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Epidemiology of healthcare associated infections in Germany: Nearly 20 years of surveillance

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ABSTRACT

Objective: To describe the epidemiology of healthcare-associated infections (HAI) in hospitals participating in the German national nosocomial infections surveillance system (KISS).
Method: The epidemiology of HAI was described for the surveillance components for intensive care units (ITS-KISS), non-ICUs (STATIONS-KISS), very low birth weight infants (NEO-KISS) and surgical site infections (OP-KISS) in the period from 2006 to 2013. In addition, risk factor analyses were performed for the most important infections of ICU-KISS, NEO-KISS and OP-KISS.
Results: Data from a total of 3,454,778 ICU patients from 913 ICUs, 618,816 non-ICU patients from 142 non-ICU wards, 53,676 VLBW from 241 neonatal intensive care units (NICU) and 1,005,064 surgical patients from operative departments from 550 hospitals were used for analysis. Compared with baseline data, a significant reduction of primary bloodstream infections (PBSI) and lower respiratory tract infections (LRTI) was observed in ICUs with the maximum effect in year 5 (or longer participation) (incidence rate ratio 0.60 (CI95 0.50–0.72) and 0.61 (CI95 0.52–0.71) respectively). A significant reduction of PBSI and LRTI was also observed in NEO-KISS when comparing the baseline situation with the 5th year of participation (hazard ratio 0.70 (CI95 0.64–0.76) and 0.43 (CI95 0.35–0.52)). The effect was smaller in operative departments after the introduction of OP-KISS (OR 0.80; CI95 0.64–1.02 in year 5 or later for all procedure types combined). Due to the large database, it has not only been possible to confirm well-known risk factors for HAI, but also to identify some new interesting risk factors like seasonal and volume effects.
Conclusions: Participating in a national surveillance system and using surveillance data for internal quality management leads to substantial reduction of HAI. In addition, a surveillance system can identify otherwise not recognized risk factors which should – if possible – be considered for infection control management and for risk adjustment in the benchmarking process.

1. Introduction

The main objective of the National Reference Centre for surveillance of nosocomial infections was and still is to develop, maintain and evaluate the national reference database KISS (Krankenhaus-Infektions-Surveillance-System). After the development of surveillance protocols for the first two surveillance components (ITS-KISS for healthcare-associated infections (HAI) in intensive care units (ICU) and OP-KISS for surgical site infections (SSI)) in 1996, KISS started data collection with a small number of voluntary participating hospitals in 1997. The number of participating institutions has increased from year to year. To meet the needs and expectations of the participants, further surveillance components have been added: NEO-KISS for very low birth weight (VLBW) infants, ONKO-KISS for hematology/oncology patients, STATIONS-KISS for device-associated infections in non-ICU wards, MRSA-KISS and CDAD-KISS for hospital-based surveillance of methicillin-resistant *Staphylococcus aureus* (MRSA) and Clostridium difficile-associated diarrhea (CDAD). Finally, a surveillance component for hand rub consumption (HAND-KISS) has also been introduced. Meanwhile, the majority of German hospitals participate in at least one surveillance component. In order to handle the increasing number of participants and technical progress in the hospitals, an online data management system has been

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introduced. Furthermore, measures to routinely evaluate data quality have been developed (Gastmeier et al., 2008). Because of the main objective – to provide benchmark data for comparison – evaluations have been performed regularly to determine if this aim has been achieved. In general, a mean reduction of HAI rates of about 20–30% was observed in various surveillance periods (Zuschneid et al., 2003, 2007; Brandt et al., 2006; Gastmeier et al., 2005, 2006, 2009; Bärwolff et al., 2006; Schwab et al., 2007, 2012). Since the establishment of the Healthcare-Acquired Infection Network (HAI-net) at the European Centres for Disease Prevention and Control (ECDC), KISS provides the German data for the European surveillance network.

In addition, the data have been used to provide epidemiological reports and to identify risk factors for the development of infections. Altogether, about 100 original articles listed in PubMed were published based on KISS results from 1999 to 2014.

The aim of this report is to provide data about the development of the whole system in the course of the last eighteen years and to focus on the four most comprehensive surveillance components (ITS-KISS, STATIONS-KISS, NEO-KISS and OP-KISS) to describe the development of HAI rates and to identify significant risk factors for HAI. Data about the development of multiresistant pathogens causing HAI and Clostridium difficile-associated diarrhea were published recently and are therefore not included (Meyer et al., 2012, 2014; Gastmeier et al., 2014; Leistner et al., 2014).

The main objectives are:

- The presentation of the frequency of HAI in German hospitals (ICU, non-ICU, VLBW infants and operative departments) participating in KISS and their development over time.
- The analysis of risk factors and confounders for HAI in German hospitals (ICU, non-ICU, VLBW infants and operative departments) participating in KISS, focusing on units/departments that began to participate in 2006 or later.

