intra-thoracic injuries. She died of "massive hemorrhaging from a torn abdominal aorta."

Lap belt cases from the Transport Canada "Fully Restrained Occupant Study" (FROS):

Case 0119

This crash involved a 1976 Plymouth Volare; it was classified 12 FDEW 3.(*) The driver was a 56-year-old woman, five feet, two inches tall, weighing 182 pounds, and wearing a three-point lap-shoulder belt. The investigator concluded that she was wearing the belt correctly. She sustained serious injuries (AIS 3): fractures of the third and fourth ribs on the left, left pneumothorax, bruising at the waist, a lacerated knee, and a fracture of the left wrist. She probably received her torso injuries from contact with the steering wheel, intensified by the fact that the two lap-belted rear seat occupants crashed into the back of the front seat.

The right front passenger was a 68-year-old woman, five feet, two inches tall, weighing 150 pounds and wearing a three-point lap-shoulder belt. It is not recorded whether she wore the belt correctly. She also was subjected to the overloading of the front seat back caused by the lap-belted rear seat occupants. She sustained a ruptured spleen (AIS 4), ruptured bowel (AIS 5), and fractured vertebrae (AIS 3).

The left rear lap-belted passenger was a 78-year-old woman, four feet, 11 inches tall, weighing 160 pounds. She sustained belt-induced injuries: ruptured bowel (AIS 5), two tears of the small bowel mesentery (AIS 5), lacerations of the spleen (AIS 4), fractured fifth, sixth, seventh, and eighth left-side ribs (AIS 3), fractured right wrist (AIS 2), comminuted fracture of the right tibia (AIS 2), fractured nose (AIS 1), and contusions at the abdomen (AIS 1).

The right rear lap-belted passenger was a 76-year-old woman, five feet tall, weighing 180 pounds. She sustained facial, chest, intra-thoracic, spinal, intra-abdominal, and extremities injuries: a ruptured diaphragm, complete transections of the sigmoid colon and small intestine, ruptured aorta, ruptured iliac arteries, bilateral hemothorax, bilateral rib fractures, fractured thoracic vertebra, fractured sternum, fractured nose, and abrasions and contusions of the abdominal wall. She died of her injuries. Her facial and upper torso injuries were probably caused by violent contact with the back of the front seat, the intra-thoracic and intra-abdominal injuries by high loading from the lap belt.

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* This code is from the Collision Deformation Classification system, widely used by motor vehicle crash investigators to classify crashes according to the principal direction of force, location and extent of contact damage, etc. It does not denote severity in terms comparable to such designations as Delta V (used by the Safety Board in its crash investigations), although accomplished interpreters can deduce severity to some extent from the code. It is not readily translatable into terms accessible to lay readers but may be of significance to technical readers and is included here for that reason.

Case 0152

This crash, classified 12 FDEW 3, involved a 1976 Datsun B210. In this case, the investigator concluded there was no loading of the front seat back by the rear seat occupant, there was no intrusion that would account for the occupants' injuries, and the driver did not violently contact the steering assembly.

The driver was a 71-year-old woman, five feet, three inches tall, weighing 165 pounds. She wore a three-point lap-shoulder belt; although she apparently was using the "comfort clip" tension reliever, the investigator concluded she wore the belt system "snug." She received serious injuries that required 18 days' hospitalization: a "large" laceration of the forehead, contusion of the upper left chest, a "sore neck," and a "deep laceration" of the left knee. The overall AIS rating of these injuries was 3 (serious).

The right front passenger was a 20-year-old woman, weight and height unrecorded. She wore a three-point lap-shoulder belt, but it is not indicated whether she wore it correctly. She did not, apparently, use the "comfort clip" tension reliever. She sustained only minor injuries (AIS 1): an abrasion across the right shoulder, sternum, and left breast. She suffered "neck pain."

The right rear passenger was a 16-year-old woman, weight and height unrecorded. She wore a lap-only belt. She survived a severed ureter (AIS 3), a compression fracture of the second lumbar vertebra (AIS 2), forehead abrasions (AIS 1), bilateral contusions of the abdominal wall (AIS 1), and a contusion below the left knee (AIS 1).

Case 0174

This crash of a 1973 Ford LTD was classified 12 FYEW 4. The driver, a 17-year-old man, six feet, three inches tall and 195 pounds, was wearing his three-point lap-shoulder belt. It is possible that the shoulder portion had excessive slack in it. He spent nine days in the hospital beginning recovery from a fractured right upper tibia (AIS 2), a laceration of the right knee (AIS 2), a comminuted fracture of the nose (AIS 2), fractured left rib (AIS 2), and an abrasion of the left forearm (AIS 1).

The right front passenger was a 16-year-old man, five feet, eight inches tall, 125 pounds, wearing a three-point lap-shoulder belt (he also may have worn the shoulder portion loosely). He was in hospital for six days, having sustained minor and moderate facial fractures (AIS 1 and 2), an AIS 2 compression fracture of the fifth lumbar vertebra, and an AIS 1 forehead laceration.

The right rear passenger was a 17-year-old man, six feet tall, 145 pounds, wearing a lap belt. The investigator concluded that he wore the belt snugly; the belt may have crossed his abdomen at or above the iliac crests, though this is not certain. He spent 49 days in the hospital, beginning recovery from critical intra-abdominal injuries: laceration of the caecum (AIS 5) and laceration of the mesentery (AIS 3). He also sustained an AIS 2 compression fracture of the fourth lumbar vertebra and an AIS 1 contusion of the lower abdominal wall.

Case 0150

This case involved no loading of the front seatback by the rear seat occupant, no injurious intrusion, no injurious contact by the driver with the steering system, and the rear seat occupant reportedly wore the lap belt correctly. The crash involved a 1976 Chevrolet Nova and was classified 12 FRES 9.

The driver was a 31-year-old man, five feet, eight inches tall, 125 pounds, wearing his three-point lap-shoulder belt correctly. He sustained minor bruising of his chest and ankle and was not hospitalized.

The right front passenger was a 33-year-old woman, five feet tall, 115 pounds, wearing her three-point lap-shoulder belt correctly. She sustained moderate brusing of the left hip and a fractured rib on the left side. She was not hospitalized.

The right rear passenger was a 52-year-old woman, five feet, four inches tall, 122 pounds, wearing a lap-only belt correctly. She was hospitalized for four days, having sustained facial bruising (AIS 1) and moderately severe (AIS 2) lower abdominal wall bruising.

Case 0153

This case involved a crash of a 1976 VW camper and was classified as 12 FYEW 7. The driver was a 38-year-old man, height and weight unrecorded. He was unrestrained. There was severe intrusion into his seating location. He sustained a comminuted fracture (AIS 3) of the left femur, a fracture of the left wrist (AIS 2), facial bruising, lacerations, and fractures (all AIS 1), chest bruising (AIS 1), and lacerations and abrasions of the left thigh (AIS 1).

The right front passenger was a 34-year-old woman, height and weight unrecorded. She was correctly wearing her three-point lap-shoulder belt. There was severe intrusion at her seating location also. She sustained a fracture in the left leg (AIS 2), a fracture in the left ankle (AIS 2), minor bruising.

The left rear passenger (behind the driver) was a 35-year-old woman, weight and height unrecorded, wearing a lap-only belt. The investigator concluded that not only was she wearing the lap belt correctly (snug and low) and sitting erect at the time of impact, but also that the lap belt did not "ride up" over the iliac crests during the crash. Nevertheless, she sustained critical head, spinal, and intra-abdominal injuries: brain contusion (AIS 5), dislocation of the third and fourth lumbar vertebrae (AIS 5), complete transection of the lumbar spine (AIS 5), ruptured duodenum (AIS 5), concussion (AIS 5), and fracture of the skull on the right side (AIS 4). She died of her injuries.

The right rear passenger was a 32-year-old woman, weight and height unrecorded (at autopsy she was found to be "obese"), wearing a lap-only belt. The investigator concluded that it was possible the belt was above the iliac crests at the time of impact. She sustained a complete transection of the abdominal aorta (AIS 5), a complete transection of the caecum (AIS 5), a complete transection of the ureter (AIS 3), partial transection of the spine (AIS 5), dislocated vertebrae (AIS 5), lower abdominal hemorrhaging (AIS 5), and bruising of the abdominal wall (AIS 2). She died of her injuries.

