

**Protocol: Severe Traumatic Brain Injury – Management of the Pediatric Patient: (≤ Age 17)**  
**Resuscitation Phase of Care: Emergency Department**



Hennepin County **Medical Center**

Traumatic Brain Injury Center • [www.hcmc.org/braininjury](http://www.hcmc.org/braininjury)

*This protocol is developed utilizing the Brain Trauma Foundation's 3<sup>rd</sup> Edition of the "Management of Severe Traumatic Brain Injury" (May 2007) [www.braintrauma.org](http://www.braintrauma.org) and the "Guidelines for the Acute Medical Management of Severe TBI in Infants, Children and Adolescents," a supplement to Pediatric Critical Care Medicine (July 2003). Any deviation from the national guidelines will be resourced.*

| Parameter           | Goal during Resuscitation Phase  | Source Document |
|---------------------|--|-----------------|
| Neurological Checks | Assess GCS at time of admission to ED (prior to intubation and sedation when possible), at post-resuscitation and as needed in between. Utilize Pediatric GCS.   |                 |
| Oxygenation         | <p>Patient to be on 100% FiO<sub>2</sub><br/>           Goal O<sub>2</sub> saturation 100%<br/>           Goal <u>arterial</u> PaO<sub>2</sub> ≥ 100 mmHg unless otherwise instructed</p> <p>RSI (Rapid Sequence Intubation) is preferred method of intubation unless contraindicated.<br/>           iSTAT ABG for baseline<br/>           ABG is preferred, if ABG unobtainable, obtain a <u>venous</u> blood gas (VBG)<br/> <u>Venous</u> goals for PO<sub>2</sub> is 25-40 mmHg and PCO<sub>2</sub> 35-40 mmHg</p> <p>Goal <u>arterial</u> PaCO<sub>2</sub> 30-35 mmHg unless otherwise instructed<br/>           Avoid hyperventilation unless ICP &gt; 30 mmHg &amp;/or there are signs of progressive neurological deterioration unresponsive to other measures. Hyperventilate to ICP of 25 mmHg.<br/>           Keep PaCO<sub>2</sub> &gt; 25 mmHg</p> <p>All intubated patients must have an end tidal CO<sub>2</sub> monitor.</p> |                 |

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| Parameter                                       | Goal during Resuscitation Phase   | Source Document  |
|---|---|--|
| Blood Pressure Management & Fluid Resuscitation | <p><b>Goal SBP</b><br/>                     For Infants:<br/>                     For Children ages 1 – 10: Minimum SBP 70 + 2X their age for goal SBP 50<sup>th</sup> percentile for age, sex and height.</p> <p>For children &gt; age 10: use adult parameters, 100mmHg<br/>                     Maintain pressures with fluids, crystalloid (NS) with colloids and blood products as needed.</p> <p>If fluids unsuccessful begin blood pressure support with Dopamine 2.5 – 20 mcg/kg/min. ASAP change to Norepinephrine 0.01 - 1 mcg/kg/min</p> | <p>Neurosurgery<br/>                     Focus/Volume<br/>                     15/December, 2003</p> <p>Blood Pressure Levels for Boys and Girls by Age and Height Percentile (See Appendix 1)</p> |
| Intracranial Pressure Monitoring                | <p>Placement in ED left to the discretion of the Neurosurgery Staff MD or Chief Resident MD<br/>                     Goal ICP &lt; 15 mmHg</p>  |  |
| CPP Management                                  | <p>Goal &gt; Infants: 35-40 mmHg, Children &gt; Age 1, will vary from 40-65. Individual goals will be determined by Neurosurgery Staff</p> <p>Regardless of age, CPP &lt; 40 is associated with poor outcome</p>  | <p>Neurosurgery<br/>                     Focus/Volume<br/>                     15/December, 2003</p>   |
| Fluid Management                                | <p>NS unless otherwise instructed. Bolus of 20 ml/kg. May repeat PRN.<br/>                     No dextrose containing solutions</p>   |  |
| Electrolyte Management & Hyperosmolar Therapy   | <p>Begin infusion of 5% NaCl 3 ml/kg to a maximum of 150 ml<br/>                     IV over 15 minutes x 1 in patients with progressive neurological deterioration or a CT scan showing tight cisterns or midline shift<br/>                     May infuse peripherally in a new <b>large vessel</b> site. Change infusion to a central line as soon as possible</p>  | <p>HCMC ED protocol<br/>                     (Biros, Jancik &amp; GL Rockswold)</p>  |

