

## **The Israeli "Nature of Injury by Site" Diagnostic Matrix**

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The Israeli "Nature of Injury by Site" diagnostic matrix was developed in 1996 , in the Injury Prevention and Control Section of the Health Services Research Unit, Ministry of Health. Researchers from this department and clinical personnel from the Trauma Branch of the Israeli Defense Forces Medical Corps were instrumental in its' design.

The environment and circumstances in which this took place are highly relevant. Development occurred within the National Trauma Registry, a multi-center collaboration, aimed at assisting in the evaluation and improvement of quality of care at the individual hospital level. The registry was endorsed by the National Trauma Council which oversees trauma system development.

The criteria for registration in the Israeli Trauma Registry are: all casualty admissions to hospital, emergency department deaths, and transfers to a higher level trauma center. In other words, not the standard trauma center exclusion criteria of those survivors released before 48 or 72 hours.

At the national level, management and policy-oriented analyses of injury data were required. There was interest in obtaining information on the nature and extent of severe injury, as well as on long term morbidity, residual disability, resource allocation and cost.

The matrix was developed in order to respond to the need for a supplementary tool which would standardize queries into the data collected; questions such as the number and characteristics of patients with fractures of the acetabulum, and the patterns of injury associated with pedestrian accidents. There were queries relating to service planning, including requests for estimates of the immediate and long term outcome of eye trauma, manpower needs for orthopedic trauma, and effectiveness of triage and transfer for neurosurgical cases. Thus, the background in which our matrix was developed was a very particular one, and influenced our approach.

The purpose of the matrix was to enable easy and uniform access to patient records, grouped by clinically meaningful diagnosis, and to enable counts of the injured persons and not only of numbers of injuries. We wanted to describe case load in a manageable number of diagnostic categories. Additional aims were to enable case-mix adjustment and to identify injury profiles.

### **Matrix Characteristics**

The matrix is ICD-9 CM based. There are 120 diagnostic cell groups, as compared with 74 diagnostic groups in the U.S. matrix, developed by MacKenzie, Champion and Cox. In response to the needs of the environment in which the matrix was developed, the Israeli matrix has 22 injury sites while the U.S. matrix has 9. The 12 nature of injury categories are equivalent in both classifications. The comparison being made between the two matrices is for

traumatic injury only, so that foreign bodies and poisoning are not included.

There is relatively easy access to detailed diagnostic cells; the matrix is flexible and is easily collapsed into larger categories and easily broken down into greater detail. Patients with burns or fractures can be identified using a complete column count. Hip fractures are a one-cell subgroup.

The Israeli matrix, designed for five ICD-9 positions (XXX.XX) for trauma registries and based on a clinical rationale, allows identification of severe injuries and surgical specialties, and in the future will, hopefully, identify patterns of injury related to disability. The U.S. matrix has been developed for a wider range of databases and is appropriate for 3 and 4 digit hospital discharge data as well.

There are, of course, great similarities in the distribution of codes in the Israeli and U.S. matrices, although the Israeli matrix is more detailed as demonstrated in the following comparison: Traumatic brain and mild brain injury were defined separately, in line with the CDC definition of central nervous system injuries, and other head injuries were categorized separately. These can all be combined and collapsed into one group. Injuries to the eye have been separated from other facial injuries. There has been a recent request to identify maxillo-facial injuries separately.

Differentiation between cervical, thoracic, and lumbo-sacral injuries to the spinal cord is an integral distinction in the Israeli matrix, while the U.S. version is not subdivided by regions.

The abdomen and pelvis are defined separately in the Israeli matrix. The pelvic ring (without the pelvic vertebrae), pelvic contents and genital organs are a separate site group; the U.S. matrix includes the pelvic ring in with the lower extremities and abdominal and pelvic injuries are jointly defined. Those are, basically, the differences between the matrices.

However, as many of the Israeli subdivisions are based on the fourth and fifth digit of the ICD code, some of the regional distinctions may be lost in redefining the diagnostic cell classification to three and four digit codes. This task remains to be done, and considerable detail may be lost in doing so.

### **Implementation of the Matrix**

Summary and analysis of injury diagnostic data using the matrix is important. The U.S. matrix has been applied to NCHS data, using the primary diagnoses in the hospital discharge data file, i.e., one diagnosis on the hospital discharge record was selected. This may be in the first diagnosis field recorded, or the most severe according to some classification system. However, it is important to access ALL diagnoses on the record. This is the way to define injury cases and the way that we think it is appropriate to summarize injury data - regardless of whether the database is a trauma registry or a hospital discharge record. The matrix would be used to summarize all recorded injury diagnoses.