APPENDIX C

SELECTED CASES FROM MEDICAL LITERATURE ON LAP BELT INDUCED INJURIES

Aiken, D.W. (1963). Lap belt-induced jejunal perforation of the small intestine. Undetected for 6 days after crash. Injury probably caused by sudden compression between belt buckle and spinal column. Only external indication of belt injury was welt across lower abdomen, below umbilicus. Probable correct belt use, no submarining.

Backwinkel, K.D. (1968). Reports 2 cases. Case 1: A 61-year woman in rear with lap belt; frontal impact, followed by right lateral. Belt bruising across abdomen seen initially, accompanied by complaints of abdominal pain, but condition seemed stable until next morning, when severe pain developed and woman went into shock. At laparotomy, a tear in the mesentery of the small bowel was found, with about 12" of gangrenous bowel. Generalized peritonitis was present and the woman died on the operating table. Case 2: A 19-year man in "high speed" frontal hit, wearing lap belt in right front seat. Driver ejected, fractured nose. Lap belt wearer had extensive multiple laceration of scalp, upper/lower lips, requiring emergency surgency. 20" x 20" area of abrasion and ecchymosis corresponding to seat belt dimensions across lower abdomen, right across left and right iliac crests (indicates correct belt placement). Fracture of third lumbar vertebra. Abdominal distention, no blood at 4-quadrant tap. At laparatomy, however, 750 cc of old blood found, along with perforation of ileum, large tear in mesentery of small bowel, which extended down to inferior mesenteric vein. Also, incomplete tear of ileocolic artery. A 15-cm length of sigmoid colon was "completely stripped of its external coat of serosa, muscularis propria, submucosa, and muscularis mucosae."

Blumenberg, R.M. (1967). Reports 20 cases of "intra-abdominal visceral and mesenteric trauma due to the seat belt syndrome" in the literature at that time. Reports a new case: 25-year lap belted man involved in an approximate 35 mph lateral skid into pole. Received facial lacerations, contusions of the lower abdominal wall at the iliac crests (indicates proper belt placement). Discharged from hospital. 3 days later, abdominal distention and cramping appeared. Internal inspection found a linear tear of the mesosigmoid "extending to its root, and avulsion of the mesentery of a 4-inch segment of redundant sigmoid." Also, a 2-cm performation on the mesenteric aspect of sigmoid. Required 6 weeks in hospital.

Cocke, W.M., J. and Meyer, K.K. (1963). Reports case involving frontal crash into side of another vehicle at estimated 35 mph. Unbelted driver said to have received no injury. A 62-year woman at right front, lap belted (overweight), showed a reddened band on the upper abdomen but no other symptoms noted. 5 hours later, went into shock. The spleen was "severely ruptured," required removal. Also fractured ribs.

Dajee, H. and MacDonald, A.C. (1982). Discusses 27-year woman admitted to hospital with "noticeable seat belt abrasion across the abdomen." Complained of "severe abdominal pain," was pale, with heart rate 120, blood pressure of 70/40 mm Hg. Abdominal distention with tenseness and rebound tenderness. No bowel sounds. At laparatomy, the peritoneal cavity found "filled with food fragments and blood." Transection of stomach, avulsion of the left colonic mesentery and several small bowel serosal lacerations with areas of contusion of the peritoneum and mesentery. She had lost considerable blood.

Doersch, K.B. and Dozier, W.E. (1968). Reports 3 cases of lap belt-induced injury, all in "head-on" collisions. Case 1: 45-year man. Fractured ankle, multiple facial and head injuries. Lower abdominal contusions, abrasions, and ecchymoses. Audible peristalsis, no rebound tenderness of abdomen. Abdominal bleeding noted after catheter had been in place for 8 hours. Laparotomy undertaken 12 hours after accident. Found "large mesenteric laceration beneath a 15-inch segment of infarcted ileum." Case 2: 20-year man sustained compression fracture of 4th lumbar vertebra, multiple facial fractures and lacerations. Abdominal tap was negative, no bowel sounds. Laparatomy undertaken 10 days after accident. Found 2 perforations of cecum with surrounding abscesses. Mesenteric tears and hemoperitoneum. Victim required a "very prolonged convalescence." Case 3: 23-year woman sustained facial fractures and lacerations, fractured right ankle and fracture of the fifth lumbar vertebra. Multiple abdominal contusions and abrasions, "severe 'seat belt sign.'" No abdominal spasm or rebound tenderness. Peristalsis. Hunger. Left femoral pulse moderately diminished. Abdominal taps negative twice. Began deteriorating on day 2. At surgery, found "both rectus muscles, including their sheaths, as well as their adjacent oblique musculature, were completely transected." Peritoneum torn, one continuous abscess cavity from peritoneal space into the muscles and subcutaneous tissues on each side lower abdomen. Small bowel almost completely transected. Two large mesenteric lacerations and traumatic thrombosis of left iliac artery with dissection of intima. Patient died one week later of "overwhelming sepsis."

DuBois, E.F. (1952). Reports 23 cases of intra-abdominal injuries sustained by lap belted aircraft occupants, along with 32 cases of contusions along the belt line.

Fish, J. and Wright, R.H. (1965). Presents 4 cases of lap belt-induced injuries from air crash. Case 1: Arrived hospital in shock. Bruises across lower abdomen and pelvis. Abdomen tense, tender. Paracentesis in 3 quarters was negative. found 2-foot segment of ileum avulsed from its mesentery; small seromuscular tear midportion of the intestine. Avulsed end of mesenteric artery actively bleeding. Hematoma in left transverse mesocolon; spleed had capsular tear near inferior pole. Case 2: Shortly after crash, noted pain in right flank and lower abdomen. Examination found lower abdominal wall and right flank contusions corresponding to areas of pain. Paracentesis in 4 quadrants all negative. In hospital, complained of abdominal discomfort, ate little, had low grade fever to the 13th post-injury day. Exploratory operation found proximal ileum partially transected, adjacent bowel markedly contused; the injured bowel was adherent to the left side. Case 3: This man "extracted himself without difficulty from the wreckage." Only complaint at hospital was lower abdominal and flank pain corresponding to contusions from belt. Able to eat, had normal bowel movement following day. During next 3 days, developed abdominal distention and nausea. Abdominal X-rays showed dilated loops of small intestine. Abdominal exploration on 9th post-injury day found lacerated proximal ileum adjacent to urinary bladder, with considerable surrounding inflammatory reaction. Also, large tear in mesentery. Case 4: Arrived hospital in shock, died within 1 hours. Autopsy showed "wide band of contusions across the lower abdominal wall corresponding to the seat belt. Peritoneal cavity and retroperitoneal space filled with blood. Large segment of small intestine and segment of sigmoid colon avulsed from mesentery. Hemorrhage secondary to laceration of mesentery determined to be cause of death."

Fletcher, B.D. and Brogdon, B.G. (1967). 21-year driver of "small, foreign sports car" struck rear of semitrailer "at a high rate of speed." She "flexed acutely over the seat belt and struck her face against the dashboard." Multiple hematomas of lower limbs, laceration and fracture of nose. "No abdominal contusions, hematomas, or abrasions were noted." Transverse fracture of third lumbar vertebra; also small compression fracture of anterosuperior margin of vertebra body."

Gerritsen, R. et al (1966). Reports 2 cases, both "obese" women in "head-on" collisions, said to be wearing lap belt "loosely." Case 1: Passenger in left rear. At surgery, revealed laceration of jejunum, multiple lacerations of mesentery, traumatic amputation of lower half of omentum. Case 2: Passenger in right rear. At surgery, found to have 3,000 cc of blood in abdominal cavity with lacerations of mesenteric attachment of small bowel, laceration of ileum and cecum, division of ileocecal artery, and tear in serosa of sigmoid colon.

Howland, W.J. et al (1965). 19-year male driver (5'9", 150 lb.) in estimated "80 mph, head-on" collision with steel pole. Said to be wearing belt "loosened." Remained conscious. Low back, neck, left hand pain. Facial lacerations. Numerous upper chest contusions, neck contusions and abrasions. Large hematoma in muscles both sides of midlumbar. Transverse fracture of third lumbar vertebra. Attributed injuries to "seat belt's acting as fulcrum, over which vertebral body was split transversely into two parts; the mechanism was similar to breaking a stick over one's knee."

Hurwitt, E.S. and Silver, C.E. (1965). Young woman, right front passenger, involved in ran-off-road crash into abutment at high speed. Received facial injuries, fractured vertebrae, subluxation of fourth lumbar over fifth lumbar vertebra. White striae over both iliac crests "which conformed to the region of distribution of the seat belt over this area at the time of injury." 16 months after crash, a large hernia, containing colon, small bowel, and stomach, developed in the left upper quadrant of abdomen. (Cf. Case 1 in LeMire et al.)

