**PREDICTING CERVICAL SPINE INJURY (CSI) IN CHILDREN: A MULTI-CENTERED CASE-CONTROL ANALYSIS**

***Documentation for the Public Use Dataset***

**Introduction**

The purpose of this study was to identify a set of variables that separate injured children with negligible risk of CSI from those at non-negligible risk for CSI, and to describe CSI in children. Details of the study have been published.[1] This study was conducted within the Pediatric Emergency Care Applied Research Network (PECARN), a multi-centered, collaborative pediatric emergency medicine research network. We conducted a retrospective case-control study of children with CSI by abstracting information from medical records about clinical findings, mechanism-of-injury factors, previous medical history, interventions performed, imaging obtained, and outcomes. Three controls groups were identified: (1) children seen at the same hospital within a year of the matched case, (2) children additionally matched by age and mechanism of injury, and (3) children transported to the hospital by EMS additionally matched to EMS transported cases by age.

**Data Collection**

Data collection was performed at 17 PECARN hospitals, which collectively screened 2,395 cases and 6,764 controls for eligibility. The study identified 540 cases, 1,060 unmatched (random) controls, 1,012 mechanism-of-injury and age matched (MOI) controls, and 702 age-matched EMS (EMS) controls for analyses. Information was abstracted from medical records by trained research coordinators and site investigators. Site investigators signed off on all information collected. A set of data elements was dual-abstracted from a sample of patients (see Kappa dataset) to assess agreement between different data abstractors. Study investigators also reviewed and classified radiology impressions from the study hospital (see RadiologyReview dataset). Details of that review have been published.[2]

**Inclusion/Exclusion for the Public Use Dataset**

All cases found to be eligible according to study screening criteria are included in the Public Use Dataset, along with their matched eligible controls. Cases found to be ineligible either on screening by the hospital, or upon a review of injuries by the study's principal investigator and pediatric neurosurgeon, are not included. Controls found to be ineligible on screening, and those not matched to eligible cases are not included.

**Structure of Public Use Datasets**

The Public Use Datasets are comprised of 12 separate SAS or CSV datasets. One dataset contains derived analysis variables. The remaining datasets contain data from 11 data collection forms. Annotated versions of these case report forms are included in the documentation. In a few cases, variables derived from open text are included in the datasets. Details of the derivation of these variables are included in the annotated case report forms. Corresponding open text is also included when possible.

StudySubjectID is included in all datasets, and is a unique identifier for patients which can be used to join datasets. Most datasets include one row per patient; others contain one row per StudySubjectID for a subset of cases and controls. No datasets contain multiple rows for a single patient. CaseID is used to identify the matched case for controls, and is the same as StudySubjectID for cases. SiteID and ControlType are included in all datasets for convenience.

**Listing of Datasets**

| Dataset Name | Description | Notes |
|---|---|---|
| AnalysisVariables | Derived variables used in the primary manuscript analysis (Leonard et al., 2011) | One row per patient. Documentation for this dataset is below, and NOT in the annotated eCRF. |
| Demographics | Demographics | One row per patient. |
| ClinicalPresentationField | Clinical Presentation in the Field | One row per patient. |
| ClinicalPresentationOutside | Clinical Presentation to the Outside Hospital | One row per patient. |
| ClinicalPresentationSite | Clinical Presentation to the Study Site | One row per patient. |
| InjuryClassification | Details and Classification of the Cervical Spine Injury | One row per case. This form was filled out by site investigators and then updated by the principal study investigator and pediatric neurosurgeon during a review of all CSI. Only final injury classifications are given in this dataset. |
| InjuryMechanism | Injury Mechanism Details | One row per patient. Study investigators re-classified some injury mechanisms which were originally documented as "other". Only the final mechanism categories are given, along with the original text descriptions of the mechanism of injury. |
| MedicalHistory | Previous Medical History | One row per patient. |
| RadiologyOutside | Radiology and Surgery information from the outside hospital | One row per patient. |
| RadiologySite | Radiology and Surgery information from the study site | One row per patient. |
| RadiologyReview | Review of Radiology Comments | Study investigators reviewed imaging findings from the study site and made classifications. Only the final classifications are given. One row per case with a radiology report from the study site. [2] |
| Kappa | Dual-abstracted data elements used to assess inter-observer agreement | Includes data re-abstracted by an independent reviewer for a subset of the total sample. One row per patient in the sub-sample. |

