

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

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**ON-SITE PASSENGER AIR BAG RELATED FATALITY INVESTIGATION
GENERAL DYNAMICS CASE NO: CA03-049**

**SUBJECT VEHICLE – 1998 DODGE NEON
LOCATION - PENNSYLVANIA
CRASH DATE – AUGUST 2003**

Contract No. DTNH22-01-C-17002

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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<p>16. <i>Abstract</i> This on-site investigation focused on the injury mechanisms and the cause of death for an 85-year old female front right passenger in a 1998 Dodge Neon. The Dodge was equipped with a redesigned frontal air bag system for the driver and front right passenger positions that deployed as result of the crash. The Dodge was involved in an intersection-type crash with a 1994 Ford Taurus. The Ford was occupied by an 81-year-old male driver and three other passengers. The Ford was equipped with frontal air bags that also deployed as result of the impact. The driver of the Dodge was traveling in westerly direction on a two-lane residential roadway approaching an intersection. The Ford was traveling north on a similar roadway approaching the same intersection. A witness to the crash stated to police that the Ford was stopped at the intersection stop sign and then preceded into the intersection. The impact resulted in moderate damage to the front of the Dodge and moderate damage to the right side of the Ford. The unrestrained 85-year old female front right passenger sustained a basilar skull fracture and cranial hemorrhages as a result of the deploying front right passenger air bag. She was conscious and alert at the scene and transported to a local hospital for evaluation. Due to the severity of her injuries, she was transferred via Lifeflight to a trauma center where her condition began to deteriorate. She expired from her injuries prior to admission approximately 12 hours post-crash. The unrestrained 57-year old female driver and the unrestrained 51-year old male rear right passenger of the Dodge sustained police reported minor injuries. Both occupants were transported, treated and released. The driver and the three passengers of the Ford were police reported as not injured.</p>			
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**SUBJECT VEHICLE – 1998 DODGE NEON
LOCATION - PENNSYLVANIA
CRASH DATE – AUGUST 2003**

BACKGROUND

This on-site investigation focused on the injury mechanisms and the cause of death for an 85-year old female front right passenger in a 1998 Dodge Neon (**Figure 1**). The Dodge was equipped with a redesigned frontal air bag system for the driver and front right passenger positions that deployed as result of the crash. The Dodge was involved in an intersection-type crash with a 1994 Ford Taurus. The Ford was occupied by an 81-year-old male driver and three other passengers. The Ford was equipped with frontal air bags that also deployed as result of the impact. The driver of the Dodge was traveling in westerly direction on a two-lane residential



Figure 1: 1998 Dodge Neon.

roadway approaching an intersection. The Ford was traveling north on a similar roadway approaching the same intersection. A witness to the crash stated to police that the Ford was stopped at the intersection stop sign and then proceeded into the intersection. The impact resulted in moderate damage to the front of the Dodge and moderate damage to the right side of the Ford. The unrestrained 85-year old female front right passenger sustained a basilar skull fracture and cranial hemorrhages as a result of the deploying front right passenger air bag. She was conscious and alert at the scene and transported to a local hospital for evaluation. Due to the severity of her injuries, she was transferred via Lifeflight to a trauma center where her condition began to deteriorate. She expired from her injuries prior to admission approximately 12 hours post-crash. The unrestrained 57-year old female driver and the unrestrained 51-year old male rear right passenger of the Dodge sustained police reported minor injuries. Both occupants were transported, treated and released. The driver and the three passengers of the Ford were police reported as not injured.

This August 2003 crash was reported to the National Highway Traffic Safety Administration (NHTSA) by the investigating police agency as a potential air bag related fatality. The crash information was forwarded to the Crash Investigation Division of the NHTSA and an on-site investigation of the crash was assigned to the General Dynamics Special Crash Investigations team. Cooperation with the investigating police agency was established and the vehicles were held in police impound. The on-site portion of the investigation was initiated on September 4, 2003.

