

INJURY SEVERITY SCORING

Injury Severity Scoring is a process by which complex and variable patient data is reduced to a single number. This value is intended to accurately represent the patient's degree of critical illness. In truth, achieving this degree of accuracy is unrealistic and information is always lost in the process of such scoring. As a result, despite a myriad of scoring systems having been proposed, all such scores have both advantages and disadvantages.

Part of the reason for such inaccuracy is the inherent anatomic and physiologic differences that exist between patients. As a result, in order to accurately estimate patient outcome, we need to be able to accurately quantify the patient's anatomic injury, physiologic injury, and any pre-existing medical problems which negatively impact on the patient's physiologic reserve and ability to respond to the stress of the injuries sustained.

Outcome = Anatomic Injury + Physiologic Injury + Patient Reserve

GLASGOW COMA SCORE

The Glasgow Coma Score (GCS) is scored between 3 and 15, 3 being the worst, and 15 the best. It is composed of three parameters : Best Eye Response, Best Verbal Response, Best Motor Response, as given below:

<u>Best Eye Response (4)</u>	<u>Best Verbal Response (5)</u>	<u>Best Motor Response (6)</u>
1. No eye opening	1. No verbal response	1. No motor response
2. Eye opening to pain	2. Incomprehensible sounds	2. Extension to pain
3. Eye opening to verbal command	3. Inappropriate words	3. Flexion to pain
4. Eyes open spontaneously	4. Confused	4. Withdrawal from pain
	5. Orientated	5. Localising pain
		6. Obeys Commands

Note that the phrase 'GCS of 11' is essentially meaningless, and it is important to break the figure down into its components, such as E3 V3 M5 = GCS 11. A Coma Score of 13 or higher correlates with a mild brain injury, 9 to 12 is a moderate injury and 8 or less a severe brain injury.

- Teasdale G., Jennett B., Lancet 1974; 81-83.

GLASGOW PEDIATRIC COMA SCORE

The Pediatric GCS is scored between 3 and 15, 3 being the worst, and 15 the best. It is composed of three parameters : Best Eye Response, Best Verbal Response, Best Motor Response, as given below:

<u>Best Eye Response (4)</u>	<u>Best Verbal Response (5)</u>	<u>Best Motor Response (6)</u>
1. No eye opening	1. No vocal response	1. No motor response
2. Eye opening to pain	2. Inconsolable, agitated	2. Extension to pain
3. Eye opening to verbal command	3. Inconsistently consolable, moaning	3. Flexion to pain
4. Eyes open spontaneously	4. Cries but is consolable, inappropriate interactions	4. Withdrawal from pain
	5. Smiles, oriented to sounds, follows objects, interacts	5. Localising pain
		6. Obeys Commands

ORGAN GRADING SCALES

The Organ Injury Scales were developed by the Organ Injury Scaling Committee of the American Association for the Surgery of Trauma (AAST). Originally convened in 1987, these scoring systems are modified and updated as deemed appropriate by the Committee. These scales provide a common nomenclature by which physicians may describe injuries sustained and their severity.

Each organ injury may be graded from 1 to 6. A "1" is assigned to the least severe injury while a "5" is assigned to the most severe injury from which the patient may survive. Grade 6 injuries are, by definition, not salvageable and severe enough to claim the patient's life. Injuries may also be divided by mechanism ("blunt" vs. "penetrating") or by anatomic description ("hematoma", "laceration", "contusion", "vascular").

Accompanying each injury grade in Appendix 1 is the respective International Classification of Disease-9th Edition (ICD-9) code and the Abbreviated Injury Scale (AIS) code. For some of the injuries listed, the ICD-9 code has been revised from that listed in the original AAST scales to more appropriately describe the injury.

