AN ANALYSIS OF HOSPITALIZED MOTORCYCLISTS IN THE STATE OF MARYLAND BASED ON HELMET USE AND OUTCOME

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ABSTRACT

In recent years, there has been a significant increase in mortality among motorcyclists. Despite high rates of morbidity and mortality associated with crashes among older riders, there have been relatively few studies on injured motorcyclists admitted to hospitals. In an ongoing study, data is being collected from motorcyclists involved in crashes in Maryland who were either killed or transported to the R Adams Cowley Shock Trauma Center (STC) in Baltimore, Maryland. Data on injured motorcyclists is captured from the trauma registry, hospital discharge records, autopsy reports, and through a linkage with police crash reports. Injured parties are assessed six-months and one-year post crash with the Short Form 36 (SF-36) questionnaire. The SF-36 is an evaluation tool used to determine long term outcome. Autopsy reports are obtained from the Office of the Chief Medical Examiner of Maryland (OCME).

Previous studies looking at head injuries resulting from motorcycle crashes have not been able to discriminate between operators using helmets that are and are not compliant with standards set forth by the United States Department of Transportation (DOT). Helmets will be categorized as DOT-certified, full-face, half-shell or uncertified novelty helmets. Fatal versus non-fatal crashes with resulting injuries are compared and matched by operator demographics, helmet use and type, and crash characteristics. It is anticipated that persons involved in a crash while wearing an uncertified novelty helmet have a higher risk of head injury than those who crashed while wearing a DOT-certified helmet.

From January 2007 through May 2008 there were 517 motorcycle operators admitted to the STC. The mean age of this group was 37 years and 25percent sustained a head injury with an Abbreviated Injury Score (AIS) between 1 and 6. Twenty-one percent of these helmets were identified as DOT non-certified. A comparison of head injury and helmet type revealed that 50 percent (13/26) of those wearing a uncertified novelty helmet received a head injury (AIS 1-6) as compared to 23 percent (22/96) of those wearing a DOT certified helmet.($p<.05$).

INTRODUCTION

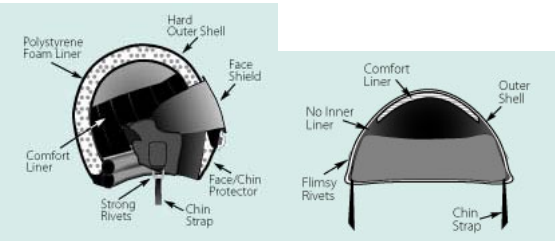
Motorcycles have become an increasingly popular mode of transportation; motorcycle registrations in the United States topped 8.1 million in 2007[1]. Motorcyclists are particularly vulnerable to injury because their vehicles provide little or no protection in the event of a crash. Helmets have repeatedly been proven to reduce the severity of head injury in crashes. However, the number of motorcyclists injured (103,000) and killed (5,154) in 2007 continued a ten year upward trend. [2]

At the same time, there has been an increase in the average engine size of motorcycles, from a mean of 769 cc in 1990 to 999 cc in 2002.[3] In addition, during the same period as the nationwide increase in fatalities, there has also been an increase in the number of states repealing or modifying motorcycle helmet use laws, as well as a decreasing rate among observed motorcyclists. While the use of a motorcycle helmet has been estimated to be 37 percent effective in preventing fatal injuries to motorcyclists who are involved in a highway crash, only 59 percent of motorcyclists who sustained fatal injuries were reported to be wearing a helmet at the time of their crash.[4] Also, in a previous study of motorcyclist fatalities focusing on head injuries that was conducted at the National Study Center for Trauma & EMS (NSC) findings revealed that motorcyclists wearing helmets were significantly less likely to suffer a traumatic brain injury (TBI) than those who were unhelmeted. [5]

The US DOT created Federal Motor Vehicle Safety Standard FMVSS No. 218 in 1973. The purpose of this standard is to reduce deaths and injuries to motorcyclists and other motor vehicle users resulting from head impacts. To do so, the standard establishes a minimum performance requirement for helmets. These requirements include three performance tests: (1) An impact attenuation test; (2) a penetration test; and (3) a retention system test; as well as various labeling requirements.

Despite the passage of mandatory helmet laws in a number of states, the persistent use of 'novelty' helmets that do not meet the requirements of FMVSS No. 218 (Illustration 1) remains relatively unchanged.

