In-depth Study on Pedestrian and Cyclist Crashes resulting in Transport to Emergency Hospital and Verification of Injury Prediction Algorithms for Vulnerable Road Users

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In 2023, two injury prediction algorithms for an Advanced Automatic Collision Notification (AACN) system were developed for the road safety benefit of pedestrians and cyclists. The algorithm development data consisted of all car-to-pedestrian and car-to-bicycle crashes that occurred throughout Japan from 2014-2019. The predicted injury values were derived from an ordinal logistic regression for minor injuries, serious injuries and fatalities. The injury prediction algorithm for pedestrians is referred to as Version 2023P and for cyclists as Version 2023C. In this study, we evaluated the injury prediction algorithms for vulnerable road users based on 110 pedestrians and 86 cyclists who were transported to Nippon Medical School, Chiba Hokuso Hospital, a trauma centre. In emergency medicine, the need for transport from crash location is determined based on the severity and urgency of the patient's injuries. We used five criteria, blood transfusion, emergency surgery, Trans-Arterial Embolization (TAE), Intensive Care Unit (ICU) admission and opinion of emergency physician, to assess whether a patient was eligible for referral to a trauma centre, using these as evaluation indicators for the injury prediction algorithms. Figure 1 shows the risk curve for pedestrian crashes, with the fatality and serious injury rates from the case studies plotted against it. In pedestrian crashes, the risk curve derived from an ordered logistic regression model which calculates injury rates for minor injuries, serious injuries and fatalities shows that the relative rates of minor and serious injuries are equivalent at 20 km/h but serious injury risk exceeds minor injury risk beyond this speed. Furthermore, the relative rates of serious injuries and fatalities are equivalent at 55 km/h but the fatality risk exceeds serious injury risk beyond this speed. Consequently, zones with a high rate of minor injuries were designated as Zone 1, those with a high rate of serious injuries as Zone 2, and those with a high fatality rate as Zone 3. The rates of serious injuries and fatalities were then plotted for each case, categorised by whether or not a trauma centre was utilised. Of the 69 patients, 62 were referred to a trauma centre and 7 were not. In Zone 1, 100% were under triaged, in Zone 2, 88.7% were correctly triaged and 11.3% were over triaged, and in Zone 3, 100% were correctly triaged. Figure 2 plots the fatality and serious injury rates for bicycle crashes against the risk curve, differentiated by whether a trauma centre was utilised. For bicycle crashes, the risk curve derived using ordinal logistic regression shows that, as with pedestrians, the rates of minor and serious injuries were equivalent at a speed of 20 km/h and serious injury risk exceeds minor injury risk beyond this speed. Furthermore, the rates of serious injury and fatality are equivalent at 73 km/h and the fatality risk exceeds serious injury risk beyond this speed. Of the 58 cyclists, 51 were assigned to a trauma centre and 7 were not. In Zone 1, as with pedestrians, there were no correct triage decisions and 100% were under triaged, in Zone 2, 87.0% were correctly triaged and 11.3% were over triaged, and in Zone 3, 100% were correctly triaged. In this case, even though Zone 1 was characterised by predominantly minor injuries among both pedestrians and cyclists, all cases did indeed require referral to a trauma centre. As a result, the under triage rate was 100%. Conversely, in Zone 2, the severe injury zone where prompt emergency rescue is critical, the algorithms achieved an accuracy rate of nearly 90% for both pedestrians and cyclists. Based on the high accuracy rate in Zone 2, it was concluded that applying the injury prediction algorithms for vulnerable road users to the AACN is effective. In emergency medical care, treatment priorities are determined based on the severity and urgency of the injured patient, known as triage. The priority level differs greatly between a patient with a serious injury requiring urgent treatment and a patient with no signs of life. The injury prediction algorithm can be used to generate risk curves for minor injuries, serious injuries and fatalities, based on the in-depth study, and it can be incorporated into the AACN system and applied to triage decisions at crash scenes.

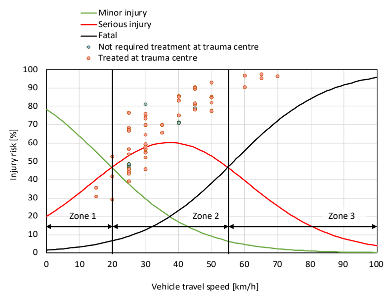

Fig.1 Plotting trauma centre applicability or not on pedestrian risk curves Version 2023P.

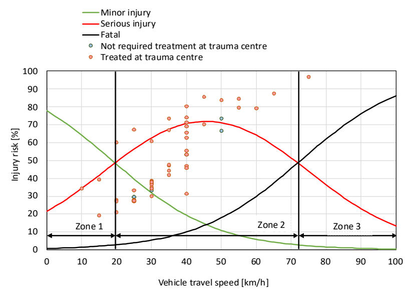

Fig.2 Plotting trauma centre applicability or not on cyclist risk curves Version 2023C.

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