

Midwest Surgical Association

# Repeal of the Michigan helmet law: early clinical impacts

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## Abstract

**BACKGROUND:** Michigan repealed a 35-year mandatory helmet law on April 13, 2012. We examined the early clinical impacts at a level 1 trauma center in West Michigan.

**METHODS:** Retrospective cohort study comparing outcome among motorcycle crash victims in a 7-month period before and after the helmet law repeal.

**RESULTS:** One hundred ninety-two patients were included. After the repeal, nonhelmeted motorcyclists rose from 7% to 29% ( $P < .01$ ). There was no difference in mortality rate after admission; however, crash scene fatalities increased significantly. Intensive care unit length of stay, mechanical ventilation time, and cost of stay were also higher in the nonhelmeted cohort ( $P < .05$ ).

**CONCLUSIONS:** Our study highlights the negative ramifications of repealing a mandatory helmet law. Motorcyclists not wearing helmets increased significantly in a short period of time. Nonhelmeted motorcyclists more frequently died on the scene, spent more time in the intensive care unit, required longer ventilator support, and had higher medical costs.

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Motorcycle helmet laws have been a controversial issue for several decades. The National Highway Safety Act, implemented in 1966, required that states mandate helmet use to receive federal highway safety and construction funds. This requirement was rescinded in 1976, when Congress revoked the authority of the US Department of Transportation to withhold state funds for helmet law noncompliance.<sup>1</sup> A dramatic increase ranging from 25% to 46% in motorcycle deaths nationwide was observed in the year after this legislative change.<sup>2</sup> Despite this negative impact, many states weakened or rescinded their motorcycle helmet laws. Today, only 19 states and the District

of Columbia maintain a universal helmet law. Secondary helmet laws, requiring only certain riders (usually those younger than 18 or 21 years) to wear a helmet, are present in 28 states. Illinois, Iowa, and New Hampshire are the only states without a helmet law.<sup>1,3</sup>

The repeal of mandatory helmet laws continues today despite an established body of evidence demonstrating the clear safety benefit of motorcycle helmets. Multiple studies have shown that nonhelmeted motorcyclists (NHMs) have a higher mortality rate than helmeted motorcyclists (HMs).<sup>1,2,4</sup> Others have found a higher incidence of lethal and nonlethal head injuries in NHMs.<sup>5</sup> Furthermore, the financial impact of the injured NHM has been consistently higher than HMs.<sup>4,6</sup>

Despite strong advocacy efforts from the health care community and traffic safety experts, Michigan repealed a 35-year universal helmet law in April 2012. This study examines the early clinical and financial impacts of the repeal of the mandatory helmet law at a level 1 trauma center in West Michigan.

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**Table 1** Demographic and clinical data, 2011 versus 2012

	2011	2012	<i>P</i> value
Male (%)	68/79 (86%)	97/113 (86%)	.96
Age (y)	41.7 ± 15.0	43.7 ± 15.1	.31
Unhelmeted riders	6/79 (7%)	33/113 (29%)	.001
Mortality	2/79 (3%)	4/113 (4%)	.16
Unhelmeted crash scene fatalities*	1/7 (14%)	10/13 (77%)	.007

\*Fatalities occurring in Michigan regional health care coalition region 6.

## Methods

### Study design

Spectrum Health Butterworth Hospital is a 815-bed, level 1 trauma, and tertiary care center serving 13 counties in West Michigan. After obtaining institutional review board approval, we retrospectively reviewed the medical records of trauma patients admitted to the trauma service involved in a motorcycle crash during 2 motorcycle seasons. We examined patient records during a 7-month period before the repeal (April 10, 2011, to November 10, 2011) and compared this to the same 7-month period after the repeal (April 10, 2012, to November 10, 2012). Patients with unknown helmet status were excluded from the study. Data collected included age, sex, helmet status, mortality, ISS, Abbreviated Injury Scale head, intensive care unit (ICU), length of stay (LOS), hospital LOS, mechanical ventilation time, admission Glasgow Coma Scale (GCS), cost of stay, insurance status, alcohol intoxication (blood alcohol content  $\geq .08\%$ ), and disposition. Data were also collected from the Michigan State Department of Transportation to determine crash scene fatalities for motorcyclists in the region served by our hospital.

### Statistical analysis

Data were analyzed using SPSS 18 (IBM, Armonk, NY). Summary statistics were calculated. Quantitative data are expressed as the mean  $\pm$  SD, whereas nominal data are expressed as a percentage. Comparisons between groups for quantitative variables were performed using the *t* test. Cost data were compared using the Mann–Whitney test. Nominal variables were evaluated using the chi-square test. Significance was assessed at *P* less than .05.