VEHICLE DATA**1998 Dodge Neon**

The 1998 Dodge Neon was identified by the Vehicle Identification Number (VIN): 1B3ES47CXW (production sequence omitted). The odometer reading at the time of the inspection was 98,013 kilometers (60,904 miles). The vehicle's date of manufacture was April, 1998. The vehicle was a four-door sedan that was equipped with a 2.0-liter, four-cylinder engine; 4-speed automatic transmission, power-front disc/rear drum brakes, OEM steel wheels with plastic hubcaps, and power steering. The manual restraint system consisted of 3-point lap and shoulder belts for the four outboard occupants and a rear center lap belt. The Supplemental Restraint System consisted of redesigned air bags for the driver and front right passenger positions. The Dodge was equipped with Voyager Road Handler tires on the front and Michelin Energy MXV4 tires on the rear (all sized P185/65R14). The vehicle manufacturer recommended tire pressure was 221 kpa (32 psi). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	206.8 kpa (30.0 psi)	2.4 mm (3/32)	No	Abraded
LR	227.5 kpa (33.0 psi)	3.1 mm (4/32)	No	None
RF	227.5 kpa (33.0 psi)	3.1 mm (4/32)	Yes	None
RR	234.4 kpa (34.0 psi)	2.4 mm (3/32)	No	None

1994 Ford Taurus

The 1994 Ford Taurus was identified by the VIN: 1FALP52U6R (production sequence omitted). The date of manufacture was March 1994. The odometer reading was 123,507 kilometers (76,746 miles) at the time of the inspection. The vehicle was a four-door sedan that was equipped with a 3.0-liter, 6-cylinder engine; a 4-speed automatic transmission, power-front disc and rear drum brakes, OEM steel wheels with plastic hubcaps and power steering. The Ford was equipped with a Supplemental Restraint System that consisted of frontal air bags that deployed as a result of the crash. The Ford Taurus was equipped with Goodyear Regatta P205/65R15 tires. The vehicle manufacturer recommended tire pressure was 221 kpa (32 psi). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	206.8 kpa (30.0 psi)	4.0 mm (5/32)	No	None
LR	203.4 kpa (29.5 psi)	4.0 mm (5/32)	No	None
RF	Flat	4.0 mm (5/32)	No	Sidewall cut
RR	189.6 kpa (27.5 psi)	4.0 mm (5/32)	No	None

SUMMARY

Crash Site

This two-vehicle crash occurred during the daytime hours of August 2003. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred at the angular four-leg intersection of two roadways. The east/west roadway was configured with one travel lane in each direction that were separated by a double-yellow centerline. The northeast/southwest two-lane roadway was unmarked. East/west traffic flow through the intersection was not controlled. The northeast/southwest traffic was controlled by a stop sign. There was a row of bushes [approximately 1.5 m (5.0 ft) high] along the east shoulder of the northbound lane. The bushes began 4.9 meters (16.0 ft) south of the eastbound road edge and extended 19.5 meters (64.0 ft) south. These bushes may have obstructed the view of the driver of the Ford to westbound traffic as he approached the intersection. However, at the intersection there were no obstructions that would have impaired the driver's vision. The posted speed limit for both roadways was 40 km/h (25 mph). The scene schematic is included in this report as **Figure 11** at the end of this report.

CRASH SEQUENCE

Pre-Crash

The 1994 Ford Taurus was northbound (**Figure 2**) driven by an 81-year old male and occupied by three adult passengers. A witness reported that the driver of the Ford stopped at the stop sign and then proceeded into the intersection directly into the path of the Dodge. The 1998 Dodge Neon was westbound driven by a 57-year old female driver, **Figure 3**. The front right and rear right passengers were an 85-year old female and a 51-year old male, respectively. All the occupants of the Dodge were unrestrained. Reportedly, the Dodge had just exited a county park located 79.2 meters (260.0 ft) east of the intersection. The female driver of the Dodge reportedly recognized the impending crash and applied the brakes. The estimated travel speed of the Dodge was 32 – 40 km/h (20 - 25 mph). No pre-crash skid marks were identified during the SCI scene inspection or documented by the police investigators.



Figure 2: Northward trajectory view at the intersection.



Figure 3: Westward trajectory view.

Crash

As the driver of the Ford entered the westbound lane of the intersection, the front of the Dodge impacted the right front aspect of the Ford. The redesigned frontal air bags in the Dodge and the (first generation) frontal air bags in the Ford deployed as a result of the impact. The computed total velocity changes (delta V) for the Dodge and Ford were 19.0 km/h (11.8 mph) and 15.0 km/h (9.3 mph), respectively.

