Projecto C: Surgical Cost-Effectiveness Analysis Database

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Abstract. In times of crisis like these, a cost-effectiveness analysis database for surgical procedures is the best tool to have. A number of clinical variables were defined to complement the cost-effectiveness analysis with one of first operation room expenditure's database implemented in a public hospital. This study is based on the same cornerstone of the ACS-NSQIP program. Some variables were collected automatically from the information systems available in the hospital, and the remaining are entered in a custom developed application be the surgeons. The indicators to provide are being defined with the surgeons and implemented in the form of dashboards. The result of this project will provide a tool for the hospital surgeons, manager and administrators to make better decisions.

Keywords: business intelligence, surgery, data mining, database, data-entry.

1 Introduction

There has never been a greater pressure for ensuring medical expenditure is controlled while waiting lists for surgery are reduced. These trends are shaping changes in hospital financing systems, hospital expenses with personnel and facilities and patient management. Tools that allow an informed interaction between parts involved - surgeons and managers - by integrating clinical performance information with that of expenditures, are either lacking or incomplete. There is also a need to collect, organize and analyse clinically relevant information for medical training, supporting routine care and conducting research.

Projecto C was conceived to try to meet some of these needs. The project consists on the development and implementation of a surgical database that could be a privileged meeting point between clinical and administrative data and interests in real time.

2 Background

The need for valid and up-to-date information to support medical practice definitely requires the combination of modern medicine and its production of high quality

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medical literature, with the capability to disseminate and apply such information. Information technologies have a vital role in such translational science process [1].

Information services, supported by databases capable of capturing and storing information onto a structured framework, while presenting clinical data in a pleasant and user-friendly interface are indispensable tools for today's medical practice [2].

Hospital Professor Doutor Fernando Fonseca was pioneer in the creation of Enterprise wide Operation Room expenditures' database and entry system. Nonetheless a database that would integrate clinical variables was missing. Recording consumables, while useful for management and helpful for performance and cost monitoring is incomplete for cost-effectiveness calculations of surgical acts. Clinical data about pre-operative, peri-operative and post-operative variables need to be integrated to ensure cost-effectiveness is clinically meaningful to professionals and managers alike.

We, therefore, tried to capture the rigour of surgical quality programs like the ACS-NSQIP (American College of Surgeons National Surgical Quality Improvement Program), which is being used in USA since 1994, with impressive results in improvement of healthcare, granting undeniable prestige to the institutions in which it is implemented. The ACA-NSQIP is a validated a risk adjusted nationwide program, based on well-defined measures of effectiveness that assesses the overall quality of the surgical procedures [3]. It had its origin in a pilot project initiated in 1991 in the Veteran Affairs Hospitals, where was associated with a 31% reduction in 30 day mortality [4]. Recent data suggests the ACS NSQIP improved risk-adjusted mortality in 66% of the participating hospitals and morbidity in 82% [5].

This database will allow a better understanding of demographics, surgical risk factors, surgical procedures, inter-individual technical variations integrated with costs, not only associated with operation room consumptions, but also with patient morbidity and mortality.

3 Objectives

The aim was the development of a clinical and administrative database that allows monitoring of real time effectiveness indicators, clinical research information, management and cost-analysis reporting.

4 Methods

After a period of bibliographic research and software development, a pilot period is taking place with one of the hospitals general surgery department named 'Cirurgia C'.

We started with the collaboration of 10 surgeons, who contributed for application design as well as inserted in the database some of the patients submitted to surgery, regardless of surgery type or demographic characteristics.

Surgeons, in a custom-made software application, insert the preoperative demographic and clinical variables. The remaining data is automatically collected from other hospital applications, such as, laboratory information system, administrative and billing system and the operation room expenditure database.

4.1 Variables

The different variables are divided in three different groups; pre-operation, operation and post-operation. The pre-operation variables allow us to evaluate the surgical risk. Operation variables partly characterize resources and techniques involved in the procedure. Finally post-operation variables try to identify complications in a 30-day post-operative period. The number of variables per group is: 46 pre-operation, 15 operations and 27 post-operation.

