ICoRSI

Independent Council for Road Safety International

International Symposium

Road Safety Around the World: Future Concerns

19 March 2018

Preventing motor vehicle crash injuries and deaths: Science vs. folklore

Part 1: Lessons from history 1910 to 1970

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Acknowledgement

ICoRSI has received support from:

Institutional donors: Tata Education & Development Trust, Mawana Sugars, University of Chicago Center in Paris, Veolia

Recommended citation

O'Neill, B. (2018). Preventing motor vehicle crash injuries and deaths: Science vs. folklore. Part 1: Lessons from history 1910 to 1970. In *Global Road Safety Issues: Discussion Papers.* Independent Council for Road Safety International*, www.icorsi.org/icorsi-pblications.*

Declaration

The papers included in this volume were prepared for discussion at the ICoRSI International Symposium *Road Safety Around the World: Future Concerns,* 19 March 2018, Paris. The papers may be published subsequently a different form.

Preventing motor vehicle crash injuries and deaths: Science vs. folklore
Part 1: Lessons from history 1910 to 1970

Brian O'Neill

1 INTRODUCTION

Motor vehicle crashes are the ninth leading cause of death globally, accounting for over 1.25 million deaths each year (WHO, 2015). This is one of the biggest public health problems facing societies today. With the rapid growth in motorization that is occurring in many low- and middle-income countries (LMICs) this problem is likely to continue to grow. This is the first of two papers summarizing the history of vehicle and highway safety countermeasures from the early days of motorization until around 1970. During this early period very limited countermeasures were adopted, and there were no efforts to determine if they were effective. The approach was, in effect, based on folklore, i.e. a body of widely held but false or unsubstantiated beliefs.

During the first six decades of motorization the very limited range countermeasures employed focused almost entirely on preventing accidents primarily by trying to change driver behaviour, reducing the consequences of accidents was not considered. The belief in this limited approach was passed through generations just like folklore, and its proponents never saw any need to evaluate the effectiveness of these programs. Unfortunately, this approach was unsuccessful, and motor vehicle crash deaths continued to increase rapidly as the numbers of automobiles in use grew.

For LMICs that are still in the relatively early phases of large scale motorization, the ineffective countermeasures that were in place in most high-income countries (HICs) for decades should provide salutary lessons on what not to do. Today there is a wide range of countermeasures shown by scientific evaluations to reduce crash deaths and injuries and many of these (sometimes with adaptations) should work in LMICs. Programs that have been repeatedly shown to be ineffective should not be adopted, despite the fact that in HICs there continues to be some support for these folklore-based approaches.

A second companion paper to this one summarizes the history of vehicle and highway safety since about 1970, when a new paradigm opened the possibilities for more comprehensive countermeasures. This newer science-based approach also recognized that countermeasures should be evaluated. The second paper summarizes what has been learned from this science-based approach to the problem.

2 MOTOR VEHICLE CRASH DEATHS AND INJURIES BECOME A PUBLIC HEALTH PROBLEM

Not long after motorized vehicles were first introduced they began to be involved in crashes. The first fatality is believed to have occurred in 1869 when a rider in an experimental steam car

in Ireland fell from the vehicle and was "run over".[1]

The U.S. was the first country where cars were mass produced, beginning in 1908 when the Ford Model T was introduced. Between 1908 and 1927 about 15 million Model Ts were produced, the original price was $825 and by 1915 the price had dropped to $345.[2]

For low and middle-income countries that are still in the relatively early phases of large scale motorization, the ineffective countermeasures that were in place in most high-income countries for decades should provide salutary lessons on what not to do.

In contrast during this same time-frame European car production was much smaller, thus in 1928 U.S. car production was over 4.3 million, whereas in countries such as Canada, France, and the United Kingdom there were fewer than 250,000 cars produced in the same year (Table 1).

Table 1. Motor vehicle production around the world in 1928.

