



A computerized surveillance system for asthma

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Abstract

Purpose – Asthma is a chronic inflammatory airways disease characterized by acute exacerbations interspaced by symptom-free periods. Its management imposes a substantial burden on healthcare services, as well as personal suffering and significant financial tolls. The aim of this paper is to demonstrate links between routinely used computerized databases and to establish an automatic mechanism for monitoring asthma patients.

Design/methodology/approach – The study population was all adult subscribers to a major health maintenance organization (HMO) in Southern Israel (230,000 adults, age 20-65 years). Relevant data for this retrospective analysis (2000 to 2004) were extracted from several computerized databases routinely used in the service: pharmacy; administrative; and each person's personal computerized medical file in the primary care clinic.

Findings – Based on data from 72 regional primary care clinics, during the study period, 11,054 adults were treated simultaneously by β_2 agonists and steroids – assumed to be asthmatics. In contrast, asthma diagnosis was recorded in only 4,061 personal files. The intersection between two databases yielded 2,569 persons recorded in both. These findings attest to the feasibility of developing computerized automatic surveillance systems for monitoring asthma patients with certain algorithms to assure service quality.

Research limitations/implications – Data extracted from the various databases were unequal quality, a factor that imposed data management difficulties.

Practical implications – Similar surveillance systems can be developed relatively easily by using comparable algorithms for monitoring different chronic diseases or introducing management indices to secure quality of services.

Originality/value – The paper focuses on developing an automatic asthma monitoring model, using information from routinely used computerized HMO DBs.

Keywords Asthma, Surveillance, Drug administration, Medical information systems, Israel

Paper type Research paper



Introduction

Asthma is a chronic airway inflammatory disease characterized by increased tracheo-bronchial tree responsiveness to multiple stimuli, with acute exacerbations interspaced by symptom-free periods. Optimal asthma management requires continuous patient surveillance and periodically modifying treatment to suit an individual's clinical state. Optimally controlled asthma is defined as minimal

respiratory symptoms, no activity limitations, normal respiratory function, absent need for rescue and minimal anti-inflammatory maintenance therapy (McFadden, 2008). The disease has significant clinical and economic impact on patients and healthcare services (Tuomisto *et al.*, 2007; Hughes *et al.*, 2006; Mosen *et al.*, 2005). Most adult asthma sufferers are managed as outpatients. To improve asthma patient care, management guidelines and quality assurance programs were developed in different countries and healthcare organizations (Haahtela *et al.*, 2006; Firoozi *et al.*, 2007; Gupta *et al.*, 2006). Additionally, specific algorithms for assessing patients were developed and criteria for assessing asthma control were established by the Global Initiative for Asthma (GINA) (Thomas *et al.*, 2009). Guidelines include inhaling short-acting β_2 agonists (SABA), physical activity and measurement of forced expiratory volume in one second (FEV1), or peak expiratory flow (PEF) values (Boulet *et al.*, 1999). Earlier studies used computerized pharmacy data to predict asthma patient emergency attendance (Schatz *et al.*, 2006a), or to assess asthma severity (McFadden, 2008).

Currently, most community clinical services are computerized to various extents, including personal medical files, pharmacy and administrative registries. Using these administrative or clinical databases (DBs) for epidemiological or financial studies is common. Extensive efforts have been made to improve hospitalized asthma patient care using computer algorithms (Smith *et al.*, 2005; Schatz *et al.*, 2006b). However, only a few similar models were developed for outpatients care. Our study's purpose was to demonstrate how several routinely used computerized DBs can be linked for: automatic surveillance mechanism; and ascertaining quality of care for asthma outpatients in a large health maintenance organization (HMO). Our specific aims were to:

- ascertain the feasibility of developing and incorporating an automatic asthma surveillance system into an HMO service using routinely used clinical and administrative databases;
- evaluate the quality of relevant information (regarding asthma) stored in various computerized DBs within the same HMO; and
- demonstrate the potential value of developing similar linkage algorithms for surveillance systems, research or quality assurance of clinical services.

Methods

Our study was conducted in a large HMO in southern Israel. The reference population included all adult (age 20-65 years) HMO subscribers. The HMO provides comprehensive health services to about 70 per cent of the population in this region (about 335,000 adults, mostly urban). Ambulatory services are provided by 180 primary care clinics and each clinic provides services for about 600-700 families. Our study data were accumulated during five years (2000-2005).

