

# Using License Manuals To Increase Awareness About Pedestrian Hazards at Intersections

## Missed Opportunity for Educating Drivers

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Motor vehicle crashes result in approximately 90,000 pedestrian injuries and 5,000 pedestrian deaths in the United States each year. Of these, 34 percent of the injuries and 18 percent of the deaths occur at intersections. In a recent study, around 5,000 pedestrian-motor vehicle crashes were coded in a population-based sample drawn from California, Florida, Maryland, Minnesota, North Carolina, and Utah. About 1,630 (32.6 percent) of these incidents occurred at intersections, with turning vehicles responsible for 30.4 percent of the incidents and another 15.9 percent due to driver violations. Along with enforcement and engineering, quality education can be very important in improving driver behavior and providing a better understanding of the vulnerability of pedestrians. State driver-licensing manuals can play a key role. Well-written, well-illustrated information on pedestrian conflicts associated with different traffic regulations and controls at intersections and on the potential hazards for pedestrians associated with driver violations, along with statistics, would encourage drivers to modify their behaviors. Better manuals are becoming increasingly important with the gradual phasing out of driver education at schools. The present level of information disseminated by 32 states and the District of Columbia was reviewed and found to be insufficient in these regards, needing significant improvements. Recommendations are offered on ways to improve the quality of information.

Success of traffic safety depends on perfect synergy among engineering, education, and enforcement. Engineering studies and statistics collected by the National Highway Traffic Safety Administration have shown that driver violations and error contribute to a significant portion of crashes and collisions. This is a cause for concern and needs to be addressed through better driver education. Drivers' manuals could be the best conduit to improve a young driver's understanding of the hazards involved in driving and his or her responsibility to avoid contributing to these hazards. It also is the authors' belief that well-written, well-illustrated manuals can have greater influence on the driver's attitude toward others in traffic.

### BACKGROUND

Motor vehicle crashes result in approximately 90,000 pedestrian injuries and 5,000 pedestrian deaths in the United States each year. Of these, 34 percent of the injuries and 18 percent of the deaths occur at intersections (1).

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What are the common causes of pedestrian-motor vehicle collisions at intersections? In a recent study, around 5,000 pedestrian-vehicle crashes were coded in a population-based sample drawn from the states of California, Florida, Maryland, Minnesota, North Carolina, and Utah (2). About 1,630 (32.6 percent) of these incidents occurred at intersections, with turning vehicles responsible for 30.4 percent of the incidents and another 15.9 percent due to driver violations (Table 1).

### TURNING MOVEMENTS

Turning movements at intersections cause higher incidents of collisions and interactions between pedestrians and vehicles (3–15). Snyder and Knoblauch's report stated that 22 percent of the incidents were caused by turning movements, and 63 percent of these conflicts occurred at signalized intersections (3). Berger and Knoblauch's study indicated that 25 percent of the incidents were caused by turning vehicles, with left-turning vehicles hitting more pedestrians (4). In Habib's study, he found that left-turning maneuvers were about four times as hazardous as through movements, and the problem was even more acute at signalized crossings. The overrepresentation of pedestrian incidents with left-turning vehicles, according to Habib, was because drivers turning left look for a gap in the through traffic and thus get distracted from watching out for pedestrians (5). An earlier study done by Shinar et al. confirmed what Habib asserted. Shinar et al. found that eye fixations were 3.6 degrees to the right at right curves, but straight ahead on left curves, contributing to the hazards at intersections (6). In a sample of 2,081 pedestrian-vehicle incidents at signalized intersections drawn from 15 cities, Zegeer et al. found that although through movements accounted for a greater percentage of incidents (60.3 percent), turning movements together accounted for 37 percent of the collisions (9).

Robertson and Carter examined 202 pedestrian incidents at 62 intersections and reported that 29 percent involved turning vehicles. Their data indicated that left-turning vehicles contributed to 59 percent of the turning incidents although such turns constituted 44 percent of the total turns (10). A study conducted by Zegeer and Cynecki (11) on right turns at signalized intersections indicated that a significant proportion of these conflicts occur at the far crosswalk.

