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Original article

Epidemiology and cost of hospital care for Lyme borreliosis in Germany: Lessons from a health care utilization database analysis

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ABSTRACT

To date, relatively little is known about the economic and medical impact of Lyme borreliosis (LB) on European health care systems, especially for the inpatient sector. This retrospective analysis is based on data provided for the years 2007–2011 by a German statutory health insurance company (DAK-Gesundheit) covering approximately 6 million insured. Total cost was calculated for a 1-year period both from the third-party payers and from the societal perspective, respectively. In our cohort the incident diagnosis of LB was coded for 2163 inpatient cases during the years 2008–2011. The median inpatient time was 9 days resulting in a median direct medical cost per hospital stay of 3917€ for adolescents and 2843€ for adults. Based on extrapolation of our findings to the German population, we would expect an average hospital admission of 5200 adults and 2300 adolescents (<18 years) for LB treatment incurring direct medical costs of more than 23 million Euro annually. The annual indirect costs due to loss of productivity would add up to more than 7 million Euro as assessed by the human capital method. Cases tended to accumulate between June and September with remarkable changes in disease manifestations in the course of the year documented in the coded secondary diagnoses. Also specific differences in the disease pattern of adolescents and adults became obvious. Age-specific incidence showed male predominance and a bimodal distribution. Incidence was highest in children aged between 3 and 17 (highest mean incidence of 29 cases/100,000 inhabitants in 6–9 year olds) with a second peak in 60–79 year old individuals. During the study period the nationwide inpatient incidence was 9/100,000 with marked regional variability. In summary, our study is one of the first European investigations on hospital care for LB inpatients and identifies LB as a possibly underestimated socioeconomic factor for health care in Germany.

Introduction

Lyme borreliosis (LB) is a bacterial infectious disease. Its agents are transmitted by ixodid ticks. LB is regarded the most common vector-borne disease in Europe and North America (Berglund et al., 1995; Wormser et al., 2006). The disease is caused by spirochetes belonging to the *Borrelia burgdorferi* sensu lato (s.l.) complex of which at least 5 genospecies are considered to be pathogenic for humans (*B. burgdorferi* sensu stricto (s.s.), *Borrelia afzelii, Borrelia garinii, Borrelia spielmanii* and *Borrelia bavariensis*) (Stanek et al., 2012). Germany, along with other central European and Baltic states, belongs to the geographic region with the highest reported incidence of LB in Europe (Lindgren and Jaenson, 2006). Due to the fact that mandatory reporting of LB was primarily established in 2002, but only for the six new federal states in the eastern part of Germany, epidemiologic data on the true incidence of the disease is rather limited. Despite the known marked regional epidemiological variability of LB, current estimations of 60,000–100,000 incident cases per year are mainly based on an older cohort study in a single German region (Huppertz et al., 1999). Currently, available official data on LB incidence in Germany range between 77.6/100,000 for the state of Brandenburg and 5.7/100,000 for the urban area of Berlin (Fülöp and Poggensee, 2008). In the absence of nationwide notification data it seems attractive to provisionally rely on other sources of data with comprehensive coverage such as hospital discharge data used in a recent study from France (Vandenesch et al.,

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2014) or claims data of health insurance companies. Following the latter approach, a study reported an average annual incidence of 261/100,000 for the diagnosis "LB" (Müller et al., 2012). These findings may point to an underestimation of the current impact of LB as a socioeconomic factor on the German health care system.

Even though the majority of LB cases present with a typical rash called erythema migrans (EM) which occurs several days to weeks after a tick bite, the disease can manifest itself progressively as a multisystem disorder in a very variable clinical fashion (Stanek et al., 2011). The wide variety of possible clinical manifestations is one of the major reasons why LB is generally perceived as an infectious disorder which is difficult to diagnose and hard to treat (Beaujean et al., 2013). Ongoing deficits in the practical management of LB patients and the lack of evidence based answers to open questions such as possible spirochetal persistence after treatment and post-infectious sequelae in some patients continue to make LB a matter of vivid popular and scientific discussions. Müller et al. calculated direct medical costs of about 51.2 million Euro for diagnostics and treatment of LB outpatients in Germany (Müller et al., 2012), but in general, little is known about the economic and medical impact of LB on European health care systems which result from uncertainties in the practical medical management of LB in the in- and outpatient sector. Moreover, reliable data focusing on LB hospital care is rather scarce, if available at all for Europe. This is why the main focus of our present study was the assessment of the associated annual (direct medical and indirect) costs for LB patients who require hospital admission and to gain additional epidemiological and clinical information on such patients.

