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Original article

Trends in the burden of infectious disease hospitalizations among the elderly in the last decade

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ABSTRACT

Background: Infectious disease is a leading cause of hospitalization. We investigated trends in infectious disease hospitalizations among the elderly in the last decade.
Methods: A total of 81,077 hospitalizations of elderly patients between 2001 and 2010 were available on the computerized database of the Ha'emek Medical Center, Israel. The proportion of hospitalizations attributable to infectious diseases was calculated.
Results: Overall, lower respiratory tract infection (LRTI) accounted for 41.0% of hospitalizations attributable to infectious diseases followed by kidney, urinary tract and bladder infections (UTI) (21.4%), upper respiratory tract infections (URTI) (10.2%), and hepatobiliary tract infections (9.8%).
The proportion of hospitalizations attributable to infectious diseases increased by 14.2% during the study period, rising from 16.9% in 2001 (1023 infectious disease hospitalizations of a total of 6043 hospitalizations) to 19.3% in 2010 (1907 infectious disease hospitalizations of a total of 9876 hospitalizations) (P for trend < 0.001). A significant increasing trend persisted after adjustment for age, ethnicity, and season, resulting in an increase from 16.9% in 2001 to 18.8% in 2010 (P for trend $= 0.001$). A significant increasing trend was observed in males (P for trend < 0.001) and a borderline significant trend was observed in females (P for trend $= 0.062$). The proportion of hospitalizations attributable to infectious diseases was higher in males and increased with age. LRTI and URTI were the major contributors to the increasing trend (P for trend $= 0.018$ and <0.001, respectively).
Conclusions: This study shows an increasing trend in infectious disease hospitalizations among the elderly in the last decade. Public health measures are needed to reduce infectious disease hospitalizations.

1. Introduction

Infectious disease is associated with substantial morbidity and mortality and remains a leading cause of visits to ambulatory clinics and hospitalization [1–4]. Infectious diseases accounted for 19% of visits to physicians in the United States [3]. In 1994, infectious diseases accounted for 23.3% of hospitalizations among American Indians and older adult Alaskan natives [5], 11% of hospitalizations among American whites, and 12% of hospitalizations among blacks and all other races [1].

Previous studies indicate an increasing trend in the burden of infectious disease hospitalizations, as reflected by an increase in the proportion of hospitalizations attributable to infectious diseases [1,5,6]. In the last few years, the overall rate of hospitalizations in the United States declined by approximately 33%, while the rate of hospitalizations for infectious diseases declined less steeply in those aged <65 and increased in those aged ≥65 years [1,7]. Consequently, the proportion of hospitalizations attributable to infectious diseases increased [1]. This may be explained by the improvement in the treatment of chronic diseases resulting in less need for hospitalization for these conditions. In addition, the aging of the population [7,8] and the increasing prevalence of elderly patients with comorbid conditions has resulted in a population that is more susceptible to infectious diseases [1,6,7]. Moreover, because of comorbidities, elderly subjects are more likely to visit the emergency department, a finding associated with a three-fold increased risk of acute infection [9]. Another important contributor is the widespread use of antibiotics and the emergence of highly resistant pathogens [10].

Recent data concerning infectious disease hospitalizations is lacking in Israel. This study describes the trend in the burden of hospitalizations attributable to infectious diseases among the elderly during the last decade in Israel.

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2. Materials and methods

2.1. Study population and data source

The study was conducted at the Ha'emek Medical Center, located in the northeastern region of Israel, which serves a population of more than 500,000 persons. Ha'emek Medical Center is one of a number of hospitals in the region and does not have specific referral sub-specialties. Referral to any of the hospitals in the region is dependent on the preference of the primary care physician, the patient, and the patient's family. This study was approved by the local institutional review board and ethics committee.

We included all admissions of elderly patients (≥65 years old at the time of hospitalization) at the Ha'emek Medical Center between 2001 and 2010 to any of the following wards: internal medicine, intensive care units, general surgery, urology, orthopedics, and gynecology.

Hospitalization data are available from a computerized database and includes reason for hospitalization, date of hospitalization, date of discharge or death, age at the time of hospitalization, gender, ethnic group, and a calculated Charlson comorbidity index for each admission.

If the patient was transferred to another ward during the hospitalization period, only the hospitalization in the first ward was considered in this study.

2.2. Infectious disease classification

The causes or reasons for hospitalization were classified into two categories: infectious causes and noninfectious causes. Infectious causes were grouped into the following categories according to the site or the type of infection using the ICD-9 coding: lower respiratory tract infection, upper respiratory tract infection, kidney, urinary tract and bladder infection, enteric infection, viral central nervous system infection, meningitis, cellulitis, tuberculosis, septicemia, hepatobiliary disease, infections of the heart, abdominal and rectal infection, infection due to internal prosthetic device, implant and graft, postoperative infection, osteomyelitis, periostitis, and other infections involving bones, and inflammatory disease of female pelvic organs.