The variables were defined from consultation of extensive literature support [6]-[26] and fertile on-going debate with surgeons involved.

4.2 Software Application

A software application was developed to support the clinical data entry for the variables that were not collected from other information systems in the hospital.

This application was developed in technologies such as Microsoft© Silverlight [27] and Microsoft© SQL Server [28]. The usage of a technology such as Silverlight provides a rapid application development (RAD) and ease deployment on the hospital, providing the surgeon access anywhere, where a computer is available.

The architecture of the application provides a simple and easy way to add, remove or modify the clinical variables. This dynamism in the variable definition was a requirement. This provides a faster decision-making on which variables are to be registered, and to ease the deployment in new wards, where there are new requirements.

This tool provides a list with all the hospital procedures, scheduled or already completed. When the surgeons select a surgery, a data entry form is shown where they can introduce the variables.

The clinical variable definition is achieved by a configuration database.

4.3 Telephone Questionnaire

Surgeons on the ward record some of the post-operation variables before or after discharge. The other variables, namely status at 30 days post-operation will be collected through a telephone questionnaire performed by a person designated by the hospital.

At the time of discharge all patients are informed about the telephone questionnaire. The telephone interviews are being held between the 30th-35th days post-surgery, regardless of the day of discharge. The hospital may select a subgroup of patient to be called in, for an appointment, depending on the complexity of the case.

The telephone questionnaire was built based on a literature review. [29][30]. The questionnaire comprehensibility was accessed firstly with pilot ward surgeons regarding the description of its contents as well as the overall construction, as well as with five patients who were randomly selected.

On the correlation of the questionnaire with the reality a sample of ten random patients was selected, and follow up appointments were held after one month.

The same telephone questionnaire was also carried by two different interviewers to 10 randomly selected patients within the same day and three days apart to evaluate its reproducibility.

4.4. Pilot Study

Given the innovative and complex nature of this project we started by a pilot study in which the database was placed to test at 'Cirurgia C' department. The timeline was not defined from the start as several software applications had to be perfected, new variables were to be added and others removed to achieve greater consensus amongst surgeons and enhance adherence and buy-in. During this period the hospital information system has evolved with several modifications that have forced us to adapt this software. Other surgery groups are being shown the project as well as inquired about variables and access.

We have now corrected several bugs and made considerable adjustments to variables but we cannot vouch for a perfect performance so the project remains in its pilot phase.

4.5 Information Dashboards and Data Integration

Information dashboards were developed using QlikTech© QlikView [31], a business intelligence tool that facilitates the development of dashboards.

The data integration is a challenge here, as we need to collect data from different systems with different technologies and structures. These systems are the laboratory information system (LIS), the operative room expenditure's, the administrative system responsible of admission, transfer and discharge (ADT), and the billing system.

The data integration was achieved using a common business intelligence process of ETL (Extract, Transfer and Load) to Staging database, so we can build our data model in QlikView according with the indicators discussed with the surgeons and management.

4.6 Cost-Analysis

Using multivariate regression we will be able to establish the cost of the surgery for each surgical team, according to the risk group and surgery type. This will also allow for comparisons inside those groups. Several algorithms for integrating this information are now in discussion.

5 Results

We are now ending the pilot phase with 62 patients included, and 64 surgical procedures, on the database. This custom designed, enterprise information data collection system is currently able to feed in real time, informative dashboards on QlikView. The surgeon are using it to produce admission, operative and discharge notes for the clinical file. Our design even allows for surgeons, to access in a simple manner their patients clinical information stored in the database from a remote access point outside the hospital in any Internet connected computer.

The algorithm to carry risk-adjusted, cost-analysis and quality improvement feedback was started. All the arrangements have been made to expand the usage of this database in another surgical and anaesthesiology department.

The software application developed is on Fig. 1and 2.

