

Motorcycle-Helmet Laws and Public Health

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Two years after the Civil War ended in a Union victory at Appomattox, a machinist named Sylvester Roper fitted a bicycle with a small steam engine. He called it a steam velocipede, and it's still considered the earliest incarnation of what would come to be known as the motorcycle (see photo). Roper eventually settled in the Cambridge, Massachusetts, area; refined a number of inventions; and amassed more than a dozen U.S. patents. In 1896, throngs of people gathered along the Charles River to watch him and his steam velocipede reach speeds in excess of 40 miles per hour. Moments later, Roper, ever the pioneer, became the first man to die in a motorcycle accident.

Later prototypes made use of more powerful and efficient internal-combustion engines, and by 1905 companies such as Victory, Indian, and Harley-Davidson were producing gas-powered motorcycles that would have left Roper's

velocipede in the dust. Although Ford's Model T may have stolen the headlines, American motorcycles became wildly popular, and their production soared. Government contracts during the First and Second World Wars diverted almost all new motorcycles away from civilian markets and into the armed forces, which allowed a small but profitable motorcycle industry to grow exponentially. By the time U.S. soldiers returned home from the battlefields of Europe and the Pacific, motorcycles had become an iconic part of American culture.

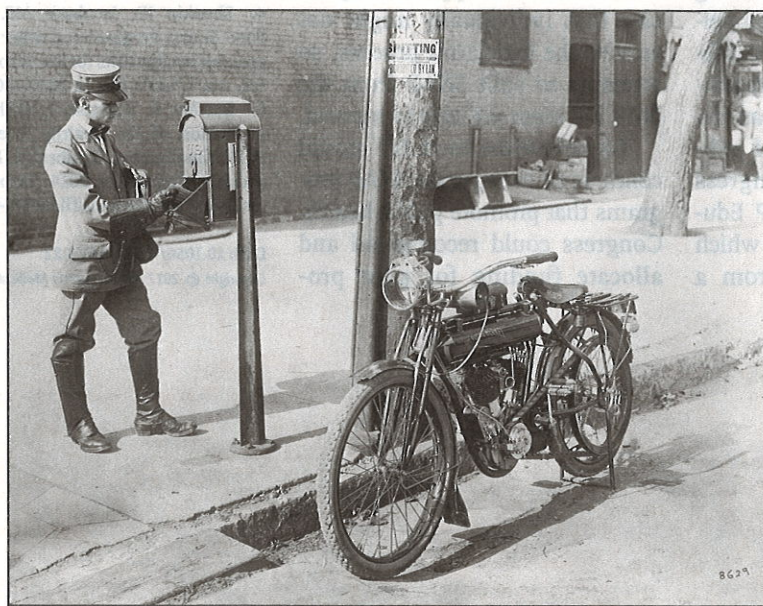
Reports of serious (and typically fatal) motorcycle-related brain injuries began to appear in the medical literature in the early 1920s. At the time, there were roughly two dozen residency-trained neurosurgeons in the United States, and the entirety of neurosurgical knowledge was contained in a few volumes. Virtually nothing was known about the

pathophysiology of traumatic brain injury.

The first person to rigorously study motorcycle injuries and demonstrate that helmets seemed to protect riders' heads was Hugh Cairns, a British neurosurgeon who trained under Harvey Cushing, known as the "father of neurosurgery." Cairns's work in the early days of World War II showed that more than 90% of head injuries caused by motorcycle accidents were fatal.¹

Although helmets have been worn in combat for thousands of years, the motorcycle helmet wasn't patented until 1953. Over the next decade, use of motorcycle helmets steadily increased in the United States, even in the absence of laws requiring it. Mortality decreased, and one study showed that wearing a helmet reduced a motorcyclist's risk of sustaining a serious head injury by 50%.² Although some of the decrease in mortality can be attributed to neurosurgical advances made during World War II — many of them pioneered by Cairns himself — there is little argument that wider use of helmets had a substantial effect.

