

List of potential predictors for LASSO variable selection procedure

Age in years

Sex

Race

- White
- Native American
- Other
- Black or African American
- Asian
- Native Hawaiian or other Pacific Islander

Hispanic ethnicity

Initial ED systolic blood pressure

Initial ED heart rate

Initial ED respiration rate

Initial ED oxygen saturation

Initial ED temperature

Initial ED Glasgow Coma Scale score

Was the initial ED GCS qualified by an obstruction to the patient's eye?

Was the initial ED GCS qualified by the patient being chemically sedated or paralyzed?

Was the initial ED GCS qualified by the patient being intubated?

Presence of supplemental oxygen during assessment of initial ED/hospital oxygen saturation level

Mechanical and/or external support of respiration during assessment of initial ED/hospital respiratory rate

Was the patient transferred in from another hospital?

Comorbid conditions:

- Bleeding disorder
- Major psychiatric illness
- Respiratory disease
- Current smoker
- Hypertension requiring medication
- Dementia
- Obesity
- Diabetes mellitus
- Alcoholism

- Drug abuse or dependence
- Congenital anomalies
- Steroid use
- Cirrhosis
- Functionally dependent health status
- Congestive heart failure
- Disseminated cancer
- History of PVD
- Prematurity
- CVA or residual neurological deficit
- Currently receiving chemotherapy for cancer
- History of myocardial infarction
- Chronic renal failure
- Esophageal varices
- Ascites within 30 days
- History of angina within 30 days

Nature and body region of injury based on ICD-9-CM Barell Injury Diagnosis Matrix

- Injury of blood vessels of the abdomen
- Burn of the abdomen
- Injury of internal organs of the abdomen
- Injury of nerves of the abdomen
- Open wound of the abdomen
- Burn of the back and buttock
- Crush injury of the back and buttock
- Open wound of the back and buttock
- Sprains and strains of the back and buttock
- Fracture of the cervical vertebral column with cord involvement
- Cervical spinal cord injury without fracture
- Dislocation of the cervical vertebral column without cord involvement
- Fracture of the cervical vertebral column without cord involvement
- Sprains and strains of the cervical vertebral column without cord involvement
- Injury of the blood vessels of the chest/thorax
- Burn of the chest/thorax
- Crush injury of the chest/thorax
- Dislocation of the chest/thorax
- Fracture of the chest/thorax
- Injury of the internal organs of the chest/thorax
- Injury of the nerves of the chest/thorax
- Open wound of the chest/thorax
- Sprains and strains of the chest/thorax

- Dislocation of unspecified extremities
- Fracture of unspecified extremities
- Burn of the eye(s)
- Injury of the nerves of the eye(s)
- Open wound of the eye(s)
- Burn of the face
- Dislocation of the face
- Fracture of the face
- Open wound of the face
- Sprains and strains of the face
- Amputation of the foot and toes
- Burn of the foot and toes
- Crush injury of the foot and toes
- Dislocation of the foot and toes
- Fracture of the foot and toes
- Open wound of the foot and toes
- Sprains and strains of the foot and toes
- Amputation of the forearm and elbow
- Burn of the forearm and elbow
- Crush injury of the forearm and elbow
- Dislocation of the forearm and elbow
- Fracture of the forearm and elbow
- Open wound of the forearm and elbow
- Sprains and strains of the forearm and elbow
- Amputation of the hand, wrist, and fingers
- Burn of the hand, wrist, and fingers
- Crush injury of the hand, wrist, and fingers
- Dislocation of the hand, wrist, and fingers
- Fracture of the hand, wrist, and fingers
- Open wound of the hand, wrist, and fingers
- Sprains and strains of the hand, wrist, and fingers
- Unspecified Injury of the hand, wrist, and fingers
- Injury of blood vessels of unspecified part(s) of the head, face, and neck
- Burn of unspecified part(s) of the head, face, and neck
- Crush injury of unspecified part(s) of the head, face, and neck
- Injury of the nerves of unspecified part(s) of the head, face, and neck
- Unspecified Injury of unspecified part(s) of the head, face, and neck
- Crush injury of the hip
- Dislocation of the hip
- Fracture of the hip
- Sprains and strains of the hip
- Burn of the knee
- Crush injury of the knee
- Dislocation of the knee