Kulowski, J. and Rost, W.B. (1956). Said to be first report of a case in which crash injury was attributed to a lap belt. Belt-induced trauma to segment of ileum; later, fibrous adhesion of the terminal ileum to the right iliac crest developed, causing obstruction of the distal part of the small bowel.

"Lap seat belt useful but can injure children," AMA 245:2281 (1981). Reports findings by orthopedic surgeon in 7 cases of serious lap belt-induced injuries among children 9 to 15 in Ontario auto crashes 1977-79 (after Ontario's mandatory belt use law in effect). All riding in rear seat, in frontal collisions. Three sustained torn posterior ligaments, lumbar spine dislocations; two of these remain paraplegic. Four sustained "Chance" fractures of lumbar spine; two of these were immobilized for 6 months in body casts and braces. One had "extensive intra-abdominal injury requiring laperotomy." All had seat belt bruises on their abdomen, facial contusions, the latter resulting from head strikes during hyperflexion over belt.

LeMire, J.R. et al (1967). Reports 2 cases. Case 1: 26-year woman at right front in rear end impact. Lap belt said to be "loose" and "high." Only sign of intra-abdominal injury was "ecchymosis and contusion of lower part of abdominal wall corresponding to site of seat belt." Five months post-crash, victim re-entered hospital. Exam found large hernia in right side of abdominal wall, containing colon and small intestine. (Cf. case described in Hurwitt and Silver.) Case 2: 24-year man in "head-on" crash. Lap belt "broke." On admission, general condition seemed good, but complained of pain, tenderness in lower abdomen. Observed for 7 hours, released. Ten hours later, returned to hospital with greatly increased abdominal pain, vomiting. Blood pressure was low, pulse elevated, weak. Abdomen rigid, with rebound tenderness. No bowel sounds. At surgery, 4-cm perforation found in proximal end of jejunum.

Ritchie, W.P. et al (1970). Reports four cases. Case 1: 35-year male driver involved in "head-on" collision "while passing at 50 mph." Car destroyed. Lap belt was in "proper position," [illegible] says that "buckle was arranged to ride across the lower part of the [illegible]en between the iliac crests." Lacerations to chin and knees. 12 [illegible] after admission, abdominal distention, vomiting. 36 hours late[illegible] ansferred in "moderate distress." Blood pressure 116/70, pulse 104. Abdomen "slightly distended, tense, diffusely tender." Rebound tenderness, most severe over right lower quadrant. No bowel sounds. No evidence of fractured lumbar vertebrae. At surgery, 1000 cc bloody fluid in peritoneal cavity. Terminal portion of ileum transected in 2 adjacent areas. Subjacent mesentery also interrupted, intervening tissue "clearly non-viable." 2 weeks in hospital. Case 2: Woman at right front in same crash. Severe back pain at admission. Fracture of 2d lumbar vertebra. 7 hours later, still severe pain, plus abdominal pain. Blood pressure 130/80, pulse 110, low fever. Transverse contusion over the lower part of abdominal wall corresponded to site of seat belt. Below contusion was palpable defect in tissues of anterior abdominal wall. Abdomen rigid, tender, with rebound tenderness over lower quadrants. No bowel sounds. At laparotomy, found circumferential serosal tear at midjejunal level, 1-cm punctate laceration of antemesenteric border of proximal protion of ileum, longitudinal serosal tear of hepatic flexure of colon. 2 months in hospital. Case 3: 11-year girl in same crash (seated rear). "Pale and agitated" at admission. Blood pressure 100/60, pulse 130 and "thready." Abdomen tense, moderately distended, extensive ecchymosis over lower quadrants. Diffuse rebound tenderness. No bowel sounds. Transverse fracture of body of 3d lumbar vertebra. At laparotomy, showed "circumferential transection of proximal protion of ileum. Serosal tear along antemesenteric border of ileum, just proximal to area of transection, rent in mesentery of ascending colon. 2 months hospital. Case 4: 7-year girl in same crash (rear seat). No signs of acute distress at admission. Blood pressure 104/60, pulse 100. Abdomen "soft and flat but not tender." Bowel sounds present. Tender contusions over anterior superior iliac spines bilaterally, no contusions on abdominal wall. Soft tissue swelling, tenderness, over lumbar spine were prominent. Fracture of 3d lumbar vertebra. Fracture of right transverse process. 5 weeks hospital.

Snyder, R.G. et al (1967). Reports 2 cases with correct lap belt use. Case 1: Right front female passenger in VW struck by oncoming car. Wearing a "snug" lap belt. Concussion, nose fracture, lacerations to cheek and left elbow. Numerous contusions and faintly visible marks from belt on lower abdomen and anterior superior iliac spines. 12 hours later, surgery found tear of jejunum about 8 inches below ligament of Treitz, which nearly severed the bowel. Case 2: 61-year woman in right front, "wearing a snug lap belt," in frontal crash at "about 30 mph." Compression fracture to body of first lumbar vertebra. Cites to "personal communication" with Nahum and Siegel, indicating in "their unpublished study of over 150 accidents in the L.A. area," more than 30 cases of seat belt injuries.

Tolins, S.H. (1964). Reports on man in right front wearing lap belt when car hit tree. Driver and three rear seat passengers unrestrained. They were all uninjured. Lap belted passenger suffered severe midabdominal wall contusion and perforation of upper jejunum. Admitted to hospital 28 hours post-injury, not operated on until 4th post-injury day.

Walpole, Bryan (1984). 45-year woman admitted to hospital after crash. "External signs of seat belt contusion" on abdomen. Swelling, generalized tenderness, marked guarding and rebound tenderness. Bowel sounds audible. "Extremely pale, very confused and gasping for air but responding to commands. Pulse 140, blood pressure 90/50, respiration 45/minute (shallow)." X-ray found left ruptured diaphragm, protrusion of abdominal contents into left chest. At emergency laparotomy, ruptured spleen removed, left 12th rib excised; diaphragmatic deficit repaired; several segments torn small bowel and mesentery removed; end-to-end anastomosis and relieving colostomy performed.

Williams, James S. and Kirkpatrick, John R. (1971). Discusses findings from 80 crash victims wearing lap belts. Intra-abdominal injuries in 42; 39 sustained intestinal or mesenteric injuries, or both. 51 had lumbar spine injuries: 32 fractures, 7 subluxations, 2 ruptured disks, 2 complete anterior dislocatoins. (6 spinal injuries were unknown). 7 patients had intra-abdominal injuries as well. 35 additional injuries due to belt: 22 to abdominal organs or other soft tissue, 4 fractured pelvis, 9 fractures of extremities or facial bones.

Williams, James S. et al (1966). Reports 4 cases, all involving correctly placed lap belts. Case 1: 42-year man in "severe" impact. Sustained perforation of mid-ileum. Case 2: 33-year woman in "severe" impact. Sustained transection of rectus muscle, blood in peritoneal cavity, mid-portion of omentum amputated from attachment to transverse colon (found "hanging by only one thin, vascular stalk"), multiple hematomas and lacerations along small bowel, contusion of right colon, serosal tear in right colon. 2 months in hospital. Case 3: 16-year girl in side impact into fire hydrant (side opposite victim). Transverse tear of duodenum around two-thirds of circumference. 3 months in hospital. Case 4: 20-year man in "severe" impact. 6-cm tear in mesentery of mid-ileum, 6-cm tear in mesosigmoid, contused sigmoid with subserosal hemorrhage, sigmoid questionably viable, blood in peritoneal cavity. 3-1/2 weeks in hospital.

APPENDIX D

GLOSSARY

This glossary briefly defines certain terms, as they have been used in this study and its appendices, that may be unfamiliar to the reader. Many of them refer to highly complex objects or processes; the definitions here are not intended to be exhaustive discussions of all aspects or nuances of these terms. Some of the definitions are based on Dorland's Illustrated Medical Dictionary (W.B. Saunders Co., 1981; 26th ed.); others are based on Johannessen and Vos, The Changing Shape of Seat Belt Systems (SAE 820796) and on Moffatt et al., Diagnosis of Seat Belt Usage in Accidents (SAE 840396).

For a fuller understanding of the anatomical parts referred to in the case summaries, consult the anatomical drawings reproduced from Dorland's at Appendix D.

ABDOMINAL FASCIA. Fibrous tissue forming part of the inner investing layer of the abdominal wall.

ANTERIOR. Situated in front of or in the forward part of an organ, toward the head end of the body.