The westbound momentum of the Dodge and its impact forward of the Ford's center of gravity induced a counterclockwise rotation to the Ford. The Ford was redirected to the northwest. The Dodge separated from the impact with a clockwise rotation. During separation, the right side doors of the Ford swiped along the left front fender of the Dodge in a minor secondary contact. The Ford slid to rest facing northwest just off the pavement in the intersection's northwest quadrant, approximately 5 m (16 ft) from the impact. The Dodge came to rest facing northwest within the boundaries of the intersection, approximately 2 m (6 ft) from the area of impact.

Post-Crash

Police and ambulance personnel arrived on-scene and found the front right passenger of the Dodge conscious and alert. The first responding officers stated to the SCI investigator that the front right passenger was walking, talking and asking for medical attention for the driver and rear right passengers of the vehicle. The front right passenger was transported to a local hospital for evaluation and treatment. Due to her advanced age and the severity of her injuries, the physicians at the local hospital decided that assessment and treatment at a regional trauma center was required. Lifeflight was requested, however, during their response time the passenger's level of consciousness became diminished and her condition began to deteriorate. She was transferred in stable but serious condition to the trauma center arriving approximately 130 minutes post-crash. A series of procedures to evaluate and treat her injuries began, however, her condition continued to deteriorate and she expired approximately 12 hours post-crash. The driver and rear right passenger of the Dodge were transported to a local hospital where they were treated and released for minor injuries. The driver and three passengers of the Ford were police reported as uninjured, they were not transported.

EXTERIOR DAMAGE

1998 Dodge Neon

Figures 4 and 5 are the front and left lateral views of the 1998 Dodge Neon. The Dodge sustained moderate frontal damage as a result of the impact with the Ford. The direct contact damage began at the left front bumper corner and extended across the vehicle's entire 142.2 cm (56.0 in) front end width. The front structure of the Dodge was shifted 11.4 cm (4.5 in) to the right as a result of the lateral momentum of the Ford during the vehicle engagement. The hood, both front fenders and front support structures were also deformed rearward. The longitudinal length of the direct contact to the hood measured 42.9 cm (16.5 in) along the vehicle's centerline. A 66 cm x 20 cm (26 in x 8 in) area of paint transfer from the Ford was identified within the hood's direct contact damage. The windshield, roof and side glazing were not damaged. All four doors remained closed during the crash and were operational post-crash. There was no change in the wheelbase dimensions. The bumper fascia was partially separated and rotated down. The residual crush documented along the bumper reinforcement was as follows: C1 =

22.0 cm (8.6 in), C2 = 23.0 cm (9.1 in), C3 = 25.0 cm (9.8 in), C4 = 20.0 cm (7.9 in), C5 = 9.0 cm (3.1 in), C6 = 0. Maximum crush was located on the centerline of the vehicle and measured 27.9 cm (11.0 in). The Collision Deformation Classification (CDC) for the impact with the Ford was 71-FDEW-2 with an incremented shift value of 60. The damage algorithm of the WinSmash program computed a total velocity change of 19.0 km/h (11.8 mph) for the Dodge. The longitudinal and lateral components were -17.9 km/h (-11.1 mph) and 6.5 km/h (4.0 mph), respectively.

The left front fender exhibited sideswiping damage from secondary contact with the right doors of the Ford that occurred during vehicle separation. The direct contact measured 55.9 cm (22.0 in) in length. The damage began 8.9 cm (3.5 in) rear of the left front axle and extended forward. The CDC for this impact was 06-LFES-1.



Figure 4: Front view of the Dodge.



Figure 5: Left lateral view.

1994 Ford Taurus

The 1994 Ford Taurus sustained moderate right side damage as a result of the crash. **Figure 6** is a right side view of the vehicle. The direct contact damage began on the right front bumper corner and extended rearward 108.4 cm (42.7 in). The damage consisted of left lateral deformation to the right front fender and right front suspension. The front end of the Ford was shifted left 6.4 cm (2.5 in). The right front wheel was deformed and restricted. The right wheelbase was reduced 3.8 cm (1.5 in). The windshield was fractured from the lateral deformation. The side and rear glazing were not damaged. The four doors remained closed during the crash and were operational post-crash. The crush profile documented at the mid-door elevation on the right side was as follows: C1 = 0, C2 = 7.0 cm (2.8 in), C3 = 7.0 cm (2.8 in), C4 = 25.0 cm (10.0 in), C5 =



Figure 6: Right side view of the 1994 Ford Taurus.

