Injury Risk Estimates: A Method for Determining Equivalent Increase in Risk of Death for Older and Younger Occupants

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I. INTRODUCTION

Not only may older occupants be more likely to sustain injuries in a car crash relative to younger occupants, but they can be more likely to die from their injuries. Rib fractures are among the injuries that are both more frequent in older occupants [1,2] and more likely to lead to death with increased age [3]. A method is presented for determining the older occupant injury probability level that results in probability of death equal to that for a younger occupant at a 50% probability of injury, using an analysis of rib fracture to illustrate the method.

II. METHODS

Using motor vehicle crash cases from the National Trauma Data Bank (NTDB), Kent et al. [3] identified pairs of fracture (AIS 3+)/no fracture (AIS <3) cases within two age groups (18-45 and 65+) as equally likely to have AIS 3+ rib fractures based on their other injuries and demographics, using methods detailed in their paper. Kent's dataset of patient pairs, along with the number of fatal cases in each group, were used in the current study to determine the rate ratio (RR) for death with, versus without, rib fracture (Equation 1) for each age group, where D is death and RF is rib fracture (rib fracture=AIS 3+). Equation 2 is the total probability of death at a given probability of rib fracture. Rearranging and substituting RR, Equation 3 is the relative probability of death at a given rib fracture probability, defined as a ratio of the probability of death at the given rib fracture probability to the probability of death with no rib fracture (RF=AIS 3+, $NoRF$=AIS <3). In the current study, this relative probability of death for occupants age 18-45 resulting from a probability of rib fracture ($P(RF)$) of 50% was estimated using Equation 3. Next, this relative probability of death and the RR calculated for age 65+ were used in Equation 3 to find the $P(RF)$ for the 65+ age group that would yield a relative probability of death for the older group equal to the relative probability of death calculated for the younger group at 50% $P(RF)$.

$$RR = \frac{P(D|RF)}{P(D|NoRF)} \quad (1)$$

$$\begin{aligned} Total\,P(D) &= P(D|RF) \times P(RF) + P(D|NoRF) \times P(NoRF) \\ &= (RR \times P(RF) + (1 - P(RF))) \times P(D|NoRF) \end{aligned} \quad (2)$$

$$\frac{Total\,P(D)}{P(D|NoRF)} = RR \times P(RF) - (1 - P(RF)) \quad (3)$$

III. INITIAL FINDINGS

A younger occupant's probability of death is 1.36 times greater with rib fracture than without and an older occupant's probability of death is 2.14 times greater with rib fracture than without (Table 1). At a 50% probability of AIS 3+ rib fracture, a younger occupant's relative probability of death is 18% higher than with no rib fracture. In contrast, for an older occupant with a 50% probability of AIS 3+ rib fracture, the relative probability of death is 57% higher than with no rib fracture. For relative probability of death due to rib fractures to equal that of a younger occupant with 50% probability of AIS 3+ rib fracture (i.e. 18%), an older occupant's probability of AIS 3+ rib fracture would need to be limited to 16%.

Table 1. Results

		Age 18-45	Age 65+
$P(D\|RF)$ from [1]		1002/9243	1135/4366
$P(D\|NoRF)$ from [1]		737/9243	531/4366
RR		1.36	2.14
$\frac{Total\,P(D)}{P(D\|NoRF)} =$	At $P(RF)$=50%	1.18	1.57
	At $P(RF)$=16%	--	1.18

IV. DISCUSSION

A method was presented to determine the older occupant rib fracture probability that results in probability of death equal to that for a younger occupant at a 50% probability of rib fracture. This method can be used to estimate equivalent age-adjusted risk for any injury, accounting for increased likelihood of death with age.

V. REFERENCES

[1] Ridella et al., IRCOBI, 2012. [2] Welsh et al., Transp Research Part F, 9(5), 2006. [3] Kent et al., AAAM, 2008.

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