AUTOMATIC LOCKING RETRACTOR (ALR). A retractor (see definition, below) that allows belt webbing to be withdrawn and then rewound, but will not permit a second withdrawal until the webbing is almost completely rewound. ALR's are most commonly seen in lap/shoulder belts with two retractors and in rear seat lap belts. The user pulls the lap belt out to a length greater than required, then latches it. The ALR rewinds the slack and then locks securely. These began appearing in American cars around Model Year 1968.

AVULSION. The tearing away of a part of a body structure.

BRAIN STEM. The stemlike portion of the brain connecting it with the spinal cord.

CERVICAL. Pertaining to the neck.

COMMINUTED. Broken or crushed into small pieces, as a comminuted fracture.

COMPRESSION FRACTURE. A fracture produced by compression (for example, a fracture of vertebrae)

CONTINUOUS LOOP. The most common type of lap/shoulder belt system in U.S. passenger cars today. One end of the lap belt is fixed to the vehicle, near the door sill, without a retractor; a continuous webbing extends across the occupant's lap, through a latch plate (either cinching or free-sliding), then up across the shoulder to a guide assembly or to an ELR. The lap belt length (snugness) must be manually adjusted by pulling webbing through the latchplate. The retractor is supposed to adjust the snugness of the shoulder belt portion automatically (perhaps affected by operation of any tension relief device in place).

CONTUSION. Bruise; injury of a part without a break in the skin.

DELTA V. Instantaneous rate of speed change at impact.

ECCHYMOSIS. A small hemorrhagic spot in the skin or mucous membrane, forming a nonelevated, rounded or irregular, blue or purple latch.

EDEMA. The presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body; usually applied to demonstrable accumulation of excessive fluid in the subcutaneous tissues.

EMERGENCY LOCKING RETRACTOR. A retractor (see definition, below) that allows the webbing to be withdrawn and rewound freely, except when the retractor is caused to lock by vehicle acceleration, rapid webbing withdrawal, or some other non-manual system.

HEMOPERITONEUM. An accumulation of blood in the peritoneal cavity.

HEMOTHORAX. A collection of blood in the pleural cavity (thorax).

INFARCTION. An area of necrosis (dead tissue) in an organ caused by a cut-off in blood supply.

LACERATION. A torn, ragged, mangled wound.

LAPAROTOMY. Surgical opening of the abdomen.

LATCHPLATE (or "tongue"). The flat metal plate attached to one end of the belt webbing and extending inside the other part of the buckle. It usually has a hole through it or notches in its dies, which engage in the buckle when it is latched. (moffatt)

Le FORT I FRACTURE. A horizontal segmented fracture of the supporting bone of the upper teeth, in which the teeth are usually contained in the detached portion of the bone.

Le FORT II FRACTURE. Unilateral or bilateral fracture of the supporting bone of the upper teeth, in which the body of this bone is separated from the facial skeleton and the separated portion is pyramidal in shape; the fracture may extend through the body of the bone down the midline of the hard palate, through the floor of the orbit, and into the nasal cavity.

Le FORT III FRACTURE. A fracture in which the entire maxilla (supporting bone for the teeth) and one or more facial bones are completely separated from the brain case.

LIGAMENT. A band of fibrous tissue that connects bones or cartilages, to support and strengthen joints; a double layer of peritoneum extending from one visceral organ to another.

MANDIBLE. The bone of the lower jaw, the largest and strongest bone of the face. (See drawing of skeleton.)

MAXILLA GINGIVA. The gums of the upper teeth.

MESENTERY. A membranous fold attaching various organs to the body wall. When used alone, the term usually signifies the peritoneal fold attaching the small intestine to the dorsal body wall.

PARACENTESIS. A surgical puncturing of a body cavity to remove fluid (by aspiration).

PARIETAL (bone). One of the bones of the side of the head (see drawing of skeleton).

PERISTALSIS. The muscle movement by which the intestines move their contents.

PNEUMOTHORAX. An accumulation of air or gas in the pleural cavity.

POSTERIOR. Situated in back of, or in the back part of.

PULMONARY CONTUSION. Bruising of the lungs.

RETRACTOR. A device for storing part of the seat belt webbing by rolling it up.

RETROPERITONEUM HEMATOMA. A localized collection of (clotted) blood in the space behind the peritoneum (the membrane lining the abdominopelvic walls and covering the viscera).

SCAPULA. The shoulder blade (see drawing of skeleton).

SEPSIS. Infection.

SEROSA. Any serous membrane. (Deserosalization is a separation of serosa from the organ or part of the body to which it had been connected.)

SUBARACHNOID HEMORRHAGE. Intracranial hemorrhage into the subarachnoid space.

SUBDURAL HEMATOMA. Accumulation of blood in the subdural space (intracranial). In the severe acute form, both blood and cerebrospinal fluid enter the space through laceration of the brain and a tear in the arachnoid (a membrane within the brain), adding subdural compression to the direct injury to the brain. In the chronic form (a gradual process, occuring weeks after the injury), only blood effuses into the subdural space through rupture of the bridging veins, usually due to closed head injury.

SUBLUXATION. A partial dislocation.

SUBMARINING. A possible event during some crash decelerations, in which belted occupants slide downward and forward, resulting in the lap belt being repositioned above the iliac crests and over the abdominal area; it may also be possible for the same results to occur by a process involving the lap belt being pulled up past the iliac crests. Submarining is not a well-understood concept and some researchers have concluded it rarely if ever occurs.

TENSION RELIEF DEVICE. A device for reducing the tension in the shoulder belt portion of a lap/shoulder belt. The most common forms are the "comfort clip," a small clip positioned on the belt webbing to limit its ability to be taken up into the retractor, and the so-called "windowshade" device. In the latter device, by extracting webbing, pausing or rewinding slightly, then extracting slightly again, the locking mode of the retractor is triggered but with slack in the shoulder belt. The slack mode is supposed to be overridden automatically by some operation such as opening the occupant's door.

TRANSECTION. A division by cutting transversely, a cross-section cut.

TRAUMATIC THROMBOSIS. Formation of coagulated blood in a part following an injury.

TYMPANIC MEMBRANE. The membrane separating the middle from the external ear.

ULNAR STYLOID PROCESS. Part of the inner, larger bone of the forearm, on the side opposite that of the thumb (see drawing of skeleton).

VEHICLE SENSITIVE RETRACTOR. A type of emergency locking retractor (see definition above) that locks when the vehicle tilts or when it changes velocity sharply in any direction.

WEBBING SENSITIVE RETRACTOR. A type of emergency locking retractor (see definition above) that lockes when the webbing is suddenly withdrawn from the retractor, as in the early phase of a crash, but does not lock wher the webbing is withdrawn slowly (normal use). (Webbing sensitive ELRs are required by European regulation; European retractors also include the vehicle sensitive feature as well.)

APPENDIX E

INJURY SEVERITY MEASUREMENT

A basic tool used in these investigations is the Abbreviated Injury Scale (AIS). 1/ This system for classifying the severity of physical injuries consists of six numbers, 1 through 6, plus a code to indicate unknown severity:

AIS	Severity Code
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Maximum injury, virtually unsurvivable

The "unknown" code used in the Safety Board's study is the numeral 7.

It is important to understand that the AIS code is specifically and only a measure of the severity of the injury. It is not a measure of the likelihood of death or any other outcome. Persons sustaining injuries at any AIS level may die from the injuries, depending on many factors such as the specific nature of the injury and the quality of treatment received. Death as an outcome is, of course, less likely at the lower levels and more likely at the higher levels.

Many persons injured in vehicle crashes sustain more than one injury. For comparisons, the most severe of these (Maximal AIS = MAIS) is often used, as in this study.

1/ As presented in the National Accident Sampling System (NASS) Injury Coding Manual (1983 Revision).

APPENDIX F

CRASH SEVERITY MEASUREMENT

The severity measure used in the Safety Board's cases is Delta V, considered by most crash researchers the best single measure of collision severity. Delta V as used in these investigations is the instantaneous rate of speed change undergone by a vehicle at impact. The Delta V estimations were generated primarily from measurements of damage sustained by the crash-involved vehicles. These measurements, of both the location and extent of structural deformation, along with the vehicles' weights, were entered into the CRASH 3 1/ computer program, through which they could be compared against the known results of crashes staged and documented over the past several years. This computer program analyzes such parameters as vehicle structural rigidity, force vectors with respect to vehicle center of mass, and the influence of individual vehicle weights. The result is a computer-generated estimate of the speed change acting on the crash vehicles at impact. While the program result is recognized as an estimate, the use of CRASH allows a uniformity of case study interpretation which could not be achieved by other commonly used investigative methods.