Country	Number
United States	4,359,000
Canada	242,000
France	210,000
United Kingdom	212,000
Germany	90,000
Italy	55,000
Czechoslovakia	13,000
Russia	1,000

In the early years of motorization U.S. crash deaths went from 751 in 1908, when the Model T was introduced, to over 26,000 in 1928. It is perhaps not surprising given the size of its crash death problem, that the U.S. led the way in efforts to address this problem. Despite these efforts, crash deaths continued to rise in alarming numbers. At the start of the U.S. involvement in World War II in 1941 there were over 38,000 crash deaths. During the war motor vehicle crash deaths declined, but after the war deaths began rising again and the annual number of deaths peaked in 1972 at almost 55,000.[3]

3 EARLY HIGHWAY SAFETY COUNTERMEASURES HAD A NARROW FOCUS

The Three E's was adopted throughout the U.S. as "the" approach to highway safety, and it continued to hold that status in much of the safety community well into the 1960s. The fundamental weakness of this approach, however, was that the entire focus was on preventing accidents, reducing their consequences was not considered. Furthermore, the effectiveness of these programs was not evaluated, their proponents were convinced that they would work, unfortunately they were wrong.

Concerns about the fatalities in the early years of U.S. motorization led to the formation of various "safety" groups, such as the National Safety Council in 1914, to combat this problem. The efforts of these groups focused exclusively on what was presumed to be the cause of almost all accidents – human error. This led to widespread efforts to prevent crashes by changing driver behaviour through various educational and publicity programs (Eastman 1984).

In the early 1920s, these safety efforts broadened slightly with the introduction of the concept of "The Three E's – Engineering, Enforcement, and Education" (Sleet, et. al., 2011). This approach was touted as an all-encompassing attack on highway accidents. The engineering focused on improvement to highways and vehicles, but only designs to help drivers avoid crashes, designs to reduce the consequences of crashes such as the removal of roadside hazards or seat belts were not considered; the

[1] https://en.wikipedia.org/wiki/Traffic_collision

[2] https://en.wikipedia.org/wiki/Ford_Model_T

[3] https://en.wikipedia.org/wiki/List_of_motor_vehicle_deaths_in_U.S._by_year

enforcement focused on traffic laws to prevent crashes; and the educational component was aimed at making "safer" drivers and pedestrians. The apparent comprehensiveness of this approach gave it a convincing appeal, and the Three E's was adopted throughout the U.S. as "the" approach to highway safety, and it continued to hold that status in much of the safety community well into the 1960s. The fundamental weakness of this approach, however, was that the entire focus was on preventing accidents, reducing their consequences was not considered. Furthermore, the effectiveness of these programs was not evaluated, their proponents were convinced that they would work, unfortunately they were wrong.

Increases in crash deaths in the U.S. in the 1950s and 60s were especially dramatic, highlighting the continuing failures of the prevailing countermeasures. Even though some individuals (including a number of physicians) had urged automakers to add features to their vehicles to reduce injuries in crashes, these proposals were largely ignored.

3.1 High school driver education

Perhaps no unproven program has had more support in the U.S. than high school driver education, by the mid-1960s it had been one of the principal countermeasures aimed at reducing motor vehicle crash deaths and injuries for more than 30 years. It began in 1932 when what was claimed to be "the most obvious approach …. To reduce traffic accidents – the development of a driver education course" was undertaken and then implemented in a Pennsylvania high school.[4] With the enthusiastic support of the safety establishment high school driver education became the holy grail for accident prevention. Despite no supporting evidence, it was proclaimed to be the only way to produce safe beginning drivers. While few people would claim that the only way to learn mathematics is in high school, for example, the advocates for driver education claimed there was no other way for young drivers to learn to be "safe" drivers.

The automobile industry supported high school driver education by having dealers loan or donate cars for use in these courses. Although the industry emphasized the importance of these courses in addressing the accident problem, it also recognized the importance of them in encouraging car sales.

Later in the1970s, as will be documented in the second part of this history, when the effectiveness of high school driver education was evaluated in England and the U.S., not only did it not produce "safer" drivers, it actually increased the crash deaths of teenagers because it encouraged them to drive earlier (when their crash risks are high) than they would have without these programs (Robertson, 1980; Shaoul, 1975).

