A Data Mining Tool and Process for Congenital Heart Defect Management

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Problem Description

One in 110 babies are born with congenital heart defects (CHDs). Some require only occasional monitoring, while others mandate aggressive intervention. Some interventions are required at birth, others are deferred until the child is older. Furthermore, early interventions can require further surgical repair at a later age. At Loma Linda Children's Hospital, there is not an easy way to identify all CHD patients or to schedule these deferred repairs. An analytics study found over 14,000 potential CHD patients, and a manual review of 100 patient charts and histories by a cardiothoracic surgeon revealed that approximately 10% were overdue for patient monitoring or surgical intervention.

Our challenge is that it is untenable for a cardiothoracic physician to manually review 14,000 patients. Furthermore, there needs to be a process to classify and follow up on current and new patients to eliminate this problem in the future. This problem is challenging because there is a wide range of follow-up timeframes recommended for CHD patients, ranging from weekly to biannually. This challenge is further exacerbated because our current EMR has only been in use since 2013, our patient diagnosis records are sparse and error-prone, and much of the meaningful information is available only in physicians' free text progress notes.

Solution

We identified 119 CHD diagnosis categories and grouped them into 33 broader categories. We then mapped all of the EMR diagnoses into these categories and developed a series of prioritization rules to determine the correct single category to classify each patient. These include type of diagnosis, when the diagnosis was made, the patient's age, and surgical interventions. We mined billing, surgical, echocardiogram and diagnosis history to identify our patient cohort and classify them. Once we classified each patient, we pushed this data point into our EMR as "suggested" fundamental diagnosis group and allowed the cardiologists and cardiothoracic surgeons to accept or override these diagnoses. To facilitate analysis by cardiologists and cardiothoracic surgeons, we created an interface allowing quick access to important portions of the patient's chart and history, including surgical notes and echocardiograms. To encourage the provider to review and finalize the diagnoses, we created alerts which notify the providers when they see a patient who needs classification, and analytics dashboards that allow the project champion to monitor, review and assist the classification progress. Additionally, we mined the patient's primary cardiologist from the patient medical and visit and referral history. Finally, we asked the provider to enter a follow-up date for each patient as they approve or override the fundamental diagnosis and primary cardiologist.

All of this is then used to create a solution to identify patients who are overdue for follow-up. We created a health maintenance workflow and hired a nurse practitioner to assist with the classification of historical patients and to actively manage and facilitate patient contacts.

Results and Future Work

Our project has identified 2960 alive CHD patients. So far, the cardiologists and nurse practitioner have reviewed and classified 31% of these patients. Our algorithm correctly identified the primary cardiologist for 93% of our patients and the fundamental current CHD diagnosis for 78%. Our plan is to improve the classification algorithm by evaluating the patients and diagnoses when the cardiologist overrides the suggested diagnosis. Additionally, as a teaching university, we plan to utilize our new fundamental diagnosis groupings and patient cohort to facilitate additional analytics and research. Finally, we plan to update our workflow to allow documentation for patients who moved away or who are reported as deceased to avoid unnecessary patient followup.

Conclusion

Our solution will allow us to identify and contact CHD patients who need follow-up care or additional intervention. This both improves patient lives and creates new revenue for our hospital. Through a combination of data mining and improved physician workflow, we can both improve our management of our CHD population and reduce the manual effort required by our specialists.