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ORIGINAL ARTICLE

Real-time database drawn from an electronic health record for a thoracic surgery unit: high-quality clinical data saving time and human resources†

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THORACIC

Abstract

OBJECTIVES: The aim of the present study was to verify whether the implementation of an electronic health record (EHR) in our thoracic surgery unit allows creation of a high-quality clinical database saving time and costs.

METHODS: Before August 2011, multiple individuals compiled the on-paper documents/records and a single data manager inputted selected data into the database (traditional database, tDB). Since the adoption of an EHR in August 2011, multiple individuals have been responsible for compiling the EHR, which automatically generates a real-time database (EHR-based database, eDB), without the need for a data manager. During the initial period of implementation of the EHR, periodic meetings were held with all physicians involved in the use of the EHR in order to monitor and standardize the data registration process. Data quality of the first 100 anatomical lung resections recorded in the eDB was assessed by measuring the total number of missing values (MVs: existing non-reported value) and inaccurate values (wrong data) occurring in 95 core variables. The average MV of the eDB was compared with the one occurring in the same variables of the last 100 records registered in the tDB.

A learning curve was constructed by plotting the number of MVs in the electronic database and tDB with the patients arranged by the date of registration.

RESULTS: The tDB and eDB had similar MVs (0.74 vs 1, $P = 0.13$). The learning curve showed an initial phase including about 35 records, where MV in the eDB was higher than that in the tDB (1.9 vs 0.74, $P = 0.03$), and a subsequent phase, where the MV was similar in the two databases (0.7 vs 0.74, $P = 0.6$). The inaccuracy rate of these two phases in the eDB was stable (0.5 vs 0.3, $P = 0.3$). Using EHR saved an average of 9 min per patient, totalling 15 h saved for obtaining a dataset of 100 patients with respect to the tDB.

CONCLUSION: The implementation of EHR allowed streamlining the process of clinical data recording. It saved time and human resource costs, without compromising the quality of data.

Keywords: Lung surgery • Data collection • Data quality

INTRODUCTION

In times of cost restraints, clinical data represent the centrepiece of nearly every initiative designed to bend the health-care quality and cost curves and to promote research [1]. Every data collection system should provide high-quality up-to-date data in order to reliably guide clinical and management policies [2, 3]. Nevertheless, scanty information can be found in the literature about the quality of clinical databases [4], particularly in thoracic surgery. The aim of the present study was to verify whether the implementation of an electronic health record (EHR) in a thoracic surgery unit allows creation of a high-quality clinical database saving time and costs in comparison with the traditional method of data collection.

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METHODS

Since 1990, our unit has been maintaining an institutional prospective electronic database (traditional database, tDB), according to on paper documents, such as clinical charts, surgical records, blood test reports and spirometric examinations. The on-paper documents were compiled by multiple individuals. On a regular basis (twice per month), a single data manager inputted selected data into the database. The tDB comprised >200 items; among these, 95 were identified as core variables and periodically verified in order to monitor the quality of data collection. The data collected in the EHR were used both for audit and for research purposes. Obviously, not all 95 considered items were necessary in order to periodically audit the clinical and surgical activity of our unit. On the other hand, the set of variables (available for clinical studies) within the electronic register automatically generated from

the EHR largely overcame the core variables identified for this study. We decided to use just the 95 core variables for the present analysis considering them as a significant sample of the entire set of items.

In August 2011, our unit adopted an EHR as part of the clinical practice. The EHR was developed as a joint work by an electronic engineer and two physicians of our unit. Multiple physicians were responsible for the EHR compilation, carried out in four distinct phases:

(i) entering demographic data and medical history during the preoperative evaluation;
(ii) entering surgical data immediately after the operation;
(iii) entering data about multiple clinical outcomes at discharge;
(iv) entering the staging data and final check, when pathological report is available.

In addition, each day data were recorded describing the postoperative daily clinical course. During the initial period of implementation of the EHR, periodic meetings were held with all physicians involved in its use in order to monitor and standardize the data registration process. The EHR is able to automatically generate a real-time database (EHR-based database, eDB), without the need for a data manager imputing data. In addition to all elements of the tDB, the eDB contains 160 new items.

The data quality of the first 100 anatomical lung resections recorded in the eDB was verified by measuring the total number of missing values (MVs) occurring in the 95 selected core variables. We counted a null value as an MV, every time an existing piece of data traceable from clinical documents was non-reported within the eDB. The average number of MVs in the electronic database was compared with that of MVs occurring in the same variables of the last 100 records registered in the tDB. Moreover, we verified the accuracy of the eDB, counting the number of wrong values of the eDB. We considered as wrong/inaccurate each reported value not correctly reflecting the real-world object described in the clinical documents.