- Fracture of the knee
- Sprains and strains of the knee
- Amputation of the lower leg and ankle
- Burn of the lower leg and ankle
- Crush injury of the lower leg and ankle
- Dislocation of the lower leg and ankle
- Fracture of the lower leg and ankle
- Sprains and strains of the lower leg and ankle
- Fracture of the lumbar vertebral column with cord involvement
- Lumbar spinal cord injury without fracture
- Dislocation of the lumbar vertebral column without cord involvement
- Fracture of the lumbar vertebral column without cord involvement
- Sprains and strains of the lumbar vertebral column without cord involvement
- Burn of the neck
- Crush injury of the neck
- Fracture of the neck
- Injury of the nerves of the neck
- Open wound of the neck
- Sprains and strains of the neck
- Amputation of other and unspecified parts of the lower extremities
- Injury of the blood vessels of other and unspecified parts of the lower extremities
- Burn of other and unspecified parts of the lower extremities
- Crush injury of other and unspecified parts of the lower extremities
- Fracture of other and unspecified parts of the lower extremities
- Open wound of other and unspecified parts of the lower extremities
- Sprains and strains of other and unspecified parts of the lower extremities
- Unspecified Injury of other and unspecified parts of the lower extremities
- Amputation of other and unspecified parts of the upper extremities
- Injury of the blood vessels of other and unspecified parts of the upper extremities
- Burn of other and unspecified parts of the upper extremities
- Crush injury of other and unspecified parts of the upper extremities
- Fracture of other and unspecified parts of the upper extremities
- Injury of the nerves of other and unspecified parts of the upper extremities
- Open wound of other and unspecified parts of the upper extremities
- Unspecified Injury of other and unspecified parts of the upper extremities
- Burn of other regions of the head
- Injury of the nerves of other regions of the head
- Open wound of other regions of the head
- Unspecified Injury of other regions of the head
- Injury of the blood vessels of other or multiple body regions
- Burn of other or multiple body regions
- Fracture of other or multiple body regions
- Injury of the nerves of other or multiple body regions
- Injury of the blood vessels of the pelvis and urogenital organs

- Burn of the pelvis and urogenital organs
- Crush injury of the pelvis and urogenital organs
- Dislocation of the pelvis and urogenital organs
- Fracture of the pelvis and urogenital organs
- Injury of the internal organs of the pelvis and urogenital organs
- Injury of the nerves of the pelvis and urogenital organs
- Open wound of the pelvis and urogenital organs
- Sprains and strains of the pelvis and urogenital organs
- Fracture of the sacrum and coccyx with cord involvement
- Spinal cord injury at the level of the sacrum and coccyx without fracture
- Dislocation of the sacrum and coccyx without cord involvement
- Fracture of the sacrum and coccyx without cord involvement
- Sprains and strains of the sacrum and coccyx without cord involvement
- Amputation of the shoulder and upper arm
- Burn of the shoulder and upper arm
- Crush injury of the shoulder and upper arm
- Dislocation of the shoulder and upper arm
- Fracture of the shoulder and upper arm
- Open wound of the shoulder and upper arm
- Sprains and strains of the shoulder and upper arm
- Unspecified Injury of the shoulder and upper arm
- Fracture of unspecified part(s) of the vertebral column with cord involvement
- Spinal cord injury at unspecified part(s) of the vertebral column without fracture
- Dislocation of unspecified part(s) of the vertebral column without cord involvement
- Fracture of unspecified part(s) of the vertebral column without cord involvement
- System wide and late effects
- Fracture of the thoracic vertebral column with cord involvement
- Thoracic spinal cord injury without fracture
- Dislocation of the thoracic vertebral column without cord involvement
- Fracture of the thoracic vertebral column without cord involvement
- Sprains and strains of the thoracic vertebral column without cord involvement
- Burn of the trunk
- Crush injury of the trunk
- Fracture of the trunk
- Injury of the nerves of the trunk
- Open wound of the trunk
- Unspecified Injury of the trunk
- Injury of the blood vessels of unspecified body region(s)
- Burn of unspecified body region(s)
- Crush injury of unspecified body region(s)
- Dislocation of unspecified body region(s)
- Fracture of unspecified body region(s)
- Injury of internal organs of unspecified body region(s)
- Injury of nerves of unspecified body region(s)