20.0 cm (7.9 in), C6 = 18.0 cm (7.1 in). The CDC for the impact was 02-RYEW-2. The total velocity change computed for the Ford was 15.0 km/h (9.3 mph). The longitudinal and lateral components for the Ford were -9.6 km/h (6.0 mph) and -11.5 km/h (7.1 mph), respectively.

The right doors of Taurus exhibited abrasions and paint transfers resultant to the secondary contact with the left front fender of the Dodge during separation. The contact damage began 152.1 cm (59.9 in) forward of the right rear axle on the mid-aspect of the right front door. The contact extended 116.6 cm (45.9 in) rearward and ended on the mid-aspect of the right rear door. The CDC of this was 12-RPES-1.

INTERIOR DAMAGE

1998 Dodge Neon

The interior damage to the Dodge was minor and attributed to occupant contacts and deployment of the Supplemental Restraint System. There was no intrusion as a result of the exterior crash forces. **Figure 7** is an interior view of the Dodge.



Figure 7: Interior view of the Dodge.

The driver seat was located in a mid-track position. The seat position measured 10.2 cm (4.0 in) forward of full rear. The total seat track travel measured 20.3 cm (8.0 in). The seat back was reclined 10 degrees aft of vertical. The horizontal distance from the center hub of the steering wheel to the seat back measured 49.5 cm (19.5 in). The adjustable head restraint was full down.

The steering wheel was rotated approximately 90 degrees counterclockwise at inspection. Minor deformation [estimated at 0.8 cm (0.3 in)] was observed to the upper sector of the steering wheel rim. There was no displacement of the shear capsules. The tilt steering column was in the full up position. The driver's knee bolster exhibited an 8.9 cm by 5.1 cm (3.5 in by 2.0 in) triangular scuff from contact with the driver's right lower extremity. This contact was located 7.6 cm (3.0 in) left of the steering column centerline. The position of the contact was consistent with position of the driver's right foot on the brake pedal at the time of the impact.

The front right seat was in a rear-third track position that measured 4.1 cm (1.6 in) forward of full rear. The total seat track travel measured 19.1 cm (7.5 in). The recline mechanism for the front right seat back was broken as a result of loading from the right rear occupant. The seat back could be moved and positioned at any angle throughout its adjustment range. The back aspect of the seat back was spattered with blood over a 20 cm x 33 cm (8 in x 13 in) area, but otherwise appeared undamaged. The adjustable head restraint was full down.

The front right and front center aspects of the interior exhibited contacts consistent with the forward left trajectory of the front right passenger, **Figure 8**. The glove box door exhibited two contact scuffs attributed to contact with the passenger's right lower extremity. The scuffs measured 20.3 cm (8.0 in) and 12.7 cm (5.0 in), respectively. The scuffs were oriented in an angular manner from the upper center aspect of the glove box door to lower left inboard corner. A 15.2 cm (6.0 in) longitudinal abrasion was located on the lower edge of the center stack side panel. This abrasion was attributed to contact with the passenger's left knee. The front right passenger sustained a 7.9 cm (3.1 in) laceration over the left knee consistent with the loading.



Figure 8: Front right passenger interior.

A 5.1 cm (2.0 in) vertical abrasion was also noted on the side panel attributed to probable left hand contact. A 1 m (3 ft) red cane was found within the front right occupant space. The cane was fractured 0.6 m (2.0 ft) above its base. The fracture probably occurred due to the forward and left kinematic pattern of the rear right passenger. Red paint transfers consistent with loading from the side of the cane were identified on the vertical edge of the instrument stack side panel. Two linear red abrasions on the top center instrument panel measuring approximately 6.4 cm (2.5 in) in length were also identified. These abrasions resulted from contact with the top aspect (hook) of the cane. The outboard (right) air conditioner/heater vent louver was noted to be displaced from the instrument panel. The occupant contacted the louver in a bracing action with her right hand at impact. During her bracing, the occupant loaded and fractured her right forearm displacing the louver.