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| Parameter               | Goal during Resuscitation Phase  | Source Document                    |
|-------------------------|--|------------------------------------|
| Glucose Management      | Goal range: < 150 mg/dl<br>No treatment required in the ED phase of care unless glucose > 300 mg/dl as risk of hypoglycemia is greater than risk of hyperglycemia  |                                    |
| Anti-convulsant Therapy | Phenytoin load 18 mg/kg IV in normal saline at a rate of 25 mg/min in central line or secure peripheral line. (Fosphenytoin 18 mg/kg “PE”)<br><br>If contraindication to Phenytoin/Fosphenytoin consider Valproic Acid (Depacon) 20 mg/kg over 5-10 minutes  | HCMC Pediatric Emergency Drug Book |
| Sedation                | Midazolam (Versed) is initial drug of choice in children. Initiate midazolam drip 0.05 - 0.1 mg/kg/hr for patients with agitation or increased ICP, after the patient is intubated and titrate up to desired level of sedation per MD order<br><br>In situations where the benefit outweighs the risk, consider Propofol. Loading dose 1 mg/kg. Maintenance dose 10-67 mcg/kg/min. |                                    |
| Analgesia               | Fentanyl to be initiated at admission after the initial neurological exam. IV infusion 1-3 mcg/kg/hr and titrate to effect.<br><br>Morphine 0.05 - 0.1 mg/kg/hr<br>Maximum dose 10 mg/hr   |                                    |
| Paralytic               | Vecuronium to be used at the discretion of physician. Begin 0.1 mg/kg/dose to maximum of 10 mg.  |                                    |
| Radiological Imaging    | Non-contrast CT scan ASAP  |                                    |

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Appendix 1: Blood Pressure Levels for Children (Source: [http://www.nhlbi.nih.gov/guidelines/hypertension/child\\_tbl.pdf](http://www.nhlbi.nih.gov/guidelines/hypertension/child_tbl.pdf))