## Results

One hundred ninety-eight patients involved in motorcycle crashes were admitted to the trauma service during the study period. Six patients were excluded from our study because helmet status was unknown. There were 165 men (86%), and the average age was 42.9  $\pm$  15.1 years (mean  $\pm$  SD). Seventy-nine riders presented before the helmet law repeal (2011) and 113 presented after the helmet law repeal

(2012). Thirty-nine patients were NHMs, 33 of whom were patients admitted in 2012. There were 6 NHMs included in the study before the repeal.

Demographic and clinical data for the 2 groups are shown in Table 1. When comparing the 2011 and 2012 patient cohorts, the 2 groups were not significantly different. However, the percentage of NHM rose significantly from 7% to 29% after the helmet law repeal in 2012 (*P* < .01). There was also a significant increase in before arrival nonhelmeted fatalities in 2012, rising from 14% to 77% after the repeal (*P* < .01).

Table 2 compares the helmeted and nonhelmeted cohorts. There was not a significant difference in mortality rate between these 2 groups. ISS, Abbreviated Injury Scale head, Glasgow Coma Scale, hospital LOS, and insurance status were also not found to be different between the 2 groups. ICU LOS, mechanical ventilation time, and hospital charges were significantly higher in the NHM cohort (*P* < .01). NHMs were more frequently intoxicated (blood alcohol level > .08). There was no statistically significant difference in payor (commercial insurance, private payment, Medicare or Medicaid) between the 2 cohorts (*P* = .85).

## Comments

On April 13, 2012, after 35 years of mandatory helmet legislation, state leaders in Michigan approved a partial helmet law. Michigan motorcyclists may go without a helmet if the rider is older than 21 years, obtains a \$20,000 insurance supplement, and has either 2 years of experience or completes a safety course. This law was heavily debated. Advocates voiced concern about lost tourism revenue and violation of personal freedom. Adversaries, on the other hand, expressed worry about the safety impact of repealing an existing mandatory helmet law.

This study revealed 6 significant findings after the repeal of the mandatory helmet law in Michigan. The incidence of NHMs and on-scene fatalities increased. The surviving NHMs required a longer ICU stay and more time on the ventilator. This population was more frequently under the influence of alcohol and used more hospital resources.

There is a strong correlation between mandatory helmet laws and motorcyclist compliance. States that support a mandatory helmet law report compliance up to 94%. Those states without a mandatory helmet law have significantly lower helmet use.<sup>1,7–9</sup> In the 3 years after the repeal of a

**Table 2** Demographic and clinical data, helmeted versus unhelmeted riders (N = 192)

	Helmeted	Unhelmeted	P value
Male (%)	130/153 (85%)	35/39 (90%)	.59
Age (y)	42.2 ± 15.3	45.8 ± 14.3	.19
Mortality	5/153 (3%)	1/39 (3%)	>.999
ISS	14 (4–66)	12 (4–50)	.62
AIS head	2 (1–5)	3 (2–5)	.34
GCS	15 (3–15)	15 (3–15)	.008*
Hospital LOS	3 (1–33)	4 (1–30)	.083
BAC ≥ .08%	11/77 (14%)	11/23 (48%)	.001
ICU LOS	0 (0–33)	0 (0–30)	.02†
Ventilator time (d)	0 (0–27)	0 (0–28)	.02‡
Cost of stay	\$21,212 (3,064–286,335)	\$32,920 (5,997–255,330)	.01

AIS = Abbreviated Injury Scale; BAC = blood alcohol content; GCS = Glasgow Coma Scale; ICU = intensive care unit; LOS = length of stay.

Fatalities occurring in Michigan regional health care coalition region 6.

\*Based on distribution, the values for helmeted are greater than the values for unhelmeted.

†Based on distribution, the values for unhelmeted are greater than the values for helmeted.

‡Based on distribution, the values for helmeted are greater than the values for unhelmeted.

mandatory helmet law in Florida, helmet use dropped from 80% to 33%.<sup>8</sup> A similar phenomenon was documented in Arkansas and Texas.<sup>10</sup> In Michigan, we observed an increase in the number of NHMs arriving to our trauma center almost immediately after institution of the repeal. In the year before the repeal, 7% of our patients were NHMs and in the 7 months after the repeal, this rose to 29%.