Approval

The research proposal was approved by the regional hospital's ethic committee. No direct contact was made with any asthma patient in the study.

Data collection and analyses

Data were extracted from several administrative and clinical computerized DBs routinely used in the HMO. These DBs were developed at different times by different HMO departmental staff in response to specific needs. Therefore, their structure and

operation were quite different. The DBs we used in this retrospective cohort study were:

- Personal (computerized) medical file (PMF) used by all attending physicians in the primary care clinics for day-to-day patient management. The PMF contains patient's socio-demographic information, diagnoses, active health problems, clinic visits, laboratory test results, prescribed medications and summaries of consultation with specialists. Diagnoses in the file are free text not ICD codes.
- Pharmacy Registry (PR) in which all prescribed medications are recorded mainly for financial control. Each prescription contains information on: date, patient's name and his/her unique identification number (ID), prescribed medication's unique code, physician name and the primary care clinic's code.
- Central Administrative Registry (CAR) – in which demographic and administrative data related to all subscribers are registered (for administrative purposes).

We extracted the following data from these DBs for each person in our study: birth date, birth country, gender, patient's personal physician, clinic code and location and length of time drugs were used. By linking PMF and PR DBs, three patient groups were created:

- Probable asthma patients – those for whom combined β_2 agonists and steroids medications were prescribed (simultaneously) and recorded in the PR database for at least three periods during the study time but no asthma diagnosis record was found in the PMF.
- Possible asthma patients – those diagnosed as asthmatics in the PMF, but no indications that they were treated with β_2 agonists and steroids medications were found in the PR DB during the study period.
- Asthma patients identified in both DBs as asthmatics. These patients could have received asthma treatment as well as other medications for c-morbidities.

Results

We collected data from 72 regional primary community clinics, serving about 230,000 adults aged between 20-65 years. From the PR DB, 11054 patients receiving β_2 agonists and steroids for at least three months each year during the study were identified. They represent about 5 per cent of the adult population in the region. In contrast, only 4,061 files in the PMF DB contained an asthma diagnosis. Intersecting two DBs, using the AND Boolean operator, resulted in 2,569 persons complying with our asthma patient diagnosis, while the OR operation generated 12,546 asthma patients – a six times larger number than the intersection value. This discrepancy attests to the DB data quality differences. The asthma group's ($n = 2,569$) mean age was 44 ± 13 years and 62.8 per cent ($n = 1,614$) were women. These patients were distributed evenly among all 72 primary care clinics, indicating no particular bias in recording or diagnoses among physicians or clinics. Among patients diagnosed as asthmatics, the most frequent co-morbidities were: dislipidemia (18 per cent); hypertension (9 per cent); anemia (7 per cent); osteoporosis (6 per cent); and sleep complaints (5 per cent).

The surveillance model

We developed an automatic asthma monitoring model (Figure 1) and proposed it to the HMO managers. Our asthma surveillance algorithm uses information continuously collected in several DBs that are regular service components. Introducing an extra data into the DBs was unnecessary. By utilizing this iterative process, it is possible to gradually build an asthma patient DB and check compliance to treatment protocol, medication side effects, etc. Additionally, when the linkage procedure does not identify asthma diagnosis in the PMF for individuals whose PR records shows he or she is treated for asthma, then an electronic message is sent to the physician in charge, requesting diagnosis confirmation or asking for the medications regimen to be reviewed. Moreover, the algorithm can send various messages to physicians in relation to further patient evaluations that seems necessary. The linkage loop is activated every six months for long-term group monitoring and for updating the asthma patient list. Thus, a high quality dedicated DB of all adult asthma patients in the region is gradually being built and updated. The same method could be used to create regional DBs for other chronic diseases.

Discussion

Our main purpose was to demonstrate the feasibility and potential benefits of linking computerized DBs for surveying and monitoring asthma patients in a community healthcare system. By incorporating linkage systems into routinely used DBs, we can improve asthma care, check and control medications and assist cost containment.