- Moore EE, Shackford SR, Pachter HL, et al: Organ injury scaling - spleen, liver and kidney. *J Trauma* 29:1664, 1989.
- Moore EE, Cogbill TH, Malangoni MA, et al: Organ injury scaling II: pancreas, duodenum, small bowel, colon and rectum. *J Trauma* 30:1427, 1990
- Moore EE, Cognill TH, Jurkovich GJ, et al: Organ injury scaling III: chest wall, abdominal vascular, ureter, bladder and urethra. *J Trauma* 33:337,1992
- Moore EE, Malangoni MA, Cogbill TH, et al: Organ injury scaling IV: thoracic vascular, lung, cardiac and diaphragm. *J Trauma* 36:229, 1994
- Moore EE, Cogbill TH, Jurkovich MD, et al: Organ injury scaling: spleen and liver (1994 revision). *J Trauma* 38:323, 1995

ABBREVIATED INJURY SCALE

The Abbreviated Injury Scale (AIS) is an anatomical scoring system first introduced in 1969. Since this time it has been revised and updated against survival so that it now provides a reasonably accurate ranking of the severity of injury. The latest incarnation of the AIS score is the 1998 revision. The AIS is monitored by a scaling committee of the Association for the Advancement of Automotive Medicine.

Injuries are ranked on a scale of 1 to 6, with 1 being minor, 5 severe, and 6 a nonsurvivable injury. This represents the 'threat to life' associated with an injury and is not meant to represent a comprehensive measure of severity. The AIS is not an injury scale, in that the difference between AIS1 and AIS2 is not the same as that between AIS4 and AIS5. There are many similarities between the AIS scale and the Organ Injury Scales of the AAST.

Injury	AIS Score
1	Minor
2	Moderate
3	Serious
4	Severe
5	Critical
6	Unsurvivable

- Copes WS, Sacco WJ, Champion HR, Bain LW, "Progress in Characterising Anatomic Injury", In *Proceedings of the 33rd Annual Meeting of the Association for the Advancement of Automotive Medicine, Baltimore, MA, USA* 205-218

INJURY SEVERITY SCORE (ISS) & NEW INJURY SEVERITY SCORE (NISS)

The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an AIS and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score.

An example of the ISS calculation is shown below:

Region	Injury Description	AIS	Square Top Three
Head & Neck	Cerebral Contusion	3	9
Face	No Injury	0	
Chest	Flail Chest	4	16
Abdomen	Minor Contusion of Liver Complex Rupture Spleen	2 5	25
Extremity	Fractured femur	3	
External	No Injury	0	
Injury Severity Score:			50

The ISS score takes values from 0 to 75. If an injury is assigned an AIS of 6 (unsurvivable injury), the ISS score is automatically assigned to 75. The ISS score is virtually the only anatomical scoring system in use and correlates linearly with mortality, morbidity, hospital stay and other measures of severity. Its weaknesses are that any error in AIS scoring increases the ISS error. Many different injury patterns can yield the same ISS score and injuries to different body regions are not weighted. Also, as a full description of patient injuries is not known prior to full investigation & operation, the ISS (along with other anatomical scoring systems) is not useful as a triage tool.

As multiple injuries within the same body region are only assigned a single score, a proposed modification of the ISS, the "New Injury Severity Score" (NISS), has been proposed. This is calculated as the sum of the squares of the top three scores regardless of body region. The NISS has been found to statistically outperform the traditional ISS score.

- Baker SP et al, "The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care", J Trauma 14:187-196;1974

INTERNATIONAL CLASSIFICATION OF DISEASES INJURY SEVERITY SCORE (ICISS)

ICISS utilizes the ICD-9 codes assigned to each patient to calculate a severity of injury score. Measured survival risk ratios are assigned to all ICD-9 trauma codes. The simple product of all such ratios for an individual patient's injuries have been found to predict outcome more accurately than ISS.

$$\text{ICISS} = (\text{SRR})_{\text{injury1}} \times (\text{SRR})_{\text{injury2}} \times (\text{SRR})_{\text{injury3}} \times (\text{SRR})_{\text{injury4...}}$$

ICISS is promoted as being able to be calculated from existing hospital information without the need for a dedicated trauma registrar. This assumes, however, that the non-clinical hospital coders are able to accurately interpret and document the injuries sustained.