Fig. 1. Procedure list: This is where surgeons search the procedure they want to start the introduction of the variables that are need manual entry

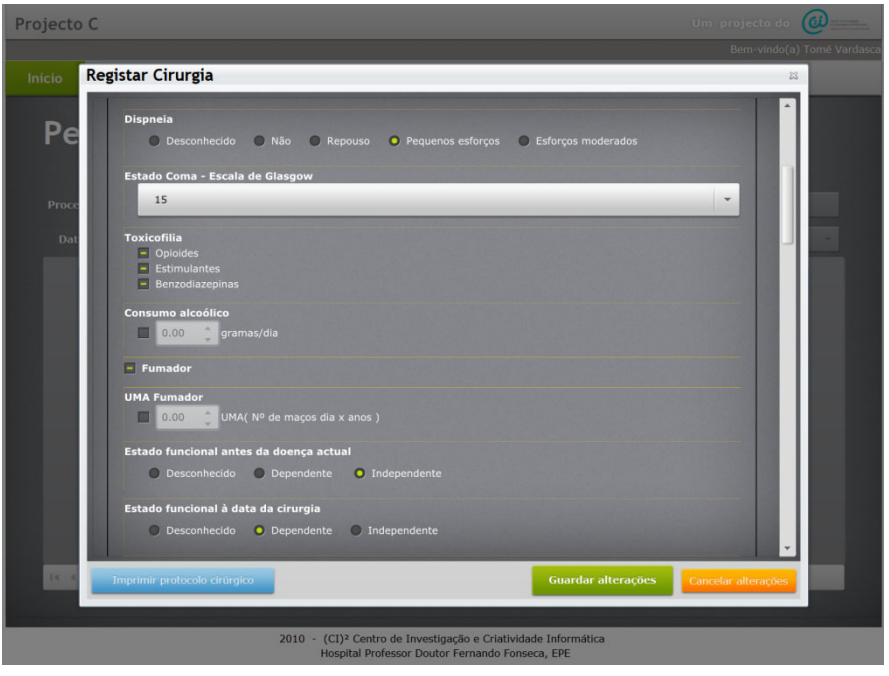

Fig. 2. Data entry form: This is the main interface where the surgeons register the variables that need manual entry

We created several dashboards with the help of the surgeons and the managers; an example is displayed in Fig. 3.

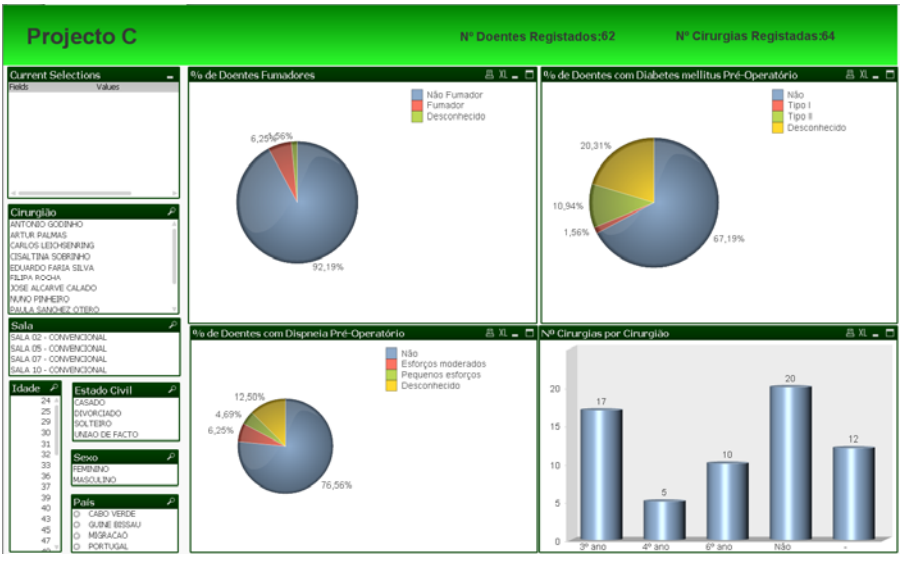

Fig. 3. A sample dashboard developed using QlikView©

6 Discussion

To our knowledge we are now running the first enterprise wide, validated, outcome-based, risk-adjusted, and peer-informed program for measurement and enhancement of surgical care quality. The number of patients in the database represent far less than the total number of surgical procedures that took place during the time period, which is expect during this pilot phase. Problems with the access to the application in the early days, the choice of variables and logistics to carry regular telephone questionnaires, all contributed to that.

