Chapter 5

Development of Clinical Prediction Rule for Failed Non-Surgical Reduction of Intussusception

Publication of short communication in this chapter is listed below.

Khorana J, Patumanond J, Ukarapol N, Laohapensang M, Visrutaratna P, Singhavejsakul J. Clinical prediction rules for failed nonoperative reduction of intussusception. TherClin Risk Manag. 2016;12:1411-6.

Intussusception in children is common at age three months to three years. Due to the occurrence among small children, parental concerns are an important element to cope with. Information about the diagnosis, treatment and prognosis are crucial issues for family members. After the diagnosis of intussusception was established, the contraindication for non-surgical reduction was looked for and adequate resuscitation was performed. When no contraindications were observed, nonsurgical reduction was attempted. The prognostic factors to reduce failure were studied and used to predict the outcome of the reduction to better advise parents. No widely used scoring system was available to predict failed nonsurgical reduction of intussusception.

In 1986, a large study series of intussusception in China by Guo was conducted among 6,396 patients with intussusception over 13 years,[1] using air enema. From this study, the first clinical criteria scoring system for intussusception was established. The factors used to predict the success ratecomprised duration of onset, age, interval between the onset of symptom and bloody stool, stool characteristics, coexisting diarrhea, abdominal distension and dehydration. The success rate of reduction was decreased when the score was more than 15 of 25. After that, no study proposed any prediction score for successful intussusception reduction.

In 2007, Fragoso set an equation to predict failed result of air enema reduction.[2]The given probability equation was $e^{g(x)/1} + e^{g(x)}$, where $g(x) = 1.225x1 - 0.480x2 - 2.444x3 + 0.058x4 - 6.949$ (x1, sex: 0 [female] or 1 [male]; x2, age in months; x3, delayed diagnosis: 0 [no] or 1 [yes] and x4, neutrophils [%]). The author also stated no clinical relevance was found in this equation model.

Our 2016 study established clinical prediction rules to predict the failure of nonsurgical reduction of intussusception.[3] Ten parametersused to calculate prediction scores from a related study included demography (body weight), symptoms (duration of symptoms, vomiting, rectal bleeding and abdominal distension), signs (body temperature, palpable mass and location of the mass), sonographic findings and method of reduction.

Development of clinical prediction rule

The clinical prediction model for failed reduction of intussusception was derived using ten significant risk factors from a related study. Numerical parameters such as bodyweight, duration of symptoms and temperature were separated in two groups. The logistic regression model was used to construct the item scores transformed from the regression coefficients of each factor. The regression coefficients were converted to transformed coefficients by dividing the smallest coefficient in the model, i.e., 0.23 and then rounding up to the nearest integer to create the assigned score (Table 5.1).

Total score was calculated from all item scores added together. The higher the total score, the higher the risk for reduction failure. The total scores ranged from 0 to 16. We categorized these as low risk (scores 0-11) and high risk groups (scores 12-16) as shown in Table 5.2.

The score model set up to predict failed outcome of the reduction were constructed from ten parameters. The receiver operating characteristic (ROC) curve of the failed nonoperative reduction of intussusceptions predicted by risk scoring scheme was performed. The area under the ROC curve, which determined the prediction ability of the score model, was 80.68% as shown in Figure 5.1.

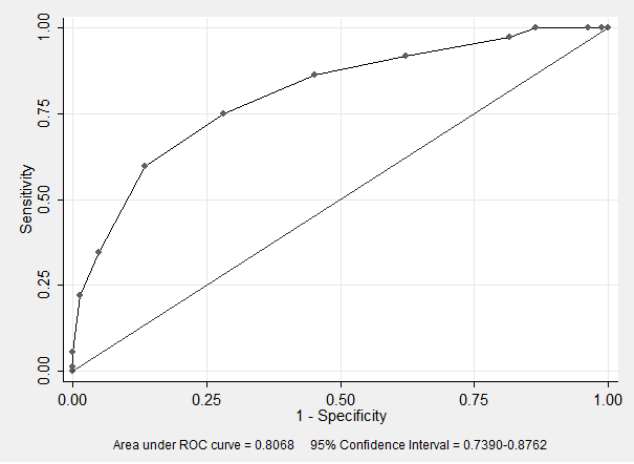

Figure 5.1 The Receiver operating characteristic (ROC) curve of failure non-operative reduction of intussusceptions predicted by risk scoring scheme (curved line) and a 50% chance prediction (diagonal line). Sources :TherClin Risk Manag. 2016;12:1411-6.

