Final Project Analysis

Bhavya Kandimalla
410.712 Advanced Practical Computer Concepts for Bioinformatics
Summer 2017

Background

Emergency Medical Service (EMS) pre-hospital care is an essential component of medical treatment that can influence successful hospital care. The speed and quality of high performing EMS systems have been found to improve patient outcomes, especially for trauma care, and can decrease the likelihood of necessary extensive future procedures.[1, 2, 3] Moreover, with the increase in ambulance diversions, in part, due to a 26% increase in Emergency Department (ED) visits, reduction of available hospital beds, and 9% decrease in EDs, EMS care has become vital in the past decade.[4, 5] Focused quality assurance (QA) and quality improvement (QI) of EMS performance can better integrate pre-hospital and hospital-based care, increase the overall quality of patient care, and even influence overall hospital length of stay, readmissions, and cost-of-care. Quantifying and evaluating EMS performance, however, has proven to be a challenging process improvement effort.

Evaluating first responder performance is convoluted by the variety and complexity work environment variables encountered. Three main performance metrics are usually used to quantify EMS operations: input capabilities, process of successfully implementing procedures and protocols, and patient response outcome to EMS intervention.[6] A number of these assessments, which include analysis of response time (RT), cardiac arrest mortality rate outcomes, and pre-hospital evaluation technique (PET), reveal useful, but limited, information about EMS quality care.

Response time is the amount of time between ambulance dispatch and on-scene arrival. EMS standards require that 90% of Priority 1, life-threatening, calls are responded to within nine minutes.[7] Although the ease of gauging RTs makes it a convenient performance indicator, analysts argue it is an inadequate, unreasonable measurement that overshadows other quality indicators and results in the detriment of patient care in addition to health, safety, wellbeing, and morale of emergency medical technicians (EMTs).[6, 8]

---

[1] Institute of Medicine. "Emergency Medical Services at the Crossroads." *The National Academies Press* (2006): 1-273.

[2] National Highway Traffic Safety Administration. "EMS Makes a Difference: Improved Clinical Outcomes and Downstream Healthcare Savings. A Position Statement of the National EMS Advisory Council1." *Annals of Emergency Medicine* 57.2 (2011): 169.

[3] Walz, Tim, and Sue Myrick. "The Field EMS Quality, Innovation and Cost-Effectiveness Improvement Act, H.R. 3144." *National Association of State EMS Officials Bills*. <http://www.nasemso.org/documents/FieldEMSBillWhitePaper2011.pdf>.

[4] Institute of Medicine. "Emergency Medical Services at the Crossroads." *The National Academies Press* (2006): 1-273.

[5] Kellermann, Arthur L. "Crisis in the Emergency Department." *New England Journal of Medicine* 355.13 (2006): 1300-303.

[6] Al-Shaqsi, Sultan. "Response Time as a Sole Performance Indicator in EMS: Pitfalls and Solutions." *Dovepress Journal* 2 (2010): 1-6.

[7] Fitch, J. "Response Times: Myths, Measurement & Management." *JEMS* 30 (2005): 47-56.

[8] Price, L. "Treating the Clock and Not the Patient: Ambulance Response times and Risk." *Quality and Safety in Health Care* 15.2 (2006): 127-30.

More recently, analytical focus has shifted to evaluating patient outcomes.[9] For example, in some services cardiac arrest dispatches, a division of Priority 1 emergencies, are used as a patient outcome metric.[7, 10] The ability of EMS providers to employ successful, time-dependent treatments necessary for optimal cardiac arrest patient survival is assumed to be an indication of their capacity to effectively respond to other critical calls, such as stroke and major traumatic injury.[11] However, even if the assumption holds, variables including discrepancies in patients' histories, co-morbidities, self-care, and situational events, such as bystander cardiopulmonary resuscitation (CPR) and defibrillation prior to first responder arrival, directly influence patient outcomes.[11, 12, 13] Additionally, solely evaluating cardiac arrest events limits key information about the vast array of other patient-condition outcomes.

Another method, the PET, compares EMS pre-hospital procedures to the patient's most emergent condition and ED diagnosis using diagnosis codes.[14] However, this idea requires shared EMS and hospital electronic records, which is atypical when multiple pre-hospital agencies using different electronic PCR systems transport to the same hospital.[15]

Project Goal

The purpose of this project was to create a tool used by EMS groups to analyze EMS provider quality of care for specific learning outcome empirical data and targeted process improvement. This idea builds on the PET model by correlating EMS and ED encounters from two separate raw databases and uses an algorithm based on a 5-3-1-0 point system to quantify EMS care. The project further develops the functionality of an analysis database I previously created in Microsoft Access. The goal was to transfer the database to MySQL and to show proof of concept that the program can be accessed online for use.

Program Specifics

The program consists of three main tables that are queried to output the results: an EMS patient table, a hospital patient table, and a crosswalk I previously built that correlates a maximum of five

---

[9] McLay, Laura A., and Maria E. Mayorga. "Evaluating Emergency Medical Service Performance Measures." (2009): 1-19.

[10] Davis, Robert. "Atlanta Becomes a Template for Improving Cardiac-Arrest Survival Rates." *USA Today* 21 Aug. 2007.

