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Understanding Crash Risk Factors

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Few traffic crashes have a single cause. Most crashes happen because of the cumulative effect of multiple risk factors, as well as an unlucky convergence of driver error and traffic events. Not every crash can be avoided, but understanding the chain of crash risk factors and causes gives us more opportunities to break the chain.

Risk vs. Cause

In the Federal Motor Carrier Safety Administration's Large Truck Crash Causation Study (LTCCS), driver error and other factors (vehicle equipment failure, environmental hazards) were most often found to be the immediate or "proximal" causes of crashes - or what the study referred to as "critical reasons." Consider the crash cause "looked but did not see." This driver mistake can trigger crashes with other vehicles, such as at intersections or during a lane change.

But before the proximal cause, there is risk. Crashes can happen to anybody under any circumstances, but usually they happen against the backdrop of elevated risk. Figure 1 below shows a conceptual crash timeline.

Risk factors set up a situation where driver errors or other failures are more likely and/or have greater consequences. Multiple risk factors can exist at the same time, and have an additive effect on total risk. There can also be more than one proximal crash cause, although usually one major cause stands out. In the LTCCS, only one critical reason was designed for each crash, and it was assigned to just one vehicle in a multi-vehicle crash.

Crash and incident risk varies widely among different commercial drivers. Most drivers are reliable and safe, but a relatively small percentage (perhaps 10-15%) is heavily over-involved in crashes and incidents. Luck plays a role in crash involvement, but risk differences among drivers are not primarily a matter of luck. The same drivers tend to be at-risk year after year and their risk can usually be tied to known driver traits like personality (e.g., aggressive, impulsive, sensation-seeking), engrained driving habits (e.g., speeding, tailgating, inattention), medical conditions (e.g., sleep apnea, heart conditions), and driver age (younger drivers). Safety belt non-use is also a risk factor for driver crash involvement. It's not a *driving* behavior, but it's a *driving-related* behavior that reflects a risk-taking personality. Once a crash occurs, belt non-use is also associated with a 3-fold increase in truck driver injury severity. All of these factors may be considered *enduring driver characteristics* because they reflect long-term driver traits that usually change slowly (e.g., age) or not at all (e.g., medical conditions if untreated).

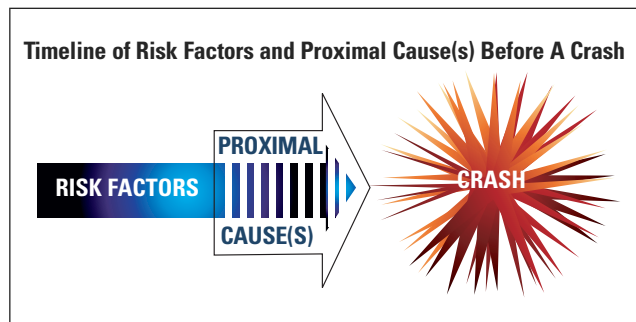


Figure 1. Timeline of risk factors and proximal cause(s) before a crash.



Some driver risk factors are *temporary*, not enduring. Every day, humans experience a rollercoaster of alertness highs and lows called the *circadian rhythm*. For most people, mornings and evenings are peaks. An alertness dip occurs in the early-to mid-afternoon, and a deep valley in the early morning hours from about 3 a.m. to 6 a.m. Driving during the early morning circadian valley isn't necessarily unsafe, but smart carriers and drivers make special efforts to prevent fatigue if operating in this time period.

Other temporary driver risk factors include short-term illnesses (e.g., colds), some medications, and moods, especially if strong. The LTCCS also found an interesting temporary risk factor for truck drivers. At any given time while driving, the driver's familiarity with the roadway affects the likelihood of his or her causing a crash. Truck drivers at fault in their LTCCS crashes

(in a single-vehicle crash or an at-fault multi-vehicle crash) were about twice as likely to be unfamiliar with the road as those not at-fault. "Unfamiliarity" was defined as having rarely or never driven the road before.

Situational risk factors are those outside the driver. Vehicle, roadway and environmental risk factors operate constantly. In the LTCCS, at-fault trucks were more than twice as likely to have mechanical deficiencies as those not at-fault. Curves and ramps are roadway risk factors for rollovers and other single-vehicle crashes. Comparisons between truck incident involvement and exposure demonstrate that trucks have greatly elevated risks while driving in dense traffic and on undivided highways. The crash and incident risk in construction zones is at least ten times higher than on regular roads. Adverse weather elevates risk, but not as much as heavy traffic and undivided roads. Both truckers and 4-wheelers seem to moderate their driving in foul weather to compensate for their increased risk.

