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Antimicrobial prescribing patterns in a large tertiary hospital in Shanghai, China

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ABSTRACT

Whilst the '*Principles of clinical use of antibiotics*' was released by the Ministry of Health of the People's Republic of China in 2004, limited research has been conducted to evaluate the quality of antibiotic use in real-world practice. In this study, we sought to examine antimicrobial prescribing patterns in a large tertiary hospital in Shanghai, China. De-identified outpatient and emergency department pharmacy records containing antimicrobials were extracted from the hospital electronic health records system. Antimicrobial prescribing patterns and out-of-pocket medical costs for antimicrobials were evaluated by patient demographics and the primary diagnosis. Antimicrobial prescriptions stratified by patient age group (<5, 5–17, 18–49, 50–64 and ≥65 years) were also examined. A total of 363 642 antimicrobial prescriptions in 2014 were obtained, corresponding to 197 781 unique patients. Approximately 18% of antimicrobial-containing prescriptions were for acute upper respiratory infection and bronchitis, 15% for fever or cough, 5% for gastritis and duodenitis and non-infective gastroenteritis and colitis, and 7% for other diagnoses without clear indications of bacterial infection. Cephalosporins were the most frequently prescribed antibiotic class (55%). Age-specific antimicrobial prescriptions showed different patterns between children and adults. A total of US$4.6 million were spent as out-of-pocket costs on antimicrobials in 2014, and the median antimicrobial cost per prescription was $9. Unnecessary antibiotic use is still common in real-world clinical practice and remains a public health challenge. Antibiotic-related medical expenditure also presents an important economic burden.

1. Introduction

Antibiotic resistance is 'a global health crisis' and is one of the 'greatest challenges for public health' [World Health Organization (WHO)]. Overuse of antibiotics is the primary risk factor for antibiotic resistance and can cause adverse drug events [1]. In China, antibiotic resistance due to overuse of antibiotics has been a persistent public health problem [2,3]. Several studies have reported that a high percentage (>50%) of outpatient visits result in prescription of antibiotics [4–6]. In 2004, the '*Principles of clinical use of antibiotics*' was released by the Ministry of Health of the People's Republic of China to guide appropriate antibiotic use [7]; and in 2012, a formal legislation was established to regulate the rational use of antibiotics in all clinical settings [8]. Reform of the healthcare system in China has also helped to eliminate financial incentives associated with antibiotic prescriptions for hospitals and physicians [9]. During 2012–2014, a nationwide campaign of rational antibiotic use was implemented at secondary and tertiary hospitals to establish clinical infrastructure for antibiotic management, to reinforce regulation and clinical guidelines for rational antibiotic use, to set specific targets for antibiotic prescriptions, and to develop surveillance systems to monitor and audit antibiotic prescriptions [10,11].

Following this national antibiotic use campaign, a few studies have shown significant reductions in antibiotic use in China, indicated by decreasing antibiotic prescribing rates and defined daily doses (DDDs) as well as lower patient costs for antibiotics across different healthcare settings in China [12–14]. Whilst these studies demonstrate important achievements of the national campaign, knowledge gaps still exist regarding the quality of antibiotic use. Therefore, more research is needed to better evaluate the effect of the national antibiotic campaign on reducing irrational use of antibiotics.

Studies using a random sample of primary care facilities indicated that between 2009 and 2011, <40% of outpatient antibiotic prescriptions were appropriate and about 80% of patients with a

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cold, pharyngitis or acute bronchitis were prescribed antibiotics [5,6]. However, given the large volume of the patient populations, it is not feasible to review all of the medical or pharmacy records to determine irrational use of antibiotics at secondary or tertiary public hospitals. Considering the establishment of electronic data systems was a key component in the national antibiotic use campaign in order to collect health records, these large available data sets offer a unique opportunity to monitor antibiotic prescriptions. In this study, we sought to explore routinely collected electronic health record (EHR) data to examine the real-world antimicrobial prescribing patterns in a large tertiary hospital in Shanghai, China.

2. Methods and materials

2.1. Setting and patient population

Shanghai Tenth People's Hospital of Tongji University (Shanghai, China) is a level 3A hospital, which is the highest-level hospital in China with the most advanced medical technologies providing outpatient and emergency care and inpatient services to nearly 900 000 people living in the catchment area. This 1860-bed hospital employs ca. 4200 staff and is responsible for delivering high-quality medical care. The hospital also provides a number of specialised care and comprehensive programmes, including nursing specialty, stomatology, a traditional Chinese medicine (TCM) centre for cardio-cerebrovascular diseases and a visual restoration centre. Because of the unique features of the healthcare system in China, Shanghai Tenth People's Hospital serves as a primary care facility through the outpatient departments that include internal medicine, paediatrics, surgery, otolaryngology, dentistry, infectious diseases, dermatology, obstetrics and gynaecology, and TCM.

