

## Coagulopathy Is Associated with Complications in Polytrauma Patients Undergoing Fracture Fixation

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**Purpose:** Coagulopathy, secondary to hemorrhage, and potentially aggravated by preexisting factors, is a contributor to morbidity and mortality in trauma patients. However, the relationship between coagulopathy and outcomes in trauma patients is poorly defined. This study evaluates coagulopathy determined by routine laboratory studies as a predictor of complications in multiply injured trauma patients with orthopaedic injuries. We hypothesized that routine laboratory indicators of coagulopathy on presentation and perioperatively would be associated with complications.

**Methods:** Laboratory and clinical data were prospectively collected for 375 consecutive, skeletally mature patients with unstable spine, pelvis, and/or femur fractures and injury to at least one other system, with minimum ISS of 16, treated over 30 months. 263 men (70.1%) and 112 women were included with mean age 39.9 years and mean ISS 26.9. They underwent a total of 540 surgical procedures during the initial hospitalization, including both orthopaedic (n = 495) and nonorthopaedic (n = 45) operations. Coagulopathy was defined as international normalized ratio (INR) of  $\geq 1.3$ , prothrombin time (PT) of  $\geq 14.1$ , partial thromboplastin time (PTT) of  $\geq 36$ , or platelet count of  $< 100,000/\mu\text{L}$ . Complications were compared for patients with coagulopathy within 8 hours of injury (n = 68) versus those with normal coagulation parameters (n = 307). Binary logistic regression was used to determine odds ratios (ORs) of complications with worsening measures of coagulopathy. Adjudicated complications included pneumonia (PNA), acute respiratory distress syndrome (ARDS), acute renal failure (ARF), multiple organ failure (MOF), deep vein thrombosis (DVT), pulmonary embolism (PE), wound infection, sepsis, and death.

**Results:** 68 patients (18.1%) were coagulopathic within 8 hours of injury, with 56 (82.3%) having INR  $\geq 1.3$ , 54 (79.4%) having PT  $\geq 14.1$ , 22 (32.4%) having PTT  $\geq 36$ , and 22 (32.4%) having platelet count  $< 100\text{K}$ . For coagulopathic patients, the mean highest INR within 8 hours of injury was slightly lower than the highest INR at anytime (see table). The highest INR occurred within the first 8 hours in 47% of coagulopathic patients, with 13.3%, 7.2%, 22.9%, 8.4%, and 1.2% occurring from 8 to 16 hours, 16 to 24 hours, 24 to 36 hours, 36 to 48 hours, and greater than 48 hours after injury, respectively. There were similar findings for the highest mean PT and PTT. The lowest mean platelet values were highest within 8 hours of injury. Coagulopathic patients had higher ISS (38.4 vs 24.3,  $P < 0.001$ ) and more abdominal injuries (51% vs 22%), especially liver lacerations (32% vs 9.1%). Mean age and number of head and chest injuries were similar between groups. 56% of coagulopathic patients and 27% of patients with normal coagulation studies developed at least one complication ( $P < 0.001$ ), with more PNA (17.7% vs 8.5%,  $P = 0.023$ ), ARF (8.8% vs 2.0%,  $P = 0.003$ ), ARDS (4.4% vs 1.3%,  $P = 0.116$ ), MOF (4.4% vs 0%,  $P < 0.006$ ), infection (16.2% vs

6.2%,  $P < 0.001$ ), and death (14.7% vs 2.3%,  $P < 0.001$ ) in the coagulopathic group. Although binary logistic regression showed that between admission and 8 hours pH, base deficit, platelet, PT, and INR were predictors of complications individually; after controlling for age and ISS there was no statistical significance. As the hospital course extended, measures of coagulopathy were still not statistically significant predictors of complications when controlled for age and ISS.

**Conclusion:** Coagulopathy occurred in 18% of our patients and was more frequent with abdominal injuries, which may generate large amounts of hemorrhage. Coagulopathy was associated with higher rates of all measured complications. Although coagulopathy is associated with complications, increasing measures of coagulopathy were not predictive of complications when controlled for age and ISS. Further study is needed to determine whether more aggressive early correction of coagulopathy should be incorporated into existing resuscitation protocols. Additionally, more specific diagnostic techniques, such as thromboelastography, may be helpful in individualizing treatment.

**For Coagulopathic Patients (n=68):**

| <b>INR</b>   | <b>Mean Max</b> | <b>SD</b> | <b>N</b> |
|--------------|-----------------|-----------|----------|
| 0 to 8 hrs   | 1.482           | 0.411     | 68       |
| 8 to 16 hrs  | 1.274           | 0.406     | 46       |
| 16 to 24 hrs | 1.254           | 0.176     | 37       |
| 24 to 36 hrs | 1.394           | 0.191     | 35       |
| 36 to 48 hrs | 1.326           | 0.221     | 34       |
| > 48 hrs     | 1.257           | 0.193     | 23       |
| Any time     | 1.557           | 0.399     | 68       |
| <b>PT</b>    |                 |           |          |
| 0 to 8 hrs   | 15.765          | 2.952     | 66       |
| 8 to 16 hrs  | 14.339          | 4.821     | 46       |
| 16 to 24 hrs | 14.143          | 2.040     | 37       |
| 24 to 36 hrs | 15.874          | 2.243     | 35       |
| 36 to 48 hrs | 15.118          | 2.585     | 34       |
| > 48 hrs     | 14.222          | 2.366     | 23       |
| Any time     | 18.054          | 4.800     | 68       |
| <b>PTT</b>   |                 |           |          |
| 0 to 8 hrs   | 33.703          | 9.913     | 64       |
| 8 to 16 hrs  | 29.000          | 3.857     | 33       |
| 16 to 24 hrs | 29.077          | 2.226     | 26       |
| 24 to 36 hrs | 30.167          | 5.205     | 18       |
| 36 to 48 hrs | 30.467          | 4.734     | 15       |
| > 48 hrs     | 31.200          | 5.473     | 10       |
| Any time     | 35.627          | 9.826     | 67       |
| <b>PLT</b>   |                 |           |          |
|              | <b>Mean Min</b> | <b>SD</b> | <b>N</b> |
| 0 to 8 hrs   | 137.439         | 66.892    | 66       |
| 8 to 16 hrs  | 124.593         | 50.518    | 59       |
| 16 to 24 hrs | 120.690         | 36.063    | 58       |
| 24 to 36 hrs | 115.983         | 36.504    | 60       |
| 36 to 48 hrs | 107.750         | 35.603    | 52       |
| > 48 hrs     | 105.925         | 34.675    | 53       |
| Any time     | 86.779          | 34.231    | 68       |

The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.