### Right Turn on Red

The contributing author for the pedestrian chapter in the *Traffic Engineering Handbook*, Wallace L. Braun, deputy director, Department of

**TABLE 1 Intersection-Related Incidents in California, Florida, Maryland, Minnesota, North Carolina, and Utah**

	Number of Incidents	Percentage	Severity: Serious or Fatal	Most Vulnerable
<b>Vehicle turn</b>	497 (30.4%)	30.4	18%	Adult (25 and above)
<b>Intersection dash</b> Pedestrian struck while running through an intersection, and/or driver's view was blocked until the instant before the impact.	363 (22.3%)	22.3	34%	Children (0-9) and youth (10-14)
<b>Driver violation at intersection</b> Pedestrian struck while proceeding straight ahead and the driver committed a violation, such as failing to yield, DWI, speeding. <i>(Possible scenarios Figures 1-5; 6a)</i>	259 (15.9%)	15.9	28	Combination but fewer children
<b>Multiple threat</b> The pedestrian entered the traffic lane in front of standing or stopped traffic and was struck by another vehicle traveling in the same direction as the stopped traffic.	64 (3.9%)	3.9	28%	Youth and teens
<b>Walked into a vehicle at intersection</b>	42 (2.6%)	2.6	20%	Adult
<b>Trapped</b> The pedestrian was struck while crossing at a signalized intersection when the light changed and the traffic started moving. <i>(Figure 4)</i>	41 (2.5%)	2.5	12%	Youth and elderly (65+)
<b>Intersection - Other</b> Includes walking in the travel lane, standing in the roadway and other undetermined factors. <i>(See Figures 1&amp;3)</i>	364 (22.3%)	22.3	42	Combination but fewer children
<b>TOTAL</b>	1,630	100	-	-

Source: Adapted from U.S. DOT, Federal Highway Administration, Pedestrian Crash Types: A 1990s Informational Guide, April 1997.

TABLE 2 Before-and-After Studies on Right Turn on Red

Authors	Before and After at RTOR Collision and Crash Data Between Pedestrians & Vehicles
Zador, et al. (7)  Analysis of incident data from six states between 1974-77 when RTOR was introduced.	57 percent increase 79 percent increase in urban areas  30 percent increase among child pedestrians 110 percent increase among elderly pedestrians 100 percent increase among adults
Preusser, et al. (8)	45 percent increase in pedestrian crashes in New York (excluding New York City) 86 percent in Wisconsin 66 percent in Ohio 96 percent in New Orleans, LA

Vehicles and Traffic, Washington D.C., has written, "Right turns on a red light should in general be prohibited as unfair and unsafe for pedestrians (12)."

Right turn on red (RTOR) has been practiced for the past 50 years in the western United States. The eastern states adopted this rule in the 1970s. In the late 1970s and early 1980s, several studies were conducted on collision and crash rates to assess whether permissive right turns on red adversely affected the incident rates. Most studies found there was an increase in pedestrian-vehicle conflicts (Table 2).

Other studies on RTOR also found several shortcomings with the practice; some of the studies are summarized in Table 3.

### Left Turn on Red

Most states permit left turn on red (LTOR) at the intersection of two one-way streets. Although not many data have been collected on the risk to pedestrians posed by LTOR, it is likely that this practice also leads to increased pedestrian crashes.

