Risk of Head Injury and HIC scores

The attached indicates the relative risk of head injury at different HIC scores. Generally the score of 1000 is the point at which the probability of no injury is zero and the probability of a fatal injury starts to rise from zero. In relation to scores between 0 and 1000 the risk and the severity of the injury increases. The types of head injuries that are tracked can be characterized as;
Minor – where there is skull trauma without loss of consciousness; fracture of nose and teeth; superficial face injuries
Moderate – skull trauma with or without dislocated skull fracture and brief loss of consciousness. Fracture of facial bones without dislocation; deep wound(s)
Critical – Cerebral contusion, loss of consciousness for more than 12 hours with intracranial hemorrhaging and other neurological signs; recovery uncertain.
From the graph we see that the risk of a moderate head injury is 20% at approximately 350 HIC, a 40% risk at approximately 500 HIC and approximately 90% at 1000 HIC.
The risk of a critical head injury starts at approximately 750 HIC and is approximately 5% at 1000 HIC.

Have this data is only valuable if it is used in the development of strategies to reduce the severity of an anticipated in jury or develop methods of observation and treatment when an injury occurs. Reality should dictate that both will have to be applied.

An owner/operator of a playground should consider that specification of a lower HIC score than 1000 will reduce the risk and severity of the injury. In addition where an injury does occur on a surface where the HIC exceeds 350, there should be a program in place that takes the injury child to hospital for observation for head trauma. At this stage the assessment of medical professionals will take over.

X1. INJURY RISK CURVES

Most of what is known about the relationship between impact magnitude and head injury risk comes from experiments using cadavers and human volunteers subject to high accelerations and impacts under laboratory conditions. The data from these experiments form the basis of automotive and aircraft impact protection standards. There has been no research directly relating the magnitude of an impact from a playground fall to the severity of the injuries sustained. We therefore rely on data from automotive industry experiments to provide insights into injury risk.
Figure X2.1 shows the probability of different degrees of injury occurring as a result of impacts with a given HIC score. These "Expanded Prasad / Mertz Curves" are based on data from cadaver experiments in which the relationship between HIC scores, skull fracture and brain damage were observed [1, 2]. The two solid curves in this figure show the probabilities of no injury and of fatal head injury. Broken lines show the probability of minor, moderate and critical head injuries, defined as follows:

Minor head injury -- a skull trauma without loss of consciousness; fracture of nose or teeth; superficial face injuries.
Moderate head injury – Skull trauma with or without dislocated skull fracture and brief loss of consciousness. Fracture of facial bones without dislocation; deep wound(s).
Critical head injury – Cerebral contusion, loss of consciousness for more than 12 hours with intracranial hemorrhaging and other neurological signs; recovery uncertain.

As an example of how Figure X.2.1 is interpreted; if a person experiences a head impact equivalent to a HIC score of 500, there is a 79% chance that they will suffer a minor injury. At 38%, the risk of a moderate injury at this HIC level is also significant. The risk of this impact producing a severe or fatal head injury is very low, however. It is also notable that the chance of experiencing a 500 HIC impact without suffering an injury of any kind is only 21%.

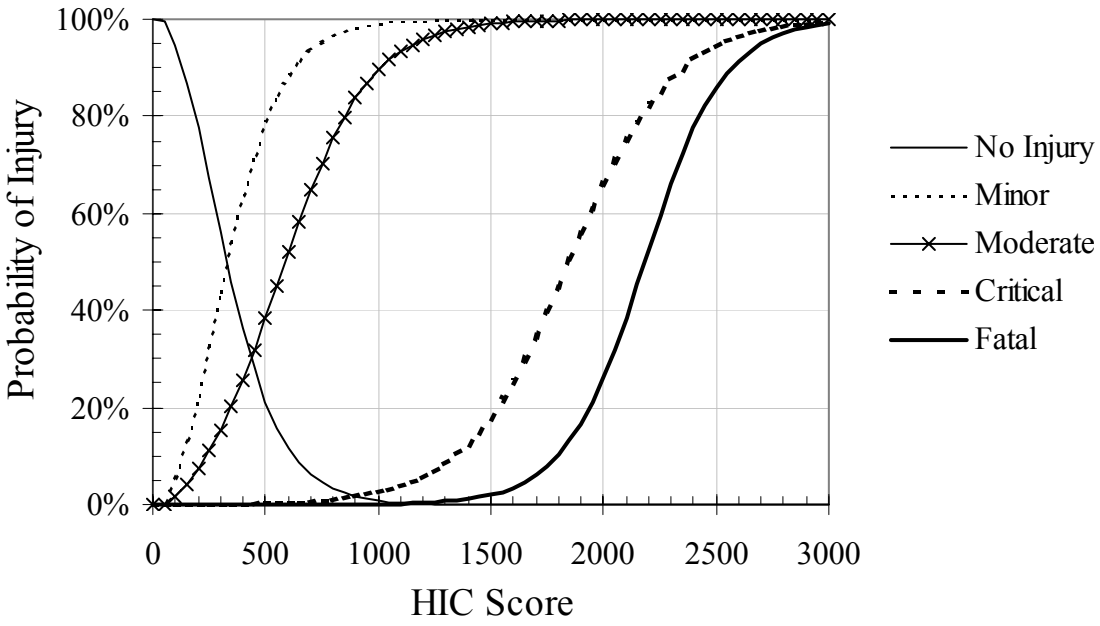

Figure X2.1: Probability of Specific Head Injury Level for a Given HIC Score.

5 NHTSA "Final Economic Assessment, FMVSS No. 201, Upper Interior Head Protection", June 1995.

6 Prasad, P. and Mertz, H.J. The Position of the United States Delegation to the ISO Working Group on the Use of HIC in the Automotive Environment. SAE # 851246 Society of Automotive Engineers.