Table 5.1 Item Scoring Scheme for Predictors for Failure Reduction of Intussusception Derived from Coefficients of Selected Indicators

Risk indicators	Coefficients	Transformed Coefficients	Assigned Score
Weight			
≤ 12 Kg	0.39	1.70	2
> 12 Kg	-	-	0
Duration of symptoms			
≤48 Hours	-	-	0
> 48 Hours	0.23	1	1
Vomiting			
No	-	-	0
Yes	0.49	2.13	2
Rectal Bleeding			
No	-	-	0
Yes	0.41	1.78	2
Abdominal distension			
No	-	-	0
Yes	0.47	2.04	2
Temperature > 37.8^{o}C			
No	-	-	0
Yes	0.41	1.78	2
Palpable Mass			
No	-	-	0
Yes	0.23	1	1
Location			
Right	-	-	0
Left	0.39	1.70	2
Ultrasound (Poor Prognosis Sign)			
No	-	-	0
Yes	0.30	1.30	1
Method of Reduction			
Pneumatic	-	-	0
Hydrostatic	0.29	1.26	1

Sources :TherClin Risk Manag. 2016;12:1411-6.

Table 5.2 Distribution of Risk Failed Non-Operative Reduction of Intussusceptions, LR+ and 95% CI of LR+

Risk level	Failed n(%)	Successful n(%)	LR+	95%CI of LR+
Low (score≤11)	56(40.9)	81(59.1)	0.79	0.69-0.89
High (score>11)	16(94.1)	1(5.9)	18.22	2.48-134.02

LR+ : Likelihood Ratio of Positive, CI : confidence interval
Sources :TherClin Risk Manag. 2016;12:1411-6.

The relationship between the proportion of failed reductions with the total scores is shown in Figure 5.2. The higher the score, the higher the increased proportion of failed reductions was shown, corresponding with the estimated risk from logistic estimation.

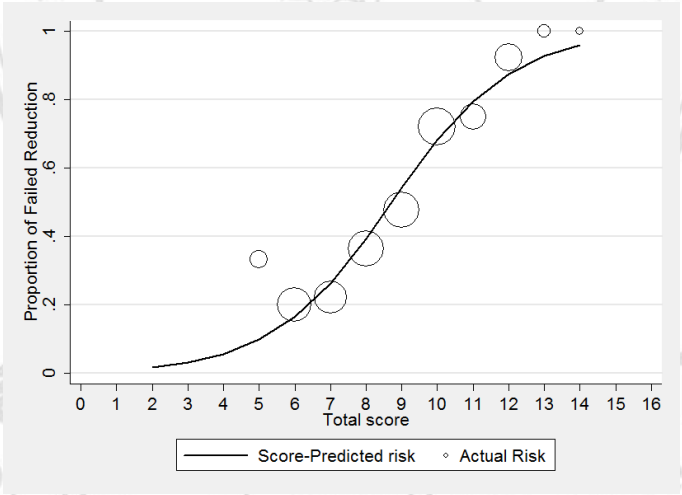

Figure 5.2 Score-Predicted Risk (line) and Actual Risk (circles) of Failed Non-Surgical Reduction of Intussusception for Each Total Score. Sources :TherClin Risk Manag. 2016;12:1411-6.

The use of a clinical prediction rule for failed reduction of intussusception

Some reports about the prediction rule for diagnosis of intussusception were disseminated. In, 2000 Kuppermann found four predictors associated with the diagnosis of intussusception,[4] i.e., abdominal radiograph, rectal bleeding, male sex and a history of vomiting. In 2011, Weihmiller set up a decision tree from the clinical criteria to diagnose intussusception.[5]In 2013, Jiang reviewed the mode of diagnosis of intussusception in seven geographic regions of the world.[6] The results varied among different areas. In Central and South America, ultrasound was used for diagnosis. However, in the Eastern Mediterranean region, contrast enema was used. In Africa, they initially operated in suspected cases.

After diagnosis is made, the mode of treatments are nonsurgical and surgical reduction. In most areas, we initially started with nonsurgical reduction. Surgical management is preserved for cases with contraindication or failed nonsurgical treatment. The outcome of nonsurgical reduction determined the next step of treatment. In areas with no equipment or facilities for nonsurgical reduction, the predicted outcome may aid in the decision for transferring the patient to the preparedness center. Another point, parental concern was also considered important. The prediction may help in the process of disseminating information.

In the past, some studies have focused on the score for predicting the treatment outcome of intussusception. Since 1986, Guo set up the score with many categories for each item but was not widely use.[1] In 1991, Rege also developed the score base on clinical criteria.[7] They found no association between the scoring pattern with morbidity, mortality or chances of reduction by barium enema. The prediction equation in 2007 was also not easy to use.[2]

In our study, we conducted a clinical prediction score using ten parameters. For text step, validation of this prediction score should be performed before its actual use.

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