- Open wound of unspecified body region(s)
- Sprains and strains of unspecified body region(s)
- Amputation of the upper leg and thigh
- Burn of the upper leg and thigh
- Crush injury of the upper leg and thigh
- Fracture of the upper leg and thigh
- Type I traumatic brain injury with skull fracture*
- Type I traumatic brain injury with intracranial injury*
- Type I traumatic brain injury with Injury of optic nerves*
- Type II traumatic brain injury with skull fracture**
- Type II traumatic brain injury with intracranial injury**
- Type III traumatic brain injury with skull fracture***

*Type I traumatic brain injury: (1) evidence of an intracranial injury, (2) moderate or prolonged loss of consciousness, (3) Shaken Infant Syndrome, or (4) injuries to the optic nerve pathways

**Type II traumatic brain injury: (1) no recorded evidence of intracranial injury, and (2a) loss of consciousness of less than one hour, (2b) loss of consciousness of unknown duration, or (2c) unspecified level of consciousness

***Type III traumatic brain injury: no evidence of intracranial injury and no loss of consciousness

ICD-9-CM codes of procedures performed within one hour of hospital arrival

- 00.17 Infusion of vasopressor agent
- 01.10 Intracranial pressure monitoring
- 01.24 Other craniotomy
- 01.31 Incision of cerebral meninges
- 03.39 Other diagnostic procedures on spinal cord and spinal canal structures
- 04.3 Suture of cranial and peripheral nerves
- 04.81 Injection of anesthetic into peripheral nerve for analgesia
- 06.09 Other incision of thyroid field
- 08.81 Linear repair of laceration of eyelid or eyebrow
- 18.4 Suture of laceration of external ear
- 21.81 Suture of laceration of nose
- 25.51 Suture of laceration of tongue
- 27.51 Suture of laceration of lip
- 31.1 Temporary tracheostomy
- 31.42 Laryngoscopy and other tracheoscopy
- 32.29 Other local excision or destruction of lesion or tissue of lung
- 33.22 Fiber-optic bronchoscopy
- 33.23 Other bronchoscopy

- 33.43 Closure of laceration of lung
- 34.01 Incision of chest wall
- 34.02 Exploratory thoracotomy
- 34.04 Insertion of intercostal catheter for drainage
- 34.09 Other incision of pleura
- 34.71 Suture of laceration of chest wall
- 34.82 Suture of laceration of diaphragm
- 34.84 Other repair of diaphragm
- 34.91 Thoracentesis
- 37.12 Pericardiotomy
- 37.49 Other repair of heart and pericardium
- 38.03 Incision of vessels, Upper Limb
- 38.08 Incision of vessels, Lower Limb Arteries
- 38.82 Other surgical occlusion, Other Head and Neck
- 38.83 Other surgical occlusion, Upper Limb
- 38.84 Other surgical occlusion, Aorta
- 38.85 Other surgical occlusion, Other Thoracic
- 38.86 Other surgical occlusion, Abdominal Arteries
- 38.87 Other surgical occlusion, Abdominal Veins
- 38.88 Other surgical occlusion, Lower Limb Arteries
- 38.89 Other surgical occlusion, Lower Limb Veins
- 38.91 Arterial catheterization
- 38.92 Umbilical vein catheterization
- 38.93 Venous catheterization, not elsewhere classified
- 38.97 Central venous catheter placement with guidance
- 38.98 Other puncture of artery
- 38.99 Other puncture of vein
- 39.29 Other (peripheral) vascular shunt or bypass
- 39.31 Suture of artery
- 39.32 Suture of vein
- 39.56 Repair of blood vessel with tissue patch graft
- 39.59 Other repair of vessel
- 39.79 Other endovascular procedures on other vessels
- 39.98 Control of hemorrhage, not otherwise specified
- 41.5 Total splenectomy
- 41.92 Injection into bone marrow
- 41.95 Repair and plastic operations on spleen
- 42.23 Other esophagoscopy
- 43.89 Open and other partial gastrectomy
- 44.61 Suture of laceration of stomach
- 44.69 Other repair of stomach
- 45.13 Other endoscopy of small intestine
- 45.61 Multiple segmental resection of small intestine
- 45.62 Other partial resection of small intestine

