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人体損傷の重症度クライテリアとその許容レベル

Criteria of Human Injury Severity and Its Acceptable Levels

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Abstract: We have been studying and searching the comprehensive risk adjustors for human injuries in the case of falling, descent and glitch of intelligent machines, utilizing dummies (Hyb-III) in JARI.　Finally we adopted the clinical indicator TRISS, which is composed of three types of risk adjustor - anatomic, physiological, and comorbid.　And they can be easily combined so that information from all three sources is used to predict outcome.　Notice that we can reach the level acceptable, TRISS > 0.980 if NISS <4 and RTS > 7.8404.　Because this score of TRISS is almost as large as maxTRIS = 0.9843 in the case of three largest AIS = (0,0,0).　Thus, our purpose of research should be focused on the decision of each maxAIS score being less than or equal 1.　The level acceptable will be both maxAIS =1 or maxAIS = 0, and so we shall perform experiments to decide these maxAIS values utilizing physical parameters.

1. Introduction

Japan Automobile Research Institute (JARI).　And we have been attempting to estimate the physical quantities as impact, pressure, acceleration, duration of the impact and an effect of protectors when we had fallings and a descents from various situations, for examples, from high place, bicycle, invalid chair, mobile robots, and so on.　According to our experiments we found that our injuries and trauma were almost divided into two major factors, which were physical factor and bio-medical factors [1].　The physical factors are mainly governed by our external and physical situations as our body height, weight, height of standing positions and so on.　And we found that those physical factors mainly addressed to anatomical injuries and anatomic scores.　The most advised trauma-specific coding lexicon is the Abbreviated Injury Scale (AIS) which was first conceived as system to define the type and severity of injuries. Thus, the physical factors have relations with AIS, and we can estimate the anatomical injury severity using only those external physical factors, and we made up calculating programs depending on only those physical factors in order to estimating AIS, HIC (head injury criteria) and mortality rates [1-3].　On the other hand, it is difficult and complicated to calculate the bio-medical factors, because those are the individual physiologic status and our comobidities, i.e., liver cirrhosis, COPD, heart illness and so on.　It is considered that the three types of risk adjustment, anatomic, physiological and comorbid, can be easily combined so that information from all three sources is used to predict outcomes.

In this paper, we would like to mention concepts of each criteria and risks, which we apply for our interesting problems of risk managements.　Using those combined risk adjustment, we intend to search a level acceptable and permutable for our human injuries.　And one of the most important and difficult tasks is to translate the physical data obtained through our dummy experiments into the clinical status or biomedical severities.

2. Trauma Severity

From medical standpoints, trauma severity is defined simply as the quantification of the risk of an outcome following trauma. It is generally thought that an amalgam combines elements of clinical acumen and statistical theory to provide a single metric used to describe aspects of patient condition after some traumatic incident.　Generally speaking, the outcome of trauma severity is used for the prediction of survival, ICU length of stay, and performance of procedure.　However, the severity scores are not typically used for clinical decision-making in the acute setting.　And those scores are used for field triage, referrals, outcomes prediction and quality improvements. In general, we have three types of risk adjustments (scores), which are a Anatomic injury Score, Physiologic Derangement Scores, and Comordity Scores

Anatomic injury score are the most developed types of risk adjustment following trauma, and the majority of scoring algorithms are designed to predict mortality.

At first, it is necessary to categorize both injuries and clinical data before making severity scores, and we enable to transcribe clinical records of traumatic incidents into codes that are understood individual injuries.　Among a lot of injury cords, the Abbreviated Injury Scale (AIS) is especially said the most advanced trauma-specific coding lexicon which was first constructed as system to define the type and severity of injuries arising from automobile accidents [4].　The AIS codes, which are classified by injury of region, type of anatomic structure, specific structure and level, consisted of a six-digit number. We are ordinarily a lot of interest of AIS severity, which are following the decimal having the range from 1 to 6. The decimal from 1 to 6 describes numerically the severity of the injury. The AIS severity of 1 is a superficial injury while a 6 is thought to be unsurvivable (Tab.1). The AIS severity (from 1 to 6) is the simplest form of a score. The maximum AIS (maxAIS), which is the largest AIS value among a set of injuries within a damaged human body. In clinical meaning, the maxAIS is highly associated with mortality but ignores information provided from other injuries.