REVISED TRAUMA SCORE

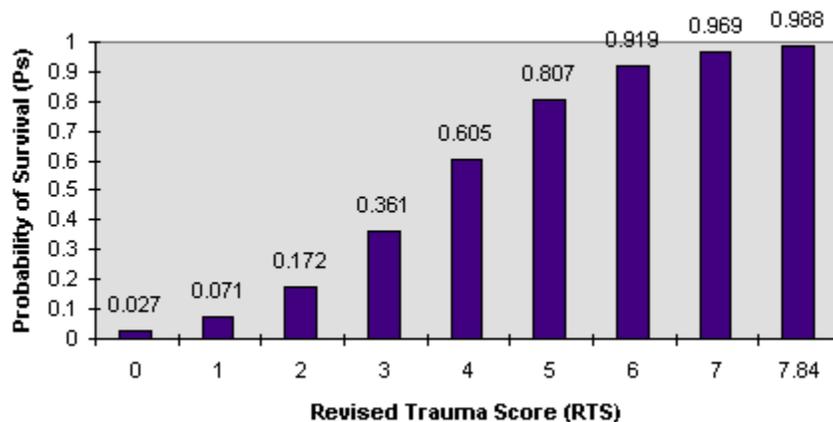
The Revised Trauma Score (RTS) is a physiological scoring system, with high inter-rater reliability and demonstrated accuracy in predicting death. It is scored from the first set of data obtained on the patient, and consists of Glasgow Coma Scale, Systolic Blood Pressure and Respiratory Rate.

Glasgow Coma Scale (GCS)	Systolic Blood Pressure (SBP)	Respiratory Rate (RR)	Coded Value
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

$$\text{RTS} = 0.9368 \text{ GCS} + 0.7326 \text{ SBP} + 0.2908 \text{ RR}$$

Values for the RTS are in the range 0 to 7.8408. The RTS is heavily weighted towards the Glasgow Coma Scale to compensate for major head injury without multisystem injury or major physiological changes. A threshold of RTS < 4 has been proposed to identify those patients who should be treated in a trauma center, although this value may be somewhat low.

Survival Probability by Revised Trauma Score



The RTS correlates well with the probability of survival.

- Champion HR et al, "A Revision of the Trauma Score", J Trauma 29:623-629, 1989
- Champion HR et al, "Trauma Score", Crit Care Med 9:672-676, 1981

TRAUMA SCORE - INJURY SEVERITY SCORE : TRISS

The Trauma Score – Injury Severity Score (TRISS) determines the probability of survival (Ps) of a patient from the ISS and RTS using the following formulae:

$$Ps = 1 / (1 + e^{-b})$$

Where 'b' is calculated from:

$$b = b0 + b1(RTS) + b2(ISS) + b3(AgeIndex)$$

The coefficients b0 - b3 are derived from multiple regression analysis of the Major Trauma Outcome Study (MTOS) database. AgeIndex is 0 if the patient is below 54 years of age or 1 if 55 years and over. b0 to b3 are coefficients which are different for blunt and penetrating trauma. If the patient is less than 15, the blunt index for b3 (Age) is used regardless of mechanism.

	Blunt	Penetrating
b0	-0.4499	-2.5355
b1	0.8085	0.9934
b2	-0.0835	-0.0651
b3	-1.7430	-1.1360

Boyd CR, Tolson MA, Copes WS: "Evaluating Trauma Care: The TRISS Method", J Trauma 1987; 27:370-378.

APPENDIX 1

Liver Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1 cm parenchymal depth	2
II	Hematoma	Subcapsular, 10-50% surface area	2
		Intraparenchymal, <10 cm in diameter	2
III	Laceration	Capsular tear, 1-3 cm parenchymal depth, <10 cm length	2
	Hematoma	Subcapsular, >50% surface area or expanding	3
		Ruptured subcapsular or parenchymal hematoma	3
		Intraparenchymal hematoma >10 cm or expanding	3
IV	Laceration	>3 cm parenchymal depth	3
	Laceration	Parenchymal disruption involving 25-75% of hepatic lobe or 1-3 Couinaud's segments within a single lobe	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within single lobe	5
	Vascular	Juxtahepatic venous injuries; i.e., retrohepatic vena cava/central major hepatic veins	5
	Vascular	Hepatic avulsion	6