There is a problem in dealing with the first recorded diagnosis only. All cases with a specific injury are never included when using only the principal diagnosis. Any specific injury

diagnosis may appear in any position in the discharge data record, so that you never get a complete picture of any given injury. In addition, there is a lack of adherence to guidelines existing for definition of first recorded or principal diagnosis. In Israel, there is no clear guideline for definition of the principal diagnosis and, in practice, considerable variation exists. There is also the issue of assigning the principal diagnosis. It is difficult to determine in cases of an injured person who has both a brain laceration and a ruptured aorta. What is the major injury? This is a difficult question to answer.

There are a number of advantages to using multiple diagnoses. They reflect the actual injury pattern in the individual. Multiple injuries are associated with greater severity and those who use the Injury Severity Score (ISS) understand that multiple injury is at the core of the whole injury picture. Utilization of all recorded injury diagnoses promotes the identification of common profiles of multiple injuries, for example: a head-on collision between a motor vehicle and a pedestrian often results in a multiple injury pattern of injury to the head, abdomen and lower extremities.

The matrix is a tool that was developed to be used in the analysis of data and its' presentation. There are two major ways of analyzing injury data. One would be by identifying and selecting for separate analysis all persons with a particular kind of injury, such as eye trauma. Specification of the appropriate matrix cells is important so that persons with any eye diagnoses are included, regardless of other injuries. Another method of analysis, perhaps more important, is through the development of mutually exclusive categories of grouped diagnoses, so that persons are counted only once, i.e., when dealing with the distribution of injury patterns in a population.

One of our first attempts at dealing with injury diagnostic groups may be seen in Table 1. Data is based on information from the eight hospitals participating in the Israeli trauma registry for 1997 and 1998. 11.6% of the 28,108 injured persons had a traumatic brain injury as defined in the matrix i.e., any one of 32 ICD 9 CM codes. These represent about half of the deaths in the registered population. Forty percent of the population had a fracture of the upper or lower extremities: 14.3% upper, and 27.5% lower. Some casualties had fractures of both the upper and the lower extremities. It is possible to explode the categories and present subgroups on a more detailed level (Table 2). For example, among those casualties with a fracture of the face, neck, or trunk, 3.3% had a fracture of the vertebral column. 1.2% of the casualties had a spinal cord injury, and, of these, 0.3% had an injury of the C-spine. The relative proportions between the different diagnostic groups are informative.

Table 1. Persons by Diagnostic Group Trauma Registry 1997-1998

DIAGNOSTIC CATEGORY	Persons with		All	
	Single Injury	Multiple Injury	No	%
Total	20375	7733	28108	100.0
Traumatic Brain Injury (head3)	1465	1795	3260	11.6
Mild brain injury (head2)	2981	2514	5495	19.5
Fracture of Face, Neck & Trunk <sup>1</sup>	1299	2816	4115	14.6
Spinal Cord Injury	135	198	333	1.2
Fracture of Extremities All	8171	3091	11262	40.1
Dislocation	165	345	510	1.8
Crush	138	165	303	1.1
Internal Injuries <sup>1,2</sup>	359	1562	1916	6.8
Sprain & Strains All	305	529	834	3.0
Superficial Injury All	574	853	1427	5.1
Contusion with Intact Skin Surface All	1381	2229	3610	12.8
Open Wound All <sup>2</sup>	1941	2651	4592	16.3
Burns	1252	71	1323	4.7
Blood Vessels <sup>2</sup>	78	315	393	1.4
Nerves <sup>1</sup>	58	189	247	0.9
Fractures unspecified	3	17	20	0.1
Unspecified Injury	66	97	162	0.6

<sup>1</sup>not including Spinal Cord Injury Rev.

<sup>2</sup>not including Traumatic Brain Injury

Table 2. Distribution of Diagnoses in Injured Population Israel Trauma Registry: 1997-1998