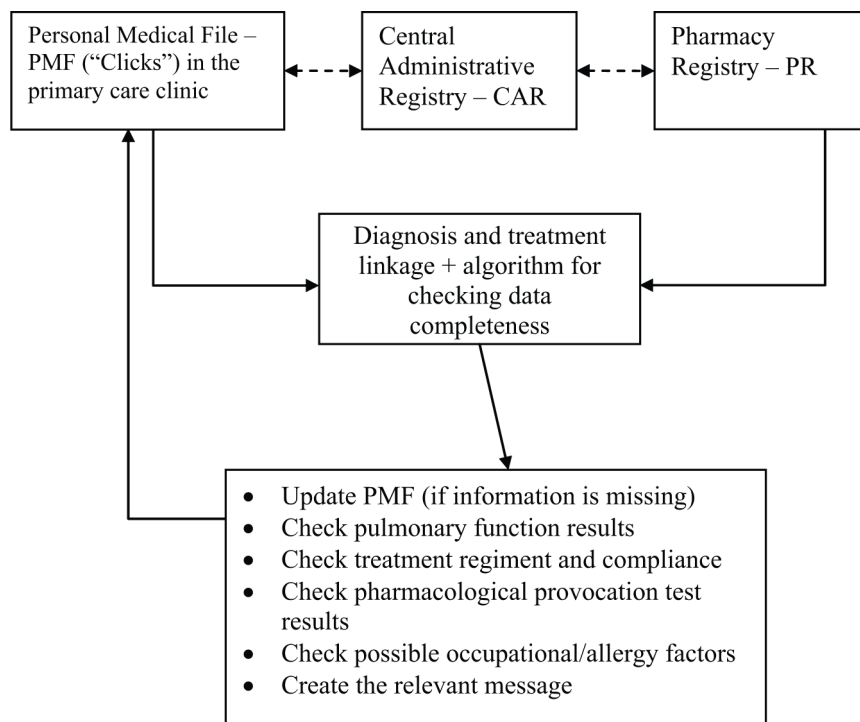


Figure 1.
The automatic regional
asthma surveillance
system

There is almost no need for financial investments for developing such mechanisms. We found that people for whom typical asthma medications were prescribed (PR DB) in the HMO was much larger than patients with an asthma diagnosis in their PMF. This result is partially explained by the PMF's construction, which does not require diagnoses or that this drug combination was also prescribed for conditions other than asthma. Additionally, through the linkage procedures, we could demonstrate variable data quality in the HMO's DBs. This results from the fragmented ways that various DBs were developed. Standardizing and integrating such DBs could bring many benefits to the organization; for example, people for whom typical asthma medications were prescribed (PR DB) was much larger than the number of patients with an asthma diagnosis in their PMF. Thus, our findings call for developing ways to bring DB data accuracy and completeness to the same levels.

By linking several DBs, we developed a system for automatic asthma surveillance system that could easily be incorporated into the HMO's regular data management systems. No extra funds or practice changes were needed. By introducing a defined checkpoint (Figure 1) that collates data from relevant DBs, periodically monitoring asthma patients is feasible, as well as reviewing recommended procedures required for optimal patient care (GINA protocol). Our algorithm can also be used to ascertain patient treatment compliance and produce flags to physicians when needed. Previous studies show that, generally, computerized medical DBs are often underused especially in respect to research opportunities (Wong and Murray, 2005; ten Berg *et al.*, 2007; Helms *et al.*, 2005). These initial DB data mining possibilities allowed us to evaluate the co-morbidities most frequently associated with asthma patients in our study group. Our evaluation confirms the numerous possibilities for utilizing these DBs for diverse medical, administrative or other patient care aspects.