**Blood Pressure Levels for Boys by Age and Height Percentile**

| Age<br>(Year) | BP<br>Percentile<br>↓ | Systolic BP (mmHg)       |      |      |      |      |      |      | Diastolic BP (mmHg)      |      |      |      |      |      |      |
|---------------|-----------------------|--------------------------|------|------|------|------|------|------|--------------------------|------|------|------|------|------|------|
|               |                       | ← Percentile of Height → |      |      |      |      |      |      | ← Percentile of Height → |      |      |      |      |      |      |
|               |                       | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th |
| 1             | 50th                  | 80                       | 81   | 83   | 85   | 87   | 88   | 89   | 34                       | 35   | 36   | 37   | 38   | 39   | 39   |
|               | 90th                  | 94                       | 95   | 97   | 99   | 100  | 102  | 103  | 49                       | 50   | 51   | 52   | 53   | 53   | 54   |
|               | 95th                  | 98                       | 99   | 101  | 103  | 104  | 106  | 106  | 54                       | 54   | 55   | 56   | 57   | 58   | 58   |
|               | 99th                  | 105                      | 106  | 108  | 110  | 112  | 113  | 114  | 61                       | 62   | 63   | 64   | 65   | 66   | 66   |
| 2             | 50th                  | 84                       | 85   | 87   | 88   | 90   | 92   | 92   | 39                       | 40   | 41   | 42   | 43   | 44   | 44   |
|               | 90th                  | 97                       | 99   | 100  | 102  | 104  | 105  | 106  | 54                       | 55   | 56   | 57   | 58   | 58   | 59   |
|               | 95th                  | 101                      | 102  | 104  | 106  | 108  | 109  | 110  | 59                       | 59   | 60   | 61   | 62   | 63   | 63   |
|               | 99th                  | 109                      | 110  | 111  | 113  | 115  | 117  | 117  | 66                       | 67   | 68   | 69   | 70   | 71   | 71   |
| 3             | 50th                  | 86                       | 87   | 89   | 91   | 93   | 94   | 95   | 44                       | 44   | 45   | 46   | 47   | 48   | 48   |
|               | 90th                  | 100                      | 101  | 103  | 105  | 107  | 108  | 109  | 59                       | 59   | 60   | 61   | 62   | 63   | 63   |
|               | 95th                  | 104                      | 105  | 107  | 109  | 110  | 112  | 113  | 63                       | 63   | 64   | 65   | 66   | 67   | 67   |
|               | 99th                  | 111                      | 112  | 114  | 116  | 118  | 119  | 120  | 71                       | 71   | 72   | 73   | 74   | 75   | 75   |
| 4             | 50th                  | 88                       | 89   | 91   | 93   | 95   | 96   | 97   | 47                       | 48   | 49   | 50   | 51   | 51   | 52   |
|               | 90th                  | 102                      | 103  | 105  | 107  | 109  | 110  | 111  | 62                       | 63   | 64   | 65   | 66   | 66   | 67   |
|               | 95th                  | 106                      | 107  | 109  | 111  | 112  | 114  | 115  | 66                       | 67   | 68   | 69   | 70   | 71   | 71   |
|               | 99th                  | 113                      | 114  | 116  | 118  | 120  | 121  | 122  | 74                       | 75   | 76   | 77   | 78   | 78   | 79   |
| 5             | 50th                  | 90                       | 91   | 93   | 95   | 96   | 98   | 98   | 50                       | 51   | 52   | 53   | 54   | 55   | 55   |
|               | 90th                  | 104                      | 105  | 106  | 108  | 110  | 111  | 112  | 65                       | 66   | 67   | 68   | 69   | 69   | 70   |