- 45.72 Open and other cecectomy
- 45.73 Open and other right hemicolectomy
- 45.74 Open and other resection of transverse colon
- 45.75 Open and other left hemicolectomy
- 45.76 Open and other sigmoidectomy
- 45.79 Other and unspecified partial excision of large intestine
- 45.91 Small-to-small intestinal anastomosis
- 45.93 Other small-to-large intestinal anastomosis
- 45.94 Large-to-large intestinal anastomosis
- 46.10 Colostomy, not otherwise specified
- 46.71 Suture of laceration of duodenum
- 46.73 Suture of laceration of small intestine, except duodenum
- 46.75 Suture of laceration of large intestine
- 46.79 Other repair of intestine
- 47.19 Other incidental appendectomy
- 48.23 Rigid proctosigmoidoscopy
- 50.22 Partial hepatectomy
- 50.61 Closure of laceration of liver
- 50.69 Other repair of liver
- 51.22 Cholecystectomy
- 52.52 Distal pancreatectomy
- 52.95 Other repair of pancreas
- 53.59 Repair of other hernia of anterior abdominal wall
- 54.0 Incision of abdominal wall
- 54.11 Exploratory laparotomy
- 54.19 Other laparotomy
- 54.21 Laparoscopy
- 54.25 Peritoneal lavage
- 54.29 Other diagnostic procedures on abdominal region
- 54.4 Excision or destruction of peritoneal tissue
- 54.59 Other lysis of peritoneal adhesions
- 54.63 Other suture of abdominal wall
- 54.64 Suture of peritoneum
- 54.72 Other repair of abdominal wall
- 54.74 Other repair of omentum
- 54.75 Other repair of mesentery
- 54.92 Removal of foreign body from peritoneal cavity
- 54.99 Other operations on abdominal organs
- 55.51 Nephroureterectomy
- 55.81 Suture of laceration of kidney
- 57.81 Suture of laceration of bladder
- 57.94 Insertion of indwelling urinary catheter
- 59.8 Ureteral catheterization
- 75.34 Fetal monitoring, not otherwise specified

- 77.31 Other bone division, Scapula
- 78.15 Application of external fixator device, femur
- 78.17 Application of external fixator device, tibia and fibula
- 79.00 Closed reduction of fracture without internal fixation, Unspecified
- 79.01 Closed reduction of fracture without internal fixation, Humerus
- 79.02 Closed reduction of fracture without internal fixation, Radius and ulna
- 79.05 Closed reduction of fracture without internal fixation, Femur
- 79.06 Closed reduction of fracture without internal fixation, Tibia and Fibula
- 79.07 Closed reduction of fracture without internal fixation, Tarsals and metatarsals
- 79.09 Closed reduction of fracture without internal fixation, Other specified bone
- 79.32 Open reduction of fracture with internal fixation, Radius and ulna
- 79.35 Open reduction of fracture with internal fixation, Femur
- 79.36 Open reduction of fracture with internal fixation, Tibia and Fibula
- 79.62 Debridement of open fracture site, Radius and ulna
- 79.65 Debridement of open fracture site, Femur
- 79.66 Debridement of open fracture site, Tibia and Fibula
- 79.71 Closed reduction of dislocation of shoulder
- 79.72 Closed reduction of dislocation of elbow
- 79.73 Closed reduction of dislocation of wrist
- 79.75 Closed reduction of dislocation of hip
- 79.76 Closed reduction of dislocation of knee
- 79.77 Closed reduction of dislocation of ankle
- 83.09 Other incision of soft tissue
- 83.14 Fasciotomy
- 83.45 Other myectomy
- 83.64 Other suture of tendon
- 83.65 Other suture of muscle or fascia
- 86.04 Other incision with drainage of skin and subcutaneous tissue
- 86.05 Incision with removal of foreign body or device from skin and subcutaneous tissue
- 86.09 Other incision of skin and subcutaneous tissue
- 86.22 Excisional debridement of wound, infection, or burn
- 86.28 Nonexcisional debridement of wound, infection or burn
- 86.59 Closure of skin and subcutaneous tissue of other sites
- 86.89 Other repair and reconstruction of skin and subcutaneous tissue
- 87.01 Pneumoencephalogram
- 87.02 Other contrast radiogram of brain and skull
- 87.03 Computerized axial tomography of head
- 87.04 Other tomography of head
- 87.09 Other soft tissue x-ray of face, head, and neck
- 87.14 Contrast radiogram of orbit
- 87.16 Other x-ray of facial bones
- 87.17 Other x-ray of skull
- 87.22 Other x-ray of cervical spine