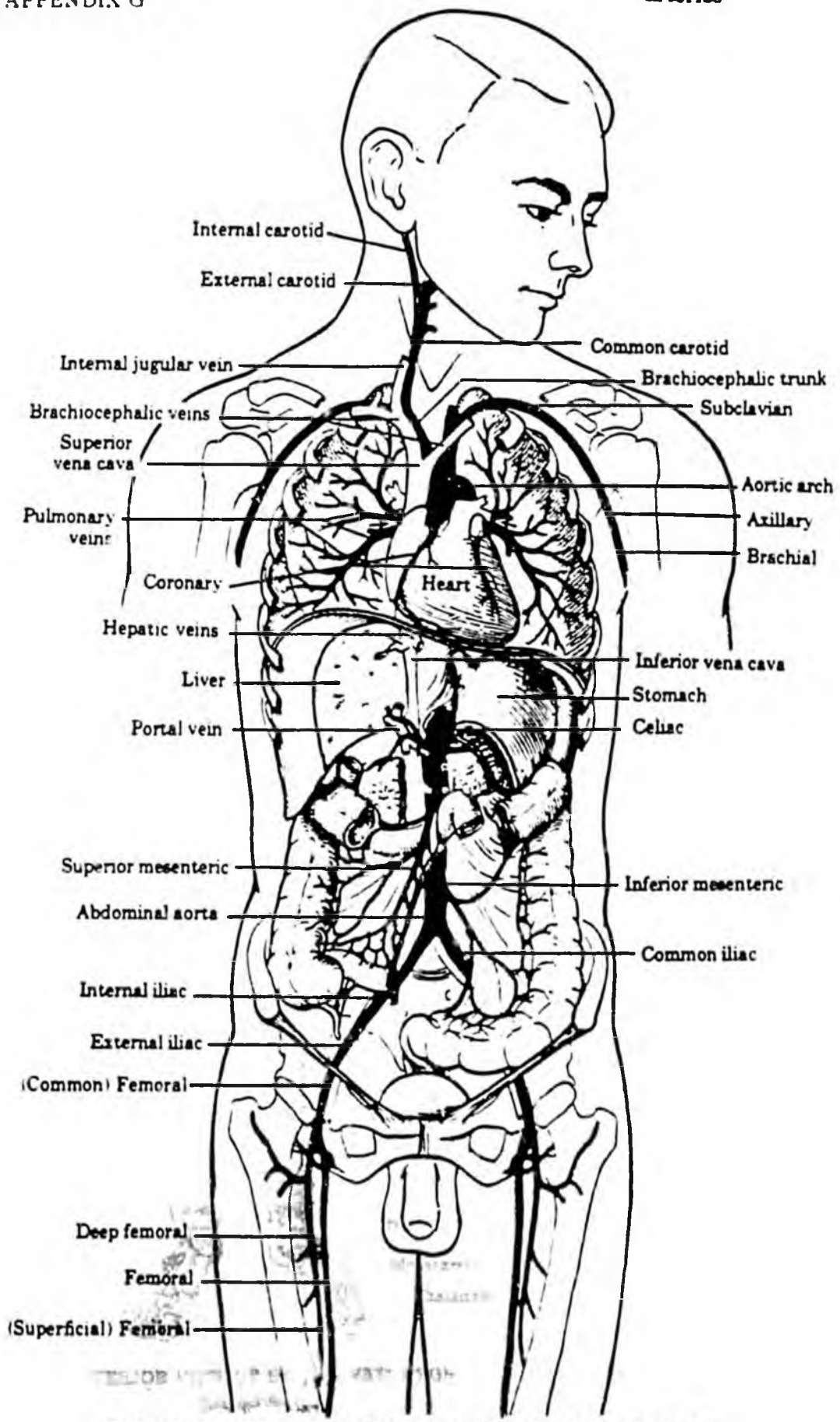
1/ CRASH stands for Calspan Reconstruction of Accident Speeds on the Highway. The program was developed with funding from the U.S. Department of Transportation as an "accident investigation aid aimed at achieving accuracy and uniformity in the interpretation of physical evidence from traffic accidents."