Evidence supporting the use of helmets continued to accumulate, and in 1967 the U.S. Department of Transportation (DOT) issued its National Highway Safety Program Standard, which made helmets mandatory for motorcyclists. Congress gave those guidelines teeth by withholding federal highway appropriations from any state that didn't enforce helmet use. Before the DOT guidelines only three states had a mandatory helmet law; by 1975, there were only three states without one.



U.S. Mail Carrier and Early Motorcycle.

Although numerous studies documented a steep decrease in motorcycle-related head injuries and mortality after the introduction of these laws, in 1976 Congress effectively chose to stop punishing states that didn't comply with the guidelines. Within 2 years, 27 states had repealed their mandatory helmet laws. Not surprisingly, motorcycle-related fatalities increased by 23% over the next year, even as motorcycle registrations grew by just 1%.³

Helmet laws have since been vigorously debated in state legislatures throughout the country, but the overall trend has been toward repeal. Advocates for helmetless riding argue that helmets limit the rider's peripheral vision and hearing and increase the risk of cervical-spine injury in the event of an accident, though multiple studies have found those concerns to be without merit. Many motorcyclists believe the choice to wear a helmet is a matter of personal liberty and have alleged that mandatory laws are unconstitutional. Courts, however, have typically failed to uphold such arguments. In the end, the issue may come down to money: motorcycle tourism pumps tens of millions of dollars into state economies each year.

The public health impact of universal helmet laws is directly proportional to the number of motorcyclists affected by them, and states with the most motorcyclists often have no such laws. Of the 10 states with more than 250,000 registered motorcycles, only 2 (California and New York) have universal helmet laws. Currently, 19 states have universal helmet laws, 3 have no helmet law whatsoever, and 28 require helmets to be worn only by motorcyclists younger than a certain age, typically 18 or 21 years.

Public policy has the potential

to dramatically improve public health, especially when it comes to transportation safety. According to the Centers for Disease Control and Prevention (CDC), the rate of motor vehicle deaths in the United States decreased from 18 per 100 million vehicle-miles traveled in 1925 to 1.7 per 100 million vehicle-miles traveled in 1997 — a trend that has been attributed to increased safety standards and wider use of seat belts. The fatality rate for occupants of passenger cars, in particular, decreased from 1.51 to 0.85 per 100 million vehicle-miles traveled between 1994 and 2014, according to the National Highway Traffic Safety Administration.

Unfortunately, there hasn't been a similar decline in the rate of motorcycle-related fatalities, which equaled about 23 per 100 million vehicle-miles traveled in both 1994 and 2014. Some 4000 to 5000 motorcyclists have been killed every year since 2009. Motorcycle fatalities now account for 14% of all U.S. traffic deaths even though motorcycles account for less than 1% of vehicle-miles traveled. Motorcyclists are 27 times as likely to die in a crash as passenger-car occupants and 5 times as likely to be injured.

There were 92,000 motorcycle-related injuries in 2014, a figure that has been steadily increasing since reaching a low of 49,000 in 1998. Among motorcyclists who are injured in a crash, studies suggest, those who weren't wearing a helmet tend to have more severe injuries, require more intensive care, and be more likely to sustain a traumatic brain injury or die than those who were wearing a helmet.

The total economic burden associated with motorcycle-related injuries and deaths amounts to billions of dollars a year, much

of which is borne by the public. A retrospective review of motorcycle crash victims treated at a level-one trauma center found that 63% of their treatment costs were paid for with public funds (mostly from Medicaid).⁴ A CDC analysis of National Highway Traffic Safety Administration data determined that about \$3 billion was saved as a result of helmet use in 2010 — and an additional \$1.4 billion could have been saved had all motorcyclists worn a helmet.

In the absence of increased regulation, preventing motorcycle-related injuries and deaths is challenging. Educational campaigns may be the only method for increasing rider compliance with existing laws and promoting safer behavior.

Helmet use has been shown consistently and unequivocally to reduce the severity of injuries from motorcycle crashes and increase the likelihood of survival after a crash. The consequences and costs of such crashes are borne not only by the victims but also by society. Unfortunately, decades of research have gone ignored, and policy decisions have been left up to states — often with devastating consequences.

Disclosure forms provided by the authors are available at NEJM.org.

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