	Number	Percent
TOTAL IN REGISTRY	28108	100.0
BURNS	1323	4.7
SUPERFICIAL, CONTUSION, SPRAINS	2355	8.4
MODERATE	19827	70.5
Extremities <sup>1</sup>	10691	38.0
Head/Face	5211	18.5
Thorax/Neck <sup>2</sup>	710	2.5
Abdomen/Pelvis	675	2.4
Unspecified	25	0.1
Multiple Moderate	2515	8.9
Head and Thorax	306	1.1
Head OR Thorax OR Abdomen AND Extremities	1528	5.4
ThoracoAbdomenal	95	0.3
Head, ThoracoAbdomenal w/wo Extremities	73	0.3
Other Multiple Injuries	513	1.8
MAJOR	4603	16.4
Head/Face	2166	7.7
Thorax/Neck <sup>2</sup>	938	3.3
Abdomen/Pelvis	468	1.7
Multiple Major	1031	3.7
Head and Thorax	315	1.1
Head OR Thorax OR Abdomen AND Extremities	289	1.0
ThoracoAbdomenal	176	0.6
Head, ThoracoAbdomenal w/wo Extremities	79	0.3
Other Multiple Injuries	172	0.6

<sup>1</sup>Including AIS \$ 3 if no other body region was injured.

<sup>2</sup>Including Back & Trunk body regions.

Identification of persons with multiple injury and the nature of their injury pattern, is more complex. Figure 1 indicates the proportions of persons with injuries in selected diagnostic categories. Within each category, the proportion of individuals having only that injury, and those having additional injuries as well, can be seen. The latter tend to be the more severely injured, and to require multiple surgical specialties on arrival in trauma units. As seen in Table 1, fractures of the extremities were the largest group.

People with major central nervous system (CNS) injuries (here including all traumatic brain and spinal cord injuries) tend to have additional injuries as well, while casualties with minor brain injuries have fewer multiple injuries. Burns tend to occur at multiple sites. However, persons with burns tend not to have other anatomic disruptions.

There are a number of approaches to the development of mutually exclusive diagnostic groups, so that the distribution of casualties with multiple injuries can be analyzed. Profiles may be developed of combinations of diagnostic groups, priority coding may be applied, etc. One possibility, feasible if working with a trauma registry or other platform in which diagnoses are mapped into the Abbreviated Injury Score (AIS), is to use this severity score to assist in determination of major or minor injuries (Table 3). Burns were dealt with separately as they tend to be defined by depth and extent of injury, and tend not to have other types of injury. Almost all of the superficial injuries, contusions or sprains and strains tended to be mild (AIS 1 or 2) and, if no additional types of injuries were present, were also put in a separate group.

Table 3. Persons by Diagnostic Group Trauma Registry 1997-1998

DIAGNOSTIC CATEGORY & SUB-GROUP	Persons with		All	
	Single Injury	Multiple Injury	No	%
Total	20375	7733	28108	100.0
Traumatic Brain Injury (head 3)	1465	1795	3260	11.6
Mild brain injury (head 2)	2981	2514	5495	19.5
Skull Fracture	520	708	1228	4.4
Concussion	2404	1979	4383	15.6
Fracture of Face, Neck & Trunk	1299	2816	4115	14.6
Face and Trachea, Larynx (Face 1, Neck 1)	389	1138	1527	5.4
Trunk All (Neck 2, Thorax 2, Abd 2, Pelvis 1, 2, Trunk)	838	1801	2639	9.4
Column all (Neck 2, Thorax 2, Abd 2, Pelvis 2)	357	576	933	3.3
Spinal Cord Injury	135	198	333	1.2
Cervical (Neck 3)	23	49	72	0.3
Thoracic (Thorax 3)	80	98	178	0.6
Lumbo Sacral (Abd 3, Pelvis 3)	32	58	90	0.3
Fracture of Extremities All	8171	3091	11262	40.1
Upper	2092	1988	4030	14.3
Lower	5912	1833	7745	27.5
Hip fracture	3295	521	3816	13.6

Major injuries had at least an AIS score of 3 or more. This kind of approach was reached after discussions with trauma surgeons, and asking them how they would describe and summarize cases with 7-9 recorded injuries. They tended to describe casualties as having a major thoraco-abdominal injury or a major brain injury, etc. Using this as an analytic approach, persons having at least one injury of AIS 3 or more were identified. After evaluation of the distribution of injuries with AIS scores of 3 or more, the 22 sites in our matrix were collapsed into 4 body regions: head (including brain), thorax, abdomen, and extremities. Multiple major injuries, or multiple trauma means that there are major injuries (AIS 3 or more) in more than one anatomic region. **[Using this definition, 3.6% of the trauma registry population had major multiple injuries. An additional 16.4% had at least one major injury in the head/brain region, the thorax or abdomen].**

What is the next stage? First of all, the matrix and some of the diagnostic combinations used will be presented for expert review and comment. The matrix must be adjusted so that it is appropriate for hospital discharge data, that is, for 3 and 4 digit ICD codes instead of the 5 digit codes on which the work to date has been done. A lot of the specificity in detail will probably be lost and that will redefine the injury files. The iterative approach to both descriptive and analytic tasks will enable evaluation of both the relevance and the effectiveness of the "nature of injury by site" diagnostic matrix. We hope that it will improve the quality of diagnostic recording and assist in development of guidelines for the promotion of international harmonization of injury data analysis.

