

Worldwide Outbreak Database: the largest collection of nosocomial outbreaks

R.-P. Vonberg · D. Weitzel-Kage · M. Behnke ·
P. Gastmeier

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Abstract Epidemiological findings of a single outbreak event may not be generalized; however, the characteristics of a typical outbreak can be determined on the basis of a large number of similar events. The Outbreak Database (<http://www.outbreak-database.com>) is the largest collection of nosocomial outbreaks currently available—and is still expanding. Articles are filed systematically, enabling those on a specific parameter of interest to be retrieved quickly. As such, this database is an extremely valuable tool on many medically related fronts, such as for educating other medical personnel, providing relevant information during the investigation of an acute outbreak, or addressing scientific-oriented questions. Several systematic reviews on a wide range of subjects, including sources of infections, types of pathogens, routes of transmission, appropriate infection control measures, and patients at risk of infection, have already been published based on information contained in this database. As this database may be used free of charge, all medical staff in the field of infection control, hygiene, and hospital epidemiology should be aware of its existence.

Keywords Nosocomial infection · Outbreak · Database · Epidemiology

Epidemiology of nosocomial outbreaks

Nosocomial outbreaks are not specific to any one medical department and can occur overall in a hospital. They usually represent quite frightening events. Uncertainty may prevail among the staff and the patients involved with respect to, for example, the probable causative pathogen (if not yet discovered as such) and the outbreak's source. Infection control personnel expend a great deal of effort in investigating such outbreaks, which may lead to unexpectedly high costs for the affected hospital [1]. There is also the risk of that the hospital will suffer from a loss of reputation if the outbreak is reported to the community by the public media [2]. Approximately 2–10% of all nosocomial infections are acquired during nosocomial outbreaks [3, 4].

Data from nosocomial outbreaks may help preventing infections

Although a nosocomial outbreak is an extremely unwanted incident, experiences based on past nosocomial outbreaks may contribute to an improvement of the quality of future medical care [5].

Illustrative education of medical staff on hospital epidemiology

The education of staff on basic infection control measures may prevent the occurrence of nosocomial infections in the

R.-P. Vonberg (✉)
Institute for Medical Microbiology and Hospital Epidemiology,
Hannover Medical School, Carl-Neuberg-Str. 1, 30625
Hannover, Germany
e-mail: Vonberg.Ralf@MH-Hannover.DE

D. Weitzel-Kage · M. Behnke · P. Gastmeier
Institute for Hygiene and Environmental Medicine,
Charité–University Medicine Berlin, Berlin, Germany
e-mail: doris.weitzel-kage@charite.de

M. Behnke
e-mail: michael.behnke@charite.de

P. Gastmeier
e-mail: petra.gastmeier@charite.de

first place. Such educative programs should involve medical students, nurses, and physicians in a wide range of medical departments as well as those active in many other healthcare-associated professions, such as physiotherapists or staff working in specialized diagnostic units of the hospital. Outbreaks are especially well-suited for educative purposes due to the rather large number of infections [6].

Support during the investigation of an ongoing nosocomial outbreak

Once a nosocomial outbreak has been identified, the aim of the infection control team is to terminate the episode as quickly as possible. A knowledge of the measures that have been successfully used previously in similar events may facilitate the efforts being made by the infection control team to control the acute situation of a current outbreak. However, in such critical situations, the infection control team needs to be able to quickly access information specific to the current situation [7].

New insights in the field of pathogen transmission

Fact-finding investigations of nosocomial outbreaks may even identify new types of pathogens (e.g., nosocomial outbreaks of the previously unknown severe acute respiratory syndrome (SARS) coronavirus [8]), unusual routes of transmission (e.g., by contaminated soap [9]), or the existence of a pseudo-outbreak (e.g., due to contamination of clinical specimens in the microbiological laboratory [10]).

Problems when using outbreaks for the prevention of further nosocomial infections

Single outbreak episodes are less helpful because their results cannot be generalized

One of the major pitfalls when doing research on nosocomial outbreaks is that experiences from a single outbreak may not apply the same way to a seemingly similar episode in other institutions. For example, the local situation, such as the number of single rooms available for the isolation of patients, the staff-to-patient ratio, and access to alcohol-based hand rub, may vary considerably between different hospitals.