APPENDIX G

ANATOMICAL DRAWINGS

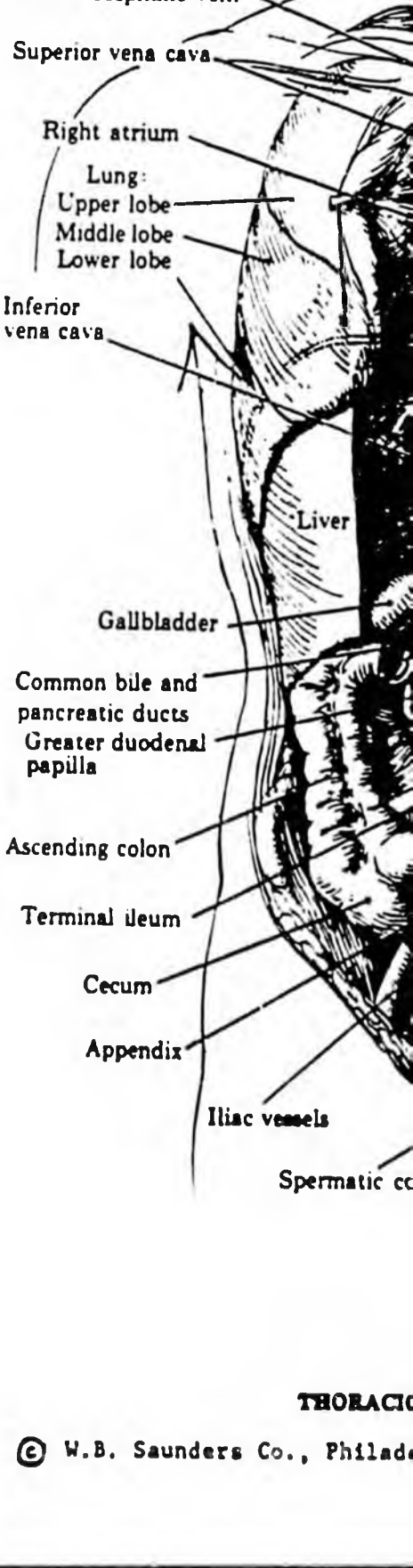
APPENDIX G

arteries



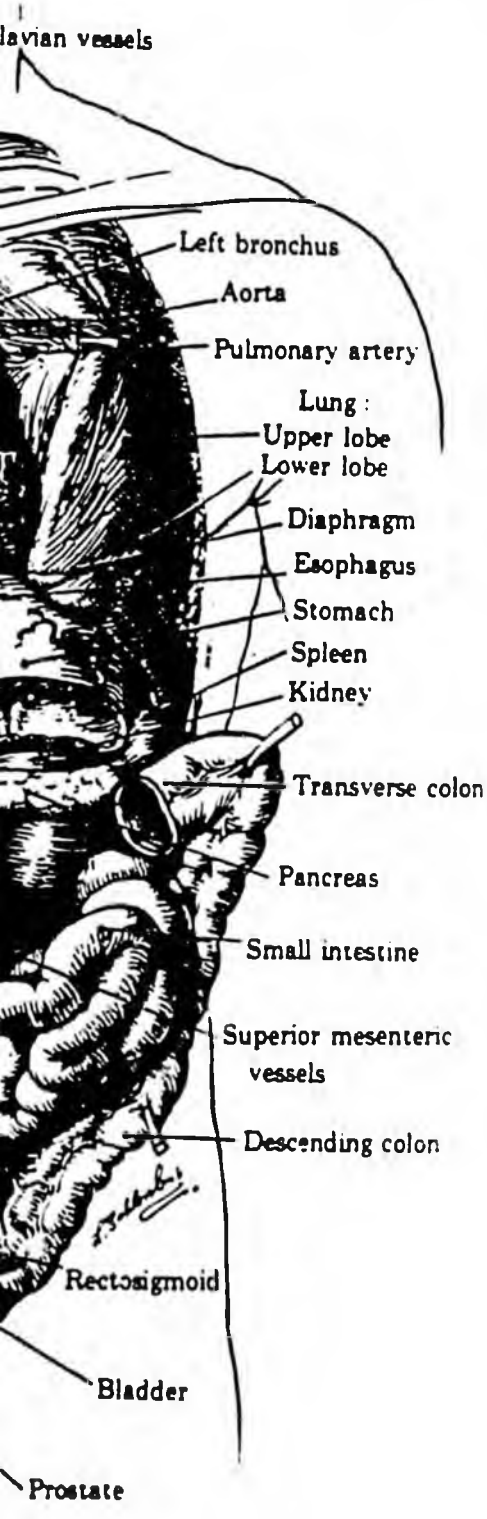
PRINCIPLE ARTERIES OF THE BODY AND PULMONARY VEINS

Plate LV



THORACIC

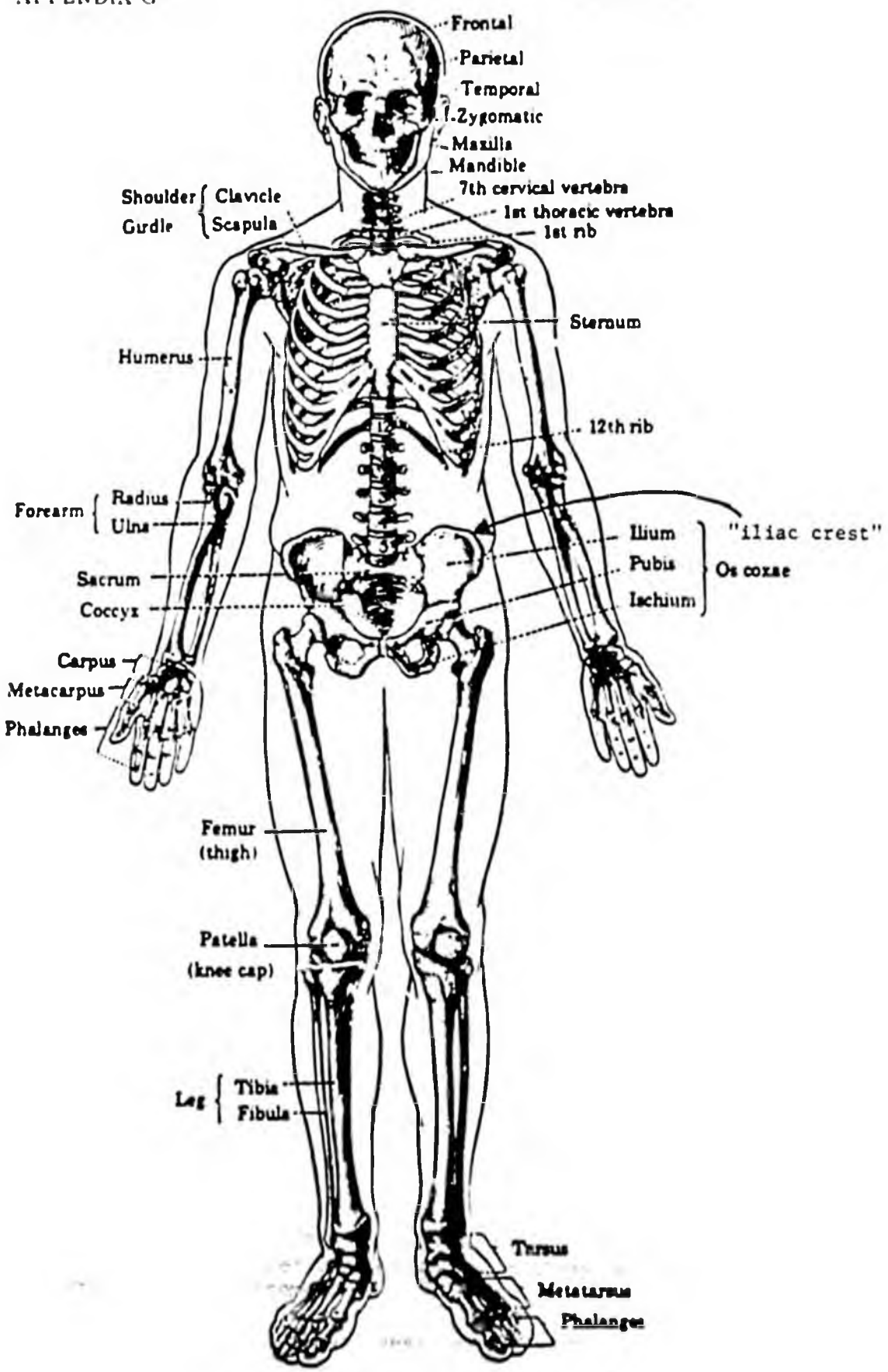
viscera



VISCERA

Permission.

APPENDIX G skeleton



ANTERIOR VIEW OF HUMAN SKELETON

APPENDIX H

PARTIAL CHRONOLOGY OF SEAT BELT RELATED EVENTS

This chronology of events related to the development and use of motor vehicle seat belts may provide some perspective for those unfamiliar with these topics. The Board was unable to locate a single, complete history of seat belts and their use; the following has been pieced together from a number of sources (14, 33, 52, 69, 71, 78, 82, 89, 110, 131, and correspondence of Thomas Turbell, Chief Biomechanics Researcher, Swedish Road and Traffic Research Institute, to Safety Board, October 11, 1985).

1930's

Several U.S. physicians equip their own cars with lap belts and begin urging manufacturers to provide them in all new cars

1953

Colorado State Medical Society publishes policy supporting installation of lap belts in all automotibles

1954

Sports Car Club of America requires competing drivers to wear lap belts

American Medical Association House of Delegates votes to support installation of lap belts in all automobiles

1955

California Vehicle Code is amended to require State approval of seat belts before their sale or use

National Safety Council, American College of Surgeons, International Association of Chiefs of Police vote to support installation of lap belts in all automobiles

Society of Automotive Engineers (SAE) appoints Motor Vehicle Seat Belt Committee

1956

Volvo markets 2-point cross-chest diagonal belt as accessory

Ford and Chrysler offer lap belts in front as option on some models

Ford begins 2-year ad campaign based on safety, focusing heavily on belts

1957

Volvo provides anchors for 2-point diagonal belts in front

Special Subcommittee on Traffic Safety, U.S. House of Representatives, opens hearings on effectiveness of seat belts in automobiles

1958

Volvo provides anchors for 2-point diagonal belts in rear

1959

Volvo introdues 3-point belt in front as standard, in Sweden

New York considers and rejects bill to require seat belts in new cars sold in State.

1960

New York again considers and again rejects seat belt bill

1961

SAE issues standard for U.S. seat belts (J4)

New York requires seat belt anchors at front outboard seat positions (effective January 1, 1962)

Wisconsin requires seat belts in front outboard seat positions

Standards Association of Australia issues standard for "safety belts and harness assemblies"

1962

Association for Aid to Crippled Children and Consumers Union sponsor landmark conference on "Passenger Car Design and Highway Safety" with occupant protection the sole theme

Six U.S. States require front outboard seat belt anchors

U.S. manufacturers provide seat belt anchors in front outboard as standard

1963

Volvo introduces 3-point belt in front as standard, in USA

Some U.S. manufacturers provide lap belts in front outboard positions (23 States have laws to require belts in front, most effective 1/64)

SAE issues revised standard (J4a)

U.S. Congress passes P.L. 88-201 to allow Commerce Department to issue mandatory standards for seat belts sold in interstate commerce

1964

About half the U.S. States require seat belt anchorages at front outboard

Most U.S. manufacturers provide lap belts at front outboard seat positions

Victoria and South Australia require seat belt anchorages at front outboard positions in new cars (either 2- or 3-point permitted)

1965

U.S. Commerce Dept. issues first seat belt standard (adopted SAE standard)

SAE issues revised standard (J4c)

All U.S. manufacturers providing lap belts in front outboard positions by this time

Some U.S. manufacturers provide automatic locking retractors (ALRs) in front seat belts

1966

Swedish regulations prohibit 2-point cross-chest diagonal belt at seats next to a door, and Y-type of 3-point belt altogether

U.S. Commerce Dept. issues revised seat belt standard (SAE J4c)

U.S. Congress passes P.L. 89-593, establishing National Highway Safety Bureau (now NHTSA)

Sports Car Club of America requires competing drivers to wear a shoulder harness as well as a lap belt (perhaps 1967, according to ref. 131)

1967

U.S. manufacturers provide lap belts at rear outboard positions (MY 1967)

NHSB issues initial Federal Motor Vehicle Safety Standards 208, 209, setting standards for lap and shoulder belts in front outboard positions, lap belts in all other positions (to take effect 1/1/68 and 3/67, respectively)

Volvo introduces 3-point belt in rear as standard, certain markets

Great Britain requires 3-points in front outboard positions

Australian standard for belt anchorages issued

South Australia requires seat belts (lap belts OK) at front outboard positions

1968

Volvo provides emergency locking retractors (ELRs) as standard in front, in Sweden

Great Britain requires retrofit of 3-point belts in front in MY 65 and newer cars

Many U.S. cars this MY provide ALRs.