* Advance one grade for multiple injuries up to grade III

Spleen Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1 cm parenchymal depth	2
II	Hematoma	Subcapsular, 10-50% surface area	2
		Intraparenchymal, <5 cm in diameter	2
III	Laceration	Capsular tear, 1-3 cm parenchymal depth which does not involve a trabecular vessel	2
	Hematoma	Subcapsular, >50% surface area or expanding	3
		Ruptured subcapsular or parenchymal hematoma	3
		Intraparenchymal hematoma >5 cm or expanding	3
IV	Laceration	>3 cm parenchymal depth or involving trabecular vessels	3
	Laceration	Laceration involving segmental or hilar vessels producing major devascularization (>25% of spleen)	4
V	Laceration	Completely shattered spleen	5
	Vascular	Hilar vascular injury which devascularizes spleen	5

* Advance one grade for multiple injuries up to grade III

Small Bowel Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness, no perforation	2
II	Laceration	Laceration <50% of circumference	3
III	Laceration	Laceration >50% of circumference without transection	3
IV	Laceration	Transection of small bowel	4
V	Laceration	Transection of small bowel with segmental tissue loss	4
	Vascular	Devascularized segment	4

* Advance one grade for multiple injuries up to grade III

Colon Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness, no perforation	2
II	Laceration	Laceration <50% of circumference	3
III	Laceration	Laceration >50% of circumference without transection	3
IV	Laceration	Transection of the colon	4
V	Laceration	Transection of the colon with segmental tissue loss	4

* Advance one grade for multiple injuries up to grade III

Rectum Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness laceration	2
II	Laceration	Laceration <50% of circumference	3
III	Laceration	Laceration ≥50% of circumference	4
IV	Laceration	Full-thickness laceration with extension into the perineum	5
V	Laceration	Devascularized segment	5

* Advance one grade for multiple injuries up to grade III

Diaphragm Injury Scale

Grade*	Description		AIS-90
I	Contusion		2
II	Laceration ≤2 cm		3
III	Laceration 2-10 cm		3
IV	Laceration >10 cm with tissue loss ≤25 cm ²		3
V	Laceration with tissue loss ≥25 cm ²		3

* Advance one grade for bilateral injuries up to grade III

Duodenum Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Involving single portion of duodenum	2
	Laceration	Partial thickness, no perforation	3
II	Hematoma	Involving more than one portion	2
	Laceration	Disruption <50% circumference	4
III	Laceration	Disruption 50-75% circumference of 2nd portion	4
		Disruption 50-100% circumference of 1st, 3rd, 4th portion	4
IV	Laceration	Disruption >75% circumference of 2nd portion	5
		Involving ampulla or distal common bile duct	5
V	Laceration	Massive disruption of duodenopancreatic complex	5
	Vascular	Devascularization of duodenum	5

* Advance one grade for multiple injuries up to grade III

Pancreas Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Minor contusion without duct injury	2
	Laceration	Superficial laceration without duct injury	2
II	Hematoma	Major contusion without duct injury or tissue loss	2
	Laceration	Major laceration without duct injury or tissue loss	3
III	Laceration	Distal transection or parenchymal / duct injury	3
IV	Laceration	Proximal transection or parenchymal injury involving ampulla	4
V	Laceration	Massive disruption of pancreatic head	5

* Advance one grade for multiple injuries up to grade III

Kidney Injury Scale

Grade*	Description		AIS-90
I	Contusion	Microscopic or gross hematuria	2
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration	2
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum	2
	Laceration	<1 cm parenchymal depth of renal cortex without urinary extravasation	2
III	Laceration	<1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation	3
IV	Laceration	Parenchymal laceration extending through the renal cortex, medulla, and collecting system	4
V	Vascular	Main renal artery or vein injury with contained hemorrhage	4
	Laceration	Completely shattered kidney	5
	Vascular	Avulsion of renal hilum which devascularizes kidney	5

* Advance one grade for multiple injuries up to grade III

Ureter Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
II	Laceration	<50% transection	2
III	Laceration	>50% transection	3
IV	Laceration	Complete transection with <2 cm devascularization	3
V	Laceration	Avulsion with >2 cm devascularization	3

