Background: Umbilical catheters (UC) are commonly used in patients in the neonatal intensive care unit (NICU) for continuous blood pressure monitoring, blood sampling, parenteral nutrition, and medication administration. Malpositioned catheters can increase the risk of complications including hepatic injury, effusion, and cardiac arrhythmia. Catheter tip repositioning often requires additional confirmatory chest radiographs. Proper initial placement can therefore potentially decrease catheter-associated complications, cost, and radiation exposure. We sought to assess the accuracy of the Shukla formula and to identify an improved method for determining UC placement depth.

Methods: Neonates who underwent successful umbilical arterial catheter (UAC) and/or umbilical venous catheter (UVC) placement in 2016-2018 were included in this retrospective study. Catheter depth was estimated using the Shukla formula then adjusted based on thoracoabdominal radiograph(s) to achieve an optimal final depth. The distance between the T1 and T12 vertebral bodies was measured for every infant and final UC depth was plotted against both birth weight (BW) and T1-T12 distance. Trend lines were generated using B-spline and linear regression, respectively.

Results: Data were collected from 236 UACs and 242 UVCs appropriately positioned in 350 neonates with median gestational age of 28 (22-41) weeks and BW of 980 (340-5080) grams. The Shukla formula tended to overestimate insertion depth and successfully predicted initial proper positioning in only 44% of UACs and 36% of UVCs. A non-linear relationship between catheter depth and BW (Figure 1), and a linear relationship between catheter depth and T1-T12 distance (Figure 2) was determined.

Conclusions: UCs placed using the Shukla formula frequently require repositioning for correct placement due to a non-linear relationship between catheter depth and BW. The T1-T12 distance may be a more reliable predictor of proper UC depth in a subset of infants who have chest radiographs prior to catheter insertion.
Figure 2.