TABLE 1. AIS Components, Definition of 1-6

AIS SEVERITY	ORDINAL DESCRIPTION	MOTARITY (range %)
1	Minor injury	0.0
2	Moderate injury	0.1 – 0.4
3	Serious injury	0.8 – 2.1
4	Sever injury	7.9 – 10.6
5	Critical injury	53.1 – 58.4
6	Virtually unsurvival injury	-

In 1974, Baker et al. proposed the method of a multi-injury score, what is called, Injury Severity Score (ISS)[5]. The ISS divides the body into six regions —head or neck, face, abdominal, chest, extremities, and external. The largest AIS value in each of the three most severely injured regions is subset, and then we should take the sum of the squares of these AIS values in order to make up ISS. The ISS enable to predict well mortality of injured human, however, ISS has a lot of defects. For example, the ISS only considered one injury in each of the body regions and thus ignores important injury information.

Osler et al. formulated the New Injury Severity Score (NISS) to improve some of the ISS defects. Especially, they attempted to introduce effects of multiple occurrences of serious injuries within a body region[6]. The NISS is the sum of the square of the three most sever AIS values, regardless of body region. Those improvements bring us a slight prediction advantage. Thus, we should adopt the NISS severity score instead of ISS, and NISS enable to calculate with using the sum of the square of the three most sever AIS values, and NISS is given as the following relation (Eq.(1)):

Using Tab. 1 and Tab. 2, the three largest AIS values—1^{st} maxAIS, 2^{nd}maxAIS, 3^{rd} maxAIS－ are chosen, and then NISS score can be determined by the following definition:

$$NISS = (1st \max AIS)^2 + (2nd \max AIS)^2 + (3rd \max AIS)^2 \quad (1)$$

We should notice, the mortality of table1 does not mean the effects of multiple occurrences of serious injuries within a body region, multi-injury score, but it is related to the single injury score. An estimation of our acceptable AIS level, given injuries by falling and descent and wound from robots, enables to practice with those tables (Tab1, Tab2). It is desirable that the AIS level is taken less than AIS 1 because of no mortality (0%) within a single injury (Tab.1). The Eq.(1) suggests the level acceptable of multi-injury of human body, and then maximum NISS (maxNISS) is decided by the three maxAIS scores. The Eq.1 gives a relation,

$$NISS = (1)^2 + (1)^2 + (1)^2 \le 3 \quad (2)$$

and maxNISS = 3.

Instead of using single AIS score, we can consider in NISS describing multi-injury of our body (Fig1, [7]). The Fig.1 shows a relation between NISS and survival rate P(s). The injuries are divided into two trauma. One is Bunt type, another is Penetrating type. The point A means100% level survival position which NISS score has vales less than 4 in spite of our age (whether more than 55 years old or not). Thus, we can decide the acceptable level by using NISS. The Fig.1 teaches us a following relation, survival rate P(s):

$$P(NISS) \Rightarrow P(s < 4) \cong 1.0). \quad (2)$$

So, We obtain maxNISS less or equal 3. Considering both relations Eq.(1) and Eq.(2), we notice they are same values. So max NISS of the level acceptable has following combinations of maxAIS. The possible max NISS, P-maxNISS (maxNISS socre) = (1^{st} max AIS, 2^{nd} max AIS, 3^{rd} maxAIS):

P-maxNISS (3) = (1,1,1), (2) = (1,1,0), (1) = (1,0,0), (0) = (0,0,0) < (4) = (2,0,0) (4)

The above combinations include all of cases of possible level acceptable within survival rate 1.0.

（to be continue in Life 2012 conference）

Conclusion

We have been studying and searching the comprehensive risk adjustors for human injuries in the case of falling, descent and glitch of intelligent machines, utilizing dummies (HybIII) in JARI. Finally we adopted the clinical indicator TRISS, which is composed of three types of risk adjustor - anatomic, physiological, and comorbid. And they can be easily combined so that information from all three sources is used to predict outcome. Notice that we can reach the level acceptable, TRISS > 0.980 if NISS <4 and RTS > 7.8404. Because this score of TRISS (0.980←(1,1,1)) is almost as large as maxTRIS = 0.9843 in the case of three largest AIS = (0,0,0). Thus, our purpose of research should be focused on the decision of each maxAIS score being less than or equal 1. The level acceptable will be both maxAIS =1 or maxAIS = 0, and so we shall perform experiments to decide these maxAIS values utilizing physical parameters, pressure, impact, force and so on.

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[1] Matsuura H, Nakano M, Tamagawa M, Nemoto T, Kubota R, Kubota M., Mechanical Injury of Human Bodies, ICIC Express Letters, An International Jurnal of Research and Surveys, *ICIC International*, vol. 6, No.6, pp1629-1634, 2011

[2] Kenneth D. Boffard(ed.), *Manual of Definitive Surgical Trauma Care*, Iatsic (International Association for Trauma Surgery and Intensive Care), HODDER ARNOLD, London UK, 2010.

[3] Partrick DK, J. Wayne M, and Turner MO (David F, Kenneth LM, and Ernest M., ed.,), Trauma, McGrawHill, U.S.A. 2008.