Previous studies have documented an inverse relationship between mortality and helmet use. This trend is supported by our findings. Our study revealed a significantly increased crash scene mortality rate for NHMs. Before the repeal, only 1 NHM crash scene fatality was reported in our region. The number of crash scene mortalities increased 10-fold after the Michigan helmet law repeal. The increase in crash scene fatalities among NHMs is an unfortunate effect of helmet law repeals documented in multiple states and has been confirmed by national studies.<sup>7,8,10</sup> An analysis of nearly 77,000 patients from the National Trauma Data Bank (NTDB) found the mortality in no helmet law states to be 5.9% versus 4.3% in universal helmet law states.<sup>1</sup> Another study using the NTDB revealed a mortality rate of 7.1% in NHMs versus 4.3% in HMs.<sup>4</sup> A cross-sectional study analyzing national discharge data found that patients hospitalized in states without universal helmet laws are more likely to die during their hospitalization.<sup>9</sup> It is surprising that lawmakers continue to support the repeal of mandatory helmet legislation given the clear mortality benefit of helmet use. In light of this policy trend, injury prevention efforts focusing on factors other than the helmet have been suggested. These include lower speed limits, improved rider education, graduated licensing, and higher visibility clothing.<sup>8</sup>

Although our crash scene mortality for NHMs was higher after the repeal, it was surprising that we did not find an increase in hospital mortality, ISS, or brain injury for this cohort. This finding is not consistent with the data reported in other studies. The increase in hospital mortality is often attributed to severe traumatic brain injury. Neurosurgeons

at the University of Miami encountered a significantly increased number and severity of brain injuries admitted to their trauma center after the repeal of a mandatory helmet law.<sup>7</sup> Similar results were found in Illinois, Arkansas, and North Carolina where NHMs had a higher ISS and sustained head and neck injuries more frequently.<sup>2,10,11</sup> In our study, there was no difference in ISS or neurologic insult, which likely explains why our inpatient mortality was the same. We believe that the most injured patients in our study died at the scene and were, therefore, selected out of the inpatient population entirely. We plan to confirm this hypothesis with further review of the autopsy findings, specifically focusing on head and neck injury patterns.

The NHM cohort had longer ICU LOS and required more time on the ventilator. This finding is consistent with the literature but comes as a surprise as the severity of injury in the 2 cohorts was the same. There was no difference in the overall LOS between the 2 cohorts, and reporting on this is varied within the literature.<sup>4,10</sup>

NHMs in our study were significantly more likely to be drunk (blood alcohol content >.08). Forty-eight percent of NHMs were intoxicated, compared with 14% of HMs. Trends toward risky behavior among NHMs have been described in multiple studies. NHMs are not only more likely to be using alcohol but also more likely to have an alcohol level that exceeds the legal limits,<sup>10</sup> consistent with our findings. This is reflected in a study from the NTDB, who found alcohol and drug use to be significantly more common in the NHMs.<sup>4</sup> These findings reinforce the importance of emphasizing safety measures beyond helmet use.

It has been well documented that injured NHM incur a higher cost of stay.<sup>2–4,11</sup> A 35% increase in health care costs was found for the NHMs in our study (\$32,700 vs 21,300). We attribute this finding to the increased ICU LOS and ventilator time among the NHMs. An analysis of Illinois motorcyclists reported a 23% increase in health care costs among NHMs.<sup>2</sup> The economic impact of

NHMs is one that can be reversed. This was demonstrated in Nebraska where total acute medical charges decreased by 38% after implementation of the helmet use law.<sup>3</sup> Although the primary concern of the health care provider is patient safety, rising costs of health care and the known economic burden of NHMs should also be considered in the decision to repeal mandatory helmet laws.

Insurance status and disposition must be considered when assessing the economic impact of the NHMs. We did not find a difference among insurance payor type or disposition location. The literature suggests that NHMs are much less likely to have health insurance and have an increased need for rehabilitation.<sup>1,4,9</sup> We did not capture whether patients required home health care or outpatient therapy. This factor may have an impact on our results, and potential financial differences may be uncovered when this analysis is complete.

In only 7 months after the repeal of the mandatory helmet law in Michigan, we have uncovered several concerning trends. Most alarming is the dramatic increase in the number of NHMs and on-scene fatalities. Although the passage of the 2012 mandatory helmet law repeal in Michigan is discouraging to many health care professionals, we find it promising that the negative impacts of partial helmet laws appear to be reversible. This has been seen in Nebraska and California where re-enactment of a mandatory helmet law has resulted in fewer crashes, fatalities, and severe head injuries.<sup>3,12</sup> We are committed to a continued analysis of the clinical impact of the helmet law repeal and will continue to educate the public on its effects.

## Limitations

There are several limitations of this study including the retrospective design of this analysis. Other limitations include short time period, small sample size, and local geographic boundaries. The cause of crash scene fatalities is unknown. Alcohol use may be a confounding variable. Some have suggested that drunk drivers are more likely to exhibit riskier behaviors including speeding and using less protective gear. Despite these limitations, we have uncovered several disturbing trends. Continued analysis is required to further determine the clinical impact of this change.