|               | 95th                  | 108                      | 109  | 110  | 112  | 114  | 115  | 116  | 69                       | 70   | 71   | 72   | 73   | 74   | 74   |
|               | 99th                  | 115                      | 116  | 118  | 120  | 121  | 123  | 123  | 77                       | 78   | 79   | 80   | 81   | 81   | 82   |
| 6             | 50th                  | 91                       | 92   | 94   | 96   | 98   | 99   | 100  | 53                       | 53   | 54   | 55   | 56   | 57   | 57   |
|               | 90th                  | 105                      | 106  | 108  | 110  | 111  | 113  | 113  | 68                       | 68   | 69   | 70   | 71   | 72   | 72   |
|               | 95th                  | 109                      | 110  | 112  | 114  | 115  | 117  | 117  | 72                       | 72   | 73   | 74   | 75   | 76   | 76   |
|               | 99th                  | 116                      | 117  | 119  | 121  | 123  | 124  | 125  | 80                       | 80   | 81   | 82   | 83   | 84   | 84   |
| 7             | 50th                  | 92                       | 94   | 95   | 97   | 99   | 100  | 101  | 55                       | 55   | 56   | 57   | 58   | 59   | 59   |
|               | 90th                  | 106                      | 107  | 109  | 111  | 113  | 114  | 115  | 70                       | 70   | 71   | 72   | 73   | 74   | 74   |
|               | 95th                  | 110                      | 111  | 113  | 115  | 117  | 118  | 119  | 74                       | 74   | 75   | 76   | 77   | 78   | 78   |
|               | 99th                  | 117                      | 118  | 120  | 122  | 124  | 125  | 126  | 82                       | 82   | 83   | 84   | 85   | 86   | 86   |
| 8             | 50th                  | 94                       | 95   | 97   | 99   | 100  | 102  | 102  | 56                       | 57   | 58   | 59   | 60   | 60   | 61   |
|               | 90th                  | 107                      | 109  | 110  | 112  | 114  | 115  | 116  | 71                       | 72   | 72   | 73   | 74   | 75   | 76   |
|               | 95th                  | 111                      | 112  | 114  | 116  | 118  | 119  | 120  | 75                       | 76   | 77   | 78   | 79   | 79   | 80   |
|               | 99th                  | 119                      | 120  | 122  | 123  | 125  | 127  | 127  | 83                       | 84   | 85   | 86   | 87   | 87   | 88   |
| 9             | 50th                  | 95                       | 96   | 98   | 100  | 102  | 103  | 104  | 57                       | 58   | 59   | 60   | 61   | 61   | 62   |
|               | 90th                  | 109                      | 110  | 112  | 114  | 115  | 117  | 118  | 72                       | 73   | 74   | 75   | 76   | 76   | 77   |
|               | 95th                  | 113                      | 114  | 116  | 118  | 119  | 121  | 121  | 76                       | 77   | 78   | 79   | 80   | 81   | 81   |
|               | 99th                  | 120                      | 121  | 123  | 125  | 127  | 128  | 129  | 84                       | 85   | 86   | 87   | 88   | 88   | 89   |
| 10            | 50th                  | 97                       | 98   | 100  | 102  | 103  | 105  | 106  | 58                       | 59   | 60   | 61   | 61   | 62   | 63   |
|               | 90th                  | 111                      | 112  | 114  | 115  | 117  | 119  | 119  | 73                       | 73   | 74   | 75   | 76   | 77   | 78   |
|               | 95th                  | 115                      | 116  | 117  | 119  | 121  | 122  | 123  | 77                       | 78   | 79   | 80   | 81   | 81   | 82   |
|               | 99th                  | 122                      | 123  | 125  | 127  | 128  | 130  | 130  | 85                       | 86   | 86   | 88   | 88   | 89   | 90   |