Then, two different curves were constructed by plotting the average number of MVs with the patients ordered by the date of registration for both the electronic database and tDB. These curves represent, respectively, the trend of the eDB MV rate during the implementation of the EHR (learning curve) and during the last period of use of the tDB (benchmark curve).

Finally, we quantified the total time spent for obtaining both the tDB and the eDB. The total time for the tDB was obtained by adding the time for compiling the on-paper clinical chart (physician) plus the time for closing the clinical chart with stage of disease and final pathological report (physician) plus the time for entering data in the electronic database (data manager). The total time for the eDB was obtained by adding the time spent for completing each of the four phases of EHR compilation mentioned above; the real-time eDB is then automatically generated.

A descriptive statistic was used. Results are reported as means and standard deviation for numeric variables or frequency of occurrence for categorical variables. Comparative analysis was performed by means of the unpaired Student's *t*-test for numeric variables and χ^2 test or Fisher's exact test as appropriate for categorical variables. The statistical analysis was performed using the Stata 9.0 statistical software (Stata Corp., College Station, TX, USA).

RESULTS

The tDB and the eDB had similar numbers of average MVs (MV-tDB mean: 0.74 ± 1.9 vs MV-eDB mean: 1.1 ± 2, $P = 0.13$), as reported in Table 1.

Figure 1 shows the MV trends for both databases. The MV rate curve of the eDB presented an initial phase of ∼35 records, where the eDB MV was higher than the tDB MV (1.9 ± 2.7 vs 0.74 ± 1.9, $P = 0.03$), and a subsequent plateau phase, where the eDB MV and tDB MV were similar (0.7 ± 1.2 vs 0.74 ± 1.9, $P = 0.6$; see also Table 1).

The inaccuracy rates of the eDB during the learning phase and the plateau phase of implementation of the EHR were stable. In particular, the accuracy rate during the learning phase of the EHR use was 0.5 ± 1, while it was 0.3 ± 0.75 ($P = 0.3$) when the process of compilation of the HER was stable and uniform (plateau phase of the curve).

Table 2 summarizes the average time required to carry out each step of the DB maintenance processes. Compared with the traditional process of data recording, the use of EHR was able to save 9 min per each patient data item on average. Therefore, a total of 15 h was saved for obtaining the compilation of the entire dataset of 100 patients.

DISCUSSION

Main finding

The present study demonstrated that the implementation of an EHR in a thoracic surgery unit allows automatically generating and prospectively maintaining a high-quality institutional database. At the same time, the adoption of this instrument, used by multiple physicians during the daily clinical practice, was associated with saving time and human resources.

Context

The use of medical registries for driving clinical decision-making, monitoring the quality of care and developing management

Table 1: Results of the comparison of missing value rates between tDB and eDB

	Missing value rate	*P*-value
Traditional DB (100 points)	0.74 ± 1.9	0.13
EHR-based DB (100 points)	1.1 ± 2	
Traditional DB (100 points)	0.74 ± 1.9	0.03
EHR-based DB learning curve (35 points)	1.9 ± 2.7	
Traditional DB (100 points)	0.74 ± 1.9	0.6
EHR-based DB experienced phase (65 points)	1.9 ± 2.7	

Results are expressed as means ± standard deviation.
DB: database; EHR: electronic health record.

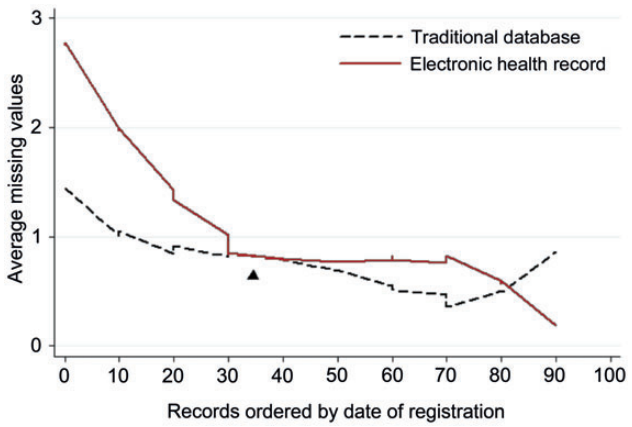

Figure 1: Curves describing the missing value trends for the tDB and eDB.

Table 2: Timing for database maintenance

Database	Phases	Mean time required (min)	Total time for single record (min)	Total time for entire database (100 points) (h)
tDB	On-paper clinical chart compilation	27	49	81.7
	Clinical chart completion and closure	8		
	Data entering in the electronic database	14		
eDB	EHR compilation during preoperative evaluation	25	40	66.7
	Entering surgical data	3		
	Entering outcomes	4		
	Entering staging and final check	8		

strategies has become mandatory in health-care systems [4]. Particularly in Thoracic Surgery, the European Association of Cardio-Thoracic Surgery/European Society for Thoracic Surgeons (EACTS/ESTS) Working Group on Structures in Thoracic Surgery in 2001 formally stated the importance of the data collection process to improve quality of care [5]. More recently, health-care providers favoured the implementation of EHR as an instrument able to improve quality of care, promote clear and updated knowledge exchange and cut down costs. Nevertheless, the use of EHR does not seem widespread in our specialty and scanty information is available about the quality of the data derived from it, as well as the costs involved in its implementation [6–8].