### Four-Way Stops

The four-way stop is more common in the United States than elsewhere. It is used where traffic-signal warrants prescribed by the

TABLE 3 Other Studies on Right Turn on Red

Authors	Other Studies
Knoblauch et al. (1987) (16)	RTOR had the highest hazard score based on the number of pedestrian - vehicle collisions at intersections. RTOR was compared with LTOG, RTOG, and going straight.
Chadda and Schonfeld (1985) (15)	The primary danger according to Preusser et al was mostly because driver looks left for a gap in traffic, finds a gap and pulls out into the path of a pedestrian crossing from the far right. The RTOR vehicle hazard zones as defined by Chadda and Schonfeld are primary and secondary hazard zones as follows: Primary Hazard Zones are those where the pedestrians are hit while crossing on green (Figure 4). The probability of conflicts and interactions are highest at this zone. The Secondary Hazard Zone is the crosswalk area on the cross street.
Zegeer and Cynecki (1985) (11)	56.9 percent of drivers fail to make a full stop before turning. Near crosswalk conflicts and interactions were greater than at the far crosswalk. About 9.3 percent of the RTOR vehicles were involved in conflicts with pedestrians.
Zegeer and Cynecki (1985) (13)	The study was based on observational data for more than 67,000 drivers at 110 intersections in Washington, D.C.; Detroit, Michigan; and Dallas - Austin, Texas.  The data indicated that given an opportunity to violate NTOR, 21 percent of the drivers violate the law. Such violations lead to conflicts with pedestrians about 16 percent of the time.  Data collected at 29 RTOR allowed approaches indicated 56.9 percent violated the law: 14.8 percent did not stop; 42.1 percent rolling stop; 43.1 percent made full stops (36.0 percent forced to stop by oncoming vehicles and pedestrians; 7.1 percent were voluntary stops)

*Manual on Uniform Traffic Control Devices (16)*—such as a minimum vehicular volume, an interruption of continuous traffic, and a minimum pedestrian volume—are not satisfied (17).

Studies comparing different types of traffic controls have shown that collisions at four-way stop signs are much lower than at signalized or uncontrolled intersections (3–4,18). The studies done by Pietrucha, Opiela, Knoblauch, and Crigler (19) conclude that conflicts resulting from noncompliance were insignificant. (“Not looking” for pedestrians, however, was highly correlated with conflicts in the study.) The major problem with stop signs is very low driver compliance. According to Homburger et al. (20), only 5 to 20 percent of all drivers come to a complete stop at a stop sign, 40 to 60 percent come to a “rolling” stop below 8 km/h (5 mph), and 20 to 40 percent pass through at higher speeds. The study conducted by Zegeer and Cynecki found that 7 percent of the drivers stopped, 57.3 percent came to a rolling stop, and 10.9 percent did not stop at all (13). These statistics would lead to the conclusion that failing to yield to pedestrians could be a problem at such intersections.

### DRIVER EDUCATION—REVIEW OF MANUALS

The summary of the studies indicates that pedestrians can encounter different types of hazards at intersections due to unsafe interactions with vehicles. Drivers need to be educated about these possible adverse interactions so that they are adequately aware of the associated drawbacks with certain turning movements and traffic controls. This is particularly important for new drivers who, unlike experienced drivers, are learning the rules of the road and are unfamiliar with the associated risks and hazards at intersections.

A study was conducted to review the driver’s manuals of 32 states and the District of Columbia (21–53). The objective was to evaluate if the quality and level of information provided to new drivers warned them about the adverse interactions with pedestrians at intersections. The information that the authors felt would adequately address this is as follows:

1. Statistical information on pedestrian-vehicle conflicts at intersections (similar to Table 1), with photographs such as in Figures 1 to 4;



**FIGURE 1** Pedestrians forced to step on the travel lane to avoid flooded crosswalks.



**FIGURE 2** Left-turning vehicles in the path of pedestrians.

2. Types of movements that are most hazardous for pedestrians and the reasons why (left turns, RTOR), with illustrations (such as in Figure 4);
3. Safest ways to conduct turns;
4. Illustrations for proper turns, with texts; and
5. Compliance issues (yielding to pedestrians at stop signs and at RTOR).