During the crash sequence, the unrestrained rear right passenger loaded and ramped up the inboard aspect of the front right seat back. During that kinematic sequence, he struck the seat back with his head resulting in epistaxis (bloody nose). Due to the 11 o'clock direction of force and the clockwise vehicle rotation, the passenger's trajectory was directed between the front seats. In this manner he displaced the center console and contacted the center mirror. The stalk of the rearview mirror was fractured from contact by the rear right passenger's head. Two dark (black) scuffs were noted to the center front headliner directly above the location of the center mirror indicative of contact. The center console was shifted left 2.0 cm (0.8 in). Blood was noted to the backside of the rearview mirror and blood spatter was identified on the transmission shifter and center instrument panel. The blood evidence was consistent with the rear right passenger's epistaxis.

MANUAL RESTRAINT SYSTEM

1998 Dodge Neon

The 1998 Dodge Neon was equipped with manual 3-point lap and shoulder safety belts for the outboard seating positions. The center rear position was equipped with a lap belt. The driver's safety belt was configured with an Emergency Locking Retractor (ELR) and sliding latch plate. The driver's adjustable D-ring was in the full down position. Inspection of the webbing and latch plate hardware revealed evidence of historical use. However, there was no crash related evidence identified. The driver was unrestrained at the time of the crash.

The front right safety belt was configured with a cinching latch plate and ELR. The front right adjustable D-ring was located 5.7 cm (2.2 in) below the full up position. The latch plate revealed evidence of historical use, however, there was no crash related evidence identified on the restraint indicative of use in the crash. Based on the results of the inspection, the occupant kinematics and the occupant's injuries, the front right passenger was unrestrained in the crash.

The rear outboard safety belts were configured with cinching latch plates and ELR's. Minor evidence of historical use was identified. There was no crash related evidence identified on the rear right restraint. The rear right passenger was unrestrained at the time of the crash based on the results of the inspection and his forward kinematic pattern.

SUPPLEMENTAL RESTRAINT SYSTEM

1998 Dodge Neon

The 1998 Dodge Neon was equipped with a redesigned frontal air bag system that deployed as result of the crash. The driver air bag module was located in the center hub of the steering wheel and was configured with a single cover flap. The flap measured 22.9 cm (9.0 in) wide by 17.1 cm (6.8 in) in height. The diameter of the deployed driver air bag measured 60.9 cm (24.0 in). The bag was tethered by two internal straps sewn to the face of the bag and vented by two ports in the 11 and 1 o'clock positions on the back side of the air bag. A 6.4 cm (2.5 in) make-up transfer was documented on the center line of the air bag and located 3.0 cm (1.2 in) into the 12 o'clock sector. The transfer resulted from contact with the driver's face.

The front right passenger air bag was a top-mount design located in the right aspect of the instrument panel. The air bag had properly deployed as a result of the crash. The rectangular-shaped vinyl cover flap measured 34.3 cm x 15.2 cm (13.5 in x 6.0 in), width by height. There was no deformation of the cover flap or evidence of occupant contact.

Upon initial inspection, the front right passenger air bag membrane was found partially tucked back into the module and the membrane was fused (melted) to the inflator, **Figure 9**. Upon freeing the membrane, it was observed that the face of the membrane was melted in two regions, **Figure 10**. Referring to Figure 10, the upper and lower melted regions measured 51.6 cm x 6.4 cm (8.0 in x 2.5 in) and 10.2 cm x 5.1 cm (4.0 in x 2.0 in), respectively. After the Dodge came to rest at the time of the crash, the membrane was partially tucked back into the module, presumably by the front right passenger. The membrane then partially melted due to the residual heat of the inflator and became fused. None of the police investigators involved in the crash investigation were aware of the post-crash state of this air bag prior to SCI involvement.



Figure 9: Front right passenger air bag upon initial inspection.



Figure 10: View of the face of the air bag.

The face of the front right passenger air bag measured 46 cm x 61 cm (18 in x 24 in), width by height. It was tethered by two straps sewn to the center and upper aspects face. The rearward excursion of the bag measured 28 cm (11 in) from the vertical face of the instrument panel. The air bag was vented by a 6.4 cm (2.5 in) diameter port located on the top panel of the air bag. Examination of the face of the air bag was unremarkable. There was no evidence of occupant contact identified on the face of the air bag.