We are now working on a standard operative procedure for the information to be inserted in a more reproducible way.

Increasingly the reduction in the amount of variables depending on manual insertion and efforts to embed the application into the hospital EHR will ease its use. Data-mining and reporting will help surgeons more and more in their clinical activities, surgery planning and learning processes, as well as to the administrative responsible controlling supply and demand as well as cost effectiveness of the consumables. Only further in time, all the benefits from this information system will start to pay off, as will some of the remaining reservations about the project disappear.

There is the necessity of more regular appointments with the surgery department and the management team. These appointments give a better understanding of what indicators need more work or what are unnecessary as the number of surgeries in the database is growing.

7 Conclusions

The data analysis allowed by this database will provide information to help surgeons, managers and hospital administration decision-making, in an unprecedented manner.

Projects like this help hospital do be more effective in a time of crisis, while caring for and improving patient safety and quality of care.

8 Future work

There is some interest at the hospital administration on the expansion of a system like this to all the surgery services, as it provides a better cost and quality control.

The surgeon teams are also interested on the data analysis for research purposes, using this project as a tool to scientific work.

References

1. Doebbeling, B.N., Chou, A.F., Tierney, W.: Priorities and strategies for the implementation of integrated informatics and communications technology to improve evidence-based practice. J. Gen. Intern. Med. 21(suppl. 2), 50–57 (2006)

2. Welke, K.F., Karamlou, T., Diggs, B.S.: Databases for assessing the outcomes of the treatment of patients with congenital and paediatric cardiac disease -a comparison of administrative and clinical data. Cardiol. Young. (18 suppl. 2), 137–144 (2008)
3. ACS NSQIP website, https://acsnsqip.org/main/resources_information_packet.pdf (accessed November 18, 2009)
4. Khuri, S.: The NSQIP: a new frontier in surgery. Surgery 138(5), 837–843 (2005)
5. Hall, B.L., Hamilton, B.H., Richards, K., et al.: Does surgical quality improve in the American College of Surgeons National Surgical Quality Improvement Program: an evaluation of all participating hospitals. Ann. Surg. 250(3), 363–376 (2009)
6. Rogers, S.O.: The Holy Grail of surgical quality Improvement: process measures or risk-adjusted outcomes? Am. Surg. 72(11), 1046–1050 (2006); discussion 1061–1069, 1133–1148
7. Khuri, S.: Safety, quality, and the National Surgical Quality Improvement Program. Am. Surg. 72(11), 994–998 (2006); discussion 1021–1030, 1133–1148
8. Wu, W., Schifftner, T.L., Henderson, W.G., et al.: Preoperative hematocrit levels and postoperative outcomes in older patients undergoing non cardiac surgery. JAMA 297(22), 2481–2488 (2007)
9. Regenbogen, S.E., Ehrenfeld, J.M., Lipsitz, S.R., et al.: Utility of the surgical apgar score: validation in 4119 patients. Arch. Surg. 144(1), 30–36 (2009); discussion 37
10. Park, A.M., Storm, D.W., Fulmer, B.R., et al.: A prospective study of risk factors for nephrolithiasis after Roux-en-Y gastricbypasssurgery. J. Urol. 182(5), 2334–2339 (2009)
11. Huang, Z., Xu, L., Yang, T., et al.: Hepatic resection: ananalysis of the impact of operative and perioperative factors on morbidity and mortality rates in 2008 consecutive hepatectomy cases. Chin. Med. J. 122(19), 2268–2277 (2009)
12. Englesbe, M.J., Pelletier, S.J., Magee, J.C., et al.: Seasonal variation in surgical outcomes as measured by the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP). Ann. Surg. 246(3), 456–462 (2007); discussion 463–465
13. Dimick, J.B., Osborne, N.H., Hall, B.L., Ko, C.Y., Birkmeyer, J.D.: Risk adjustment for comparing hospital quality with surgery: how many variables are needed? J. Am. Coll. Surg. 210(4), 503–508 (2010)
14. Dimick, J.B., Chen, S.L., Taheri, P.A., et al.: Hospital costs associated with surgical complications: a report from the private-sector National Surgical Quality Improvement Program. J. Am. Coll. Surg. 199(4), 531–537 (2004)
15. Davenport, D.L., Henderson, W.G., Khuri, S.F., Mentzer, R.M.: Preoperative risk factors and surgical complexity are more predictive of costs than postoperative complications: a case study using the National Surgical Quality Improvement Program (NSQIP) database. Ann. Surg. 242(4), 463–468 (2005); discussion 468–471
16. Cohen, M.E., Bilimoria, K.Y., Ko, C.Y., Richards, K., Hall, B.L.: Effect of subjective preoperative variables on risk-adjusted assessment of hospital morbidity and mortality. Ann. Surg. 249(4), 682–689 (2009)
17. Chetta, A., Tzani, P., Marangio, E., et al.: Respiratory effects of surgery and pulmonary function testing in the preoperative evaluation. Acta Biomed. 77(2), 69–74 (2006)
18. Gibbs, J., Cull, W., Henderson, W., et al.: Preoperative serum albumin level as a predictor of operative mortality and morbidity: results from the National VA Surgical Risk Study. Arch. Surg. 134(1), 36–42 (1999)
19. Warner, D.O., Warner, M.A., Barnes, R.D., et al.: Perioperative respiratory complications in patients with asthma. Anesthesiology 85(3), 460–467 (1996)

