Challenges of Trustable AI and Added-Value on Health
B. Séroussi et al. (Eds.)

doi:10.3233/SHTI220438

Suitability of Reusing Pre-Doctoral Student Activity Data from an Educational Information System for Quality Measures of Caries Risk

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Abstract. Dental caries management requires individualized follow-up and prophylaxis based on patients' caries risk (PCR). In large pre-doctoral clinics, the use of institutional quality measures (QMs) is essential to control the quality of patient follow-up and to evaluate the need for improvement measures. The aim of this retrospective study was to evaluate the suitability of reusing student activity data for the development of QMs of caries risk. Two approaches for predicting PCR using student activity data were evaluated and compared. The first approach used the procedure codes recommended by the Dental Quality Alliance and the second used these same codes along with three educational codes. The sensitivity, specificity, overall accuracy of the two approaches were evaluated. A Receiver Operating Characteristic (ROC) curve analysis was carried out, and the areas under the ROC curve of the two approaches were compared using Delong's test. A two-tailed P value ≤ 0.05 was considered statistically significant. While the two approaches were able to correctly predict PCR, the approach using both procedure and educational codes showed better predictive performance. The reuse of student activity data is an easy and robust method for the development of QMs of caries risk that can help improve monitoring and quality of patient care.

Keywords. Dental Informatics, Information System, Quality Measure, Dentistry, Education

1. Introduction

Dental caries prevention remains an important public health issue today. Still considered the most common chronic disease in the world [1], carious lesions can have significant adverse consequences for patients' health and functional status when left untreated [2]. However, since 2002, patients with dental caries have benefited from major

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developments in diagnosis [3], evaluation [4], and global management [5]. The latter involves individualized follow-up and prophylaxis based on patients' caries risk (PCR), which is currently defined as either high or low.

In pre-doctoral dental clinics, the global management of dental caries represents an organizational challenge because any malfunction can result in loss to follow-up and poor patient outcomes. In this context, the use of institutional quality measures (QM) appears essential to control the quality of patient follow-up and to evaluate the need for improvement measures. As early as 2011, the absence of QMs was identified as a barrier preventing oral health improvement, and in particular the reduction of oral health disparities [2].

In dentistry, the Dental Quality Alliance defined a set of standardized adult and pediatric QMs based on the Code on Dental Procedures and Nomenclature (CDT) to help assess oral healthcare access, process, and outcomes [6]. To date, most studies evaluating the use of QMs have employed administrative claims data [7,8]. Although the results are encouraging, access to and direct use of administrative data by dental practitioners is often difficult [9], notably in pre-doctoral clinic. Moreover, the development of QMs is impaired by the absence of diagnostic code usage in electronic dental records (EDRs).

At the Dental Department of Timone hospital (AP-HM - Assistance Publique - Hôpitaux de Marseille, France), as in other pre-doctoral clinics, care is mainly provided by dental undergraduate students under the close supervision of licensed dental practitioners [10] . Approximately 280 dental students handling about 12,000 patients each year. At the end of each patient visit, the procedures performed, and the skills acquired by the student are recorded in a structured way in an internally developed information system named ECHO. This information system then transmits the required billing information to the administrative department and allows the bi-annual evaluation of students.

The aim of this study was to evaluate the suitability of reusing pre-doctoral student activity data from the ECHO for the development of QMs of caries risk.

2. Materials and Methods

This retrospective study used student activity data stored in the ECHO information system of the Dental Department of Timone Hospital. This information system is registered in the CIL/AP-HM register under the number #2018-01 and contains, for each student, all the patients under care with the associated care activity and the validated skills. This study was registered in the RGPD/AP-HM register under the number #2021-61 and validated by the Ethics Committee of Aix-Marseille University (2021-06-03-11).

Patients were included in the study via ECHO based on the 2021 Dental Quality Alliance specifications of the QM "Percentage of children under age 21 years who have caries risk documented in the reporting year" (CRD-CH-A). Inclusion criteria were being aged between 1 and 21 years and undergoing continuous follow-up defined by at least two visits over 12 months with no interval greater than 31 days between them. A two-year inclusion period (from 2019/04/01 to 2021/03/31) was chosen.