| **Documentation for Analysis Variables (AnalysisVariables dataset)** | | | |
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| **Variable Name (Variable label)**<br>*Description of the variable* | **Values** | **Dataset(s) Used** | **Algorithm for derivation** |
| **AlteredMentalStatus**<br>**(Altered mental status)**<br>*GCS < 15, AVPU-scale (Alert, Voice, Pain, Unresponsive) < A, evidence of intoxication, or mental status descriptions deemed by consensus panel to represent altered level of consciousness* | 1=ALTERED<br>0=UNALTERED<br>.=MISSING | ClinicalPresentation-Site (a) | ALTERED if one of:<br>- AVPUDetails = (V, P, or U)<br>- TotalGCS or TotalGCSManual between 3 and 14<br>- AVPUMentaltxtCat = ALTERED<br>UNALTERED otherwise if one of:<br>- TotalGCS or ManualGCS =15<br>- AVPUDetails = A<br>- AVPUMentaltxtCat=UNALTERED<br>MISSING otherwise |
| **LOC (Loss of consciousness)**<br>*History of loss of consciousness post-injury* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | YES if one of<br>- a.HxLOC = Y or 3<br>- c.FieldDocumentation=EMS and c.HxLOC = Y or S<br>- b.EDDocumentation=ED and b.HxLOC = Y or S<br>NO otherwise if one of:<br>- a.HxLOC = N<br>- c.FieldDocumentation=EMS and c.HxLOC = N<br>- b.EDDocumentation=ED and b.HxLOC = N<br>MISSING otherwise |
| **Ambulatory (Ambulatory)**<br>*Child >2 years reported as able to ambulate post-injury* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | NO (ambulatory by at least one source) if one of<br>- a.PtAmbulatoryPriorEMSArrival = Y<br>- c.FieldDocumentation=EMS and c.PtAmbulatoryPriorEMSArrival = Y<br>- b.EDDocumentation=ED and b.PtAmbulatoryPriorArrival = Y<br>YES (non-ambulatory) otherwise if one of:<br>- a.PtAmbulatoryPriorEMSArrival = N or 3<br>- c.FieldDocumentation=EMS and c.PtAmbulatoryPriorEMSArrival = N or PA<br>- b.EDDocumentation=ED and b.PtAmbulatoryPriorArrival= N or PA<br>MISSING otherwise |
| **FocalNeuroFindings**<br>**(Focal Neurological findings)**<br>*Paresthesias, loss of sensation, motor weakness or other neurological finding deemed consistent with spine injury by consensus panel (ex. priapism)* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if one of:<br>- a.ptparesthesias=Y<br>- a.PtSensoryLoss=Y<br>- a.PtExtremityWeakness=Y<br>- a.OtherNeuroDeficitDescCat=YES<br>MISSING otherwise if any of a.ptparesthesias, a.ptSensoryLoss, or a.PtExtremityWeakness are ND.<br>NO otherwise |
| **PainNeck**<br>**(Complaint of neck pain)**<br>*History states that the child (if >2 years) complained of neck pain* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if a.PtCompPainNeck = 1<br>NO otherwise if a.PtCompPain=Y, N, NA, S, or P<br>MISSING otherwise |
| **PosMidNeckTenderness**<br>**(Posterior midline neck tenderness)**<br>*Physical exam notes neck tenderness as posterior, midline or at a designated cervical level; or a descriptor that consensus panel deemed consistent with posterior midline neck tenderness* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if one of:<br>- a.PtTenderNeckPos=1<br>- a.PtTenderNeckMid=1<br>- a.PtTenderNeckLevel=1<br>- a.PtTenderNeckOtherTxtCat=YES<br>NO otherwise if a.PtTEnder=NA or S<br>MISSING otherwise if a.PtTender =YND, ND or is missing<br>NO otherwise |