2.3. Definition of terms

The proportion of hospitalizations attributable to infectious diseases was calculated by dividing the number of hospitalizations due to infectious diseases in each year by the total numbers of hospitalizations in the same year.

The Charlson comorbidity index is a weighted index that takes into account the number and the seriousness of comorbid conditions [11]. To study trends in the severity of comorbid conditions, we used the traditional Charlson comorbidity index grouped into four categories: score 0, no comorbid conditions; score 1–2, mild; score 3–4, moderate; score ≥5, severe [6,11].

2.4. Statistical analyses

Continuous variables were presented as means and standard deviations (SD) or medians with the inter-quartile range (IQR) as appropriate. Categorical data were presented as proportions. The comparison of continuous variables between two categories was performed with Student's *t*-test or the Mann–Whitney test as appropriate. The association between categorical variables was tested with the Chi-square test.

The proportion of hospitalizations attributable to infectious diseases was adjusted for age, ethnicity, and season by means of the direct adjustment method, using the population of the year 2001 as the standard reference population.

Trends in the adjusted proportions during the study period (2001–2010) were studied with logistic regression. The adjusted P for trend was estimated by including the year of the study period as a continuous variable in the model. The method of generalized estimating equations (GEE) was used to account for correlations of hospitalizations from the same subject.

A P-value of less than 0.05 for the two-tailed test was considered statistically significant. All statistical analyses were performed using SPSS 18.0 (SPSS Inc., Chicago).

3. Results

A total of 81,284 hospitalizations of elderly patients were identified during the study period in the analyzed wards of the Ha'emek Medical Center. Because the cause of hospitalization was missing in 207 hospitalizations, 81,077 hospitalizations were included in the final analyses. Overall, 15,195 (18.7%) of the hospitalizations were attributable to infectious diseases.

Compared with subjects hospitalized with noninfectious diseases, the subjects with infectious diseases were more likely to be males, patients of Arab origin, of older age, and to have a longer duration of hospitalization (P value < 0.001 for each) (Table 1).

3.1. Infectious disease hospitalizations

Overall, lower respiratory tract infections (LRTI) accounted for 41.0% of hospitalizations attributable to infectious diseases, followed by kidney, urinary tract and bladder infections (UTI) (21.4%), upper respiratory tract infections (URTI) (10.2%), and hepatobiliary tract infections (9.8%). LRTI accounted for 49.4%, 45.9%, 32.1%, and 34.8% of infectious disease hospitalizations in the winter, spring, summer, and autumn, respectively (P value < 0.001).

During the study period, there was a significant increasing trend in the crude proportion of hospitalizations attributable to infectious diseases: from 16.9% (1023 infectious disease hospitalizations of a total of 6043 hospitalizations) in 2001 to 19.3% (1907 infectious disease

Table 1
Characteristics of elderly subjects hospitalized at the Ha'emek Medical Center during the years 2001–2010 stratified by the causes of hospitalization (infectious versus noninfectious).

Variable	All (n = 81,077)	Type of admission		P value
		Infectious (n = 15,195)	Noninfectious (n = 65,882)	
Gender				<0.001
Males	40,569 (50%)	7858 (51.7%)	32,709 (49.6%)	
Females	40,508 (50%)	7335 (48.3%)	33,173 (50.4%)	
Ethnicity				<0.001
Jews	65,597 (80.9%)	11,914 (78.4%)	53,683 (81.5%)	
Arabs	15,480 (19.1%)	3281 (21.6%)	12,199 (18.5%)	
Age group				<0.001
65–74.9 years	36,506 (45.0%)	5756 (37.9%)	30,750 (46.7%)	
75–84.9 years	32,699 (40.3%)	6329 (41.7%)	26,370 (40.0%)	
≥85 years	11,872 (14.7%)	3110 (20.5%)	8762 (13.3%)	
Season				0.004
Winter	21,891 (27.0%)	4192 (27.6%)	17,699 (26.9%)	
Spring	20,250 (25.0%)	3859 (25.4%)	16,391 (24.9%)	
Summer	19,666 (24.3%)	3516 (23.1%)	16,150 (24.5%)	
Autumn	19,270 (23.7%)	3628 (23.9%)	15,642 (23.7%)	
Ward of admission				<0.001
Internal medicine	54,471 (67.3%)	11,886 (78.2%)	42,585 (64.4%)	
General surgery	10,740 (13.2%)	1949 (12.8%)	8791 (13.3%)	
Urology	4964 (6.1%)	958 (6.3%)	4006 (6.1%)	
Orthopedic	5071 (6.3%)	271 (1.8%)	4800 (7.3%)	
Gynecology	1009 (1.2%)	43 (0.3%)	966 (1.5%)	
Intensive care	4822 (5.9%)	88 (0.6%)	4734 (7.2%)	
Duration of admission (days)				
Mean ± SD	4.6 ± 5.8	5.4 ± 6.5	4.4 ± 5.6	<0.001
Charlson comorbidity index				
Median (inter-quartile range)	1 (0–2)	1 (0–2)	1 (0–2)	<0.001