There are several reasons why it is critical to adequately address these topics. First, it is necessary to educate and inform drivers (new and experienced) of the causes of pedestrian deaths and injuries. Second, it is important to explain who are most prone to be the victims and the reasons behind this. Third, drivers must understand what types of hazards to expect and how to be alert and cautious to avoid them. Fourth, it is important to make people more conscious of their responsibilities as drivers and of the vulnerability of pedestrians. Fifth, drivers can be taught to take actions to protect pedestrians, such as yielding further back at crosswalks on multilane roads and at signalized intersections, so that drivers in other lanes can see the pedestrian in time to take action. Lastly, while engineering and enforcement improvements at intersections should be pursued, drivers also need to be well informed so that they act responsibly at intersections.

Review of the state driver’s manuals indicated that none offered any statistical information or explanation on pedestrian-vehicle conflicts at intersections. There was no information on the most haz-



**FIGURE 3** Pedestrians trapped at an intersection.





**FIGURE 4** Primary hazard zones are those in which the pedestrians are hit while crossing on green. Secondary hazard zones are the crosswalk areas on the cross street.

ardous movements or illustrations depicting these hazards. Furthermore, this review showed that none of the illustrations had pedestrians in them, and only 57 percent of the states mentioned yielding to pedestrians in the corresponding text. Most of the illustrations were found to be inadequate, some were very confusing, and almost all needed improvement (Table 4).

Since RTOR has been found to be hazardous for pedestrians, the authors reviewed the information provided by states on RTOR. Also examined, since noncompliance was a major problem at stop signs, was information on this issue and on the requirement by law to yield to pedestrians. Table 5 summarizes the findings. The review showed that none of the states had any statistical information on collisions at RTOR or data on noncompliance at stop signs. None of the states offered illustrations showing the possible conflict points at RTOR, and only 12 states mentioned yielding to pedestrians at stop signs. Overall, the information on RTOR and stop signs appeared to be inadequate and needed significant improvement.

**DISCUSSION OF RESULTS**

Driving is a very complex task involving a variety of skills, the most important of which are the receiving and analyzing of information to execute appropriate action. Level of training along with good roadway design can play a significant role in ensuring accurate processing of information and subsequent responses to potential hazards (54–57). Although drivers’ attitudes toward vulnerable road users (pedestrians and bicyclists) may be influenced by their personal values and emotions, positive reinforcement through well-worded information could

**TABLE 4** Driving Instructions: Making Correct Turns with Respect to Pedestrians

	States	Illustrations include conflict & interaction points with peds.	Corresponding text mentions stopping and yielding to peds.	Comments
1.	AK	No	Yes	Need improvement (p. 21-23)
2.	AR	No	No	Need improvement (confusing illustrations) (p. 17-18)
3.	AZ	No	No	Need improvement (confusing illustrations) (p. 29-31)
4.	CA	No	Yes for RT only (p. 24)	Need improvement (p. 28-29)
5.	CO	No	No	Need improvement (p. 18)
6.	CT	No	No	Need improvement (confusing illustrations) (p. 8)
7.	FL	No	Yes	Need improvement (confusing illustrations) (p. 40-42)
8.	GA	No	No	Need improvement (confusing illustrations)
9.	HI	No	No	Need improvement (p. 32)
10.	IN	No	Yes	Need improvement (p. 22-24)
11.	IA	No	No	Need improvement
12.	KY	No	No	Need improvement (p. 16)
13.	MA	No	No	Need improvement (p. 67-68)
14.	MD	No	Yes	Need improvement (p. 28-30)
15.	ME	No	No	Need improvement (p. 35-36)
16.	MI	No	Yes	Need improvement (p. 27)
17.	MN	No	No	Need improvement (p. 89-91)
18.	NC	No	No	Need improvement (p. 38-39)
19.	NE	No	Yes	Need improvement (confusing illustrations) (p. 37)
20.	NH	No	No	Illustration confusing (p. 43)
21.	NM	No	Yes	Need improvement (p. 14-15)
22.	NY	No	Yes	Need improvement (p. 42-44)
23.	NV	No	Yes	Need improvement (p. 28-30)
24.	OK	No	No	Need improvement (p. 21-25)
25.	OR	No	Yes	Need improvement (p. 32-33)
26.	OH	No	No	Need improvement (p. 20-21)
27.	PA	No	No	Need improvement (confusing illustrations) (p. 4-6)
28.	TN	No	Yes	Need improvement (p. 50-51)
29.	TX	No	No	Need improvement (p. 6-5 - 6-7)
30.	VA	No	No	Need improvement (p. 2-13)
31.	VT	No	Yes	Need improvement (p. 22-23)
32.	WA	No	Yes	Information provided in p. 22 should be added to the diagrams in p. 17-19
33.	D.C.	No	No	Needs a driver’s manual, not a list of questions & answers