Two faint blood spatter patterns were noted on the bottom surface of the air bag. These spatter patterns were attributed to contact with the front right occupant's lower extremities. The areas measured 8.9 cm x 7.6 cm (3.5 in x 3.0 in) and 15.2 cm x 7.6 cm (6.0 in x 3 in) and were located on the inboard lower corner and center aspects of the bottom surface, respectively.

OCCUPANT DEMOGRAPHICS

1998 Dodge Neon

	<i>Driver</i>	<i>Front Right Passenger</i>	<i>Rear Right Passenger</i>
<i>Age/Sex:</i>	57-year old/Female	85-year old/Female	51-year old/Male
<i>Height:</i>	Not reported	155 cm (61 in)	Not reported
<i>Weight:</i>	Not reported	75 kg (165 lb)	Not reported
<i>Seat Track Position:</i>	Mid-track	Rear-thirdNot-adjustable
<i>Manual Restraint Use:</i>	None	None	None
<i>Usage Source:</i>	SCI inspection	SCI inspection	SCI inspection
<i>Type of Medical Treatment:</i>	Treated and released	Fatal prior to admission to trauma center	Treated and released

OCCUPANT INJURIES
1998 Dodge Neon
Driver

<i>Injury</i>	<i>Injury Severity AIS update 98</i>	<i>Injury Mechanism</i>	<i>Source</i>
Left wrist abrasion, NFS	Minor 790202.1,2	Deploying driver air bag	A
Left wrist contusion, NFS	Minor 790402.1,2	Fling injury into left interior panel	A
Left lateral rib contusion	Minor 450202.1,2	Steering wheel rim (probable)	A
Right knee abrasion	Minor 890202.1,1	Knee bolster	A

Note: The above injuries were identified in the Emergency Room records of the treating local hospital (Source A).

Rear Right Passenger

<i>Injury</i>	<i>Injury Severity AIS update 98</i>	<i>Injury Mechanism</i>	<i>Source</i>
Bloody nose, Epitaxis	Minor 251090.1,4	Seat back loading	Police
Superficial abrasion of the left ear lobe	Minor 290202.1,2	Seat back loading	A
Superficial abrasion of the left leg, NFS	Minor 890202.1,2	Seat back loading	A

It should be noted that the rear right passenger was blind. This individual was transported to a local hospital (Source A) and examined. The Emergency Room records indicated the occupant only sustained two minor abrasions. Reportedly, the passenger denied any injuries and had no complaint of pain during his examination. He stated that he thought he struck his left ear, but he denied any head injury or loss of consciousness. He was up and ambulatory at the scene of the crash without difficulty. The occupant's epitaxis was reported by the police investigator and was evidenced by the blood spatter on the front right seat back and the center aspect of the front interior.

Front Right Passenger

<i>Injury</i>	<i>Injury Severity (AIS update 98)</i>	<i>Injury Mechanism</i>	<i>Source</i>
Very large extensive subdural hemorrhage left frontal at the vertex inferiorly and posteriorly into the left parietal, left temporal and left occipital; Subdural hemorrhage in the right temporal region	Critical 140654.5,3	Acceleration injury due to contact with the deploying front right passenger air bag	B,C