* Advance one grade for multiple injuries up to grade III

Bladder Injury Scale

Grade*	Description		AIS-90
I	Hematoma	Contusion, intramural hematoma	2
	Laceration	Partial thickness	3
II	Laceration	Extraperitoneal bladder wall laceration <2 cm	4
III	Laceration	Extraperitoneal (>2 cm) or intraperitoneal (<2 cm) bladder wall laceration	4
IV	Laceration	Intraperitoneal bladder wall laceration >2 cm	4
V	Laceration	Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone)	4

* Advance one grade for multiple injuries up to grade III

Urethra Injury Scale

Grade*	Injury Type	Description	AIS-90
I	Contusion	Blood at urethral meatus; urethrography normal	2
II	Stretch Injury	Elongation of urethra without extravasation on urethrography	2
III	Partial Disruption	Extravasation of urethrography contrast at injury site with contrast visualized in the bladder	2
IV	Complete Disruption	Extravasation of urethrography contrast at injury site without contrast visualization in the bladder; <2 cm of urethral separation	3
V	Complete Disruption	Complete transection with >2 cm urethral separation, or extension into the prostate or vagina	4

* Advance one grade for multiple injuries up to grade III

Abdominal Vascular Injury Scale*

Grade†	Description	AIS-90
I	Non-named SMA or SMV branches	NS
	Non-named IMA or IMV branches	NS
	Phrenic artery / vein	NS
	Lumbar artery / vein	NS
	Gonadal artery / vein	NS
	Ovarian artery / vein	NS
	Other non-named small arterial or venous structures requiring ligation	NS
II	Right, left, or common hepatic artery	3
	Splenic artery/vein	3
	Right or left gastric arteries	3
	Gastroduodenal artery	3
	IMA or IMV trunk	3
	Primary named branches of mesenteric artery or vein	3
	Other named abdominal vessels requiring ligation/repair	3
III	SMV trunk	3
	Renal artery/vein	3
	Iliac artery vein	3
	Hypogastric artery/vein	3
	Vena cava, infrarenal	3
IV	SMA trunk	3
	Celiac axis proper	3
	Vena cava, suprarenal and infrahepatic	3
	Aorta, infrarenal	4
V	Portal vein	3
	Extraparenchymal hepatic vein	3/5
	Vena cava, retrohepatic or suprahepatic	5
	Aorta, suprarenal, subdiaphragmatic	4

* This classification system is application to extraparenchymal vascular injuries. If the vessel injury is within 2 cm of the organ parenchyma, refer to the specific organ injury scale.

† Increase one grade for multiple grade III or IV injuries involving >50% vessel circumference. Downgrade one grade if <25% vessel circumference laceration for grades IV or V.

Chest Wall Injury Scale*

Grade†	Injury Type	Description	AIS-90
I	Contusion	Any size	1
	Laceration	Skin and subcutaneous	1
	Fracture	<3 ribs, closed; nondisplaced clavicle closed	1-2
II	Laceration	Skin, subcutaneous and muscle	1
	Fracture	≥3 adjacent ribs, closed	2-3
		Open or displaced clavicle	2
		Nondisplaced sternum, closed	2
		Scapular body, open or closed	2
III	Laceration	Full thickness including pleural penetration	2
	Fracture	Open or displaced sternum, flail sternum	2
		Unilateral flail segment (<3 ribs)	3-4
IV	Laceration	Avulsion of chest wall tissues with underlying rib fractures	4
	Fracture	Unilateral flail chest (≥3 ribs)	3-4
V	Fracture	Bilateral flail chest (≥3 ribs on both sides)	5

* This scale is confined to the chest wall alone and does not reflect associated internal thoracic or abdominal injuries.