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**Blood Pressure Levels for Boys by Age and Height Percentile (Continued)**

| Age<br>(Year) | BP<br>Percentile<br>↓ | Systolic BP (mmHg)       |      |      |      |      |      |      | Diastolic BP (mmHg)      |      |      |      |      |      |      |
|---------------|-----------------------|--------------------------|------|------|------|------|------|------|--------------------------|------|------|------|------|------|------|
|               |                       | ← Percentile of Height → |      |      |      |      |      |      | ← Percentile of Height → |      |      |      |      |      |      |
|               |                       | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th |
| 11            | 50th                  | 99                       | 100  | 102  | 104  | 105  | 107  | 107  | 59                       | 59   | 60   | 61   | 62   | 63   | 63   |
|               | 90th                  | 113                      | 114  | 115  | 117  | 119  | 120  | 121  | 74                       | 74   | 75   | 76   | 77   | 78   | 78   |
|               | 95th                  | 117                      | 118  | 119  | 121  | 123  | 124  | 125  | 78                       | 78   | 79   | 80   | 81   | 82   | 82   |
|               | 99th                  | 124                      | 125  | 127  | 129  | 130  | 132  | 132  | 86                       | 86   | 87   | 88   | 89   | 90   | 90   |
| 12            | 50th                  | 101                      | 102  | 104  | 106  | 108  | 109  | 110  | 59                       | 60   | 61   | 62   | 63   | 63   | 64   |
|               | 90th                  | 115                      | 116  | 118  | 120  | 121  | 123  | 123  | 74                       | 75   | 75   | 76   | 77   | 78   | 79   |
|               | 95th                  | 119                      | 120  | 122  | 123  | 125  | 127  | 127  | 78                       | 79   | 80   | 81   | 82   | 82   | 83   |
|               | 99th                  | 126                      | 127  | 129  | 131  | 133  | 134  | 135  | 86                       | 87   | 88   | 89   | 90   | 90   | 91   |
| 13            | 50th                  | 104                      | 105  | 106  | 108  | 110  | 111  | 112  | 60                       | 60   | 61   | 62   | 63   | 64   | 64   |
|               | 90th                  | 117                      | 118  | 120  | 122  | 124  | 125  | 126  | 75                       | 75   | 76   | 77   | 78   | 79   | 79   |
|               | 95th                  | 121                      | 122  | 124  | 126  | 128  | 129  | 130  | 79                       | 79   | 80   | 81   | 82   | 83   | 83   |
|               | 99th                  | 128                      | 130  | 131  | 133  | 135  | 136  | 137  | 87                       | 87   | 88   | 89   | 90   | 91   | 91   |
| 14            | 50th                  | 106                      | 107  | 109  | 111  | 113  | 114  | 115  | 60                       | 61   | 62   | 63   | 64   | 65   | 65   |
|               | 90th                  | 120                      | 121  | 123  | 125  | 126  | 128  | 128  | 75                       | 76   | 77   | 78   | 79   | 79   | 80   |
|               | 95th                  | 124                      | 125  | 127  | 128  | 130  | 132  | 132  | 80                       | 80   | 81   | 82   | 83   | 84   | 84   |
|               | 99th                  | 131                      | 132  | 134  | 136  | 138  | 139  | 140  | 87                       | 88   | 89   | 90   | 91   | 92   | 92   |
| 15            | 50th                  | 109                      | 110  | 112  | 113  | 115  | 117  | 117  | 61                       | 62   | 63   | 64   | 65   | 66   | 66   |
|               | 90th                  | 122                      | 124  | 125  | 127  | 129  | 130  | 131  | 76                       | 77   | 78   | 79   | 80   | 80   | 81   |
|               | 95th                  | 126                      | 127  | 129  | 131  | 133  | 134  | 135  | 81                       | 81   | 82   | 83   | 84   | 85   | 85   |
|               | 99th                  | 134                      | 135  | 136  | 138  | 140  | 142  | 142  | 88                       | 89   | 90   | 91   | 92   | 93   | 93   |
| 16            | 50th                  | 111                      | 112  | 114  | 116  | 118  | 119  | 120  | 63                       | 63   | 64   | 65   | 66   | 67   | 67   |
|               | 90th                  | 125                      | 126  | 128  | 130  | 131  | 133  | 134  | 78                       | 78   | 79   | 80   | 81   | 82   | 82   |
|               | 95th                  | 129                      | 130  | 132  | 134  | 135  | 137  | 137  | 82                       | 83   | 83   | 84   | 85   | 86   | 87   |
|               | 99th                  | 136                      | 137  | 139  | 141  | 143  | 144  | 145  | 90                       | 90   | 91   | 92   | 93   | 94   | 94   |
| 17            | 50th                  | 114                      | 115  | 116  | 118  | 120  | 121  | 122  | 65                       | 66   | 66   | 67   | 68   | 69   | 70   |
|               | 90th                  | 127                      | 128  | 130  | 132  | 134  | 135  | 136  | 80                       | 80   | 81   | 82   | 83   | 84   | 84   |
|               | 95th                  | 131                      | 132  | 134  | 136  | 138  | 139  | 140  | 84                       | 85   | 86   | 87   | 87   | 88   | 89   |
|               | 99th                  | 139                      | 140  | 141  | 143  | 145  | 146  | 147  | 92                       | 93   | 93   | 94   | 95   | 96   | 97   |