Need Improvement: Colored illustrations (preferably photographs) and accompanying texts for proper turning need to be added. The diagrams and text must include information on the presence of pedestrians and bicyclists. Confusing illustrations: There is too much information in the diagram, confusing the reader.

TABLE 5 Information Provided on Right Turn on Red and Stop Signs

States	Collision Statistics at RTOR	Illustrations on Possible Points of Conflict	Yielding to Peds. at RTOR	Statistics on Non-Compliance at STOP Signs	Yielding to Peds. at STOP Signs
1. AK	No	No	Yes (p. 48)	No	Yes (p. 40)
2. AR	No	No	Yes (p. 11)	No	No (p. 19)
3. AZ	No	No	Yes (p. 29)	No	No (p. 33)
4. CA	No	No	Yes (p. 27)	No	No (p. 17)
5. CO	No	No	No (p.12)	No	Yes (p. 12)
6. CT	No	No	No (p. 5)	No	No (p. 7)
7. FL	No	No	No (p. 56)	No	No (p. 58)
8. GA	No	No	NA	No	Yes (p. 19)
9. HI	No	No	Yes (p. 39)	No	No (p. 44)
10. IN	No	No	Yes (p. 24)	No	Yes (p. 11)
11. IA	No	No	No (p. 61)	No	Yes (p. 51)
12. KY	No	No	No (p. 12)	No	No (p.14)
13. MA	No	No	Yes (p. 68)	No	No (p. 70 )
14. MD	No	No	Yes (p. 51)	No	Yes (p. 57)
15. ME	No	No	Yes (p. 31)	No	Yes (p. 32)
16. MI	No	No	Yes (p. 29)	No	No (p. 27)
17. MN	No	No	No (p. 91)	No	Yes (p. 59)
18. NC	No	No	No (p. 68)	No	No (p. 71)
19. NE	No	No	Yes (p. 19)	No	No (p. 33)
20. NH	No	No	Yes (p. 36)	No	No (p. 39)
21. NM	No	No	Yes (p. 15)	No	No (p. 11)
22. NY	No	No	Yes (p. 34)	No	Yes (p. 31-32)
23. NV	No	No	Yes (p. 18)	No	No (p. 17)
24. OK	No	No	No (p. 35)	No	Yes (p. 26)
25. OR	No	No	Yes (p. 20)	No	No (p. 34)
26. OH	No	No	Yes (p. 20)	No	Not Available
27. PA	No	No	Yes (p. 4-5)	No	Yes (p. 3-1)
28. TN	No	No	Yes (p. 66)	No	No (p. 48, 53)
29. TX	No	No	Yes (p. 5-1)	No	No (p. 5-5)
30. VA	No	No	Yes (p. 2-19)	No	Yes (p. 2-21)
31. VT	No	No	Yes (p. 34)	No	No (p. 33; 36)
32. WA	No	No	Yes (p. 25)	No	No (p. 28)
33. D.C.	No	No	No	No	No