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| **TenderNeck**<br>**(Any neck tenderness)**<br>*Any documented tenderness on physical examination of the neck* | | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if a.PtTenderNeck=1<br>NO otherwise if a.PtTenderNeck=Y, N, NA, or S<br>MISSING otherwise |
| **Torticollis (Torticollis)**<br>*Torticollis, limited range of motion or difficulty moving the neck noted in history or physical examination* | | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if a.limitedrangemotion=Y<br>NO if a.limitedrangemotion=N, 3, 4, or NA<br>MISSING otherwise |
| **Substantial Injury**<br>*Observable injuries that are life-threatening, warrant surgical intervention or inpatient observation* | **SubInj_Head (Head)**<br>*Considered cranial region of the head (ex. skull fracture or intracranial hemorrhage)* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if a.OtherInjuriesHead=1<br>NO otherwise if a.OtherInjuries = Y or N<br>MISSING otherwise |
| | **SubInj_Face (Face)**<br>*Considered non-cranial region of the head (ex. orbital, maxilla or mandible fractures)* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if a.OtherInjuriesFace=1<br>NO otherwise if a.OtherInjuries = Y or N<br>MISSING otherwise |
| | **Subinj_Ext (Extremity)**<br>*Considered legs to hip and arms to clavicle (ex. long bone fractures or de-gloving injuries)* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if a.OtherInjuriesExt=1<br>NO otherwise if a.OtherInjuries = Y or N<br>MISSING otherwise |
| | **SubInj_TorsoTrunk (Torso)**<br>*Thorax including clavicles, abdomen, flanks, back including the spine and the pelvis (ex. rib fractures,, visceral or solid organ injury, or a pelvic fracture)* | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a) | YES if any of the following:<br>- a.OtherInjuriesChest=1<br>- a.OtherInjuriesBack=1<br>- a.OtherInjuriesFlank=1<br>- a.OtherInjuriesAbd=1<br>- a.OtherInjuriesPelvis=1<br>NO otherwise if a.OtherInjuries = Y or N<br>MISSING otherwise |
| **Predisposed (Predisposing condition)**<br>*Conditions known to predispose to CSI and that are observable on physical exam (Down Syndrome, Klippel-Feil Syndrome, Achondrodysplasia, Mucopolysaccaridosis, Ehlers-Danlos Syndrome, Marfan Syndrome, Osteogensis Imperfecta, Larsen's Sydrome, Juvenile Rheumatoid Arthritis, Juvenile Ankylosing Spondylitis, Renal Osteodystrophy, Ricketts, History of CSI or cervical spine surgery)* | | 1=YES<br>0=NO | MedicalHistory (m) | YES if any of the following:<br>- m.BodyAsAWhole0=1<br>- m.BodyAsAWhole1=1<br>- m.BodyAsAWhole2=1<br>- m.BodyAsAWhole3=1<br>- m.BodyAsAWhole4=1<br>- m.BodyAsAWhole5=1<br>- m.Genitourinary1=1<br>- m.Endocrinological1=1<br>- m.HematologicLymphatic1=1<br>- m.HematologicLymphatic2=1<br>- m.OtherPredisposingCondition is non-missing, and not one of the following: 'Os Odontoideum','Arnold Chiari Malformation','Cervical spinal stenosis', or 'Congenital anomaly of cervical vertebrae'<br>NO otherwise<br>(never MISSING) |