[11] Stiell, IG, GA Wells, BJ Field, DW Spaite, VJ De Maio, R. Ward, DP Munkley, MB Lyver, LG Luinstra, T. Campeau, J. Maloney, and E. Dagnone. "Improved Out-of-hospital Cardiac Arrest Survival through the Inexpensive Optimization of an Existing Defibrillation Program: OPALS Study Phase II. Ontario Prehospital Advanced Life Support." *JAMA* 281 (1999): 1175-181.

[12] De Maio, VJ, IG Stiell, GA Wells, and DW Spaite. "Optimal Defibrillation Response Intervals for Maximum Out-of-hospital Cardiac Arrest Survival Rates." *Annals of Emergency Medicine* 42 (2003): 242-50.

[13] Larsen, MP, MS Eisenberg, RO Cummins, and AP Hallstrom. "Predicting Survival from Out-of-hospital Cardiac Arrest: A Graphic Model." *Ann Emerg Med.* 22 (1993): 1652-658.

[14] Rubin, M. (2008a). One for Good Measure: Evaluating EMS. EMS World (http://www.emsworld.com/article/10320727/ems-quality-assurance) December. pp. 94-99.

[15] Office of Technology Assessment. *Rural Emergency Medical Services*. Rep. no. OTA-H-4455. Washington: U.S. Congress, 1989.

EMS impressions given as a patient "diagnosis" during hospital transport with eventual hospital diagnoses in decreasing relevance where impression 1 relevance ≥ impression 2 ≥ impression 3 ≥ impression 4 ≥ impression 5.

The `insert.py` script creates the three program tables. It is commented out to protect the database contents from accidental runs. A table of EMS patients from an EMS database and a data file of hospital patients from a hospital database, which recorded a maximum of three most relevant hospital diagnoses for each event, are input as raw data. The project uses sample patient data occurring between 01/2011 and 01/2013 from a New York EMS squad and hospital. To create the patient tables and comply with HIPPA laws a strong hashing algorithm is used to de-identify the patients based on full name and date of birth. To compile the EMS patient table, lines 19, 23-25, and 30-31 of the script should be un-commented and run. To create the hospital patient table, lines 20, 23-25, and 33-35 should be un-commented. Finally, to populate the crosswalk, lines 18 and 27-28 of the script should be un-commented and run. The `tables.sql` code defines the structure of these three tables, and it is also commented out to protect the database contents from accidental runs.

The `views.sql` script queries the three tables to make eight views, which are dropped, and one table. The EMS and hospital patient tables are correlated by ID and admit and dispatch dates being within one day of each other to make a patient-event view. Since some patient-events had multiple noted EMS impressions per treatment, the events were then further narrowed in a view to only include those where one impression was assigned. Six views were needed to calculate the EMS quality points for each event using the crosswalk to quantify EMS performance based on a 5-3-1-0 point system assigned to impression-diagnosis matches. Five points were awarded if the EMS impression matched the first hospital diagnosis, three points were awarded if the impression matched the second diagnosis, one point was awarded if the impression matched the third diagnosis, and zero points were awarded if the impression did not match the hospital diagnosis. The table queries the patient-events and sums all points for each event.

The `querydb.cgi` code runs the queries and returns the results to the http://bfx.eng.jhu.edu/bkandim1/410.712 Advanced Practical Computer Concepts for Bioinformatics/final/ webpage. The output is formatted into a table with ID, dispatch and admit date, EMS impression, reason for visit, diagnosis 1, diagnosis 2, diagnosis 3, and quality points score by the `table.html` script, and the `table.css` code adds styling elements. The `index.html` code allows the user to search and filter the results by score and impression, while the `search.js` script prints an error message if the query fails.

Tests scripts `query.sql` and `query.py` are also included in the source code.

Project Challenges

One of the main challenges regarding this project was translating the Microsoft Access SQL code into MySQL. I quickly realized, while the syntax was similar, key functions and symbols were different and needed to be adapted. This required me to re-write the program algorithms with proper MySQL syntax.

Another challenge to implementing the data was computing the quality point scores for each patient-event. First, the points for each of the three diagnoses had to be computed separately because the patient events table needed to be joined with the crosswalk for the analysis. Next, summing the total quality points by joining the separate views was a second obstacle, which took a lot of trial and error to merge the NULL values in each view without outputting duplicate events.

Program Results

Overall, the database was successfully transferred to MySQL, and I was able to show proof of concept that the EMS quality control tool can be accessed online. However, it should be noted that the Microsoft Access database correlated 794 patient-events from the raw files, whereas the web tool only correlated 724 events.

Future Development of Program

For future development, the reason for the differences in correlated patient-events between the two databases must be addressed. Additionally, it would be useful to allow the user to view the raw EMS and hospital patient tables and the crosswalk online as different interfaces. Furthermore, it would be beneficial to include graph views of the data and develop statistical analysis capabilities for the tool. Lastly, when reviewing the results, challenges with capturing the level of detail for the impression-diagnosis matches were observed. For future program releases, the crosswalk should be improved to capture the possibility of medical conditions developing and further progressing/deteriorating, for instance syncope progressing to unconsciousness/unresponsiveness, during transport to the hospital.