Limitations

A possible bias of the study is represented by the fact that two physicians were directly involved in both the development of the EHR contents and their integration within the hospital informatics network. This could improve their level of expertise for the following electronic data collection process.

There were no available raw data (i.e. before the periodic data quality check) about inaccurate values of the tDB. So we could not compare the two databases in terms of accuracy.

The lack of benchmarks of data quality for clinical databases in thoracic surgery makes the obtained data quality results debatable.

Clinical inferences

This study emphasizes some aspects of the process of implementation of an EHR in a thoracic surgery unit.

In particular, it describes the possibility of obtaining a real-time database directly derived from the EHR, compiled by multiple physicians during their daily clinical practice. This database was characterized by a high level of data quality: in fact, the completeness and accuracy rate were, respectively, 98.9 and 99.6%. Particularly, after an initial learning period, the completeness rate was in line with the one obtained by the traditional data-collecting process, necessitating a specific data manager activity. This finding is in line with the published evidence addressing the quality of data derived from electronic health systems [9, 10].

Moreover, it should be taken into account that this method of prospective data collection without a hypothesis of study in mind could preserve theme from biased observations [11].

In our experience, the adoption of an EHR allowed saving the time for obtaining a clinical database with respect to the previous data collection system. This is at variance with a previous publication, describing the use of the electronic record as more time consuming, in particular for physicians, in comparison with the on-paper document compilation [12].

Recommendation

The present work highlights the importance of implementing the use of EHR in clinical practice for a thoracic surgery unit. In fact, the adoption of this instrument allowed to obtain a base of clinical data with a high-quality level (completeness and accuracy rates of ~99%), comparable with that of a tDB compiled in accordance with clinical on paper documents. At the same time, the possible automatic generation of a real-time database reduces time and human resource costs involved in data collection processes.

Conflict of interest: none declared.

REFERENCES

[1] Ferraris VA, Edwards FH, Shahian DM, Ferraris SP. Risk stratification and comorbidity. Card Surg Adult 2008;3:199–246.
[2] Batini C, Cappiello C, Francalanci C, Maurino A. Methodologies for data quality assessment and improvement. ACM Comput Surv 2009;41:1–52.
[3] Wang R, Strong D. Beyond accuracy: what data quality means to data consumers. J Manage Inf Syst 1996;12:4–19.
[4] Arts DG, de Keizer NF, Scheffer GJ. Defining and improving data quality in medical registries: a literature review, case study, and generic framework. J Am Med Inform Assoc 2002;9:600–11.
[5] Klepetko W, Aberg THJ, Lerut AEMR, Grodzki T, Velly JF, Walker WS *et al*. Structure of general thoracic surgery in Europe: by the EACTS/ESTS Working Group on structures in thoracic surgery. Eur J Cardiothorac Surg 2001;20:663–8.
[6] Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E *et al*. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Ann Intern Med 2006;144:742–52.
[7] Ashish KJ, Timothy GF, Karen D, Catherine D, Alexandra S, Sara R *et al*. How common are electronic health records in the United States? A summary of the evidence. Health Affairs 2006;25:w496–507.
[8] Menachemi N, Collum TH. Benefits and drawbacks of electronic health record systems. Risk Manage Healthcare Policy 2011;4:47–55.
[9] Warsi AA, White S, McCulloch P. Completeness of data entry in three cancer surgery databases. Eur J Surg Oncol 2002;28:850–6.
[10] Salati M, Brunelli A, Dahan M, Rocco G, Van Raemdonck DEM, Varela G, on behalf of the European Association of Thoracic Surgeons Database Committee. Task-independent metrics to assess the data quality of medical registries using the European Society of Thoracic Surgeons (ESTS) Database. Eur J Cardiothorac Surg 2011;40:91–8.
[11] Treasure T, Crowe S, Chan KM, Ranasinghe A, Attia R, Lees B *et al*. A method for early evaluation of a recently introduced technology by deriving a comparative group from existing clinical data: a case study in external support of the Marfan aortic root. BMJ Open 2012;2:e000725.
[12] Poissant L, Pereira J, Tamblyn R, Yuko Kawasumi Y. The impact of electronic health records on time efficiency of physicians and nurses: a systematic review. J Am Med Inform Assoc 2005;12:505–16.