Very significant resources have been and continue to be invested in ways to produce "safer" drivers with education and training programs which have not worked, when one simple maxim (if followed) could be sufficient and that is: "obey all traffic laws."

3.2 Advocates for more comprehensive approach to countermeasures

In the 1920s and 30s a handful of individuals in the U.S., several of whom were physicians, recognized that the exclusive focus of accident prevention was too limited. One of these early pioneers was a plastic surgeon Dr. Claire L. Straith who had seen what the interiors of automobiles could do to occupants of crash-involved vehicles, especially their faces.[5] In the early 1930s Straith installed seat belts and crash padding into his own vehicle. He also regularly had meetings with representatives of the automobile industry urging them to redesign automobile

[4] http://pabook2.libraries.psu.edu/palitmap/DriversEd.html

[5] https://en.wikipedia.org/wiki/Claire_L._Straith

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interiors to reduce injuries in accidents, although a few of his concepts were incorporated into some vehicles in the 1930s, changing driver behaviour prevailed as the principal countermeasure (Eastman, 1984).

After the war when motor vehicle crash deaths in the U.S. began rapidly increasing again, other individuals also advocated changing vehicle designs to reduce crash injuries. These included Dr. Fletcher Woodward and Colonel John P. Stapp, and in 1954 these individuals prompted The American College of Surgeons to recommend that automakers should emphasize occupant protection in crashes as a fundamental part of vehicle design and as part of this, should include seat belts capable of withstanding a force of at least 20 G's (Eastman, 1984).

In response to these efforts, in the early 1950s the U.S. automobile industry did begin to appoint safety engineers, however, they had small staffs and limited resources. It was another pioneer outside of the automobile industry - Hugh DeHaven - a self-trained engineer and pathologist, who was responsible for many of the early developments in crash injury research, including the Cornell Aeronautical Laboratory's Crash Injury Research Program which began in the mid-1950s, and among other achievements pioneered automobile crash testing. In 1951, DeHaven and a colleague Roger Griswold obtained the first patent for a three-point lap and shoulder belt (Andréasson & Bäckström, 2000).

Because of the efforts by these and other pioneers, changes were made to some aspects of automobile designs to reduce crash injuries, and in 1956 Ford promoted a "safety package" for its new cars that included improved door locks, some interior padding, and lap belts. The sales of the 1956 Ford were disappointing, most likely because that year Chevrolet had a redesigned model and emphasized performance and styling in its advertising. The Ford sales failure was widely interpreted in the automobile industry as proof that "safety doesn't sell." This, despite the fact that some of the optional safety features, including seat belts, sold well. Meanwhile, the safety establishment, with strong automobile industry support, continued with its focus on accident prevention by changing behaviour.

3.2.1 Safety belts

Even though seat belts had been used in U.S. automobile racing as early as 1932, it was not until the 1950s that the U.S. automobile industry began to gradually equip some vehicles with safety belts. In 1954 General Motors (GM) had concluded that "seat belts are not essential for safe driving." However, in 1955 Chrysler and Ford began offering seat belts as optional equipment, and one year later GM also began offering them as optional equipment.

The industry, however, continued to resist efforts to make safety belts standard equipment, but in the 1960s starting with Wisconsin in 1961, a number of states passed legislation requiring the installation of front-seat lap belts. The industry had resisted these laws, but once several states had such laws it was easier for the

industry to make belts standard equipment than deal with different laws in various states.

During the 1950s interest in seat belts was also growing in a number of European countries where they were beginning to be installed on a voluntary basis by several car manufacturers. In these early days, there were three different seat belt designs in use. The lap belt was the predominant design used in the U.S., and its primary role was to prevent occupants from being ejected. For a period in Sweden, there was interest in a two-point sash belt that was fitted horizontally across occupants' chests, however, it was quickly recognized that the chest was not a strong part of the human anatomy, and the sash belt design was modified to mount diagonally across the chest so that the stronger clavicle bone could take the crash loads, these sash designs were primarily intended to reduce injuries from interior impacts. In 1958 Volvo made 2-point sash belts standard equipment, at about the same time SAAB equipped some export models with this type of belt, and it made them standard equipment in 1962 (Andréasson & Bäckström, 2000).