Illustration 1



Compliant Helmet Novelty Helmet

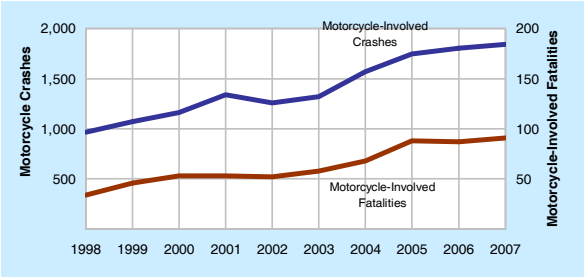
NHTSA has published an NPRM (73 FR 57297) on October 2, 2008, to amend FMVSS No. 218 to address the issue of novelty helmets. Some of the proposed amendments to FMVSS No. 218 would help realize the full potential of compliant helmets by aiding state and local law enforcement officials in enforcing state helmet use laws, thereby increasing the percentage of motorcycle riders wearing helmets compliant with FMVSS No. 218. The amendments would do this by adopting additional requirements and revising existing requirements to reduce misleading labeling of novelty helmets that creates the impression that uncertified, noncompliant helmets have been properly certified as compliant.

This study provides a general description of the characteristics of motorcycle crashes in Maryland and the injury patterns associated with those crashes. For this analysis, the prevalence of 'novelty' helmet use and subsequent head injury among motorcycle operators in Maryland who were transported to a trauma center as the result of a highway crash was examined.

METHODS

The Maryland Automated Accident Reporting System (MAARS) collects data on more than 100,000 crashes that occur annually. An analysis of this database was used to provide a general description of the number and type of motorcycle crashes that occur in the state. In addition, information on injuries and helmet type was collected from persons who were transported to the STC as a result of their crash during the period January 2007 through May 2008. During the course of their hospital stay, these crash-involved motorcycle operators were approached and asked to provide

Figure 1



consent for participation in the study. Upon consent, they were asked a series of questions about their riding habits and the type of crash in which they were involved and a series of questions about their general health and activity level prior to their crash. If available, the helmet they were wearing at the time of the crash was photographed. These photographs were used to identify any damage that may have resulted from the crash and to classify the helmet as being DOT-certified. Demographic characteristics and the nature and extent of the injuries sustained were captured from the STC trauma registry database. For this analysis, any documented brain or skull injury with a severity of 1 or higher, using the Abbreviated Injury Scale (AIS), was classified as a brain injury.

RESULTS

Crash Characteristics

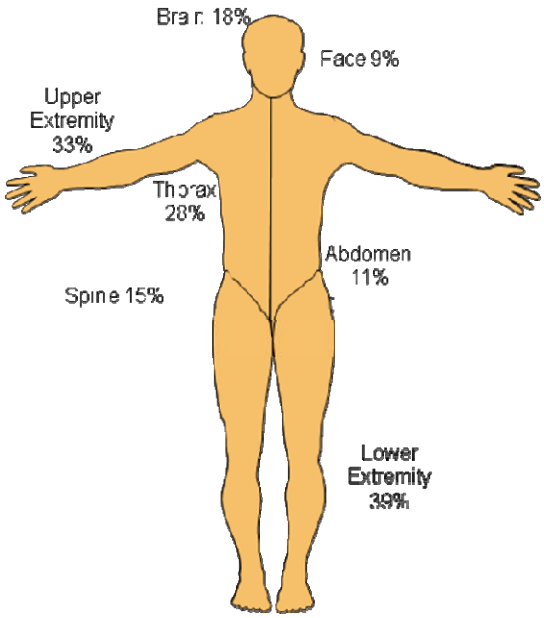
During calendar year 2007 there were 1,841 motorcycle crashes and 96 fatalities that occurred on Maryland roads. Both numbers continue an upward trend in both crashes and fatalities that extends back to the late 1990's (Figure 1). The vast majority of the motorcycle operators involved in a crash was men (89 percent) and persons between the ages of 35 and 49 accounted for 34 percent of the riders involved in a crash. More than 40 percent of the crashes occurred on the weekend (Saturday - Sunday) and 60 percent occurred between the hours of noon and 8pm (Table 1).

Table 1 – Maryland Motorcycle Crash and Rider Characteristics					
Total Riders Involved in Crashes				Riders Killed in Crashes	
	N	%		N	%
Gender					
Male	1,680	89		87	99
Age					
<20	106	5.6		5	5.7
20-34	672	35.5		33	37.5
35-49	653	34.6		35	39.8
50-64	320	16.9		12	13.6
65+	32	1.7		3	3.3
Helmet Use					
Yes	1,403	74.0		77	87.5
Unknown	331	17.5		6	6.8
Total Motorcycle Crashes				Fatal Motorcycle Crashes	
Day of Week					
Weekday	1,046	56.8		49	53.8
Weekend	795	43.2		42	46.2
Hour of Day					
12am – 8am	231	12.5		12	13.2
8am – 12pm	199	10.8		6	6.6
12pm – 8pm	1,105	60.0		54	59.4
8pm – 12am	305	16.6		19	20.9

Injured Motorcycle Operators

From January 2007 through May 2008 there were 517 motorcycle operators admitted to the STC as the result of a roadway crash. The mean age of this group was 37 years and 25 percent sustained a brain injury. The distribution of injuries (AIS 2+) to other body regions for this group is illustrated in Figure 2. Injuries to the upper and lower extremities, as expected, were observed most frequently. The mean Injury Severity Score was 14.5 (range 1-75). Among this group of patients, 153 (30 percent) of those motorcycle operators who arrived at the trauma center provided consent to have photographs taken of the helmet they were wearing at the time of the crash. Based on these photographs, 21 percent of these helmets were identified as novelty (or DOT uncertified helmets. Examples of helmets examined at the STC are presented in Figure 3. Case 1 illustrates a FMVSS No. 218 certified helmet with minor damage to the left side. Case 2 illustrates a novelty helmet affixed with a warning label on the inside warning that it will not protect against serious injury. Case 3 illustrates a novelty helmet that sustained significant damage as a result of the crash.