Materials and methods

Dataset and data analysis

The present cost-of-illness-study is based on a retrospective analysis of health insurance data for the years 2007–2011. Data was provided by a German statutory health insurance company (DAK-Gesundheit [DAK-G]) that covered approximately 6 million insured individuals during the study period. Patient data were anonymous but patient-specific information was available. Informed consent is not required for such an analysis in Germany. Data from LB inpatients contained detailed medical and demographic information according to legal obligations (§ 301 SGB V) and the mandatory system of diagnosis related groups (DRG) established in Germany since 2004 (Reinhold et al., 2009). Additionally, information on work-loss data were included which enabled us to assess possible indirect costs by the human capital method.

Data of patients with LB as a primary diagnosis were extracted by using the following documented hospital International Classification of Diseases Revision 10 – German Modification (ICD-10-GM) code: A69.2 (Lyme disease; erythema chronicum migrans due to *B. burgdorferi*). Patients were included if they had suffered from LB resulting in hospital admission with a minimal duration of one night in the hospital. To determine the incidence of hospitalized LB patients, individuals already coded as inpatients with a diagnosis of LB in 2007 were excluded from the analysis for the subsequent years (2008–2011). Because the start of clinical signs is of particular epidemiologic interest, the date of hospital admission was indicative for the assignment of each case.

As in some other countries, a modification of ICD-10 is used in Germany (Jetté et al., 2010). A system of hierarchical primary and secondary keys allows multiple coding in which the primary key stands for the underlying disease and the secondary key displays the clinical pattern of the disorder. The LB manifestations that can be identified from this analysis (ICD-10-GM-codes given in brackets) are: meningitis (G01*); encephalitis, myelitis or encephalomyelitis (G05.-*); facial nerve disorders (G51.-); polyneuropathy (G63.0*) and arthritis (M01.2-*). The exact diagnosis of erythema chronicum migrans is not definitely recognizable because the ICD-10-GM-codes for LB and erythema chronicum migrans are identical (A69.2). Because all relevant information on secondary diagnoses in our dataset was submitted without any time specification, only cases with a single inpatient stay could be clearly ascribed for this particular statistical evaluation. Furthermore, a relevant secondary diagnosis was not coded in some patients and multiple entries were recorded for some individuals.

Determination of total cost

For this study the incorporated cost components consisted of direct medical costs for hospitalization and indirect costs resulting from the loss of productivity. In this total cost approach, costs were calculated for a period of one year, both from the third-party payers and from the societal perspective. According to existing German standards (Hanover consent) the calculated production loss was based on the average gross income (Graf von der Schulenburg et al., 2007). Consequently, our estimates of indirect costs are the result of the average earnings and the mean number of work days lost for all German inpatients between 18 and 64 years of age. However, short-term absence from work without doctor's contact was not included.

Statistics

All insured individuals were stratified by gender, age (groups of 3–5 years) and the available 5-digit residence codes. The insured population of the DAK-G is known to consist of more women than men (ratio: 1.6:1). To avoid a potential bias possibly arising from a non-representative sex and age composition of our cohort, we first analyzed and then standardized our study population by age and gender based upon official statistical data as provided for the German population by the Federal Statistical Office of Germany. The place of domicile was used for purposes of further standardization.

Results

Epidemiology of hospital admission

From 2008 to 2011, the incident diagnosis of LB was coded in a total of 2163 cases (2008: $n = 591$; 2009: $n = 512$; 2010: $n = 549$; 2011: $n = 511$). In our cohort, 1001 inpatients were male and 1162 female with a median age of 47 years for males and 54 years for females ($p < 0.05$). Besides this significant difference, an additional analysis of age distribution revealed a bimodal pattern with two peaks, one in children aged 5–14 years and one in the group of 65–74 year-old individuals. The subgroup of adolescents ($n = 580$; defined as individuals <18 years) was mainly treated in pediatric departments (94% of cases), whereas more than half of the adult patients ($n = 1583$; age ≥18 years) were admitted to neurology units (55% of cases). Of the remaining adult patients, most were referred to internal medicine and to dermatology departments (27% respectively 6% of all adult cases). Our findings indicate that >90% of hospital stays occurred in a few medical disciplines only. The most frequently assigned DRGs of the dataset were T64B (i.e. other infectious & parasitic diseases with complex diagnosis, age > 15 years) in 70% of all cases and T64A (i.e. other infectious & parasitic diseases with complex diagnosis, age < 16 years) in 25% of all cases. The corresponding median length of hospital stay in our cohort was 9 days (IQR: 5–14) independent of the department of first admission. Concerning the seasonal pattern of admissions, our dataset showed an accumulation of LB inpatients between June and September. This marked seasonality varied only slightly each year