BP, blood pressure

\* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

For research purposes, the standard deviations in Appendix Table B–1 allow one to compute BP Z-scores and percentiles for boys with height percentiles given in Table 3 (i.e., the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height Z-scores given by (5% = -1.645; 10% = -1.28; 25% = -0.68; 50% = 0; 75% = 0.68; 90% = 1.28%; 95% = 1.645) and then computed according to the methodology in steps 2–4 described in Appendix B. For children with height percentiles other than these, follow steps 1–4 as described in Appendix B.

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**Blood Pressure Levels for Girls by Age and Height Percentile**

| Age<br>(Year) | BP<br>Percentile<br>↓ | Systolic BP (mmHg)       |      |      |      |      |      |      | Diastolic BP (mmHg)      |      |      |      |      |      |      |
|---------------|-----------------------|--------------------------|------|------|------|------|------|------|--------------------------|------|------|------|------|------|------|
|               |                       | ← Percentile of Height → |      |      |      |      |      |      | ← Percentile of Height → |      |      |      |      |      |      |
|               |                       | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th |
| 1             | 50th                  | 83                       | 84   | 85   | 86   | 88   | 89   | 90   | 38                       | 39   | 39   | 40   | 41   | 41   | 42   |
|               | 90th                  | 97                       | 97   | 98   | 100  | 101  | 102  | 103  | 52                       | 53   | 53   | 54   | 55   | 55   | 56   |
|               | 95th                  | 100                      | 101  | 102  | 104  | 105  | 106  | 107  | 56                       | 57   | 57   | 58   | 59   | 59   | 60   |
|               | 99th                  | 108                      | 108  | 109  | 111  | 112  | 113  | 114  | 64                       | 64   | 65   | 65   | 66   | 67   | 67   |
| 2             | 50th                  | 85                       | 85   | 87   | 88   | 89   | 91   | 91   | 43                       | 44   | 44   | 45   | 46   | 46   | 47   |
|               | 90th                  | 98                       | 99   | 100  | 101  | 103  | 104  | 105  | 57                       | 58   | 58   | 59   | 60   | 61   | 61   |
|               | 95th                  | 102                      | 103  | 104  | 105  | 107  | 108  | 109  | 61                       | 62   | 62   | 63   | 64   | 65   | 65   |
|               | 99th                  | 109                      | 110  | 111  | 112  | 114  | 115  | 116  | 69                       | 69   | 70   | 70   | 71   | 72   | 72   |
| 3             | 50th                  | 86                       | 87   | 88   | 89   | 91   | 92   | 93   | 47                       | 48   | 48   | 49   | 50   | 50   | 51   |
|               | 90th                  | 100                      | 100  | 102  | 103  | 104  | 106  | 106  | 61                       | 62   | 62   | 63   | 64   | 64   | 65   |
|               | 95th                  | 104                      | 104  | 105  | 107  | 108  | 109  | 110  | 65                       | 66   | 66   | 67   | 68   | 68   | 69   |
|               | 99th                  | 111                      | 111  | 113  | 114  | 115  | 116  | 117  | 73                       | 73   | 74   | 74   | 75   | 76   | 76   |
| 4             | 50th                  | 88                       | 88   | 90   | 91   | 92   | 94   | 94   | 50                       | 50   | 51   | 52   | 52   | 53   | 54   |
|               | 90th                  | 101                      | 102  | 103  | 104  | 106  | 107  | 108  | 64                       | 64   | 65   | 66   | 67   | 67   | 68   |
|               | 95th                  | 105                      | 106  | 107  | 108  | 110  | 111  | 112  | 68                       | 68   | 69   | 70   | 71   | 71   | 72   |
|               | 99th                  | 112                      | 113  | 114  | 115  | 117  | 118  | 119  | 76                       | 76   | 76   | 77   | 78   | 79   | 79   |