† Advance one grade for multiple injuries up to grade III

Extrahepatic Biliary Tree Injury Scale

Grade*	Description	AIS-90
I	Gallbladder contusion/hematoma	2
	Portal triad contusion/hematoma	2
II	Partial gallbladder avulsion from liver bed; cystic duct intact	2
	Laceration or perforation of the gallbladder	2
III	Complete gallbladder avulsion from liver bed	3
	Cystic duct laceration	2-3
IV	Partial or complete right hepatic duct laceration	2-3
	Partial or complete left hepatic duct laceration	2-3
	Partial common hepatic duct laceration (<50%)	3
	Partial common bile duct laceration (<50%)	3
V	>50% transection of common hepatic duct	4
	>50% transection of common bile duct	4

* Advance one grade for multiple injuries up to grade III

Heart Injury Scale

Grade*	Description	AIS-90
I	Blunt cardiac injury with minor ECG abnormality (nonspecific ST or T wave changes, premature atrial or ventricular contraction or persistent sinus tachycardia)	3
	Blunt or penetrating pericardial wound without cardiac injury, cardiac tamponade, or cardiac herniation	3
II	Blunt cardiac injury with heart block (right or left bundle branch, left anterior fascicular, or atrioventricular) or ischemic changes (ST depression or T wave inversion) without cardiac failure	3
	Penetrating tangential myocardial wound up to, but not extending through, endocardium, without tamponade	3
III	Blunt cardiac injury with sustained (≥ 5 beats/min) or multifocal ventricular contractions	3-4
	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid valvular incompetence, papillary muscle dysfunction, or distal coronary arterial occlusion without cardiac failure	3-4
	Blunt pericardial laceration with cardiac herniation	3-4
	Blunt cardiac injury with cardiac failure	3-4
	Penetrating tangential myocardial wound up to, but not extending through, endocardium, with tamponade	3
IV	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid valvular incompetence, papillary muscle dysfunction, or distal coronary arterial occlusion producing cardiac failure	3
	Blunt or penetrating cardiac injury with aortic mitral valve incompetence	3 5
	Blunt or penetrating cardiac injury of the right ventricle, right atrium, or left atrium	5
V	Blunt or penetrating cardiac injury with proximal coronary arterial occlusion	5
	Blunt or penetrating left ventricular perforation	5
	Stellate wound with <50% tissue loss of the right ventricle, right atrium, or left atrium	5
VI	Blunt avulsion of the heart	6
	Penetrating wound producing >50% tissue loss of a chamber	6

* Advance one grade for multiple penetrating wounds to a single chamber or multiple chamber involvement

Lung Injury Scale

Grade*	Injury Type	Description	AIS-90
I	Contusion	Unilateral, <1 lobe	3
II	Contusion	Unilateral, single lobe	3
	Laceration	Simple pneumothorax	3
III	Contusion	Unilateral, >1 lobe	3
	Laceration	Persistent (>72 hrs), air leak from distal airway	3-4
	Hematoma	Nonexpanding intraparenchymal	
IV	Laceration	Major (segmental or lobar) air leak	4-5
	Hematoma	Expanding intraparenchymal	
	Vascular	Primary branch intrapulmonary vessel disruption	3-5
V	Vascular	Hilar vessel disruption	4
VI	Vascular	Total, uncontained transection of pulmonary hilum	4

* Advance one grade for multiple injuries up to grade III
Hemothorax is scored under thoracic vascular injury scale

Thoracic Vascular Injury Scale

Grade*	Description	AIS-90
I	Intercostal artery/vein	2-3
	Internal mammary artery/vein	2-3
	Bronchial artery/vein	2-3
	Esophageal artery/vein	2-3
	Hemiazygos vein	2-3
	Unnamed artery/vein	2-3
II	Azygos vein	2-3
	Internal jugular vein	2-3
	Subclavian vein	3-4
	Innominate vein	3-4
III	Carotid artery	3-5
	Innominate artery	3-4
	Subclavian artery	3-4
IV	Thoracic aorta, descending	4-5
	Inferior vena cava (intrathoracic)	3-4
	Pulmonary artery, primary intraparenchymal branch	3
	Pulmonary vein, primary intraparenchymal branch	3
V	Thoracic aorta, ascending and arch	5
	Superior vena cava	3-4
	Pulmonary artery, main trunk	4
	Pulmonary vein, main trunk	4
VI	Uncontained total transection of thoracic aorta or pulmonary hilum	5

* Increase one grade for multiple grade III or IV injuries if >50% circumference; decrease one grade for grade IV and V injuries if <25% circumference.