The Department of Internal Medicine is the largest outpatient department consisting of eight divisions: general internal medicine; asthma and pulmonary; cardiology; endocrinology; gastroenterology; haematology; nephrology; and neurology. The emergency departments, which cover services that are provided by the outpatient departments except infectious diseases and dermatology, are open 24 h a day to serve patients with urgent medical needs. In Shanghai, healthcare costs for most urban residents are covered by medical insurance (employer-based or private) or government programmes; patients can choose their healthcare providers without referrals or can walk in to any clinics during regular working hours. The pertinent out-of-pocket medical costs (physician charges, laboratory tests or medication costs) are almost the same across different healthcare facilities. Thus, a large number of patients seek primary care at Shanghai Tenth People's Hospital. However, because there are more physicians available at the outpatient departments, in general patients prefer going to the outpatient departments unless they have urgent or life-threatening conditions. In 2014 there were 2 176 653 outpatient visits, and visits to the Department of Internal Medicine accounted for 46% of the total outpatient visits (994 661), but the total emergency department visits were only 367 119.

In response to the national antibiotic use campaign, Shanghai Tenth People's Hospital launched a special antimicrobial management committee that was composed of infectious diseases physicians, infectious diseases pharmacists and infection control specialists to categorise and oversee antibiotics use. Prescriptions of antibiotics that are classified as 'restricted use' require approval by the committee, and restricted antibiotics are primarily used in inpatient care. Clinical pharmacists also evaluate a random sample of outpatient prescriptions on a monthly basis to identify possible irrational use of antibiotics and to provide feedback to the antimicrobial management committee and the leadership. Meanwhile, in Shanghai a strict policy has been implemented to restrict profits for drug sales at public hospitals, especially tertiary hospitals. The incomes both for hospitals and physicians rely on government financial support and medical profits resulting from the volume of work or the effort spent on treating patients. Therefore, at Shanghai Tenth People's Hospital physicians do not gain economic incentives for prescribing antimicrobials. A computerised network is implemented across the clinical departments to manage routine operations of the hospital and to maintain EHRs, providing a foundation for evaluating the real-world antimicrobial prescription patterns.

2.2. Data sources

The de-identified pharmacy records of hospital-based outpatient departments and emergency departments (EDs) indicating any antimicrobial(s) prescribed during 1 January 2014 to 31 December 2014 were extracted from the hospital EHR system. The ED records were exclusively for outpatients. According to the WHO classification scheme [15], antimicrobial prescriptions were identified using the China National Drug Code directory, generic names or brand names. We focused on systemic antimicrobials and did not include topical antimicrobial prescriptions such as ophthalmic ointments and skin creams in this study. Each antimicrobial-containing prescription record included a pseudo patient identifier (ID), a pseudo prescription ID, the visit date, patient age and sex, the WHO International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) code [16] for the primary diagnosis based on the patient's chief complaint, clinical department, detailed antimicrobial prescription (antimicrobial drug code, dosage, route and package), and the out-of-pocket medical costs for antimicrobials and for all medications per prescription (converted from Chinese Yuan into 2014 US$ based on an exchange rate of 6.40 Yuan to US$1). One patient can have multiple antimicrobials prescribed during one visit or multiple visits during the study period.

2.3. Data analysis

Antimicrobials were classified as cephalosporins, macrolides/lincosamides, quinolones, penicillins, aminoglycosides, tetracyclines, imidazoles and other classes [7]. Within each class, the top three most commonly prescribed drugs were checked. Patients' primary diagnoses were grouped into 10 diagnostic categories according to the ICD-10 code [16].

Consistent with the antimicrobial drug evaluation method, antimicrobial prescribing patterns were examined by patient age groups and sex, date of visit, clinical department and the primary diagnosis [17]. Antimicrobial prescriptions were also stratified by patients' age group (<5, 5–17, 18–49, 50–64 and ≥65 years). Data were analysed using SAS v.9.3 (SAS Inc., Cary, NC). This study was approved by the Institutional Research Ethics Review Board of Shanghai Tenth People's Hospital of Tongji University.

3. Results

A total of 363 642 antimicrobial-containing prescriptions in 2014, corresponding to 197 781 unique patients and 429 650 antimicrobials, were obtained from the EHR system. There were 219 648 outpatient prescriptions and 143 994 ED prescriptions. The majority of prescriptions were for broad-spectrum antibiotics, and prescriptions for other antimicrobials, including antifungals, antivirals or antimycobacterials, were rare (<5% of the total study records). Among the 197 781 patients, 46% had multiple antimicrobial prescriptions (Fig. 1). Seasonal variation was observed across all age groups, indicating more antimicrobial prescriptions occurring in winter months (January and December 2014) (Fig. 2a). Interestingly, a second peak of antimicrobial prescriptions was seen during July–August 2014 in adults aged 18–49 years. The distribution of