| 5             | 50th                  | 89                       | 90   | 91   | 93   | 94   | 95   | 96   | 52                       | 53   | 53   | 54   | 55   | 55   | 56   |
|               | 90th                  | 103                      | 103  | 105  | 106  | 107  | 109  | 109  | 66                       | 67   | 67   | 68   | 69   | 69   | 70   |
|               | 95th                  | 107                      | 107  | 108  | 110  | 111  | 112  | 113  | 70                       | 71   | 71   | 72   | 73   | 73   | 74   |
|               | 99th                  | 114                      | 114  | 116  | 117  | 118  | 120  | 120  | 78                       | 78   | 79   | 79   | 80   | 81   | 81   |
| 6             | 50th                  | 91                       | 92   | 93   | 94   | 96   | 97   | 98   | 54                       | 54   | 55   | 56   | 56   | 57   | 58   |
|               | 90th                  | 104                      | 105  | 106  | 108  | 109  | 110  | 111  | 68                       | 68   | 69   | 70   | 70   | 71   | 72   |
|               | 95th                  | 108                      | 109  | 110  | 111  | 113  | 114  | 115  | 72                       | 72   | 73   | 74   | 74   | 75   | 76   |
|               | 99th                  | 115                      | 116  | 117  | 119  | 120  | 121  | 122  | 80                       | 80   | 80   | 81   | 82   | 83   | 83   |
| 7             | 50th                  | 93                       | 93   | 95   | 96   | 97   | 99   | 99   | 55                       | 56   | 56   | 57   | 58   | 58   | 59   |
|               | 90th                  | 106                      | 107  | 108  | 109  | 111  | 112  | 113  | 69                       | 70   | 70   | 71   | 72   | 72   | 73   |
|               | 95th                  | 110                      | 111  | 112  | 113  | 115  | 116  | 116  | 73                       | 74   | 74   | 75   | 76   | 76   | 77   |
|               | 99th                  | 117                      | 118  | 119  | 120  | 122  | 123  | 124  | 81                       | 81   | 82   | 82   | 83   | 84   | 84   |
| 8             | 50th                  | 95                       | 95   | 96   | 98   | 99   | 100  | 101  | 57                       | 57   | 57   | 58   | 59   | 60   | 60   |
|               | 90th                  | 108                      | 109  | 110  | 111  | 113  | 114  | 114  | 71                       | 71   | 71   | 72   | 73   | 74   | 74   |
|               | 95th                  | 112                      | 112  | 114  | 115  | 116  | 118  | 118  | 75                       | 75   | 75   | 76   | 77   | 78   | 78   |
|               | 99th                  | 119                      | 120  | 121  | 122  | 123  | 125  | 125  | 82                       | 82   | 83   | 83   | 84   | 85   | 86   |
| 9             | 50th                  | 96                       | 97   | 98   | 100  | 101  | 102  | 103  | 58                       | 58   | 58   | 59   | 60   | 61   | 61   |
|               | 90th                  | 110                      | 110  | 112  | 113  | 114  | 116  | 116  | 72                       | 72   | 72   | 73   | 74   | 75   | 75   |
|               | 95th                  | 114                      | 114  | 115  | 117  | 118  | 119  | 120  | 76                       | 76   | 76   | 77   | 78   | 79   | 79   |
|               | 99th                  | 121                      | 121  | 123  | 124  | 125  | 127  | 127  | 83                       | 83   | 84   | 84   | 85   | 86   | 87   |
| 10            | 50th                  | 98                       | 99   | 100  | 102  | 103  | 104  | 105  | 59                       | 59   | 59   | 60   | 61   | 62   | 62   |
|               | 90th                  | 112                      | 112  | 114  | 115  | 116  | 118  | 118  | 73                       | 73   | 73   | 74   | 75   | 76   | 76   |
|               | 95th                  | 116                      | 116  | 117  | 119  | 120  | 121  | 122  | 77                       | 77   | 77   | 78   | 79   | 80   | 80   |
|               | 99th                  | 123                      | 123  | 125  | 126  | 127  | 129  | 129  | 84                       | 84   | 85   | 86   | 86   | 87   | 88   |

