Pilot Implementation of a Clinical Research Data Warehouse Linking Intra-Operative Physiological Data With Post-Operative Outcomes

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Background: Improving access to clinical data is a key component of the research and quality improvement work at BC Children's Hospital (BCCH),[1] and likely many other academic medical centers. Informed by a recent narrative review of clinical data warehouse technologies,[2] we are developing a pediatric clinical research data warehouse using the i2b2 (Informatics for Integrating Biology and the Bedside) framework.[3] Here, we describe the development of the data model for our pilot implementation and our current data integration pipeline.

Methods: The source data included: (a) intra-operative physiological vital signs variables, captured from operating room (OR) Philips and GE/Datex patient monitors;[4] (b) a historic cohort of surgical outcomes with some custom fields[5] from the American College of Surgeons Pediatric National Surgical Quality Improvement Program (P-NSQIP);[6] and (c) a small selection of booking data, including demographic and procedure fields from the Operating Room Scheduling Office System (ORSOS). Having consulted with clinicians, we minimized the number of clinical variables to fields commonly captured or deemed particularly relevant and coded them using the SNOMED-CT terminology. We developed a custom data model capturing five broad categories of information: demographics, visit details (including surgery as well as pre- and post-surgery observations), laboratory tests, procedures (using the Current Procedural Terminology - CPT) and vital signs. Instead of incorporating raw vital signs data into the model, we included derived variables describing some basic data characteristics for each vital sign: percent case coverage with valid data, duration of valid data, median, low and high values (defined as 5^{th} and 95^{th} centile for the case). In addition, we limited the time frame to between the first and last valid SpO_2 and rejected simple data artifacts. Finally, we linked the OR vital signs data to the clinical information from P-NSQIP and ORSOS, where possible, using a probabilistic approach based on procedure date, location, and room entry and exit times.[5]

Results: The 2016 pilot data cohort included 6,432 vital signs casefiles from our main ORs and 1,590 cases with surgical outcomes from our P-NSQIP cohort. We were able to match 1,328 cases from these two datasets.[5] The data integration pipeline is shown in Figure 1, with part of the data model expanded in the i2b2 cohort creation tool.

Conclusion: The feasibility of this approach was established, yet its utility in supporting research or quality improvement initiatives has yet to be demonstrated. The usability of the user-facing component also remains to be determined. Future work includes: defining age-appropriate abnormality indicators for relevant outcomes such as hypotension, hypocarbia and hypothermia, by extending framework for neonatal anesthesia vital signs deviations;[7] improving the automated case matching tools; and incorporating additional outcome databases, such as those from the pediatric intensive care unit.

References:

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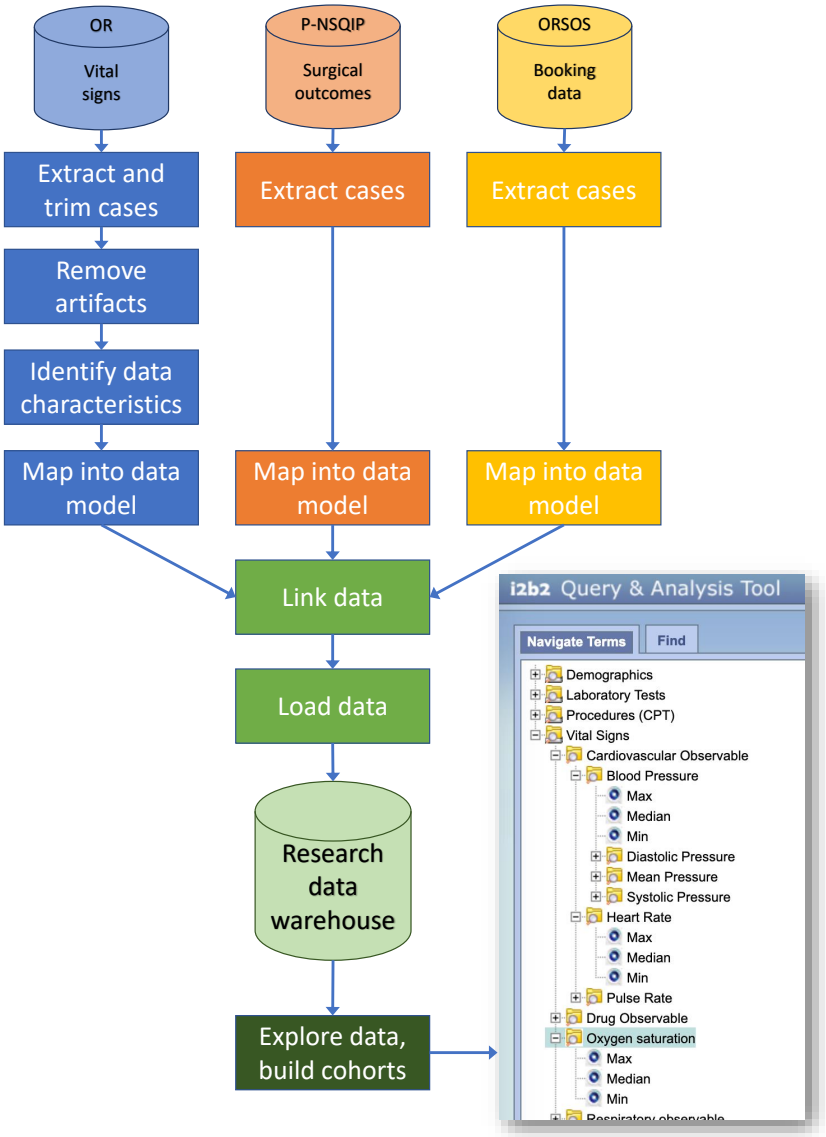

Figure 1: Data integration pipeline for pilot implementation.