The three-point lap/shoulder belt, which addressed both ejection and interior impacts became a standard feature on Volvo cars in 1959, other manufacturers did not offer lap/shoulder belts as standard equipment until much later, for example, Mercedes did not offer them until 1968.

There was a fundamental problem with safety belts, however, and that was in all countries most motorists failed to buckle them, and so their protective potential was not being realized. The first attempts to increase belt use in the late 1960s and early 70s were based on changing behaviour by educating drivers, for example, in the U.K. starting in 1971 there was a national public information program to encourage belt use.[6] There is no indication that this program had any effect on belt use in the U.K., which remained low.

3.2.2 Motorcycle helmets

Motorcycle crash helmets date back to the Brooklands race track in England in 1914, where the medical officer, Dr. Eric Gardner, became concerned about the frequency of head injuries. As a result, he had canvas and shellac helmets made that were stiff enough to withstand a blow and smooth enough to glance off any projections. These helmets became mandatory for the 1914 Isle of Man TT motorcycle races, and it was reported that normally these races resulted in "several concussion" cases, but in 1914 there were none.[7]

In 1935 the death of T.E. Lawrence (Lawrence of Arabia) from head injuries sustained in a motorcycle crash prompted a neurosurgeon, Dr. Hugh Cairns, who treated him before his death, to study the problem of fatal head injuries to motorcycle riders and in 1941 he published his first report "Head Injuries - the importance of crash helmets" in the British Medical Journal (Cairns, 1941). Later that same year the British Army issued an order for all motorcycle dispatch riders to wear crash helmets.

In 1953 University of Southern California (USC) Professor C.F. "Red" Lombard patented a motorcycle helmet designed to absorb the shock of an impact. Along with the layer of comfort padding in a helmet, this helmet also had another outer layer of padding that absorbed and also spread out the energy created by impact.[8] This was the beginning of the development of the modern-day motorcycle helmet. As with safety belts, however, many motorcyclists chose not to wear helmets.

4 TRAFFIC SAFETY LAWS

A number of traffic safety laws such as speed limits and restrictions on alcohol-impaired driving were introduced from the very beginnings of motorization. Around 1915 in the U.S. traffic laws

[6] https://en.wikipedia.org/wiki/Clunk_Click_Every_Trip

[7] https://en.wikipedia.org/wiki/Motorcycle_helmetreference

[8] http://www.eagleleather.com/The-History-of-Motorcycle-Helmets-586/

became part of the Three E's approach to traffic safety. The focus of these early traffic laws was on catching and convicting offenders, not on any deterrent effects they might have on other drivers. Counts of offenders were all that was measured, there were no attempts to evaluate whether these laws reduced the problems at which they were aimed. This focus continued for decades.

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4.1 Speed limits

The first maximum speed limit was 10 mph (16 km/h) introduced in the United Kingdom in 1861.[9] Today speed limits vary significantly by type of road: urban, rural, limited access highways, etc., and by country. Whether or not the early speed limits controlled driving speeds is not known.

4.2 Alcohol-impaired driving laws

As early as 1897, the first recorded drunk driving arrest was made. A London cab driver had been drinking and driving and crashed into a building, he was arrested for drunk driving and eventually pled guilty to the charge.[10] In 1906, the state of New Jersey enacted the first U.S. law that made it a crime to drive an automobile while intoxicated. A similar law was enacted in 1910 in New York, and other states soon followed.[11] However, these early laws required proof of intoxication with no specific definition of what level of inebriation qualified, as a result a driver had to be visibly impaired, i.e. "drunk" in order to be convicted. This meant that many significantly impaired drivers could not be convicted.

The focus of these early traffic safety laws was on catching and convicting offenders, not on any deterrent effects they might have on other drivers. This focus continued for decades.