Acute cerebral edema; Extensive mass effect and shift of the midline structures 1.4 cm posterior, lateral right; basal cisterns completely distorted	Critical 140666.5,2	Acceleration injury due to contact with the deploying front right passenger air bag	B
Intraventricular hemorrhage, right temporal horn	Severe 140678.4,1	Acceleration injury due to contact with the deploying front right passenger air bag	B
Hinge type basilar skull fracture; hemotympanum on the left	Severe 150206.4,8	Deploying front right passenger air bag	A,C
Leptomeninges congested and exhibit patchy subarachnoid hemorrhage	Serious 140684.3,9	Loading of the instrument panel accentuated from the rear by the unrestrained rear right passenger	C
Right temporal bone fracture perpendicular to the long axis of the petrous apex as well as a transverse fracture.	Moderate 150402.2,1	Loading of the instrument panel accentuated from the rear by the unrestrained rear right passenger	B
Mild comminuted fracture of the right zygomatic arch	Moderate 251800.2,1	Loading of the instrument panel accentuated from the rear by the unrestrained rear right passenger	B
5x7 cm swollen, well demarcated purple hemorrhage in the right temporal region	Minor 190402.1,1	Loading of the instrument panel accentuated from the rear by the unrestrained rear right passenger	C
Forehead laceration above the left eye brow	Minor 290602.1,7	Unknown, possibly eyeglasses	A
A few superficial abrasions about the nose and right cheek	Minor 290202.1,4 290202.1,1	Deploying front right passenger air bag	C
Right eye sub-conjunctival hemorrhage	Minor 240416.1,1	Deploying front right passenger air bag	C
Marked purple swollen contusion of the entire, right forearm wrist and hand	Minor 790402.1,1	Bracing against right instrument panel	C
Comminuted fracture of the distal right radius	Serious 752804.3,1	Bracing against right instrument panel	B
Left hand contusion, NFS	Minor 790402.1,2	Center instrument panel	C
26x15 cm contusion of the distal right thigh, right knee and proximal right leg	Minor 890402.1,1	Glove box door	C
Shaft fracture of the distal right femur	Serious 851814.3,1	Glove box door accentuated by loading of the rear right passenger	B
7x5 cm contusion lateral left knee	Minor 890402.1,2	Lower aspect of the center instrument panel	C

8 cm avulsive type laceration over the left knee	Minor 890802.1,2	Lower center instrument panel accentuated by loading of the rear right passenger	B
Comminuted left patella fracture	Moderate 852400.2,2	Lower center instrument panel accentuated by loading of the rear right passenger	B

Note: the above injuries were identified in the Emergency Room records (A), Trauma Center Records including radiology (B), and the Autopsy Report (C).

Discussion:

An analysis of the nature of the skull fractures indicated that basilar and temporal fractures were not linked. Rather, the injuries resulted from two separate mechanisms. Further, the basilar skull fracture had to have occurred first. The basilar fracture occurred due to a transmission of distributed force through the intact (stronger) skull causing the fracture across the (weaker) base. The basilar skull fracture was caused by the deploying front right passenger air bag. Then a more localized impact to the right aspect of the skull occurred which resulted in the right temporal and zygomatic arch fractures. These fractures resulted from an impact to the instrument panel accentuated by the loading of the rear right passenger.

Had the right temporal and zygomatic fractures occurred first, the right aspect of the skull would have been compromised. Consequently, the skull would not be able to withstand the force of a second impact and transmit that load through its structure to the skull base. The skull most likely would have fractured into a different pattern and not resulted in the identified basilar hinge fracture.

OCCUPANT KINEMATICS

1998 Dodge Neon

Driver

The 57-year-old female driver of the 1998 Dodge Neon was seated in a presumed upright posture in a mid-track position. The driver was not restrained by the manual 3-point lap and shoulder belt. She reported that she was braking in response to the impending crash.

At impact, the frontal air bags deployed. The inflating driver air bag contacted and abraded the driver's left wrist and displaced the hand from the steering wheel. The left hand was flung into minor contact with an unidentified component of the left interior as evidenced by the wrist contusion. The driver initiated a forward trajectory in response to the 11 o'clock direction of the impact and contacted the deployed driver's air bag with her head and chest. A make-up transfer was noted to the air bag from contact by the driver's face. As the driver continued her forward trajectory her left knee contacted the bolster evidenced by the identified scuff. The scuff was directed from right to left indicative of the clockwise vehicle rotation and angular force direction. During the ride down of the crash, the driver loaded through the deployed air bag and her left ribs contacted the steering wheel rim resulting in the minor rim deformation and the identified contusion. The driver then rebounded back into her seat. She was able to exit the vehicle under her own power.

Rear Right Passenger

The 51-year-old male rear right passenger of the 1998 Dodge Neon was seated in a presumed upright posture and was not restrained by the manual 3-point lap and shoulder belt. The passenger was totally blind and was unaware of the impending crash.