In addition, risk factors for the transmission of pathogens or for the development of infection in susceptible patients can hardly reach any statistical significance if the overall number of cases is rather low. For this reason, data from a single nosocomial outbreak only rarely provides new insights that could be used for infection prevention.

Quality of reporting of nosocomial outbreaks is often low and relevant data may be missing

The specific parameter of interest that the medical staff wants to retrieve from a published outbreak report may vary. It may well be that the particular characteristic is actually missing in the article. This is especially likely to happen if no standardized manner of outbreak reporting (e.g., as is claimed in the ORION statement [11, 12]) is applied, and the data set in the outbreak description remains incomplete. To date, the overall quality of publications on nosocomial outbreaks is rather low and can usually be equated to the level of evidence of case reports only [13].

A large number of outbreaks need to be screened in order to provide reliable data

On the basis of the preceding points, it is evident that data gathered from a large set of similar outbreaks—as opposed to single episodes—are required as this approach will provide much more representative results [14]. However, collecting large amounts of such data often proves being difficult for several reasons:

- (1) Identifying relevant articles is generally time-consuming. One of the standard approaches to obtaining relevant information is to search international databases, such as PubMed. A subsequent check of the retrieved abstracts may reveal that many articles are not within the scope of interest. In addition, one single outbreak may be described in multiple publications, or the data from one single outbreak may be fragmented and published in different articles.
- (2) Search options might be limited. So-called “open access journals” are currently still the minority in the medical literature. The accessibility to other articles typically depends on the type of contract between the library of the institution and the journal’s publishers. This commercial relationship (or lack of it) greatly complicates the retrieval of articles.
- (3) An outbreak report may have been filed only in a journal that is not listed in the major literature databases. This represents a most severe problem in research on nosocomial outbreaks as all of those articles will be missed by the usual initial search strategy approach.

The Worldwide Outbreak Database

There is currently a feasible alternative to those mentioned above for locating relevant articles on nosocomial

outbreaks. The Worldwide Outbreak Database contains standardized data extracted from a large number of outbreak reports published in the medical literature [6, 7]. Data are entered into the database on a regular basis by specially trained physicians of the Charité University Hospital (Berlin, Germany). As such, the Outbreak Database represents the most comprehensive collection of all kinds of nosocomial outbreaks currently available. This database can be assessed via the Internet (<http://www.outbreak-database.com>) by anyone interested in epidemiology and infection control. Use of this database is free of charge. After a no-cost registration as a user, an advanced search mode even allows the user to combine various parameters, such as the number of cases, fatality rates, setting (place, time, and medical department), types of pathogens, the outbreak's source, and the route of transmission.

The Outbreak Database is an independent initiative and has no commercial relationship with commercially oriented companies. Cases from intensive care units (1,010 outbreaks), other types of wards for inpatients in hospitals (1,309), outpatient care (195), and nursing homes (157) are included in the database. A total of 2,322 outbreaks are currently filed in this database, and the number is increasing steadily. The number of all articles on nosocomial outbreaks compiled in the Outbreak Database and the date of their publication are given in Fig. 1. An average number of 27.9 patients were affected in those outbreaks (median 12). In 724 (31.2%) of the nosocomial outbreaks, members of the medical staff were also infected or became colonized during the outbreak. There are 240 pathogenic species (bacteria, viruses, fungi, and parasites) listed in the Outbreak Database. *Staphylococcus aureus* (300 outbreaks), *Pseudomonas aeruginosa* (162), *Acinetobacter baumannii* (129), *Klebsiella pneumoniae* (129), and *Serratia marcescens* (103) are the five most often reported causative agents.