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| **HighriskDiving**<br>**(High Risk Diving Mechanism)**<br>*Diving* | 1=YES<br>0=NO<br>.=MISSING | InjuryMechanism (i) | YES if i.InjuryPrimaryMechanism=12<br>MISSING if i.i.InjuryPrimaryMechanism is ND<br>NO otherwise |
| **HighRiskFall**<br>**(High Risk Fall Mechanism)**<br>*Fall from a height ≥ 10 feet* | 1=YES<br>0=NO<br>.=MISSING | InjuryMechanism (i) | YES if i.InjuryPrimaryMechanism=9 and i.FallFromElevation=3<br>MISSING if i.i.InjuryPrimaryMechanism is missing or if i.InjuryPrimaryMechanism = 9 and i.FallFromElevation is missing<br>NO otherwise |
| **HighRiskHanging**<br>**(High Risk Hanging Mechanism)**<br>*Hanging* | 1=YES<br>0=NO<br>.=MISSING | InjuryMechanism (i) | YES if i.InjuryPrimaryMechanism=13<br>MISSING if i.i.InjuryPrimaryMechanism is missing<br>NO otherwise |
| **HighRiskHitByCar**<br>**(High Risk Hit by Car Mechanism)**<br>*Pedestrian, bicycle rider or non-motorized vehicle struck by a motor vehicle* | 1=YES<br>0=NO<br>.=MISSING | InjuryMechanism (i) | YES if i.InjuryPrimaryMechanism=3, 5, or 6<br>MISSING if i.i.InjuryPrimaryMechanism is missing<br>NO otherwise |
| **HighRiskMVC**<br>**(High Risk MVC Mechanism)**<br>*Head on collision, rollover, ejected from the vehicle, death in the same crash or speed ≥ 55 mph* | 1=YES<br>0=NO<br>.=MISSING | InjuryMechanism (i) | YES if any of the following:<br>- i.MVCHOC=1<br>- i.MVCRO=1<br>- i.MVCEFA=1<br>- i.MVCDSC=1<br>- MVCSpeed=3<br>NO if i.InjuryPrimaryMechanism = 1 and MVCHOC=0 and MVCRO=0 and MVCEFA=0 and MVCDSC=0 and MVCSpeed=1 or 2<br>MISSING otherwise if i.InjuryPrimaryMechanism =1 or ND<br>NO otherwise |
| **HighRiskOtherMV**<br>**(High Risk Other MV Mechanism)**<br>*Non automobile, MVC (ex. motorcycle)* | 1=YES<br>0=NO<br>.=MISSING | InjuryMechanism (i) | YES if i.InjuryPrimaryMechanism=2<br>MISSING if i.i.InjuryPrimaryMechanism is missing<br>NO otherwise |
| **AxialLoadAnyDoc**<br>**(Axial load to any region of the head)**<br>*The impact was noted in history to be head first, any region of the head* | 1=YES<br>0=NO | InjuryMechanism (i) | YES if i.HeadFirst=Y<br>NO otherwise<br>(never MISSING) |
| **AxialLoadTop**<br>**(Axial load to top of the head)**<br>*The impact was noted in history to be head first, region noted to be top of head* | 1=YES<br>0=NO | InjuryMechanism (i) | YES if i.HeadFirstRegion=top<br>NO otherwise<br>(never MISSING) |
| **Clotheslining**<br>**(Clothes-lining)**<br>*Injury the result of a rope, cable, or similar item exerting traction on the neck while the child is in motion* | 1=YES<br>0=NO | InjuryMechanism (i) | YES if i.clotheslining=Y<br>NO otherwise if i.clotheslining=N<br>MISSING if i.clotheslining=ND<br>NO if i.InjuryPrimaryMechanism = 1,6,9,10,11,12, or 13<br>MISSING otherwise |