2. Materials and methods

The definitions and methods of the various KISS components have been published earlier (Gastmeier et al., 2006; Geffers et al., 2008), www.nrz-hygiene.de. To give an overview about the number of participants, an inventory of the number of participants per calendar year was performed as well as an analysis of the distribution of KISS participants in the German federal states. To describe the current situation, we concentrated on the largest surveillance components with HAI data (ITS-KISS, STATIONS-KISS, NEO-KISS and OP-KISS) in the period from 2009 to 2013. The risk factor analyses used the data from the 8-year surveillance period from 2006 to 2013. This time period was chosen because new CDC definitions for pneumonia and new pathogen codes have been used since 2006. In addition, several analyses have been performed to investigate the effectiveness of surveillance for the period until 2006 (Zuschneid et al., 2003, 2007; Brandt et al., 2006; Gastmeier et al., 2005, 2006, 2009; Bärwolff et al., 2006; Schwab et al., 2007, 2012), but almost none for the period since 2006.

Incidence density and device-associated infection rates were calculated for primary blood stream infections (PBSI) and lower respiratory tract infections (LRTI) or pneumonia and urinary tract infections in ITS-KISS, STATIONS-KISS and NEO-KISS and incidence rates of surgical site infections (SSI) were calculated following the 6 most frequent procedures or the 5 procedure types with the highest SSI rates, respectively.

To identify risk factors and confounders for HAI, univariable and multivariable risk factors analyses were performed using the available factors in the individual surveillance components for ITS-KISS, NEO-KISS and OP-KISS. Risk factor analyses were not performed for STATIONS-KISS because of the smaller number of participating units.

To analyze the data of ITS-KISS and OP-KISS, generalized linear models (GLM) were applied to estimate the association between the number of HAI per month (ITS-KISS) or the occurrence of SSI (following an operative procedure) (OP-KISS) with the available factors in the respective component. Because observations within an ICU or an operative department are not statistically independent, generalized estimating equation (GEE) models were calculated which account for this clustering effect by using an exchangeable correlation structure (Zeger et al., 1988; Localio et al., 2001). For the outcome 'number HAI per month' (ITS-KISS data set), a negative binomial distribution in the GEE models was used and the log number of patient days during each month was treated as offset parameter. For the outcome 'SSI following an operative procedure' (OP-KISS data set), a binomial distribution in the GEE model was applied.

In NEO-KISS, VLBW-infants are included in surveillance on a patient-by-patient basis for 50 days, on average. To analyze independent risk factors for the occurrence of HAI until achieving 1800 g weight, transfer to another unit or death (cf. NEO-KISS protocol), Cox-proportional hazard regression was used. The Cox-regression considers the time to event (HAI) adequately. For patients with more than one HAI (of the same type) only the first HAI was considered.

For all three risk factor analyses only units/operative departments starting surveillance on the 1 January 2006 or later were included. All data between 1 January 2006 and 31 December 2013 were analyzed. In all analyses, categorical parameters were dummy coded and the variable selection was stepwise backward with the significance level of $p = 0.05$ for removing a variable from the model. All analyses were performed using R [Chicago, IL] and SAS 9.2 [SAS Institute, Cary, NC, USA].

3. Results

The number of KISS participants increased from year to year in most of the surveillance components. Depending on the component, a substantial number of wards or departments are now participating (Table 1). At the end of July 2014, KISS had a total of 1482 participating hospitals. 1072 hospitals remain when hospitals participating only in HAND-KISS are not considered (participation in HAND-KISS is easy because of less workload). Fig. 1 describes the percentage of beds covered by hospitals participating in at least one KISS component in a federal state (Fig. 1A for all surveillance components focusing on HAI and multiresistant pathogens and 1B for all participating hospitals including those taking part in HAND-KISS only).

Altogether, data from a total of 3,454,778 ICU patients from 913 ICUs, 618,816 non-ICU patients from 142 non-ICU wards, 53,676 VLBW from 241 neonatal intensive care units (NICU) and 1,005,064 surgical patients from operative departments from 550 hospitals were used for analysis. Table 2 presents the overall incidence densities of HAI and incidence densities of device-associated infections in ITS-KISS, STATIONS-KISS and NEO-KISS for comparison. Urinary tract infection rates (UTI) are similar in ICUs and non-ICU wards when patient days are used as denominator. However, calculating device-associated UTI rates results in much higher UTI rates in non-ICU wards. Central venous catheter (CVC)-associated primary bloodstream infection (PBSI) rates are also much higher in non-ICU wards compared with ICUs ($p < 0.001$). The results also confirm the substantial difference of HAI rates in VLBW according to birth weight groups ($p < 0.001$).