Two approaches for predicting PCR status (high or low) using student activity data from ECHO were evaluated and compared. The first approach (ECHO Pro) employed the CDT procedure codes recommended by the Dental Quality Alliance as a proxy for PCR status. These codes were mapped to the procedure codes currently in use in France (CCAM - Classification Commune des Actes Médicaux). The second approach (ECHO

Pro +Edu) used the procedure codes above along with the following educational codes: (1) pulpotomy in patients aged over 16 years in a context of painful emergency; (2) root canal disinfection in a context of painful emergency; and (3) general anesthesia assistance in pediatric dentistry (usually performed for large-scale restorative procedures in high caries risk children). Patients for whom a procedure and/or educational code was reported in ECHO during the inclusion period were considered to be at high caries risk (no loopback approach was carried out).

The predictive performance of the two approaches was evaluated by determining their sensitivity, specificity, and overall accuracy. A Receiver Operating Characteristic (ROC) curve analysis was also carried out and the areas under the ROC curve (AUC) values of the two approaches compared using Delong's test [11]. To conduct these analyses, the PCR predicted using the two approaches was compared to the PCR reported in patients' EDRs, the latter being considered as the gold standard. The number of EDRs to be reviewed was estimated based on a prevalence of high PCR of 0.7 (as per preliminary data) with a type I error (α) of 0.05 and an accuracy of 90% [12,13]. Since we could not make an educated guess for sensitivity and specificity, we made the conservative choice of 50% [12]. The estimated number of EDRs to be reviewed was 321. The EDRs were randomly selected from the list of included patients until the number 321 was reached. As only free text notes were available in the EDRs, these were reviewed by two calibrated evaluators to identify the reported PCR.

Data were extracted from ECHO using PHP and MySQL scripts with CSV spreadsheet output. The PCR reported in EDRs were entered manually on a Microsoft Excel® spreadsheet. All analyses were performed with R for Windows® version 4.1.1. A two-tailed P value ≤ 0.05 was considered statistically significant.

3. Results

Over the inclusion period, 7,195 patients aged between 1 and 21 years visited the Dental Department of Timone Hospital. Of these, 2,261 met the inclusion criteria. A total of 384 randomly selected patient files had to be reviewed to obtain the 321 EDRs needed to evaluate the predictive performance of the two approaches (63 files were excluded due to incomplete or missing EDRs). The prevalence of patients at high caries risk was 0.67 (0.61-0.72). The predictive performance of the ECHO Pro and ECHO Pro+Edu approaches is presented in Table 1 with 95% confidence intervals.

Table 1. Predictive performance of the ECHO Pro and ECHO Pro+Edu approaches: True positive (TP); false positive (FP); false negative (FN); true negative (TN); prevalence (P); sensitivity (Se); specificity (Sp); overall accuracy (OA).

Approach	TP	FP	FN	TN	Se	Sp	OA
ECHO Pro	151	28	63	79	0.71 (0.64-0.72)	0.74 (0.64-0.82)	0.72 (0.66-0.77)
ECHO Pro+Edu	177	30	37	77	0.83 (0.77-0.88)	0.72 (0.62-0.80)	0.79 (0.74-0.83)

The overall accuracy was superior to the No Information Rate with a significant P-value of 0.03 for ECHO Pro and of 5.9e-07 for ECHO Pro+Edu. The ROC curve analysis (Figure 1) showed an AUC of 0.72 (0.67-0.77) for ECHO Pro and an AUC of 0.77 (0.72-

0.82) for ECHO Pro+Edu. The comparison of AUC values using Delong's test showed a significant difference in favor of ECHO Pro+Edu (P = 7.5e-05).