- 87.23 Other x-ray of thoracic spine
- 87.24 Other x-ray of lumbosacral spine
- 87.29 Other x-ray of spine
- 87.41 Computerized axial tomography of thorax
- 87.42 Other tomography of thorax
- 87.43 X-ray of ribs, sternum, and clavicle
- 87.44 Routine chest x-ray, so described
- 87.49 Other chest x-ray
- 87.71 Computerized axial tomography of kidney
- 87.76 Retrograde cystourethrogram
- 87.77 Other cystogram
- 87.79 Other x-ray of the urinary system
- 88.01 Computerized axial tomography of abdomen
- 88.02 Other abdomen tomography
- 88.03 Sinogram of abdominal wall
- 88.09 Other soft tissue x-ray of abdominal wall
- 88.11 Pelvic opaque dye contrast radiography
- 88.19 Other x-ray of abdomen
- 88.21 Skeletal x-ray of shoulder and upper arm
- 88.22 Skeletal x-ray of elbow and forearm
- 88.23 Skeletal x-ray of wrist and hand
- 88.24 Skeletal x-ray of upper limb, not otherwise specified
- 88.25 Pelvimetry
- 88.26 Other skeletal x-ray of pelvis and hip
- 88.27 Skeletal x-ray of thigh, knee, and lower leg
- 88.28 Skeletal x-ray of ankle and foot
- 88.29 Skeletal x-ray of lower limb, not otherwise specified
- 88.33 Other skeletal x-ray
- 88.36 Lymphangiogram of lower limb
- 88.37 Other soft tissue x-ray of lower limb
- 88.38 Other computerized axial tomography
- 88.39 X-ray, other and unspecified
- 88.40 Arteriography using contrast material, unspecified site
- 88.41 Arteriography of cerebral arteries
- 88.42 Aortography
- 88.43 Arteriography of pulmonary arteries
- 88.44 Arteriography of other intrathoracic vessels
- 88.47 Arteriography of other intra-abdominal arteries
- 88.48 Arteriography of femoral and other lower extremity arteries
- 88.49 Arteriography of other specified sites
- 88.50 Angiocardiology, not otherwise specified
- 88.61 Phlebography of veins of head and neck using contrast material
- 88.71 Diagnostic ultrasound of head and neck
- 88.72 Diagnostic ultrasound of heart

