MEDINFO 2004
M. Fieschi et al. (Eds)
Amsterdam: IOS Press

A System For Modeling Medication Requirements For the Management of Drug Resistant Tuberculosis In Developing Countries

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Key words: modeling, medications, medical record systems

Introduction

Multi-drug resistant tuberculosis (MDR-TB) is a major and growing health problem in a number of developing countries such as Peru and South Africa and also the former Soviet Union. This disease was thought to be virtually untreatable in developing countries but recent projects, particularly one in Peru, have shown good cure rates [1]. Unfortunately the treatment is prolonged (2 years or more) and the cost of the second line anti-tuberculous drugs can be much higher than those used for conventional TB treatment. It is critical that sufficient supplies of medication be ordered in advance from the lowest cost suppliers to prevent stock-outs, and that inventories are managed to avoid excess stock that cannot be used prior to its expiry date. We have developed a system to track the drug regimens of patients receiving medications for MDR-TB, and to model current and future requirements.

Methods

All data on patients in the MDR-TB treatment program run by Socios En Salud are entered into a web based electronic medical record system (described before[2]) along with details of their medication regimens. Medication regimens are updated with any changes, ensuring an accurate and comprehensive dataset. Analysis pages have been implemented as part of the EMR for the following functions:

1) Aggregation of the total drug requirements for a group of patients for any period of time, taking into account the start and projected end dates for all patients taking specific medications.

2) Calculation of total drug requirements for the complete treatment of a number of patients, taking into account the expected total duration of treatment and duration of injectable drugs (typically 10 –12 months). The estimation is based on the average regimens given to a sample set of patients. This function is used to estimate orders for additional treatment cohorts or sites.

3) Estimation of the required medication (and costs) for a cohort of patients to complete therapy on their current regimens. This includes a model of the estimated total treatment time for patients at different stages of therapy and disease severity (similar to a time-to-event analysis for remaining in therapy).

These analyses can include price lists of medications to calculate by drug and total costs. Data on real monthly medication use is obtained from a medication database at the warehouse in Lima. This is used for comparison with the above estimates. We used data from August 2003 to show the comparison between actual and predicted use.

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Results

Currently the EMR has records on the drug regimens of 1,520 patients treated from 1996 onwards. The table shows monthly usage of 11 second line medications calculated as a 4 month mean compared to predicted usage from the EMR.

Table 1: Predicted drug use as a percentage of actual use

Medication	predicted/actual use
Amikacin	99%
Amox/Clav	98%
Capreomycin	92%
Ciprofloxin	98%
Clarithromycin	101%
Clofazamine	98%
Cycloserine	101%
Ethionamide	94%
Moxifloxacin	94%
PAS	93%
Rifabutin	97%
Mean	**97%**

Discussion

The medication costs for an MDR-TB program represent a large part of the overall budget, accurate predictions are therefore crucial. The EMR has been used for this purpose for 2 years and is compared monthly with warehouse data. The accuracy of prediction is good but care is required to include special details, such as if the remains of a vial of a injectable drug (such as capreomycin) can be reused the next day. The estimate for PAS is low due partly to the need to discard some of this powdered drug at the end of the week. The EMR is designed around the patient's drug regimen as this information is valuable for clinical care, for drug supply management and research. Care is needed in keeping this medication data accurate and up to date and we have implemented a web based medication order entry system to improve this process.

Acknowledgements

The Bill & Melinda Gates Foundation for grant support

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