Hungarian Hospital Antibiotic Consumption at the Regional Level, 1996–2005

R. Benko, M. Matuz, P. Doro, R. Viola, E. Hajdu, D.L. Monnet, G. Soos

Abstract
Background: Regional variations in antibiotic consumption in outpatients have been reported previously, but nothing is as yet known about the regional distribution of antibiotic consumption in the hospital sector in Hungary. This study was designed to explore regional variations and investigate determinants of antibiotic consumption in hospital care in Hungary.

Materials and Methods: Regional distribution-based antibiotic sales data were obtained for a 10-year period (1996–2005) for the 20 Hungarian counties. Systemic antibacterial use (Anatomical Therapeutic Chemical code: J01) was expressed as the number of defined daily doses (DDD) per 100 patient-days. The multiple linear regression model was applied to investigate the determinants of regional differences in hospital antibiotic consumption. Independent variables related to health care access, utilization of hospital resources, doctors’ workload, type of hospital care provided, and patient’s characteristics and infections were considered as possible determinants, and data on these variables were obtained for 2 years (2004, 2005). We also tested the association between hospital and ambulatory care antibiotic consumption in Hungarian regions using the Pearson correlation test.

Results: For each year during the 1996–2005 study period, there were large and stable variations in total hospital antibiotic consumption (e.g., min–max1996: 16.0–28.2; min–max2005: 15.2–32.2 DDD per 100 patient-days) depending on the region. In the two developed models (Model 1 and Model 2), the number of reported infections accounted for 53% of the observed regional variations in hospital antibiotic consumption (Model 1), and the number of reported infections together with the case-mix index were responsible for 61% (Model 2). Total antibiotic consumption in hospitals showed a positive correlation (R = 0.71, p = 0.002) with total antibiotic consumption in ambulatory care.

Conclusion: The case-mix index and the number of reported infections explained some of the observed regional variations. However, the moderate value of the models in explaining these regional variations suggest that determinants which could not be explored in this preliminary study may also contribute to regional differences. Future studies should aim at collecting data for each individual hospital as well as data on possible determinants for hospital antibiotic consumption.

Infection 2009; 37: 133–137
DOI 10.1007/s15010-008-7468-6

Introduction
The prevalence of antibiotic-resistant microorganisms is generally higher in hospitals than in the community [1]. In addition to non-compliance with infection control precautions by hospital healthcare personnel, one obvious explanation is the frequent prescription of antibiotics to hospitalized patients [2–4]. An international network, the European Surveillance of Antimicrobial Consumption (ESAC, http://www.ua.ac.be/ESAC), has attempted to collect reliable data on both ambulatory and hospital antibiotic consumption in European countries. Hungary participates in this network and on the basis of hospital antibiotic consumption data reported for 2002, it has one of the lowest hospital antibiotic use in Europe [5]. Regional variations in hospital antibiotic consumption have been investigated in a number of countries, such as Germany and Norway [6, 7]. In a previous paper, we reported regional variations in antibiotic consumption in Hungarian ambulatory care [8]. The study reported here was...
performed to explore various aspects of these regional variations and investigate the determinants of antibiotic consumption in hospital care in Hungary.

**Methods**

Wholesale data on hospital care sales of antibacterials for systemic use – i.e., group J01 of the World Health Organization (WHO) Anatomical Therapeutic Chemical (ATC) system – for each of the 20 Hungarian counties (regions) and for each year during the period 1996–2005 were kindly provided by the IMS PharmMIS Consulting Company (Budapest, Hungary). This data set has 100% coverage, as the antibiotic use of all Hungarian hospitals are included. There were 173 hospitals in Hungary (in 2005), of which only three are private, with the remainder being run by the government. There are four university-affiliated hospitals. In Hungary, hospital consumption data includes the relevant data from chronic care institutions, i.e., rehabilitation centers, chronic psychiatric institutions, pulmonary institutes, and maternity hospitals, but does not include data from nursing homes or on outpatient use (e.g., hospital outpatient departments). Product classification on the substance level and conversion of grams or international units of antibiotics into defined daily doses (DDD) were performed according to the 2005 version of the WHO ATC/DDD index [9].

Data on the number of patient-days for each region and each year were obtained from the database of the National Health Fund Administration [10]. These data on patient-days were calculated by subtracting the number of admissions from the number of occupied bed-days. Patient-days from chronic care institutions and maternity hospitals were included in these data. Total antibiotic consumption in hospitals was expressed, for each region and each year, in DDD per 100 patient-days. We also calculated the number of active agents accounting for 90% of the total hospital use, i.e., in the DU 90% [11].

To investigate the determinants for regional differences in hospital antibiotic consumption, we applied the multiple linear regression method similar to that of Filippini et al. [12]. Variables related to (1) healthcare access, (2) utilization of hospital resources, (3) doctors’ workload, (4) type of hospital care provided, and (5) patient’s characteristics and infections were considered as possible determinants of regional hospital antibiotic use. Based on these variables, the following available independent variables (year 2004 and 2005) were evaluated: number of beds per 10,000 inhabitants, number of hospital admissions per 10,000 inhabitants, average length of stay, number of patient-days per one hospital physician, percentage of active patient-days, percentage of patient-days in surgical units, percentage of patient-days in intensive care or infectious disease units, case-mix index, percentage of admitted patients aged 65 years or older, and number of reported infections per 100 patient-days. Data on independent variables were extracted from two databases [10, 13] directly maintained by or relying on data reported to the Hungarian National Health Fund Administration. A stepwise selection procedure was used, and multicollinearity between possible determinants was detected using the tolerance and variance inflation factor (VIF). A p-level < 0.05 was considered to indicate statistical significance.

We also tested the association between hospital and ambulatory care antibiotic consumption in Hungarian regions using the Pearson correlation test. For this purpose, the regional ambulatory care antibiotic consumption data were obtained for 2004 and 2005 (wholesale data from IMS PharmMIS) and expressed as DDD per 1,000 inhabitants and per day. A normal distribution of regional antibacterial use (both hospital and ambulatory) was proved by the Shapiro–Wilks test. Statistical analyses were performed with SPSS ver. 15 (SPSS, Chicago, IL).

**Results**

National hospital antibiotic consumption expressed in total number of DDDs decreased by 13.8% (from 6.2 to 5.3 million DDDs) between 1996 and 2005. As the total number of hospital patient-days also decreased during this period – by 10.8% (from 25,506,273 to 22,742,119) – the standardized consumption unit remained relatively stable in 1996–2005 (mean ± standard deviation (SD) 21.8 ± 1.7 DDD per 100 patient-days).

However, there were large variations depending on the region (Figures 1, 2). For each year during 1996–2005, there was a 1.7- to 2.4-fold (minimum maximum)