In 1936 the Norwegian parliament passed a new type of law aimed at this problem, in which the offense was defined as driving with a blood alcohol concentration (BAC) higher than 0.05%, thus precluding any need to prove "intoxication" (Hallvard, 2016). In 1939, the state of Indiana passed a similar law making it an offense to drive with a BAC of 0.15% or higher, this was the first U.S. law defining this offense in objective terms.[12] Similar laws defining the offense in terms of BACs were adopted in Sweden and other U.S. states, but with significant differences in the BAC thresholds, those in the U.S. were considerably higher than in Norway and Sweden. The Swedish law had two levels of violation, the first level was for BACs between 0.08 and 0.149, and the second more serious offense was for BAC of 0.15 and above, and the penalty for the more serious offense was imprisonment for one month.

In 1906, the state of New Jersey enacted the first U.S. law that made it a crime to drive an automobile while intoxicated.

In 1936, Dr. Rolla Harger, patented the Drunkometer, a balloon-like device into which people would breathe to determine their blood alcohol concentration (BAC), and in 1953, Robert Borkenstein, invented the Breathalyzer, which was easier to use

[9] https://en.wikipedia.org/wiki/Road_speed_limits_in_the_United_Kingdom

[10] http://www.history.com/this-day-in-history/first-drunk-driving-arrest

[11] https://en.wikipedia.org/wiki/Drunk_driving_in_the_United_States

[12] http://www.in.gov/isdt/2340.htm

and more accurate than the Drunkometer. By providing alternatives to blood testing, these devices facilitated the prosecution of drivers charged with impaired driving.[13]

Even though the laws specifying BAC thresholds and the availability of breath testing devices facilitated the prosecution of drivers who were impaired but not visibly "drunk," there were no efforts to determine if these laws reduced the problem. However, this did not stop many officials from Scandinavia making claims about the effectiveness of their laws, but these claims were later shown to be a "myth" (Ross, 1975).

4.3 Victoria, Australia – the first motorcycle helmet use law

In 1961 the State of Victoria in Australia became the first jurisdiction to require all motorcycle riders to wear helmets that met a specified performance standard in an attempt to address the problem of low helmet use.[14] There does not appear to be any research on the effectiveness of this first law. In 1967 a U.S. federal safety standard was issued that required all states to pass a motorcycle helmet use law, and by the early 1970s 47 states had such laws (see section 5.1.1 The U.S. Safety Act of 1996). Later when the federal authority to issue safety standards was weakened, many states repealed or weakened their helmet use laws.[15]

4.4 Victoria Australia – the first seat belt use law

As noted earlier even though more cars were being equipped with seat belts, either as options or as standard equipment, most of the them were not used. In 1970 the State of Victoria in Australia was the first jurisdiction to require that seat belts be worn when fitted in cars. This law was promoted by some in the medical community because of the rising costs of the government health care system. New South Wales adopted a similar law in 1971, and not long after the other Australian states and New Zealand also adopted similar laws. The seat belts in vehicles in Australia at that time were lap/shoulder belts. Early research on the effectiveness of the Victoria law reported a 21% reduction in vehicle occupant fatalities in metropolitan areas, and a 10% reduction (non-significant) in non-metropolitan areas (Foldvary & Lane, 1974). The success of this law prompted many countries to adopt similar laws in the 1970s and later.

5 BREAKTHROUGHS IN THE 1960

Beginning in the late 1950s while working for the New York State Department of Public Health, William Haddon Jr., a public health physician expanded the ideas of the early pioneers and ultimately developed a comprehensive framework for reducing deaths and injuries from motor vehicle crashes. Because of his work, New York was the first U.S. state to propose that vehicle design, including seat belts, be a central element in vehicle safety. Haddon also did seminal research quantifying the role of alcohol in crashes. As the former U.S. Senator Daniel Patrick Moynihan put it "Traffic Safety was mostly mumbo jumbo when he [Haddon] arrived on the scene, it was approaching science when he died …" in 1985 (Moynihan, 1988).