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## References

1. Croce MA, Zarzaur BL, Magnotti LJ, et al. Impact of motorcycle helmets and state laws on society's burden. *Ann Surg* 2009;250:390–4.
2. Kelly P, Sanson T, Strange G, et al. A prospective study of the impact of helmet usage on motorcycle trauma. *Ann Emerg Med* 1991;20:852–6.
3. Meulleman RL, Mlinek EJ, Collicott PE. Motorcycle crash injuries and costs: effect of a reenacted comprehensive helmet use law. *Ann Emerg Med* 1992;21:43–9.
4. Hundley JC, Kilgo PD, Miller PR, et al. Non-helmeted motorcyclists: a burden to society? A study using the National Trauma Data Bank. *J Trauma* 2004;57:944–9.
5. Mertz KJ, Weiss HB. Changes in motorcycle-related head injury deaths, hospitalizations and hospital charges following repeal of Pennsylvania's mandatory motorcycle helmet law. *Am J Public Health* 2008;98:1464–7.
6. McSwain Jr NE, Belles A. Motorcycle helmets—medical costs and the law. *J Trauma* 1990;30:1189–99.
7. Hotz GA, Cohn SM, Popkin C, et al. The impact of a repealed motorcycle helmet law in Miami-Dade County. *J Trauma* 2002;52:469–74.
8. O'Keeffe T, Dearwater SR, Gentilello LM, et al. Increased fatalities after motorcycle helmet law repeal: is it all because of lack of helmets? *J Trauma* 2007;63:1006–9.
9. Coben JH, Steiner CA, Miller TR. Characteristics of motorcycle-related hospitalizations: comparing states with different helmet laws. *Accid Anal Prev* 2007;39:190–6.
10. Bledsoe GH, Schexnayder SM, Carey MJ, et al. The negative impact of the repeal of the Arkansas motorcycle helmet law. *J Trauma* 2002;53:1078–86.
11. Eastridge BJ, Shafi S, Minei JP, et al. Economic impact of motorcycle helmets: from impact to discharge. *J Trauma* 2006;60:978–83.
12. Peek-Asa C, Kraus JF. Estimates of injury impairment after acute traumatic injury in motorcycle crashes before and after passage of mandatory helmet use law. *Ann Emerg Med* 1997;5:630–6.

## Discussion

**Roxie M. Albrecht** (Oklahoma City, OK): I would like to re-emphasize the significant finding of the >5 times increase in mortality of on-scene deaths in this article following the repeal of the Michigan motorcycle helmet law. This impressive negative impact of the repeal should be shared with those legislators who voted for the repeal. A second important point of this article is that for those patients who did get to the hospital, there was no significant difference in outcome. I believe this reflects the excellent prehospital and hospital care in West Michigan. I do have a couple of questions. The repeal required a safety course, driver experience, and a \$20,000 insurance supplement. Was there a process in place on how this should be implemented and enforced? And do you have any data on how many of your patients were compliant with these requirements? Next, one of the points of advocates for the repeal was to increase tourism. Do you have any data on the percentage of out of state patients who you cared for after the repeal, and what was the cost to your trauma system of those out of state patients? And, finally, where are you going to go from here? What further information do you feel you need to gather to take this back to the legislators to repeal the repeal?

**Titus:** Patients or riders are not being pulled over if they're not wearing a helmet, and there are currently no ramifications for not having the legally required qualifications. We don't have the data to show how much this has

increased tourism for motorcyclists and don't have the data for how many of our patients were out of state. The third question was where are we going to go from here? We did present some of our findings in the Michigan Traffic and Safety Summit legislative meeting to show that some of these negative ramifications are happening clinically among our patients and to show legislators what the impacts of this change could potentially be over the next couple of years to let them know that this is causing harm to our patients.

We are hoping to collaborate with other institutions to see what is being seen in the rest of the trauma population and find out the autopsy data if the patients who died on the scene as a main argument against our point of unhelmeted riders dying on the scene.

**James Madura** (Phoenix, AZ): I have a good friend who rides a Harley and refuses to wear a helmet, and every time he comes over, I ask him where his helmet is and he

finally told me, well, I am going to bring it next time and put it somewhere that I can't mention in a public audience. But his point has always been that he's seen what happens when people wear a helmet and they have disabling injuries and he would rather not have that and suffer what I think you have shown here is that they have a higher scene mortality. That's my comment. My question to you is, I'm wondering if you have sorted here for helmet use and non-helmet met or if you really have analyzed alcohol use versus nonalcohol use?

**Titus:** That's a very good question. As we did identify alcohol use as a definite confounding variable that could have potentially skewed our data, we have not evaluated which patients were unhelmeted that were drinking that had worse outcomes, and we also don't know the patients who died on the scene, if there were levels of alcohol that were illegal in their system, as well. So that is something we need to look into.