1969

Sweden requires 3-point belts of approved type in front

Volvo provides 3-point belt in rear as standard, all markets

Mercedes-Benz adds 3-point belt in rear outboard seats as standard, all markets

Japan requires seat belts, front and rear

Australia requires 3-point belts, front outboard seats, all cars registered since 1965

1970

Sweden requires belts in rear (diagonal and static allowed; lap-only not approved)

Victoria, Australia requires 3-point belts, front and rear and mandates use, front and rear

1971

Volvo provides ELRs as standard in rear, all markets

NHTSA amends FMVSS 208 to require passive restraints in front, to be effective 1973

New South Wales requires use of seat belts

1972

Volvo introduces adjustable B-post anchor point (not standard) to permit better fitting of shoulder portion of front lap/shoulder belts

Last Australian state law requiring belt use, front and rear, goes into effect 1/1

New Zealand requires belt use, front and rear

W. Germany requires 3-point belts, front and rear

NHTSA requires anchorages for (detachable) shoulder straps for rear outboard (FMVSS 210)

VW displays 3-point belt system with webbing pre-tensioner (Transport 72, Washington, D.C.)

1973

Mercedes-Benz provides ELR on 3-point belts in large ("S" class) cars

1974

Mercedes-Benz provides ELR on 3-point belts in midsize (300 Series) cars

Sweden requires ELR on belts in front seats

NHTSA requires 3-point belts (i.e., non-detachable shoulder straps) in front outboard positions

U.S. cars provide "vehicle-sensitive" ELRs in front outboard shoulder belts (lap belt portion has ALR)

First production tension relief device on U.S. vehicle.

1975

Sweden requires 3-point, ELR belts in rear; mandates front use by persons 15 and older

1979

France mandates seat belts in rear: either 3 lap belts or 3-points at outboard positions and lap belt at center (most manufacturers choose latter option)

New Zealand requires 3-point belts, front and rear outboard positions

1980

Mercedes-Benz provides driver side airbag and knee bolster, and pre-tensioner on all 3-point belts

1981

NHTSA rescinds requirements for eventual installation of passive restraint systems

1983

New Brunswick and Ontario make belt use mandatory, front and rear (front seat use mandatory in Ontario since 1/76)

Saab introduces 3-point in rear in all models sold in U.S. (had provided "for years" in Scandinavia and Europe)

1984

Austria makes belt use mandatory in rear for cars with vehicle approval after 1/84 (front seat use mandatory since 7/76)

W. Germany makes rear seat belt use mandatory in cars manufactured since 5/79 (mandatory use in front since 1/76)

Seven of Canada's 10 provinces by this time require occupants of moving vehicles to use whatever seat belt system is available to them

1985

Nova Scotia makes belt use mandatory, front and rear

Norway makes rear seat belt use mandatory in vehicles registered after 1/84 (front seat use mandatory since 9/75)

New York makes belt use mandatory, front and rear (in rear for persons 10 years or older)

Mercedes-Benz introduces driver side air bag with knee bolster (in addition to pre-tensioned 3-point belts) in U.S. market

TABLES: RESTRAINT vs. INJURY vs. CRASH SEVERITY

RESTRAINT USE	DELTA V							
	0 - 15 MPH		16 - 25 MPH		26 - 35 MPH		36 - 45 MPH	
	AIS 1 - 2	AIS 3 - 6	AIS 1 - 2	AIS 3 - 6	AIS 1 - 2	AIS 3 - 6	AIS 1 - 2	AIS 3 - 6
NO RESTRAINT (57)	1		8	1	11	6	17	9
	FATALITIES RESULTING					1		3
	UNINJURED	4						
LAP BELT (50)	6		9	5	5	17	1	6
	FATALITIES RESULTING			4		6		3
	UNINJURED	1						
LAP/SHOULDER BELT (32)	5		7	1	8	6	2	1
	FATALITIES RESULTING					1		
	UNINJURED			2				

RESTRAINT vs. INJURY vs. CRASH SEVERITY (in 5 mph increments, with AIS distribution)

USAGE	INJURY LEVEL	DELTA V					
		0-20 MPH	21-25 MPH	26-30 MPH	31-35 MPH	36-40 MPH	41-45 MPH
UNRESTRAINED (57)	No. of AIS 1-2	1	13	4	2	15	2
	No. of AIS 3-6		2 AIS 3, 4	1 AIS 3	4 AIS 3, 3, 3, 5	5 AIS 3, 3, 3, 3, 3	4 AIS 3, 5, 6, 6,
	No. of FATAL				1 AIS 5		3 AIS 5, 6, 6
	No. of NONE	4					
LAP BELT (50)	No. of AIS 1-2	12	3	4	1	1	
	No. of AIS 3-6		5 AIS 3,5, 6,5,4	9 AIS 3,3,3, 4,4,5,5,5,5	8 AIS 3,5,5, 3,5,5,3,4	6 AIS 4,4,5 5,5,6	
	No. of FATAL		4 AIS 2, 6, 5, 5	2 AIS 5, 5	4 AIS 5, 5, 3, 4	3 AIS 5, 5, 6	
	No. of NONE	1					
LAP/SHOULDER (32)	No. of AIS 1-2	8	4	4	6		
	No. of AIS 3-6		1 AIS 3		5 AIS 4,3,4 4,3	1 AIS 4	
	No. of FATAL						
	No. of NONE		2				

APPENDIX J

TABLES: CASE INFORMATION, FATALLY INJURED LAP BELTED PERSONS

Delta V	Degrees PDOF	Veh.Wt.	Age	Sex	Use	Injury/Severity	Seat
37 mph	-10 to +10	2893 lb	13	M	P	AIS 5 - Fatal	R
37 mph	-10 to +10	2893 lb	13	M	P	AIS 5 - Fatal	R
23 mph	> -30	3690 lb	56	F	P	AIS 2 - Fatal*	R
22 mph	-10 to +10	2261 lb	5	F	P	AIS 6 - Fatal	R
26 mph	-10 to +10	3940 lb	16	M	I	AIS 5 - Fatal	R
32 mph	-10 to +10	2715 lb	4	M	P	AIS 5 - Fatal	R
22 mph	> +30	4250 lb	82	F	P	AIS 5 - Fatal	F
40 mph	-10 to +10	4720 lb	37	F	P	AIS 6 - Fatal	F
28 mph	-10 to +10	4935 lb	6	F	P	AIS 5 - Fatal	R
33 mph	-10 to +10	2824 lb	14	M	P	AIS 5 - Fatal	R
31 mph	-10 to +30	3488 lb	64	F	P	AIS 3 - Fatal*	R
25 mph	> -30	2968 lb	62	M	P	AIS 5 - Fatal	R
33 mph	-10 to -30	2330 lb	6	F	I	AIS 4 - Fatal	R

*Highest level of injury described by available records

Definitions of codes used:

P = Proper use of lap belt

I = Improper use of lap belt

N = No restraint used

PDOF = Principal direction of force

R = Rear seat

F = Front seat

SERIOUSLY TO FATALLY INJURED LAP BELT USERS: SELECTED CRASH DATA, BY DELTA V

DELTA V	AGE								SEX		USE			PORCE				VEH. SIZE				
	0 - 5 YRS	6 - 10 YRS	11 - 15 YRS	16 - 20 YRS	21 - 30 YRS	31 - 40 YRS	41 - 50 YRS	OVER 50 YRS	FEMALE	MALE	PROPER	IMPROPER	UNDETERMINED	- 10° to + 10°	+ 10° to + 30°	- 10° to - 30°	OTHER	UNDER 3000 lbs	OVER 3000 lbs	VAN/TRUCK	TOTALS	Codes
											P	I	U	A	B	C	D	1	2	3		
15 - 20 MPH																						FATAL INJURIES ONLY
21 - 25 MPH	1							3	3	1	4			1			3	1	3		4	
26 - 30 MPH		1		1					1	1	1	1		2					1	1	2	
31 - 35 MPH	1	1	1					1	2	2	3	1		2	1	1		3	1		4	
36 - 40 MPH			2			1				3	3			3				2		1	3	
OVER 40 MPH																						
TOTALS	2	2	3	1		1		4	6	7	11	2		8	1	1	3	6	5	2	13	
15 - 20 MPH																						FATAL, AIS 3, AIS 4, AIS 5, AIS 6, INJURIES COMBINED
21 - 25 MPH	1					2		3	5	1	6			1		2	3	2	4		6	
26 - 30 MPH	1	6	1	1					2	7	8	1		9				1	2	6	9	
31 - 35 MPH	2	1	2		1			2	4	4	2	1		5	2	1		6	2		8	
36 - 40 MPH			2	2	1	1			1	5	6			6				2		4	6	
OVER 40 MPH																						
TOTALS	4	7	5	3	2	3		5	12	18	28	2		22	2	3	3	12	8	10	29	

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Official Business

C.D

TO: Senator Mitch Abood, Chair
Senate State Affairs

FROM: Representative Al Adams, Chair
House Finance Committee

DATE: April 22, 1988

RE: Repercussions of mandatory seat belt laws and HB 167

Attached is an article giving further evidence to my position against mandatory seat belt laws. I am requesting further information on the cases referred to and will furnish you with that information when it arrives.

