

# **PREDICTING UNEXPECTED RETURNS OF A PEDIATRIC PATIENT WITHIN 72 HOURS**

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## **ABSTRACT**

This study reexamined several important factors to determine revisits (RVs) of pediatric patients. Overall, six percent of the emergency department (ED) visits in Taipei metropolitan areas are RVs. Younger children, who come to the ED in the late evening hours on weekends and holidays in summer and who are inspected by a male and general physician, are highly probable to return to the ED within 72 hours.

## **INTRODUCTION**

A significant increase in the number of patients utilizing ED services makes the administrative management of emergency medicine increasingly important to assure a high level of health care quality with respect to suitable cost controls. An unscheduled revisit (URV) to an ED within 72 hours is one of the most important indicators of the Taiwan Clinical Performance Indicators (TCPI). Some revisits (RVs) may be avoidable or unnecessary and thus are costly both in financial terms and in the limitations they place on the healthcare system.

In the literature, factors affecting URVs are complicated and can be classified into five categories, including disease-related factors [1] [9] [12], patient-related factors [9] [10], physician factors [4], medical management policies [3] [7] [8], and ED-visit related factors [5].

The objectives of this study were threefold. The primary objective was to determine the incidence of total visits as well as the different categories of RVs of pediatric patients to an ED. The secondary objective was to construct URV prediction models using a number of classification techniques. The third objective was to determine the main factors affecting URVs within 72 hours by comparing patients who made revisits versus those who did not return to the EDs and to estimate the likelihood of an RV to an ED. Factors of particular interest included demographic variables, variables related to ED visits,

hospitals and physicians.

## **METHOD AND MATERIAL**

### **Materials**

Data were obtained from Taipei City Hospital, which successfully integrated 10 municipal hospitals into one unit in 2005 to provide comprehensive healthcare needs to 2.6 million residents in Taipei. Records of pediatric patients from six major branches were utilized in this study to represent the pediatric patient population of Taipei metropolitan areas. All patients, none older than 18 years of age, who visited the EDs between January 1 and December 31 in 2007, were included in this study; their computerized health records were individually reviewed to ensure the quality of the data, resulting in 40,321 total visits. Dropping records with incomplete or missing information, 34,701 records were included for the data analyses using STATA 13 and WEKA 3.6.10.

### **Methods**

Statistical analyses including multivariate logistic models were examined in this study. It is worth noting that the nonlinear effects of some continuous variables were tested in this study. In addition, only 6.52% of patients have URVs within 72 hours, resulting in a serious class imbalance problem. To improve the learning performance, this study applied the resample module in WEKA to modify the distribution of instances of the two classes. A number of supervised learning techniques were investigated, including logistic regression (LGR), support vector machine (SVM) [6], C4.5 [11] and classification and regression tree (CART) [2]. To evaluate and compare the performance of the prediction models, this study considers 10-fold cross-validation and uses the following three indicators: accuracy rate, F1-measure, and area under ROC curve (AUC).

## **EVALUATION RESULTS**

As mentioned earlier, among these records of pediatric patients, 2,263 records (6.52%) were RVs. Potential factors affecting RVs were categorized into four aspects, including characteristics of patients, ED visits, hospitals and physicians. Multivariate logistic regression models were conducted to determine significant factors among the selected variables. Odds ratios of returning to the EDs for the pediatric patients were also calculated. Our results show that age of the patients, time of day, weekends or holiday, and season of the year have significant influence on RVs. Types of hospitals and characteristics of physicians also make odds ratios different. Compared with results from related literature, acuity at triage seems not play an important role in determining the likelihoods of RVs in Taipei metropolitan areas.

In the results of classifiers, the accuracy rate of LGR, SVM, C4.5 and CART, are 0.591, 0.545, 0.910 and 0.911, respectively; the F1-measure of LGR, SVM, C4.5 and CART, are 0.590, 0.542, 0.909 and 0.907, respectively; the AUC of LGR, SVM, C4.5 and CART, are 0.624, 0.545, 0.933 and 0.881,

respectively. The results show that decision tree-based techniques (i.e., C4.5 and CART) significantly outperform regression-based techniques (i.e., LGR and SVM).