**Protocol: Severe Traumatic Brain Injury –  
Management of the Pediatric Patient: (≤ Age 17)  
Resuscitation Phase of Care: Emergency Department**



Hennepin County Medical Center

Traumatic Brain Injury Center • [www.hcmc.org/braininjury](http://www.hcmc.org/braininjury)

**Blood Pressure Levels for Girls by Age and Height Percentile (Continued)**

| Age<br>(Year) | BP<br>Percentile<br>↓ | Systolic BP (mmHg)       |      |      |      |      |      |      | Diastolic BP (mmHg)      |      |      |      |      |      |      |
|---------------|-----------------------|--------------------------|------|------|------|------|------|------|--------------------------|------|------|------|------|------|------|
|               |                       | ← Percentile of Height → |      |      |      |      |      |      | ← Percentile of Height → |      |      |      |      |      |      |
|               |                       | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th | 5th                      | 10th | 25th | 50th | 75th | 90th | 95th |
| 11            | 50th                  | 100                      | 101  | 102  | 103  | 105  | 106  | 107  | 60                       | 60   | 60   | 61   | 62   | 63   | 63   |
|               | 90th                  | 114                      | 114  | 116  | 117  | 118  | 119  | 120  | 74                       | 74   | 74   | 75   | 76   | 77   | 77   |
|               | 95th                  | 118                      | 118  | 119  | 121  | 122  | 123  | 124  | 78                       | 78   | 78   | 79   | 80   | 81   | 81   |
|               | 99th                  | 125                      | 125  | 126  | 128  | 129  | 130  | 131  | 85                       | 85   | 86   | 87   | 87   | 88   | 89   |
| 12            | 50th                  | 102                      | 103  | 104  | 105  | 107  | 108  | 109  | 61                       | 61   | 61   | 62   | 63   | 64   | 64   |
|               | 90th                  | 116                      | 116  | 117  | 119  | 120  | 121  | 122  | 75                       | 75   | 75   | 76   | 77   | 78   | 78   |
|               | 95th                  | 119                      | 120  | 121  | 123  | 124  | 125  | 126  | 79                       | 79   | 79   | 80   | 81   | 82   | 82   |
|               | 99th                  | 127                      | 127  | 128  | 130  | 131  | 132  | 133  | 86                       | 86   | 87   | 88   | 88   | 89   | 90   |
| 13            | 50th                  | 104                      | 105  | 106  | 107  | 109  | 110  | 110  | 62                       | 62   | 62   | 63   | 64   | 65   | 65   |
|               | 90th                  | 117                      | 118  | 119  | 121  | 122  | 123  | 124  | 76                       | 76   | 76   | 77   | 78   | 79   | 79   |
|               | 95th                  | 121                      | 122  | 123  | 124  | 126  | 127  | 128  | 80                       | 80   | 80   | 81   | 82   | 83   | 83   |
|               | 99th                  | 128                      | 129  | 130  | 132  | 133  | 134  | 135  | 87                       | 87   | 88   | 89   | 89   | 90   | 91   |
| 14            | 50th                  | 106                      | 106  | 107  | 109  | 110  | 111  | 112  | 63                       | 63   | 63   | 64   | 65   | 66   | 66   |
|               | 90th                  | 119                      | 120  | 121  | 122  | 124  | 125  | 125  | 77                       | 77   | 77   | 78   | 79   | 80   | 80   |
|               | 95th                  | 123                      | 123  | 125  | 126  | 127  | 129  | 129  | 81                       | 81   | 81   | 82   | 83   | 84   | 84   |
|               | 99th                  | 130                      | 131  | 132  | 133  | 135  | 136  | 136  | 88                       | 88   | 89   | 90   | 90   | 91   | 92   |
| 15            | 50th                  | 107                      | 108  | 109  | 110  | 111  | 113  | 113  | 64                       | 64   | 64   | 65   | 66   | 67   | 67   |
|               | 90th                  | 120                      | 121  | 122  | 123  | 125  | 126  | 127  | 78                       | 78   | 78   | 79   | 80   | 81   | 81   |
|               | 95th                  | 124                      | 125  | 126  | 127  | 129  | 130  | 131  | 82                       | 82   | 82   | 83   | 84   | 85   | 85   |
|               | 99th                  | 131                      | 132  | 133  | 134  | 136  | 137  | 138  | 89                       | 89   | 90   | 91   | 91   | 92   | 93   |
| 16            | 50th                  | 108                      | 108  | 110  | 111  | 112  | 114  | 114  | 64                       | 64   | 65   | 66   | 66   | 67   | 68   |
|               | 90th                  | 121                      | 122  | 123  | 124  | 126  | 127  | 128  | 78                       | 78   | 79   | 80   | 81   | 81   | 82   |
|               | 95th                  | 125                      | 126  | 127  | 128  | 130  | 131  | 132  | 82                       | 82   | 83   | 84   | 85   | 85   | 86   |
|               | 99th                  | 132                      | 133  | 134  | 135  | 137  | 138  | 139  | 90                       | 90   | 90   | 91   | 92   | 93   | 93   |
| 17            | 50th                  | 108                      | 109  | 110  | 111  | 113  | 114  | 115  | 64                       | 65   | 65   | 66   | 67   | 67   | 68   |
|               | 90th                  | 122                      | 122  | 123  | 125  | 126  | 127  | 128  | 78                       | 79   | 79   | 80   | 81   | 81   | 82   |
|               | 95th                  | 125                      | 126  | 127  | 129  | 130  | 131  | 132  | 82                       | 83   | 83   | 84   | 85   | 85   | 86   |
|               | 99th                  | 133                      | 133  | 134  | 136  | 137  | 138  | 139  | 90                       | 90   | 91   | 91   | 92   | 93   | 93   |

BP, blood pressure

\* The 90th percentile is 1.28 SD, 95th percentile is 1.645 SD, and the 99th percentile is 2.326 SD over the mean.

For research purposes, the standard deviations in Appendix Table B-1 allow one to compute BP Z-scores and percentiles for girls with height percentiles given in Table 4 (i.e., the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles). These height percentiles must be converted to height Z-scores given by (5% = -1.645; 10% = -1.28; 25% = -0.68; 50% = 0; 75% = 0.68; 90% = 1.28%; 95% = 1.645) and then computed according to the methodology in steps 2-4 described in Appendix B. For children with height percentiles other than these, follow steps 1-4 as described in Appendix B.