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General Risk of Significant Injury Implementation Guidance Document

Risk of Significant Injury Technical Working Group

16 June 2014

DoD Instruction 3200.19 describes the general procedure for assessing the reversibility of non-lethal weapons by determining the risk of significant injury (RSI).¹ Further, it establishes the health care capability (HCC) indices² as a standard in which to determine whether injuries are or are-not “significant”. HCC indices are contained in the set $\{0, 1, 2\}$ where HCC0 is associated with limited first Responder Capability, HCC1 = First Responder Capability (emergency care), HCC2 = Forward Resuscitative and Theater Hospitalization Capabilities. Injuries are significant if they are permanent³, cause death, or require medical care greater than or equal to the care described in HCC index 1.⁴ RSI is a measure of the potential or probability of a non-lethal weapon to cause a significant injury.

Mathematically, RSI can be represented as the probability of causing a permanent injury or death or an injury requiring HCC index 1 or 2;

$$\text{Eq. 1} \quad RSI = P_{SI} = P_{(PI \cup \text{death} \cup HCC \geq 1)}.$$

Since death is permanent it will always be a subset of permanent injury and will not add to the overall RSI calculation. Figure 1 shows a notional Venn diagram of the three “events” that must be accounted for in an RSI calculation. The “death event” is always completely contained within the “permanent injury event”. Therefore, equation 1 can be simplified to

$$\text{Eq. 2} \quad P_{SI} = P_{(PI \cup HCC \geq 1)}.$$

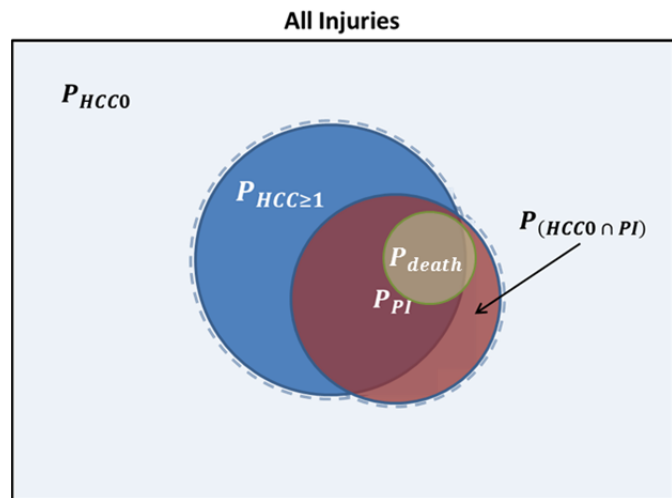


Figure 1: Notional Venn diagram of death, PI, and HCC injury "events".

Generally, the union of these two events can be expanded as the sum of the individual probabilities minus the intersection of P_{PI} and $P_{HCC \geq 1}$:

$$\text{Eq. 3} \quad P_{SI} = P_{PI} + P_{HCC \geq 1} - P_{(PI \cap HCC \geq 1)}.$$

PI and $HCC \geq 1$ are not independent events as they are both correlated to the actual severity of the injury. For example, the probability of having a permanent injury if the HCC is 0, is certainly different than the

¹ DoD Instruction 3200.19, Non-Lethal Weapons (NLW) Human Effects Characterization

² Ibid. (Enclosure 3)

³ DoDI 3200.19 defines permanent injury as “Physical damage to a person that permanently impairs physiological function and restricts the employment or other activities of that person for the rest of his or her life.”

⁴ This statement is consistent with the definition of RSI in the glossary of DoDI 3200.19. The figure on page 9 of the DoDI does not mention permanent injuries; however the definition makes it clear that the overall intent is to include permanent injuries and death.

probability of permanent injury given $HCC \geq 1$, or $P_{(PI|HCC0)} \neq P_{(PI|HCC \geq 1)}$. Therefore, P_{PI} and $P_{HCC \geq 1}$ need to be treated as conditional probabilities.

By definition

$$\text{Eq. 4} \quad P_{(PI \cap HCC \geq 1)} = P_{PI} \cdot P_{(HCC \geq 1|PI)}$$

and redistributing yields

$$\text{Eq.5} \quad P_{SI} = P_{HCC \geq 1} + P_{PI}(1 - P_{(HCC \geq 1|PI)}).$$

Substituting⁵

$$\text{Eq.6} \quad 1 - P_{(HCC \geq 1|PI)} = P_{(HCC0|PI)}$$

into the P_{SI} equation yields the general RSI equation

$$\begin{aligned} \text{Eq.7} \quad RSI = P_{SI} &= P_{HCC \geq 1} + P_{PI} \cdot P_{(HCC0|PI)}. \\ &\text{or} \\ RSI = P_{SI} &= P_{HCC \geq 1} + P_{(HCC0 \cap PI)}. \end{aligned}$$

It is likely that for most injury types the probability that the injury is permanent and requires HCC0 level care is zero.⁶ In that case Eq. 7 is reduced to

$$\text{Eq. 8} \quad P_{SI} = P_{HCC \geq 1}.$$

In some cases for practical reasons, P_{SI} cannot be calculated directly but instead models or data provide the probability of injury occurrence (significant or not). In those cases the RSI equation (Eq. 7) has to be modified to include the probability of injury occurrence, P_{IO} , and P_{SI} becomes conditional given an injury occurred,

$$\begin{aligned} \text{Eq. 9} \quad RSI &= P_{IO} \cdot P_{(SI|IO)} \\ &= P_{IO}(P_{(HCC \geq 1|IO)} + P_{(HCC0 \cap PI|IO)}). \end{aligned}$$

For many non-lethal stimuli there is potential to cause more than one type of injury. In those cases, total RSI is calculated by aggregating individual injury probabilities (using either Eq. 7 or Eq. 9) which themselves may or may not have conditional relationships to each other. However, the conditional injury aggregation is outside the scope of this paper and will be covered in future RSI implementation guidance.

⁵ $HCC \geq 1$ and HCC0 are mutually exclusive and collectively exhaustive.

⁶ A potential example where this might not be true is for permanent threshold shifts (PTS) for hearing. By definition it is a permanent injury but likely does not require HCC 1 or 2 to treat.