Figure 2



**Due to multiple body regions being injured as the result of a crash, percentages total more than 100%.*

Additionally 118 motorcycle operators provided answers to a general questionnaire that gathered information on their demographics, education level, and riding behavior. Selected characteristics of this group are provided in Table 2. Ninety-seven percent of the operators were men with a mean age of 39 years. Nearly 40 percent reported never having taken a motorcycle safety training course and the type of motorcycle ridden was distributed largely between cruisers (37 percent) and sport bikes (39 percent). Thirty-seven percent of the crashes involved a collision with another vehicle. Additionally, 65 percent reported to be wearing some type of protective clothing (excluding long pants/jeans) at the time of their crash.

A comparison of head injury and helmet type revealed that 50 percent (13/26) of those wearing a non-compliant helmet received a head injury (AIS 1-6) as compared to 23 percent (22/96) of those wearing a compliant helmet ($p<.05$). Those wearing 'novelty' helmets at the time of their crash were found to be significantly older (46.9 years vs 37.3 years, $p<.05$).

Table 2 – General Participant Characteristics	
	Percent
Gender	
Male	97
Education Level	
HS Diploma or less	45
Motorcycle Type	
Cruiser	37
Sport	39
Taken a MC training course	
No	39
Type of Crash	
Laid bike down	20
Single vehicle, object impact	31
Multiple vehicle	
Intersection related	16
Non-intersection related	21
Type of Road	
Interstate	21
City street/urban area	15
Suburban area	26
County road/rural area	29
Protective Clothing worn	65

DISCUSSION

Over the past ten years, there has been a steady and disconcerting increase in the U.S. in motorcycle crashes and fatalities. This national trend is also occurring in the state of Maryland. Maryland does have a universal helmet law, requiring all riders wear a DOT-certified helmet. This law initially helped lower the frequency of head injuries and fatalities from those injuries.[5] However, several factors including the increase in the number of motorcycles on the highway has contributed to the overall upward trend of motorcycle crashes and their subsequent injuries and the use of uncertified helmets appears to increase the likelihood of a head injury as the result of those crashes. Anecdotally, some riders prefer the appearance and feel of these novelty helmets or may wear them to satisfy the minimum requirements of the law. Whatever their reason, uncertified novelty helmets do not provide the same level of protection as helmets certified to FMVSS No. 218 which have an energy attenuating liner and shell design to prevent excessive penetrations, and a

Figure 3

Case 1 – FMVSS No. 218 DOT Certified w/ damage

Case 2 – Novelty with warning label

Case 3 Novelty with damage

retention system that can withstand loads during a crash and therefore, will not protect the motorcyclist from a brain or skull injury in the event of a crash.[6] This hypothesis has been supported by the research presented here. Of all injured riders, those wearing a non-compliant helmet were more likely to have sustained a head injury. It is important to note that the riders wearing uncertified novelty helmets were significantly older. Future analysis will incorporate injuries and helmet type for fatally injured motorcycle.

CONCLUSIONS

It has been shown that there are several distinct groups within the motorcycle riding community. Some studies have separated riders based on age, motorcycle type or riding experience. This study has provided a summary of the characteristics of motorcycle crashes and have focused on a sub-group of motorcycle operators who were injured in a highway crash and compared the occurrence of brain injuries with the helmet type, DOT-certified vs. uncertified. By analyzing riders who were injured, this project has shown that the likelihood of sustaining a brain injury increases when wearing a non-compliant helmet.

This study has provided further evidence regarding the effectiveness of use of DOT-certified helmets to reduce and prevent the severity of head injuries. Skeletal injuries have a higher likelihood of survival to positive outcomes, whereas brain injuries often lead to long-term disability or psychosocial issues. By preventing TBI, there is an increased likelihood of a positive outcome following a crash. Finally, this study exemplifies the use of the recommendation made in the Review of State Motorcycle Safety Program Technical Assessments[7] by combining multiple datasets to evaluate multiple aspects of motorcycle crashes and their subsequent injuries.

REFERENCES

[1] Federal Highway Administration, Highway Statistics 2007, State Motor Vehicle Registrations 2007 http://www.fhwa.dot.gov/policyinformation/statistics/2007/mv1.cfm

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[7]Review of State Motorcycle Safety Program Technical Assessments. DOT HS 811 082, January 2009