At impact, the rear right passenger initially exhibited a forward trajectory in response to the 11 o'clock direction of the impact force. The occupant contacted and loaded the rear of the front right seatback with his lower extremities. This contact resulted in his left leg abrasion. As his lower body decelerated, the passenger's upper body rotated forward about the waist. In this manner the passenger's chest and head contacted and loaded the upper aspect of the seat back. This contact resulted in his identified epistaxis (bloody nose). The force of his unrestrained trajectory broke the recline adjustment mechanism of the front right seat and caused the seat back to rotate forward. The passenger rode up the seat back resulting in an additional loading of the front right passenger. The passenger's seat back contact resulted in an abrasion to his left ear.

Coincident to this kinematic pattern, the vehicle began to rotate clockwise. As a result of the rotation, the rear passenger's trajectory became oriented to the 11 o'clock direction with respect to the vehicle. The passenger rode up and off the inboard aspect of the seat back and moved forward between the front seats. During his forward trajectory, the passenger contacted the center console with his lower extremities causing the center console's left displacement. The passenger contacted the cane and displaced it forward into contact with the instrument panel. The contact to the instrument panel acted like a fulcrum and the cane fractured. The upper aspect of the fractured cane was then carried forward by the passenger into contact with the top aspect of the instrument panel.

The passenger contacted the center mirror with his head fracturing its mounting stalk. This contact displaced the center mirror into contact with the headliner evidenced by the black scuffing. The blood evidence noted to the back side of the mirror and the identified blood spatter over the center front interior evidenced the rear passenger's trajectory. This passenger was actively bleeding as a result of the epistaxis. The passenger probably came to rest between the front seats and then moved back into the rear of the vehicle. He was assisted from the vehicle due to his blindness; he was alert and walking at the scene.

Front Right Passenger

The 85-year old female front right passenger was seated in a rear track position in a presumed upright posture and was unrestrained. Immediately prior to the impact, she was probably bracing against the outboard aspect of the instrument panel with her right arm. Prior to impact, the passenger initiated a forward trajectory in response to the pre-impact braking and loaded her right forearm. The forearm loading displaced the right instrument panel vent louver identified by inspection and resulted in the radial fracture. The passenger's right knee contacted the glove box door.

Upon impact, passenger responded further forward in response to the 11 o'clock direction of the impact force. The force of the impact caused the frontal air bags to deploy. At the time of the deployment, the passenger's head was positioned in-close proximity to the front right passenger

air bag module. The passenger may have been looking to the left in the direction of the impact, exposing the right side of her face to the air bag. The expanding air bag contacted and abraded the right side of her face (cheek and nose) evidenced by the facial abrasions. The head acceleration caused by the impact of the deploying air bag resulted in the fatal subdural brain hemorrhage and edema, and the force of the deploying air bag resulted in the basilar skull hinge fracture.

As the Dodge began to rotate clockwise as a result of the exterior crash force, the passenger exhibited an 11 o'clock trajectory. This trajectory was evidenced by the angular contact pattern to the glove box door and the left lower extremity contact to the side panel of the center instrument panel. The knee abrasions occurred during these contacts. Coincident to this pattern, the rear passenger was loading the seat back. As the seat back rotated forward, the front right passenger was loaded from behind into accentuated contact with the instrument panel. The accentuated loading resulted in the right femur fracture, left knee laceration, and the left patella fracture. The head and chest of the passenger loaded through the deployed air bag and her head impacted the instrument panel. The contact to the instrument panel resulted in the right scalp contusion, and the right temporal and zygomatic arch fractures.

The passenger came to rest within the front right interior. She exited the vehicle and was ambulatory at the scene. Reportedly, she was talking and she was more concerned about the condition of the other occupants than she was of herself.

MEDICAL TREATMENT

Front Right Passenger

The front right passenger was transported to a local hospital for assessment of her injuries. At that time she was alert and awake. She knew where she was and knew what medicines she was taking and the dosage. She was on Coumadin (a blood thinner). Due to her advanced age, the suspected closed head injury, and the high risk of a cranial bleed, she was transferred via Lifeflight to a regional trauma center. During the preparation of the transport, her level of conscious began to deteriorate. She was transferred in serious but stable condition. She arrived at the trauma center approximately 130 minutes post-crash. At that time, she was awake and weakly followed commands. A CT scan of the head identified the multiple head and brain trauma. Over the course of time, the uncontrolled cranial bleeds enlarged and the passenger's condition began to slowly deteriorate. She died as a result of head trauma approximately 12 hours post-crash.

