OPINION

Bicycle helmets — are they up to standard?

Jocelyn Pedder

On the 3 September, British Columbia's new mandatory bicycle helmet law came into effect. All cyclists on public roads and highways are now required to wear a bicycle helmet that meets one of the following standards CAN/CSAD113.2-M89, Snell B-90, B-90S, B-95 and N-94, ASTM F1447-94, ANSI Z90.4-1984.

The implementation of this law largely reflects the unremitting efforts of Glenna Ayerst, Director of the National Bicycle Safety Foundation, but as Glenna says, 'the new law is just the start'. The law has been introduced to reduce the incidence of head injuries from cycling and a news release from British Columbia's Ministry of Transportation and Highways quotes studies which have shown that helmets reduce the risk of head injuries by 85% and brain injury by 88%. But how effective is the law really likely to be? Arguably, BC's mandatory bicycle helmet law alone will not result in such a dramatic reduction in head injuries.

Experience in other jurisdictions has shown that legislation is an effective way of rapidly increasing helmet wearing rates. For the law requiring their use to be effective, however, bicycle helmets must be fitted and worn properly. A casual view of the riding population suggests helmets are often incorrectly worn, off the forehead and loosely secured. Locally, finding a good fitting helmet is often difficult, especially for a child, and the retention straps are often difficult to adjust.

There is considerable real-world crash data which confirms the reduced risk and exposure to head injuries from wearing a helmet. However aside from helmet fit, there is a limit to the protective capabilities of a properly worn bicycle helmet certified to a recognised standard.

Modern bicycle helmets comprise two essential features:

- An energy absorbing liner which through its own destruction reduces the violent movement and distortion of the brain and skull.
- A retention system in the form of adjustable straps buckled together to secure and position the helmet on the wearer's head.

The design of current bicycle helmets largely reflects the minimum performance requirements of helmet standards. The energy absorbing capabilities of a helmet are tested in accordance with helmet standards by placing a test helmet on a rigid anthropometric headform and dropping it from a predetermined height in guided free fall on to a steel anvil. The area of the helmet that is impact tested in helmet standards

is confined to the zone above a prescribed test line. The energy absorbing helmet material may extend beyond the test area, however in reality the test line often represents the edge of the helmet as effective protection. Modern helmets cover a relatively small area of the head and field evidence confirms the need for helmets that afford better head coverage with energy absorbing material. A bicycle helmet can only protect the area of the head which it covers.

Impact tests in current bicycle helmet standards only assess the ability of the helmet to reduce linear or translational acceleration. In light of the established effectiveness of helmets in preventing injuries, it is reasonable to assume that helmets that reduce linear acceleration are also successful in protecting against rotationally induced head injuries. However, given rotational movement of the brain may result in severe injuries, it would be prudent to develop test methods to assess a helmet's ability to reduce rotational acceleration.

It is reasonable to expect bicycle helmets to provide good protection over a broad range of survivable impact levels. Many helmet standards test helmets only in conditions approximating severe impacts. To pass these impact tests, helmets are often fabricated with dense liners that arguably fail to provide optimum protection against the more common and less severe impacts. The inclusion of both low and high energy impacts in the Canadian cycle helmet standard (CAN/CSA-D113.2-M89) with more demanding pass criteria for the low energy impact is an attempt to promote good protective capabilities over a range of impact levels.

Laboratory tests and field experience suggest that the dynamic strength of bicycle helmet straps and buckles is adequate. The stability of the fitted helmet, however, depends largely on the proper adjustment of the retention system by the cyclist. There is no test to assess the ease with which the straps may be correctly adjusted. There is no guarantee that the rider will wear the helmet properly. In local cycling traffic, helmet fit is often poor and large parts of the cyclist's head are often exposed.

Finally, bicycle helmet standards are based on adult anthropometry and head protection criteria. It is unlikely that scaled down versions of adult bicycle helmets will provide the best protection to the growing child. A recently introduced amendment to the Canadian cycling helmet standard includes lower peak acceleration limits for helmets designed for

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children under 5 years, in an attempt to better protect the more compliant nature of the heads of very young children. There is also some concern regarding the fit and stability of children's helmets which have been tested on head-forms based on adult anthropometry. Growth of the skull (and changes to head shape) takes place for about seven years after birth. Head-forms based on child head shapes are important to promote helmet design of good fit and stability for infants and toddlers.

For all these concerns, it should be noted that

field studies show that bicycle helmets are most effective in reducing the likelihood of head injuries and helmets remain the single most effective protective system available to cyclists. But bicycle helmets can and should be improved to provide better protection to all cyclists. And one effective way of doing this is to upgrade the performance requirements of helmet standards and for mandatory helmet wearing legislation to reference only those standards which promote better helmet designs for the entire cycling population.

DISSENT

Bicycle helmets reduce head injuries and should be worn by all

Peter Vulcan, John Lane

Cycling is a pleasant, healthy pastime and a low cost means of transport. Apart from the drawback of being exposed to all kinds of weather, the main disadvantage of bicycling is that in a crash, cyclists often suffer injuries, the most severe of which is usually a head injury. Bicycle helmets have provided the means to prevent many of these head injuries and the challenge facing public health and transport officials around the world is to promote and ultimately, mandate their use.

Much progress has been made in the six years since bicycle helmet wearing became mandatory in the State of Victoria, and helmet wearing is now required in all Australian states and in many jurisdictions throughout the world. British Columbia is to be commended for having the courage to take this important step in protecting its cyclists. However, although global data are not readily available, there are probably several million cyclists throughout the world in countries with varying levels of motorization, who are not wearing a helmet. This means that several tens of thousands of cyclists sustain head injuries in crashes each year.

The quoted 85% reduction in risk of head injuries and 88% for brain injuries, should be regarded as upper limits for helmets. Somewhat lower, but still substantial reductions have been found in other studies. In Melbourne, McDermott *et al* found 39% reduction in head injuries in riders wearing helmets meeting the Australian standard.¹ When certain casualties in the data of Thompson *et al* were reassigned to match the classification used in Melbourne, the Seattle reduction was 61%.² In Cambridge, England, from a series in which about one quarter of cases involved a car, Maimaris *et al* obtained data from which an injury reduction

of 67% can be derived.³ There are several other studies which show reductions in the same range.

While there is a need to improve further the protective performance of helmets, it is clear that thousands of head injuries could be prevented world wide by increasing wearing rates of existing helmets now. For example, in Victoria in 1983 about 5% of children under 12 years riding to school were wearing a helmet, and for 12–17 year olds the figure was less than 2%. The wearing rate for adults commuting was 26%, although much less in recreational cycling. After seven years of promotion, together with a \$10 rebate scheme for purchase of approved helmets, these wearing rates had risen to 77%, 18%, and 46%, respectively. The introduction of the mandatory wearing law increased the under 12 wearing rate to 92% and more than doubled the other two rates. Using statewide insurance claims for cyclists killed or admitted to hospital involved in motor vehicle related crashes, we found that the percentage with a head injury dropped from 52% in 1981/82 to 35% in 1989/90 as helmet wearing increased. There was a further drop to 25% in the first year after the mandatory wearing law was introduced.⁴

The table shows the expected annual savings by helmet wearing in a community which has 1000 cyclist head injuries per annum (assuming other factors remain unchanged). It can be seen

Expected annual savings by helmet wearing

Helmet effectiveness	Helmet wearing rate				
	5°	10°	20°	40°	80°
40°	20	40	80	160	320
80°	40	80	160	320	640

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