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| **AlteredMentalStatus2**<br>**(Altered mental status**)** | 1=ALTERED<br>0=UNALTERED<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with altered mental status variable above and change to ALTERED if one of:<br>- b.AVPUDetails = (V, P, or U)<br>- b.TotalGCS or b. TotalGCSManual between 3 and 14<br>- b.AVPUMentaltxtCat = ALTERED<br>- c.AVPUDetails = (V, P, or U)<br>- c.TotalGCS or c. TotalGCSManual between 3 and 14<br>- c.AVPUMentaltxtCat = ALTERED |
| **FocalNeuroFindings2**<br>**(Focal Neurological findings**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with focal neurological findings above and change to YES if one of:<br>- b.ptparesthesias=Y<br>- b.PtSensoryLoss=Y<br>- b.PtExtremityWeakness=Y<br>- b.OtherNeuroDeficitDescCat=YES<br>- c.ptparesthesias=Y<br>- c.PtSensoryLoss=Y<br>- c.PtExtremityWeakness=Y<br>- c.OtherNeuroDeficitDescCat=YES |
| **PainNeck2**<br>**(Complaint of neck pain**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with complaint of neck pain above and change to YES if one of:<br>- b.PtCompPainNeck = 1<br>- c.PtCompPainNeck=1 |
| **PosMidNeckTenderness2**<br>**(Posterior midline neck tenderness**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with midline neck tenderness above and change to YES if one of:<br>- b.PtTenderNeckPos=1<br>- b.PtTenderNeckMid=1<br>- b.PtTenderNeckLevel=1<br>- b.PtTenderNeckOtherTxtCat=YES<br>- c.PtTenderNeckPos=1<br>- c.PtTenderNeckMid=1<br>- c.PtTenderNeckLevel=1<br>- c.PtTenderNeckOtherTxtCat=YES |
| **TenderNeck2**<br>**(Any Neck Tenderness**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with any neck tenderness above and change to YES if one of:<br>- b.PtTenderNeck=1<br>- c.PtTenderNeck=1 |
| **Torticollis2**<br>**(Torticollis**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with torticollis above and change to YES if one of:<br>- b.limitedrangemotion=Y<br>- c.limitedrangemotion=Y |
| **Subinj_Head2**<br>**(Substantial Head Injury**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with substantial head injury above, and change to YES if one of:<br>- b.OtherInjuriesHead=1<br>- c.OtherInjuriesHead=1 |
| **Subinj_Face2**<br>**(Substantial Face Injury**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with substantial face injury above, and change to YES if one of:<br>- b.OtherInjuriesFace=1<br>- c.OtherInjuriesFace=1 |
| **Subinj_Ext2**<br>**(Substantial Extremity Injury**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with substantial extremity injury above, and change to YES if one of:<br>- b.OtherInjuriesExt=1<br>- c.OtherInjuriesExtr=1 |

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| **Subinj_TorsoTrunk2 (Substantial Torso Injury**)** | 1=YES<br>0=NO<br>.=MISSING | ClinicalPresentation-Site (a)<br>ClinicalPresentation-Outside (b)<br>ClinicalPresentation-Field (c) | Start with substantial torso injury above, and change to YES if any of the following:<br>- b.OtherInjuriesChest=1<br>- b.OtherInjuriesBack=1<br>- b.OtherInjuriesFlank=1<br>- b.OtherInjuriesAbd=1<br>- b.OtherInjuriesPelvis=1<br>- c.OtherInjuriesChest=1<br>- c.OtherInjuriesBack=1<br>- c.OtherInjuriesFlank=1<br>- c.OtherInjuriesAbd=1<br>- c.OtherInjuriesPelvis=1 |
| **Using Study Site data first, then using positive findings from field or outside hospital documentation to change the response to YES from NO or MISSING. These variables were used for a robust estimate of sensitivity/specificity. | | | |

**REFERENCES**


**1.** Leonard JC, Kuppermann N, Olsen C, et al. Factors associated with cervical spine injury in children after blunt trauma. *Annals of emergency medicine.* Aug 2011;58(2):145-155.

**2.** Nigrovic LE, Rogers AJ, Adelgais KM, et al. Utility of plain radiographs in detecting traumatic injuries of the cervical spine in children. *Pediatric emergency care.* May 2012;28(5):426-432.