Although individuals had advocated various design features such as seat belts and padded dashboards for many years, it was Haddon in the late 1960s who first articulated the ideas behind a comprehensive approach to countermeasures aimed at events before, during, and after crashes, and that also focused on road users, vehicles and their equipment, and the environment (Haddon, 1968). This broad approach with a wide range of possible countermeasures contrasts with the prior 60 years when the "safety establishment" focused entirely on changing driver

[13] http://www.history.com/this-day-in-history/first-drunk-driving-arrest

[14] http://crossroadz.com.au/OzHelmets/Rules-Vic.html

[15] These U.S. safety standards addressed issues involving road users and are not to be confused with the federal motor vehicle safety standards.

behaviour. The conceptual ideas introduced by Haddon were the basis for a fundamental change in the paradigm for preventing motor vehicle crash injuries that rapidly spread in many motorized countries starting in the late 1960s and early 70s.

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This broad approach with a wide range of possible countermeasures contrasts with the prior 60 years when the "safety establishment" focused entirely on changing driver behaviour.

5.1 U. S. Federal Safety Standards for road users, vehicles, and the environment

In 1965 a key event was the publication of *Unsafe at Any Speed*, a book by Ralph Nader, which accused the US car manufacturers of resisting the introduction of safety features such as safety belts (Nader, 1965).The book also focused on the Chevrolet Corvair and its propensity to roll over due to the characteristics of its suspension system design. It addressed the issue of occupants impacting interior design features such as steering assemblies, instrument panels, etc. Nader was also very critical of the "safety establishment" and its focus on the Three E's, which just as when it was first introduced in the 1920s, still meant "Education" and "Enforcement" aimed at the driver, and "Engineering" of the roads, not engineering of vehicles to protect occupants in crashes.

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General Motors responded to Nader's criticism of the Corvair by trying to destroy his image and for a period had him followed by private detectives. In 1966 the GM president appeared before a U.S. Senate Subcommittee and apologized for GM's campaign of harassment. The resulting publicity helped Nader's book become a best seller and was a catalyst that led to congressional hearings and two seminal pieces of legislation in 1966 - the National Traffic and Motor Vehicle Safety Act and the Highway Safety Act. These Acts authorized the U.S. federal government to play a key role in vehicle and highway safety, and were the beginning of a comprehensive government approach to highway safety countermeasures that embraced the ideas of the pioneers. The potential solutions were no longer just accident prevention.

William Haddon Jr. was appointed as the head of the National Highway Safety Bureau (NHSB), the predecessor to the National Highway Safety Administration (NHTSA). The NHSB (and later NHTSA) was tasked with implementing these two Acts, except for the road design standards, which were to be issued and administered by the Federal Highway Administration.

5.1.1 The U.S. Highway Safety Act of 1966

The Highway Safety act authorized the government to issue uniform standards for a range of issues such as: driver education; licensing; vehicle registration and inspection; emergency services, road construction, etc. Under the U.S. Constitution, traffic laws such as those addressing speed limits, driving-while-impaired, motorcycle helmet and car occupant belt use laws are established by each state. To overcome this the Highway Safety Act authorized the Department of Transportation to withhold federal road construction funds from states that did not meet the safety standards issued under this Act.

In 1967 the NHSB issued standards addressing various road user issues including driver education, driver licensing, alcohol-impaired driving and motorcycle helmet use laws.

5.1.2 The U.S. National Traffic and Motor Vehicle Safety Act of 1966

The National Traffic and Motor Vehicle Safety Act authorized the government to issue federal motor vehicle safety standards (FMVSSs) for new motor vehicles and their equipment, and in 1966 the first comprehensive set of vehicle safety standards in the world were issued for new vehicles, these included standards: for braking, tires, etc., to prevent crashes; for safety belts, padded dashboards, energy absorbing steering columns, high-penetration-resistant windshields, etc., to reduce injuries in crashes; and for fuel leakage in crashes to reduce the likelihood of fires after the crashes.

This first set of FMVSSs embraced the three phases of crashes. These were: pre-crash, encompassing events that contribute to the likelihood of crashes. The crash phase, which identifies events during the crash itself. The post-crash phase, which includes events that can increase the risks after the crash.