20. Cullen, D.J.: Obstructive sleep apnea and postoperative analgesia–a potentially dangerous combination. J. Clin. Anesth. 13(2), 83–85 (2001)
21. Wong, D.H., Weber, E.C., Schell, M.J., et al.: Factors associated with postoperative pulmonary complications in patients with severe chronic obstructive pulmonary disease. Anesth. Analg. 80(2), 276–284 (1995)
22. Lee, L., Jannapureddy, M., Albo, D., et al.: Outcomes of Veterans Affairs patients older than age 80 after surgical procedures for colon malignancies. Am. J. Surg. 194(5), 646–651 (2007)
23. Hammill, B.G., Curtis, L.H., Bennett-Guerrero, E., et al.: Impact of heart failure on patients undergoing major non cardiac surgery. Anesthesiology 108(4), 559–567 (2008)
24. Healy, K.O., Waksmonski, C.A., Altman, R.K., et al.: Perioperative outcome and long-term mortality for heart failure patients undergoing intermediate- and high-risk non cardiac surgery: impact of left ventricular ejection fraction. Congest Heart Fail 16(2), 45–49 (2010)
25. Fleisher, L.A.: Implications of preoperative heart failure: the next frontier in perioperative medicine? Anesthesiology 108(4), 551–552 (2008)
26. Kałuza, G.L., Joseph, J., Lee, J.R., Raizner, M.E., Raizner, A.: Catastrophic outcomes of noncardiac surgery soon after coronary stenting. J. Am. Coll. Cardiol. 35(5), 1288–1294 (2000)
27. Microsoft© Silverlight, `http://www.silverlight.com`
28. Microsoft© SQL Server, `http://www.microsoft.com/sqlserver/`
29. Jones, D.T., Yoon, M.J., Licameli, G.: Effectiveness of postoperative follow-up telephone interviews for patients who underwent adenotonsillectomy: a retrospective study. Arch. Otolaryngol. Head Neck Surg. 133(11), 1091–1095 (2007)
30. Gray, R.T., Sut, M.K., Badger, S.A., Harvey, C.: Post-operative telephone review is cost-effective and acceptable to patients. Ulster. Med. J. 79(2), 76–79 (2010)
31. QlikTech© Qlikview, `http://www.qlikview.com/`