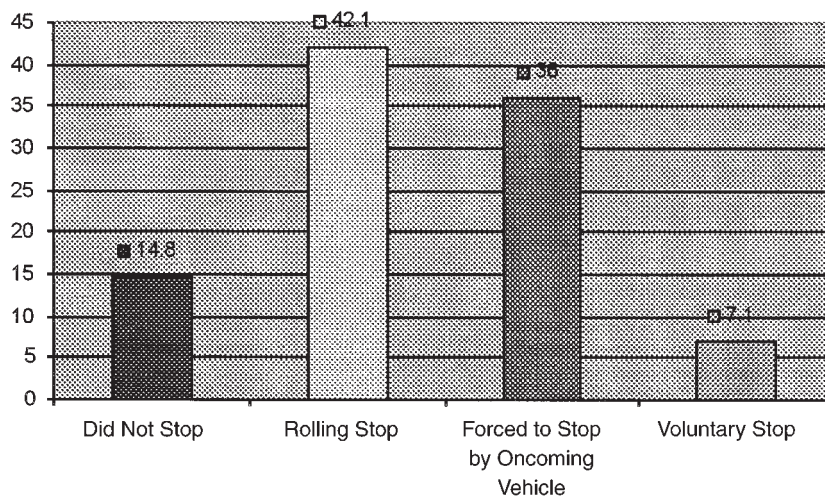


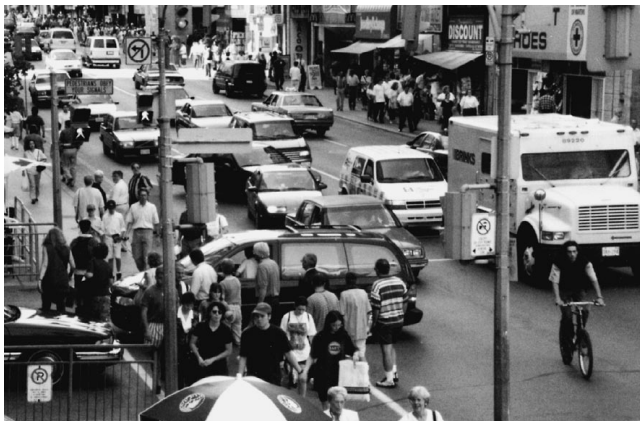
FIGURE 5 Right-turn-on-red observations at 29 intersections (13).

**TABLE 6 Right-Turn-on-Red Observations at 29 Intersections (13)**

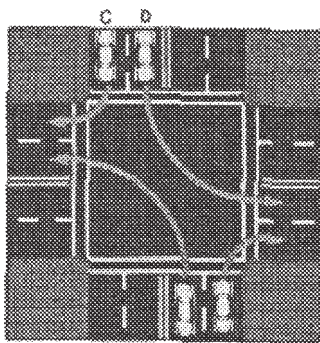
RTOR Observations	Percentage
Did not stop	14.8
Rolling stop	42.1
Forced to stop by oncoming vehicle	36
Voluntary stop	7.1

help in modifying their preferences—and the authors feel that driver's manuals can play a significant role in guiding new drivers in the right direction. That information dissemination can play an important role is well exemplified in a study conducted in British Columbia, Canada. The researchers reported that a media campaign designed to increase the percentage of left-turning vehicles yielding to pedestrians produced a long-term increase in driver-yielding behavior at signalized intersections (58). For the reasons mentioned, driver's manuals should include the five items listed previously.

Given the fact that the level of reading and the ability to grasp complex information vary, it is important to ensure that supporting data and statistical information are offered in user-friendly format. Graphs and charts may convey information more clearly than tables. For example, Figure 5 illustrates the information of Table 6.



(a)



(b)

**FIGURE 6 (a) Photograph depicting major conflict between pedestrians and vehicle illegally blocking the crosswalk; (b) illustration showing turning movements and conflicting points.**

Additionally, photographs highlighting the points of conflict as shown in Figure 6a are more meaningful than the illustration in Figure 6b in increasing driver awareness about hazards.

In order to instill responsibility in young drivers and to make it clear that driving privileges are not easy to obtain, deep and comprehensive knowledge of the laws and of the adverse outcomes of violations is necessary for new drivers. With the national trend of phasing out driver education in high schools, the driver's licensing manuals may become the only source for learning about traffic laws. The present quality of the manuals is inadequate and needs significant improvement.

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