Information Systems Developments to Detect and Analyze Chemotherapy-Associated Adverse Drug Events

Mark G. Weiner, M.D., Alice Livshits, Carol Carozzoni, Pharm.D., Erin McMenamin, Gene Gibson, Pharm.D., Alison W. Loren, M.D., Sean Hennessy, Pharm.D., M.S.C.E.
Division of General Internal Medicine, Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania School of Medicine, Philadelphia, PA 19104
Department of Pharmacy Services, Hospital of the University of Pennsylvania

A difficult balance exists in the use of cancer chemotherapy in which the cytotoxic medicine must act on the cancer without causing neutropenic fever, a condition that is caused by over-suppression of the immune system. An improved understanding of dosing strategies as well as the use of medications to support the immune system has helped to reduce the likelihood of an admission for neutropenic fever following cancer chemotherapy. Therefore, as with any drug therapy, chemotherapy administration that is temporally associated with an unexpected hospitalization for neutropenia is an adverse drug event (ADE). Analogous to other informatics research to monitor and address the occurrence of ADEs, this work develops and validates the information systems infrastructure necessary to detect the occurrence of and analyze the factors contributing to chemotherapy associated ADEs.

INTRODUCTION

As with ADEs in general, the presence of a chemotherapy-associated ADE is often not recorded directly as a discharge diagnosis. Therefore, the occurrence of an ADE must be inferred indirectly using available clinical and administrative information. While manual chart review could be used to search for ADEs, it is personnel-intensive. We therefore developed a more efficient system that leverages the information from administrative records pertaining to the patient's characteristics, the nature of the cancer, the timing and types of chemotherapy used, and the diagnostic and other details of the associated hospital admission. Once detected, the same administrative data can suggest etiological factors that may predict the occurrence of an ADE.

METHODS

Utilizing an export of billing data that was validated against a pharmacy database, we constructed a data mart consisting of cancer patients and the types and dates of the chemotherapy they received. We linked this information to hospitalization data from the same billing system and designated potential ADEs as hospitalizations that occurred within 30 days of a chemotherapy administration. The gold standard for ADE detection was determined by retrospective chart review that verified the association between the presence of neutropenia and an ADE.

To identify the chemotherapeutic agents most commonly associated with ADE admissions, we applied a coding scheme to the list of chemotherapies in which each agent was assigned a value of a successive power of 2. (1, 2, 4, 8 etc). In this manner, chemotherapeutic regimen provided to a patient could be determined directly from the billing data by summing the codes for each of the chemotherapeutic agents used within a given time interval. Codified in this way, the sum assigned to each patient represents a distinct regimen. The association between a regimen of one or more drugs and an ADE could then be assessed as an absolute incidence rate, or as a risk relative to the overall use of the regimen.

RESULTS

We identified 317 billing codes that represented 50 distinct chemotherapeutic agents. Using this list of codes, we then identified 3097 patients who received chemotherapy between July 1, 1999 and July 31, 2001. Of 1008 patients with 2040 admissions for any reason, 260 patients were admitted a total of 336 times with ADEs marked by the presence of neutropenia. Single agents most commonly associated with ADEs included cyclophosphamide, doxorubicin and cytarabine, but the risk of an ADE admission as a fraction of overall usage was highest for cytarabine, melphalan, daunorubicin and vincristine. Chemotherapy combinations that were frequently associated with ADEs included cyclophosphamide-doxorubicin-vincristine and carboplatin-paclitaxel. These combinations were used in the treatment of breast and gynecological cancers in which neutropenia admissions are typically not expected, and qualify as ADEs.

CONCLUSIONS

We developed an information system that is capable of detecting and analyzing the characteristics of chemotherapy-associated ADEs. Work is ongoing to conduct additional analyses and use the information to provide feedback to oncologists that will help improve the quality of care for cancer patients.