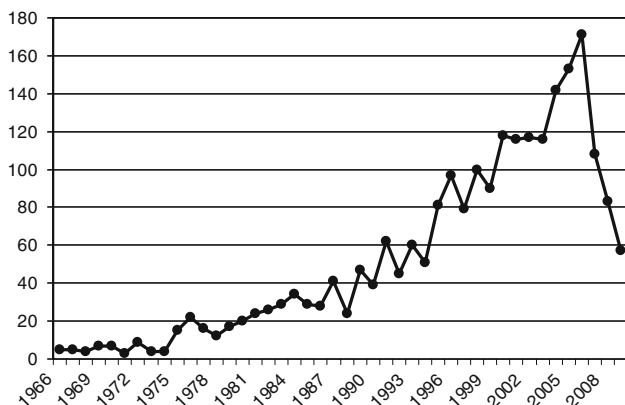


Fig. 1 Date of publication of articles as filed in the outbreak database

Table 1 Most common sources of nosocomial outbreaks

Source of the outbreak ($n = 2,322$)	n (%)
Patient	572 (24.6)
Environment	271 (11.7)
Personnel	223 (10.0)
Medical equipment/device	213 (9.2)
Drug	117 (5.0)
Food	76 (3.3)
Care equipment	37 (1.6)
Unknown	921 (39.7)

Based on the data in the database, index patients were the main source of pathogen spread (24.6% of all outbreaks), as shown in Table 1, while in 39.7% of nosocomial outbreaks, the cause was not identified. Transmission by contact was observed in 1,105 outbreaks, followed by some kind of invasive technique (373), inhalation in the airways (178), and ingestion in the gastrointestinal tract (92). In 681 (29.3%) of the outbreaks, the actual route of transmission remained unknown. As shown in Fig. 2, blood stream infections, infections of the gastrointestinal tract, and pneumonia were the most frequently diagnosed types of infections. Fig. 3 gives an overview on the infection control measures.

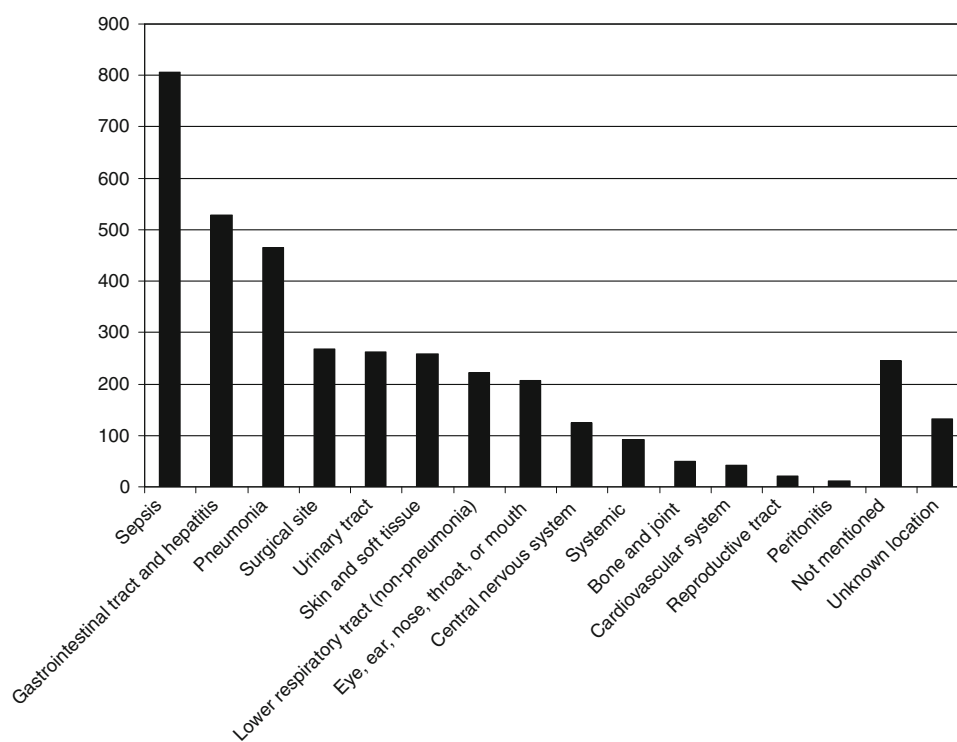
Potential applications of the Outbreak Database

To date (April 2010), the Outbreak Database has frequently been used for answering various questions in the field of outbreak investigation. In the following sections, we present a number of examples which demonstrate how this database has already made valuable contributions to the prevention of nosocomial infections.