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Measuring Relative Risk

Naturalistic driving studies are an excellent way to quantify incident risk. In these studies, trucks are instrumented with multiple cameras and sensors. Volunteer drivers drive the equipped vehicles in regular operations for an extended period; e.g., several months. All driving data is recorded on a computer, and incidents (e.g., a crash, hard braking or other sharp maneuver to avoid a crash) are captured and analyzed. Comparing incidents to normal, non-incident driving allows researchers to quantify the relative risk associated with any measured factor.

Figures 2 and 3 give two examples, one relating to drivers and one related to driving situations. Both examples are from an FMCSA-sponsored large truck naturalistic driving study conducted by the Virginia

Tech Transportation Institute. In Figure 2, 95 drivers were rank-ordered by their frequency of involvement in at-fault incidents. The average driver had about seven at-fault incidents. At the extremes, the worst driver had 43, while 18 drivers had zero at-fault incidents in several months of driving. Comparing exposure (hours of driving) to incident involvement, we found that the worst 19% of drivers were associated with 53% of all observed at-fault incidents. The risk ratio between the high- and low-risk groups in Figure 2 was 4.9. In other words, hour-for-hour, the high-risk drivers were 4.9 times riskier than were other drivers.

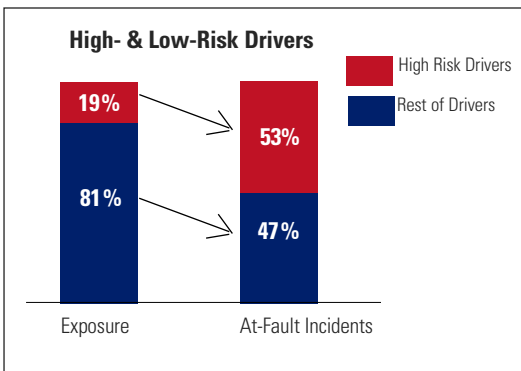


Figure 2. Exposure (hours of driving) and at-fault incidents for worst drivers and rest of drivers in truck naturalistic driving study.

Figure 3 is similar, but now we are using data from all the drivers to compare undivided to divided roadways. In the same study, analysts classified the road type in each incident video and in randomly selected driving periods. The random periods captured overall exposure to the two road types. Only 10% of tractor-semitrailer driving was on undivided roads, yet 38% of incidents occurred on them. Here the risk ratio was 5.3. In other words, every hour of driving on undivided roads had 5.3 times the incident risk of an hour on an Interstate or other divided road.

Consider the risk differences between divided and undivided roads. On divided roads, vehicles are all traveling in the same direction at relatively uniform speeds. On undivided roads, there usually are traffic signals, stops and starts, crossing vehicles, turning vehicles, pedestrians, many opportunities for distraction, and little margin-of-error.

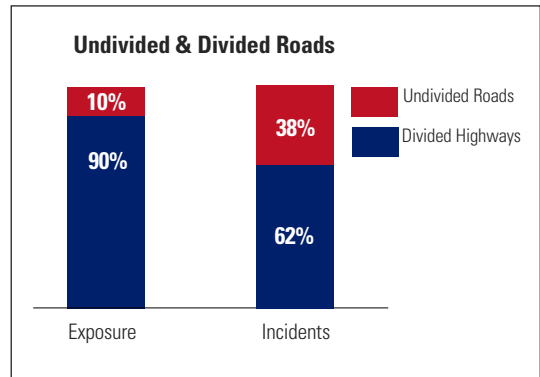


Figure 3. Exposure (percent of randomly selected time periods) and incidents for undivided and divided roadways in truck naturalistic driving study.

These two examples – driver and roadway – both had risk ratios of about five. Would you play poker if you knew the deck was stacked five-fold against you? Probably not. But high risk ratios mean big opportunities for risk reduction. Smart safety management includes being proactive to reduce pre-crash risk in all its forms. It also means employing driver training, onboard technology, and other countermeasures to prevent the driver errors and other failures that actually trigger crashes.



Editor's Note:

This article is drawn from a new book, *Safety for the Long Haul; Large Truck Crash Risk, Causation, & Prevention*. Published by ATA and available through ATA Business Solutions, *Safety for the Long Haul* is the first comprehensive textbook on large truck safety. Its 13 chapters address more than 100 large truck safety topics.

The author, Dr. Ron Knipling, is a researcher and consultant with 30 years experience in large truck safety.