Several factors affecting unexpected returns within 72 hours to the EDs were found to be important by using the multivariate logistic regressions. Similar to previous studies, the age of the patient has a strong negative influence on RVs, i.e., the younger the patient, the higher the odds of revisits. Additionally, this impact is not linear. As for the characteristics of ED visits, when a pediatric patient arrives at an ED is crucial to determine whether the patient would return to the ED or not. Accordingly, several variables were tested in the logistic models and our results were robust to show that time of day, weekdays or weekends/holidays, month or season of the year were all making the odds of returning to the EDs significantly different. Crowded evening hours, less-staff overnight on weekends or holiday, and peak seasons (or months) could be the main reasons to induce a higher return rate. As for characteristics of physicians in the Taipei City Hospital, estimated odds ratios revealed that female and pediatric physicians would significantly reduce the odds of RVs compared to male and general physicians. It is suggested that parents or health caregivers may choose an appropriate physician for the pediatric patient at the ED if permitted.

## CONCLUSION

This study reexamined several important factors to determine RVs of pediatric patients. Overall, six percent of the ED visits in Taipei metropolitan areas are RVs. Younger children, who come to the ED in the late evening hours on weekends and holidays in summer and who are inspected by a male and general physician, are highly probable to return to the ED within 72 hours.

## REFERENCES

- [1] Alessandrini, E. A., Jane, M. L., Stephanie, M. G., Cynthia, R. J. & Kathy, N. S. Return Visits to a Pediatric Emergency Department. *Pediatric Emergency Care*, 2004, 20(3), 166-171.
- [2] Breiman, L., Jerome, H. F., Richard, A. O. & Charles, J. S. *Classification and Regression Trees*. Wadsworth International Group, Belmont, California, 1984.
- [3] Goldman, R. D., Aarti, K. & Sanjay, M. Children Admitted to the Hospital after Returning to the Emergency Department Within 72 hours. *Pediatric Emergency Care*, 2011, 27(9), 808-811.
- [4] Graff, L. G., Martha, J. R., Mary, A. G. & Carl, S. W. The observable patient in the DRG era. *The American Journal of Emergency Medicine*, 1988, 6(2), 93-103.
- [5] Jacobsten, C. R., Evaline, A. A., Jane, M. L., Kathy, N.S. Unscheduled Revisits to a Pediatric Emergency Department. *Pediatric Emergency Care*, 2005, 21(12), 816-821.
- [6] Keerthi, S. S., Shevade, S. K., Bhattacharyya, C. & Murthy, K. R.K. Improvements to Platt's SMO Algorithm for SVM Classifier Design. *Neural Computation*, 2001, 13(3), 637-649.
- [7] Keith, K. D., Bocka, J. J., Kobernick, M. S., Krome, R. L., & Ross, M. A. Emergency Department

revisits. *Annals of Emergency Medicine*, 1989, 18(9), 964-968.

- [8] Lerman, B. & Michael, S. K. Return visits to the emergency department. *The Journal of Emergency Medicine*, 1987, 5(5), 359-362.
- [9] Ng, C. P. & Chung, C. H. An analysis of unscheduled return visits to the accident and emergency department of a general public hospital. *Hong Kong Journal of Emergency Medicine*, 2003, 10(3), 153-161.
- [10] Pierce, J. M., Kellerman, A. L., & Oster, C. "Bounces": An analysis of short-term Return visits to a public hospital emergency department. *Annals of Emergency Medicine*, 1990, 19(7), 752-757.
- [11] Quinlan, R. *C4.5: Programs for Machine Learning*. Morgan Kaufmann Publishers, 1993.
- [12] Walsh-Kelly, C. M., Kevin, J. K., Amy, L. D., Laura, G. & Evelyn, M. K. Emergency Department Revisits for Pediatric Acute Asthma Exacerbations Association of Factors Identified in an Emergency Department Asthma Tracking System. *Pediatric Emergency Care*, 2008, 24(8), 505-510.