How does hepatitis B virus spread from patient to patient?

Lanini et al. [15] conducted a systematic review of the medical literature on nosocomial hepatitis B virus outbreaks over a 15-year time frame (1992–2007). The primary aim of their study was to identify the most frequent infection pathways, with a secondary aim of characterizing the clinical settings involved. The Outbreak Database was one of the sources used to retrieve articles of interest. The systematic review ultimately analyzed a total of 30 papers reporting on 33 hepatitis B virus outbreaks. In most of the cases, violations of standard infection control principles were responsible for viral transmission and nosocomial infections. Heart-transplant recipients were shown to have an especially high risk of acquiring infection during transvenous endomyocardial biopsy in a contaminated environment.

Fig. 2 Distribution of infections in nosocomial outbreaks



How to avoid the use of contaminated substances?

There are numerous outbreaks in which reference is made to a contaminated drug that was used for patient care. The Outbreak Database was used to retrieve articles for a systematic review of this topic in 2006 [16]. Most of the 2,250 patients in the 128 included articles were from intensive care units and hematological departments. Septicaemia was the most frequent type of hospital-acquired infection, especially following the use of accidentally contaminated blood products or heparin–sodium chloride solutions. Half of the outbreaks were due to the use of multi-dose vials, which is against the manufacturer’s recommendations, and all of these incidents would have been avoided by adherence to standard infection control practice.

How to deal with outbreaks in Neonatology and Pediatrics departments?

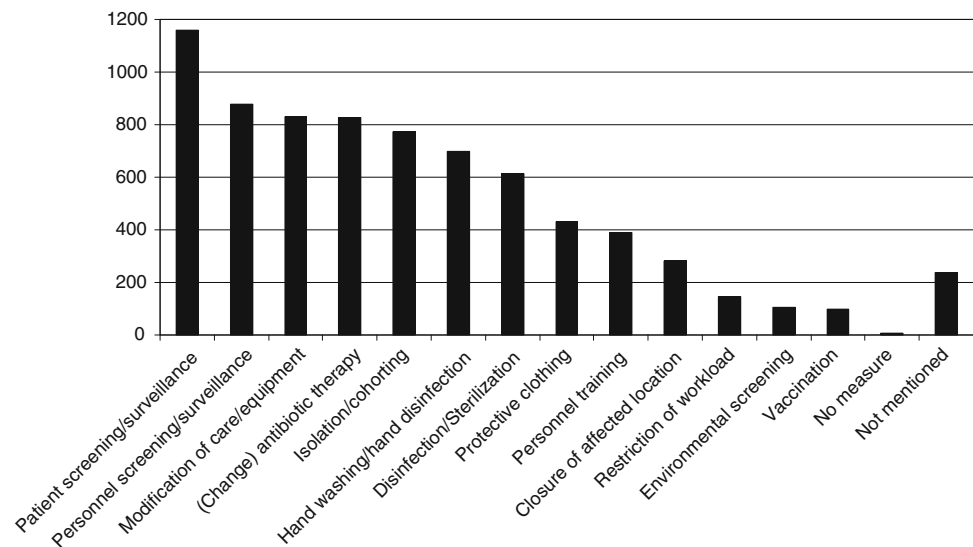
Outbreaks of *Pseudomonas aeruginosa* are often associated with considerable morbidity and mortality. This is especially true such outbreaks occur in intensive care areas or in severely immunocompromised patients in other departments, such as Oncology. Simon et al. [17] checked for the most frequent sources of *P. aeruginosa* outbreaks in neonatal (NICU) and pediatric intensive care (PICU) patients. They also determined the risk factors for the acquisition of this pathogen and summarized the typical types of infection. In addition to PubMed, they used the

Outbreak Database in their search strategy and included 24 articles (709 affected patients, at least 322 infections, median attack rate 68%, duration of the outbreaks ranging from 5 days to 7 years) in their review. In their conclusion they recommend extreme awareness for an increase in the rate of infection by *P. aeruginosa*, strict contact isolation precautions immediately after such an outbreak is recognized, good antimicrobial stewardship, and molecular typing of cultured isolates in order to confirm the outbreak.