- 88.73 Diagnostic ultrasound of other sites of thorax
- 88.75 Diagnostic ultrasound of urinary system
- 88.76 Diagnostic ultrasound of abdomen and retroperitoneum
- 88.77 Diagnostic ultrasound of peripheral vascular system
- 88.78 Diagnostic ultrasound of gravid uterus
- 88.79 Other diagnostic ultrasound
- 88.90 Diagnostic imaging, not elsewhere classified
- 88.91 Magnetic resonance imaging of brain and brain stem
- 88.93 Magnetic resonance imaging of spinal canal
- 88.97 Magnetic resonance imaging of other and unspecified sites
- 89.34 Digital examination of rectum
- 89.50 Ambulatory cardiac monitoring
- 89.51 Rhythm electrocardiogram
- 89.52 Electrocardiogram
- 89.54 Electrographic monitoring
- 89.61 Systemic arterial pressure monitoring
- 89.62 Central venous pressure monitoring
- 89.65 Measurement of systemic arterial blood gases
- 89.7 General physical examination
- 92.12 Scan of other sites of head
- 93.35 Other heat therapy
- 93.44 Other skeletal traction
- 93.45 Thomas' splint traction
- 93.46 Other skin traction of limbs
- 93.52 Application of neck support
- 93.53 Application of other cast
- 93.54 Application of splint
- 93.56 Application of pressure dressing
- 93.57 Application of other wound dressing
- 93.58 Application of pressure trousers
- 93.59 Other immobilization, pressure, and attention to wound
- 93.90 Non-invasive mechanical ventilation
- 93.93 Nonmechanical methods of resuscitation
- 93.96 Other oxygen enrichment
- 96.02 Insertion of oropharyngeal airway
- 96.04 Insertion of endotracheal tube
- 96.07 Insertion of other gastric or nasogastric tube
- 96.08 Insertion of nasointestinal tube
- 96.55 Tracheostomy toilette
- 96.59 Other irrigation of wound
- 96.6 Enteral infusion of concentrated nutritional substances
- 96.70 Continuous invasive mechanical ventilation of unspecified duration
- 96.71 Continuous invasive mechanical ventilation for less than 96 consecutive hours
- 96.72 Continuous invasive mechanical ventilation for 96 consecutive hours or more

- 97.87 Removal of other device from trunk
- 97.88 Removal of external immobilization device
- 98.20 Removal of foreign body, not otherwise specified
- 99.00 Perioperative autologous transfusion of whole blood or blood components
- 99.01 Exchange transfusion
- 99.03 Other transfusion of whole blood
- 99.04 Transfusion of packed cells
- 99.05 Transfusion of platelets
- 99.06 Transfusion of coagulation factors
- 99.07 Transfusion of other serum
- 99.09 Transfusion of other substance
- 99.18 Injection or infusion of electrolytes
- 99.21 Injection of antibiotic
- 99.22 Injection of other anti-infective
- 99.26 Injection of tranquilizer
- 99.28 Injection or infusion of biological response modifier as an antineoplastic agent
- 99.29 Injection or infusion of other therapeutic or prophylactic substance
- 99.36 Administration of diphtheria toxoid
- 99.38 Administration of tetanus toxoid
- 99.39 Administration of diphtheria-tetanus-pertussis, combined
- 99.56 Administration of tetanus antitoxin
- 99.99 Other miscellaneous procedures

Initiation of cardiopulmonary resuscitation within the first hour (ICD-9 procedures 99.60-99.69 or 37.91 for open chest cardiac massage)

Mode of transport to the hospital

- Fixed wing ambulance
- Ground ambulance
- Helicopter ambulance
- Other
- Police
- Private or public vehicle or walk in

Primary injury type

- Blunt
- Penetrating
- Other or unspecified
- Burn

Primary mechanism of injury

- Fall
- Cut or pierce
- Motor vehicle traffic occupant
- Pedal cyclist, other
- Transport, other
- Motor vehicle traffic motorcyclist
- Other specified, not elsewhere classifiable
- Struck by, against
- Firearm
- Fire or flame
- Motor vehicle traffic pedestrian
- Other specified and classifiable
- Motor vehicle traffic pedal cyclist
- Motor vehicle traffic unspecified
- Machinery
- Motor vehicle traffic other
- Unspecified
- Natural or environmental, bites and stings
- Pedestrian, other
- Natural or environmental, other
- Hot object or substance

To simulate clinicians' judgment about the severity of injuries (i.e., severity coding by non-coders), we introduced noise to the maximum Abbreviated Injury Scale (AIS) severity scores for each AIS region by adding a random offset to each. The offsets were formed from a Normal distribution with mean = 0 and standard deviation = 0.2. Because of this, maximum AIS severities ranged from -1.01 to 6.72 instead of the normal 0.00 to 6.00.

Approximation of clinical judgement of maximum Abbreviated Injury Scale (AIS) severity scores for each AIS region

- Head
- Face
- Neck
- Thorax
- Abdomen
- Spine
- Upper extremity
- Lower extremity

Prior to modeling, any binary event variable that occurred fewer than 100 times was removed from the pool of potential predictors to ensure stability of estimates.