References

- Boulet, L.P., Becker, A., Berube, D., Beveridge, R. and Ernst, P. (1999), "Canadian asthma consensus report", *Canadian Medical Association Journal*, Vol. 161, supplement 11, pp. 1-61.
- Firoozi, F., Lemi re, C., Beauchesne, M.F., Forget, A. and Blais, L. (2007), "Development and validation of database indexes of asthma severity and control", *Thorax*, Vol. 62 No. 7, pp. 581-7.
- Gupta, R., Anderson, H.R., Strachan, D.P., Maier, W. and Watson, L. (2006), "International trends in admissions and drug sales for asthma", *The International Journal of Tuberculosis and Lung Disease: The Official Journal of the International Union against Tuberculosis and Lung Disease*, Vol. 10 No. 2, pp. 138-45.
- Haahtela, T., Tuomisto, L.E., Pietinalho, A., Klaukka, T., Erhola, M., Kaila, M., Nieminen, M.M., Kontula, E. and Laitinen, L.A. (2006), "A 10 year asthma programme in Finland: major change for the better", *Thorax*, Vol. 61 No. 8, pp. 663-70.
- Helms, P.J., Ekins Daukes, S., Taylor, M.W., Simpson, C.R. and McLay, J.S. (2005), "Utility of routinely acquired primary care data for paediatric disease epidemiology and pharmacoepidemiology", *British Journal of Clinical Pharmacology*, Vol. 59 No. 6, pp. 684-90.
- Hughes, E., McCracken, M., Roberts, H., Mokdad, A.H., Valluru, B., Goodson, R., Dunn, E., Elam-Evans, L., Giles, W. and Jiles, R. (2006), "Surveillance for certain health behaviors among states and selected local areas – behavioral risk factor surveillance system, United

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- States, 2004", *MMWR. Surveillance Summaries: Morbidity and Mortality Weekly Report. Surveillance Summaries /CDC*, Vol. 55 No. 7, pp. 1-124.
- McFadden, E.R. (2008), "Asthma", *Harrison's Principles of Internal Medicine*, 17th ed., Ch. 248, McGraw-Hill Medical, New York, NY, p. 1596.
- Mosen, D.M., Macy, E., Schatz, M., Mendoza, G., Stibolt, T.B., McGaw, J., Goldstein, J. and Bellows, J. (2005), "How well do the HEDIS asthma inclusion criteria identify persistent asthma?", *The American Journal of Managed Care*, Vol. 11 No. 10, pp. 650-4.
- Schatz, M., Zeiger, R.S., Vollmer, W.M., Mosen, D., Apter, A.J., Stibolt, T.B., Leong, A., Johnson, M.S., Mendoza, G. and Cook, E.F. (2006a), "Development and validation of a medication intensity scale derived from computerized pharmacy data that predicts emergency hospital utilization for persistent asthma", *The American Journal of Managed Care*, Vol. 12 No. 8, pp. 478-84.
- Schatz, M., Zeiger, R.S., Vollmer, W.M., Mosen, D., Apter, A.J., Stibolt, T.B., Leong, A., Johnson, M.S., Mendoza, G. and Cook, E.F. (2006b), "Validation of a beta-agonist long-term asthma control scale derived from computerized pharmacy data", *The Journal of Allergy and Clinical Immunology*, Vol. 117 No. 5, pp. 995-1000.
- Smith, M.J., Rascati, K.L. and Barner, J.C. (2005), "A descriptive analysis of asthma-related medical services and prescription utilization among recipients in a Medicaid program", *The Journal of Asthma: Official Journal of the Association for the Care of Asthma*, Vol. 42 No. 6, pp. 447-53.
- ten Berg, M.J., Huisman, A., van den Bernt, P.M., Schobben, A.F., Egberts, A.C. and van Solinge, W.W. (2007), "Linking laboratory and medication data: new opportunities for pharmacoepidemiological research", *Clinical Chemistry and Laboratory Medicine: CCLM/FESCC*, Vol. 45 No. 1, pp. 13-19.
- Thomas, M., Kay, S., Pike, J., Williams, A., Rosenzweig, J.R., Hillyer, E.V. and Price, D. (2009), "The Asthma Control Test (ACT) as a predictor of GINA guideline-defined asthma control: analysis of a multinational cross-sectional survey", *Primary Care Respiratory Journal: Journal of the General Practice Airways Group*, Vol. 18 No. 1, pp. 41-9.
- Tuomisto, L.E., Kaila, M. and Erhola, M. (2007), "Asthma programme in Finland: comparison of adult asthma referral letters in 1994 and 2001", *Respiratory Medicine*, Vol. 101 No. 3, pp. 595-600.
- Wong, I.C. and Murray, M.L. (2005), "The potential of UK clinical databases in enhancing paediatric medication research", *British Journal of Clinical Pharmacology*, Vol. 59 No. 6, pp. 750-5.

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