In the meantime I would request that you hold HB 167 in the Senate State Affairs Committee until we have an adequate understanding of the consequences of passage of that legislation.

Your accommodation of my request is appreciated.

RE:

Law/Courts

Ironic seat belt litigation haunts automakers

By CHARLEY ROBERTS
ACCN News Service

WASHINGTON — For four years, the nation's automakers pushed seat belt-use laws in a vain attempt to avoid installing passive restraints such as airbags. Now they are being hit by a double whammy: airbags and an explosion in litigation related to increased seat belt use.

"There's a certain irony here," said Brian O'Neill, president of the Insurance Institute for Highway Safety in Washington.

"One of the manufacturers' concerns with airbags was litigation," he said. "Their preferred alternative was seat belts. But as the usage of seat belts has gone up with the passage of mandatory use laws in the states, the manufacturers are finding a litigation explosion involving seat belts."

The irony was driven home to the manufacturers by a $3.3 million judgment by a federal court jury in Baltimore last December. The case involved a 13-year-old boy who was paralyzed from the waist down in a head-on collision in 1985.

During the collision, Jimmy Garrett's seat belt rode up over the pelvic bones and his upper body flexed over the belt across his abdomen, breaking his back and leaving him a paraplegic.

The jury held Ford liable for Garrett's injuries. It found that an elastic band used to keep the rear lap belts from slipping behind the seat tends to cause the belts to ride up. The jury also agreed with Garrett's lawyers that the automaker should have provided more protective shoulder-and-lap type seat belts for rear seat passengers even though federal safety regulations only require lap belts like the one the boy was wearing.

It was the first case brought since the seat belt-use campaign began in 1984 and based on the shoulder-lap belt argument to result in a jury award, said Gerald Holtz, one of Garrett's attorneys. It exposed what Robert Dewey of the Washington-based Center for Auto Safety called the "tip of an iceberg" of pending and potential litigation over seat belt design defects.

Dewey said there are an estimated 300 seat belt-related lawsuits awaiting trial in the nation's courts. That number is likely to grow exponentially, Holtz said judging by the number of calls he and the other lawyers involved in the case have received since the verdict.

It is generally conceded that the boom in seat belt litigation is directly attributable to the increase in seat belt usage caused by the passage of mandatory use laws in the states.

"As usage has increased, there has also been a growing awareness of the limitations of the lap belt," said Dewey, and this awareness has been increased by the *Garrett* case."

The government has been reluctant to order the automakers to install shoulder-lap belts in the rear seat. The manufacturers, however, have acted more quickly.

Although Ford Motor Co. is still considering appealing the *Garrett* verdict, the automaker is installing shoulder-lap seat belts in the rear passenger seat of its 1988 Escorts and plans to make them standard equipment on all its new-car models by 1990.

General Motors Corp. also has begun installing rear seat shoulder-lap belts in some models this year and plans to extend the program to all models in 1989. And Chrysler plans to follow suit.

At least eight foreign car makers — Audi, BMW, Jaguar, Mercedes-Benz, Peugeot, Rolls-Royce, SAAB and Volkswagen — also are installing such belts. European countries require shoulder-lap belts, a requirement that became a key point in the *Garrett* case. Holtz said jurors were told Ford installed the belts in its European Escorts but left them out of Escorts sold in this country.

Automakers also are beginning to phase in installation of passive restraints, such as automatic seat belts, which wrap around people when they get in a vehicle, or airbags, which fill with air upon impact to cushion someone thrown forward against the steering wheel or dashboard.

It was installation of these devices, mandated in a 1984 order by then-Transportation Secretary Elizabeth Dole, that the automakers hoped to avoid when they launched a $46-million public-relations and lobbying campaign to promote seat belt usage.

Chuck Bosse, a spokesman for Traffic Safety Now Inc., the auto industry's lobbying arm on the seat belt issue, said manufacturers still believe seat belts are a more effective means of protection people in accidents, but they are resigned to complying with the passive-restraint provisions of the order.

Automakers still contend, however, that airbags are not as cost-effective as seat belts and are likely to lead to new litigation.

San Francisco firm eyes Portland market

Compiled from staff and wire reports.

Legal Briefs

Portland law firms trying to attract a high-tech clientele may want to establish their presence now, before other West Coast firms penetrate the local

developing a strong West Coast or regional practice, rather than

ter testing positive for AIDS.

The winning team will travel

The average reduction of deaths in states with safety belt laws is 28%.

The most important thing that they do not know is that everyone's privacy is invaded when someone does not buckle-up. It's true. The high costs of rehabilitation, of hospital care, of insurance, and emergency medical services, to name a few, are passed along to WHO? **YOU!**

Example: A 27 year old woman who chose to not wear her safety belt, sustained a traumatic head injury and multiple physical injuries in August 1985. Her husband, also not wearing a safety belt, was killed in the accident. She has 2 small children and is without family support.

The State of Alaska provided approximately **$90,000** worth of inpatient medical care for this client.

Outpatient rehabilitation services over a 13 month period cost the State another **$51,710.**

In addition to State funded medical care, this client and her children also receive services from other state funded agencies such as the Homemaker Program, Daycare programs, Aid to Families with Dependent Children, Food Stamps and Child Protective Services.

Her prognosis for returning to work is extremely poor.

She plans on remaining in the State of Alaska and will continue to require State funding.

Source: Alaska Treatment Center.

Being **FREE** also means having the chance to live and having a responsible government by the people that makes decisions in everyone's best interests.

Prepared by Alaska Safety Belt Use Coalition. If you would like to join our efforts to pass a safety belt law, please write or call:

SEATBELT LAWS

SAVE LIVES

Alaska Safety Belt Use Coalition
319 Seward St., Juneau, Alaska 99801
(907) 586-1400

Safety Belts are an INVASION of PRIVACY

when not worn

If you believe a safety belt law would invade your personal privacy, note the following:

★ **PRIVACY INVADED: DUI Laws**
—have saved untold lives since enacted, but take away a driver's right to choose whether he can drink or not.

★ **PRIVACY INVADED: Driving on the WRONG SIDE OF THE ROAD**—keeps orderly flow of traffic and keeps the high death rate of head-on collisions down, but . . . keeps a driver from choosing which side of the road to drive on.

★ **PRIVACY INVADED: Licensing and Testing of Drivers**—the right to choose whether one can drive his **own** vehicle has been taken away by licensing and testing procedures.

Sound a Little Ridiculous?

It is. Why? Because these laws have saved so many lives and people are generally obeying them.

Driving is a privilege, not a right. On private property, the state has no jurisdiction, but once you drive on public roads, your rights are limited by safety laws.

So What's Wrong with a Law that Requires You to Buckle-Up?

Why do so many people believe its AN INVASION OF PRIVACY?

They do not know that 90% of those 176 that died in 1985 and 1986 in Alaska were not using safety belts.

Editorial Support for a Mandatory * Safety Belt Use Law in Alaska as of Sept. 1987

Anchorage Times
Anchorage Daily News
Frontiersman
Valley Sun
Juneau Empire

* The proposed law in Alaska CSHB 167(JUD)AM is a secondary offense. The emphasis is not on fines and penalties; the emphasis is on compliance. When there is a law on the books, there is higher compliance. People cannot be pulled over for not wearing a safety belt—as is the case in Hawaii where the law is a primary offense. Under the proposed law in Alaska, people can only be fined $15, if they are stopped for other reasons and are found not to be wearing a safety belt. CSHB 167(JUD)AM passed the State House in 1987 and will be considered by the State Senate in 1988.