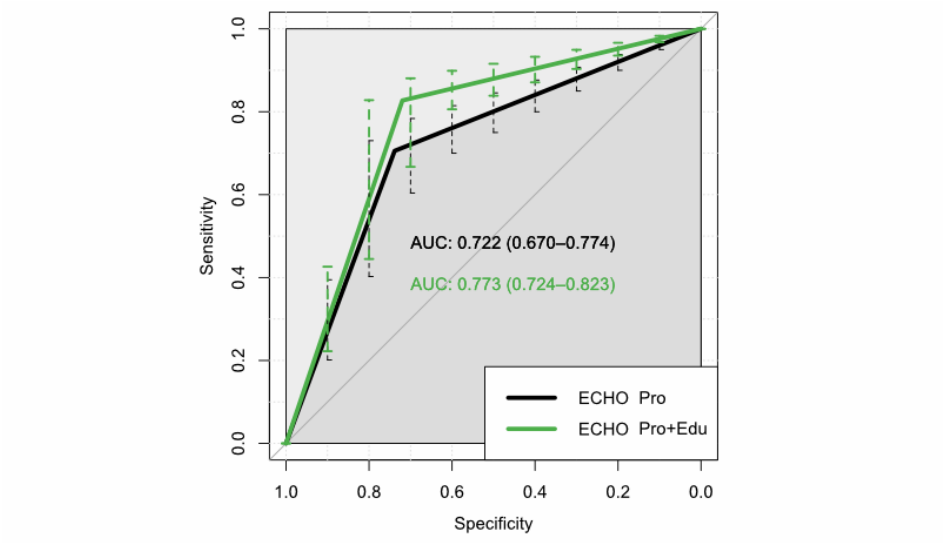

Figure 1. Receiver Operating Characteristics curve of the ECHO Pro and ECHO Pro+Edu approaches.

4. Discussion

In the absence of diagnostic code usage in EDRs in France, the standardized QMs of the Dental Quality Alliance can be used from procedure codes for the assessment of PCR. Although this required a mapping between CDT and CCAM procedure codes, the resulting test (ECHO Pro) were able to correctly predict PCR in more than 70% of cases, with a moderate P value for overall accuracy. However, the inclusion in the ECHO Pro+Edu approach of three educational codes linked to endodontic and restorative procedures yielded a higher sensitivity and resulted in better overall predictive performance. While the AUCs of the two approaches showed good predictive performance [14], a statistically significant difference between AUCs was observed in favor of ECHO Pro+Edu. In view of these findings, the approach using educational codes should be preferred.

A two-year inclusion period was chosen to limit the annual variability of results. The high prevalence of patients at high caries risk compared to the general population [15] may be explained by the fact that pre-doctoral clinics in France serve as referral centers that cater to disadvantaged populations. The percentage of patients with incomplete or missing EDRs was 16.4%. While this figure is consistent with published data [16], it does highlight the need to increase faculty and student awareness of the importance of properly filling patient records for medical and legal purposes. The fact that the ECHO is used for student validation may explain why it is more frequently completed and was able to identify and include patients for whom the EDR was incomplete or missing.

Our study has some limitations. The predictive performance of the two approaches may have been impaired by the lack of exact correspondence between the CDT and CCAM procedure codes. Unfortunately, we could not evaluate the effect on our results of mapping between these codes, as no study has evaluated the performance of the QM

"Percentage of children under age 21 years who have caries risk documented in the reporting year" (CRD-CH-A) to date—even though the latter is used as a basis for more complex QMs. Another limitation is that some of the endodontic and restorative codes can be reported in cases of trauma, which may have contributed to overestimating the prevalence of patients at high caries risk.

5. Conclusion

Our study evaluated two approaches for predicting PCR status using pre-doctoral student activity data. While the two approaches were able to correctly predict PCR, the approach using both procedure and educational codes showed better predictive performance. The reuse of activity data used for student evaluation has the advantage of being directly accessible by teaching staff and of being more often reported by students overall. Thus, reuse of student activity data provides an easy and robust method for the development of QMs of caries risk that can help improve monitoring and quality of patient care.

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