	Fracture		Dislocation	Sprain/Strain	Crush	Internal		Blood Vessels	Nerves	Open Wound	Contusion	Superficial	Burns	Unspecified
Head 1 (no TBI)	/		/	/	/	/		/	950.1-3 950.9 951	873.0 873.1 873.8 873.9	/	/	941.x0 941.x6 941.x9	/
Head 2 (mild TBI)	800, 801, 803, 804 (.0, .5)		/	/	/	CONC 850		/	/	/	/	/	/	/
Head 3 (TBI)	800, 801, 803, 804 (.2-.4, .6-.9)		/	/	/	851 854.0-.1		852-853	/	/	/	/	/	/
Neck 1	807.5-.6		/	848.2	925.2	/		9090 Incl. head and neck	957.0 Incl. head and neck 953.0 954.0	974	/	/	941.x8	959.0>Incl. face, scalp and/or neck
Neck2	805.0-.1		839.0-.1	847.0	/	/		/	/	/	/	/	/	/
Neck 3 (VC and/or SC - with SCI)	806.0-.1		/	/	/	/		/	952.0	/	/	/	/	/
Face 1	802		830	848.0-.1	925.1 Incl. face, scope	/		/	/	872 873.2-873.7	920 Incl. face, scope and/or neck	910 Incl. face, scope and/or neck	941.x1-5 941.x7 947.0	/
Face 2 (Eye)	/		/	/	/	/		/	950.0	870-871	921	918	940	/
Throat 1	807.4 flail chest	807.0-.3	839.61 839.71	848.3-.4	926.19	861-861	860 Pneumothorax	901	953.1	875 879.0-.1	922.0 922.1 922.33	/	942.x1-x2 947.1-.2	/
Thorax 2 (VC - no SCI)	805.2-.3 805.8-.9 (Unspecified) <sup>1</sup>		839.21 839.31 839.40 * <sup>1</sup> 839.49 * 839.50 * 839.59 *	847.1	/	/		/	/	/	/	/	/	/
Throat 3 (VC and/or SC - with SCI)	806.2-.3 806.8-.9 (Unspecified) <sup>1</sup>		/	/	/	/		/	952.1 958.8 952.0	/	/	/	/	/
Abd 1	/		/	/	/	863-866, 868		902.0-.4 902.87, .89	953.2 953.5	879.2-.5	922.2	/	942.x3 947.3	/
Abd 2 (VC - no SCI)	805.4-.5		839.20 839.30	847.2	/	/		/	/	/	/	/	/	/
Abd 3 (VC and/or SC - with SCI)	806.4-.5		/	/	/	/		/	952.2	/	/	/	/	/
Pelvis 1	808		839.69 839.79	846 848.5	926.0 926.12	867		902.5 902.81-.82	953.3	877-878	922.4 922.32	/	942.x5 947.4	/

Pelvis 2 (VC - no SCI)	805.6-.7		839.41-.42 839.51-.52	847.3-.4	/	/	/	/	/	/	/	/	/	
Pelvis 3 (VC and/or SCI - with SCI)	806.6-.7		/	/	/	/	/	952.3-.4	/	/	/	/	/	
Upper Ext	810-818 819 Incl. Ribs & sternum		831-834	840-842	927	/	903	953.4 955	880-884	AMP 855-887	923	912-915	943 944	959.2-.5
Lower Ext.	820 hip fracture	821-827	835-838	843-845	928	/	904.0-.8	956	890-894	AMP 895-897	924	916-917	945	959.6-.7
Trunk <sup>1</sup>	809		/	/	926.8-.9	/	/	954.1 954.8-.9	879.6-.7		922.8-.9	911	942.x0 942.x9	959.1
Back <sup>1</sup>	/		/	847.9	926.11	/	/	/	876		922.31	/	942.x4	/
Unspecified	828.2 multiple fractures	829 unspecified bones	839.8-.9	848.8-.9	929	889	904.9	957.1, 957.8-.9, 953.8-.9	879.8-879.9			919	946, 948, 947.8-.9, 949, 994.8	959.8-.9

<sup>1</sup>Included in Injury of spinal cord or spinal column.

# PERSONS IN EACH DIAGNOSTIC GROUP

N=28108