In 1968 Haddon expanded and formalized these concepts in which the human, vehicle, and environmental factors involved in crashes are separated into pre-crash, crash, and post-crash phases creating a matrix. This became known as the Haddon matrix, and is shown in Table 2 with examples of issues that can be addressed in each of the cells (Haddon, 1968).

Table 2. The Haddon Matrix

Phase	Human Factors	Vehicle and Equipment Factors	Environmental Factors
Pre-crash	Road user attitudes	Brakes	Road design
	Impairment by alcohol	Lights	Traffic safety laws
	Law enforcement	Tires	Separation of road users
Crash	Restraint use	Structural designs	Roadside hazards
	Helmet use	Crush zones	Guard rail designs
	Injury tolerance	Restraint systems	
Post-crash	Number of injured body regions	Fuel leakage	Emergency response time
	Body regions injured	Ease of access to compartment	Medical treatment
			Traffic congestion

5.2 The safety establishment resists some of the new approaches

Despite the breakthroughs in conceptual approaches, the "safety establishment" still resisted many of these ideas. Thus, in the mid-1960s an unlikely pioneer – Joe Linko, a TV repairman – had photographed hundreds of crash locations in and around New York where roadside designs had directly led to deaths and injuries in crashes. These included rigid signposts and poles, guardrail ends that could penetrate vehicle compartments, guardrails that guided vehicles into bridge abutments, etc. In 1967 Linko showed his pictures at a U.S. congressional hearing which eventually was very influential in changing the designs of roadside features so they were no longer "booby-traps". Clearly these kinds of roadside hazards were issues that should have been addressed in any comprehensive set of countermeasures. However, in response to a query about this issue from Haddon around this time, the head of the U.S. Federal Highway Administration, which was responsible for federal road standards, was reported to have said "Nice people don't leave our travelled right of way". Also about the same time the National Safety Council issued a poster showing a tree by the side of the road with the caption "They don't hit you".

6 LESSONS FOR LMIC COUNTERMEASURES

There are a number of important lessons that can be derived from this early history of countermeasures from HICs that should be absorbed by policymakers and others concerned with ways to reduce motor vehicle crash deaths and injuries in LMICs.

1966 the first comprehensive set of vehicle safety standards in the world were issued for new vehicles, these included standards: for braking, tires, etc., to prevent crashes; for safety belts, padded dashboards, energy absorbing steering columns, high penetration windshields, etc., to reduce injuries in crashes; and for fuel leakage in crashes to reduce the likelihood of fires after the crashes.

First, and probably most important, is that scientific evaluations of the effectiveness all countermeasures should be undertaken, it is not sufficient to assume that countermeasures that have been shown to be effective in some jurisdictions will always work elsewhere. It is important to recognize that many LMICs have very different traffic environments, especially the types of vehicles in use, so some of the appropriate countermeasures in LMICs may differ from those that have been shown to be effective in HICs. Similarly, passing traffic safety laws can be relatively easy, making them work, however, is harder. Thus, for example, so called "tough" laws aimed at reducing alcohol-impaired driving (popular with some American legislators in the past) that had only limited enforcement were not very effective, and similar results can be expected in LMICs. Only if there are sufficient resources available for enforcement can such laws be expected to reduce the problem.

Second, approaches proposed by "safety" experts that are based only on folklore of should be rejected. Thus, for example, history and research tells us that changing road user behaviour is extremely difficult, and that educational and publicity efforts by themselves, will inevitably fail. Despite this evidence, these failed approaches still have advocates who are sometimes able to persuade policymakers to try them again, this reinforces the need for evaluation.

The tragedy of the history of vehicle and highway safety countermeasures in HICs, is that for over 50 years countermeasures that were largely ineffective prevailed, and others that could have saved many lives were ignored by the "safety" experts.

Scientific evaluations of the effectiveness all countermeasures should be undertaken, it is not sufficient to assume that countermeasures that have been shown to be effective in some jurisdictions will always work elsewhere.

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