In order to elucidate the most helpful infection control measures for *Serratia marcescens* outbreaks in NICUs and PICUs, a similar approach as that described above was used by Voelz et al. [18]. Thirty-four outbreaks from 27 articles were examined; the infections included 112 cases of blood stream infections, 61 cases of conjunctivitis, 30 patients suffering from pneumonia, 19 patients with urinary tract infections, 16 cases of meningitis, and seven surgical site infections. Based on their systematic review, Voelz et al. suggest such measures as patient isolation, use of gloves and gowns, enforced hand disinfection, enhanced environmental disinfection measures, and the well thought-out use of antimicrobial substances. Sampling of environmental sites, however, should only be performed as a “second line measure” in the specific case where the application of the first-mentioned measures fail to control the outbreak.

Gastmeier et al. [19] compared 226 outbreaks in NICUs to 453 outbreaks in other types of ICUs. The Outbreak Database served as the primary source of data for this

Fig. 3 Infection control measures applied in nosocomial outbreaks



purpose. Coli-like bacteria were much more often involved in outbreaks in NICUs, while non-fermenting species were more frequently identified in other ICUs. The outbreak's source was identified less frequently in NICU outbreaks (49 vs. 38%), but basic infection control measures were implemented significantly more frequently in NICUs during an ongoing outbreak.

Which source, patient or staff, is more likely to spread norovirus in the hospital?

Many outbreaks due to norovirus occur in hospitals all over the world during the winter. In order to determine the risk of subsequent spread of this pathogen in relation to the type of index case (patient vs. healthcare worker), Mattner et al. [20] conducted a systematic review using the Outbreak Database among other sources of literature. They included 2,036 infected individuals from 62 outbreak wards and were able to show that the risk of infection for patients was more than doubled if the index case was also a patient compared to an infected member of the staff as an index case. The risk of other staff becoming infected by norovirus was independent of the kind of index case.

Who is at risk of an invasive aspergillosis and what are the main mould sources?

The number of severely immunodeficient individuals is increasing steadily. The aim of a systematic search of cases of nosocomial aspergillosis in the outbreak setting carried out by Vonberg et al. [21] was to identify high-risk patient groups and the causes of the spread of mould spores. Fifty-three outbreaks with 458 affected patients were included in the review, of whom 299 individuals had hematological

malignancy as underlying disease. Mortality was significantly increased in this latter patient group compared to patients without severe immunodeficiency (58 vs. 39%). Construction and/or demolition within or nearby the hospital showed to be the main sources of subsequent infection.

When should the unit be completely closed in a nosocomial outbreak?

The total closure of a medical department is the most extreme infection control measure. As such, it should be only considered and implemented if absolutely necessary. The Outbreak Database was searched by Hansen et al. [22] to characterize outbreak settings in which a closure of the entire unit was considered to be inevitable. They identified 194 outbreaks (median time until closure 14 days). Outbreaks in Geriatrics (closure rate 30%) and those due to norovirus (44%) or influenza virus (39%) were the most common outbreaks ultimately leading to closure of the ward to new admissions. Infections of the central nervous system (24%) were the most frequent type of infection.

Conclusion

Epidemiologists are becoming increasingly interested in investigating factors relating to nosocomial outbreaks. Several questions have already been addressed in systematic reviews, but many more remain as yet unanswered. The Outbreak Database has proven to be an extremely useful instrument for the investigation of nosocomial outbreaks because: (1) it provides a quick and unrestricted

access to data on a large number of outbreaks from all types of nosocomial pathogens (bacteria, viruses, and fungi), (2) the data are filed systematically and characteristics of interest may be combined by the user on demand, and (3) the information contained is up-to-date as articles are entered into the database as soon as they appear in the medical literature. We would like to encourage anyone interested in nosocomial outbreaks to use this valuable tool.

Conflict of interest None.

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