Chapter 5

Collecting, Converting, and Making Sense of Hospital Antimicrobial Consumption Data

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1. INTRODUCTION

Various methods are available to quantify drug use in hospitals. Sound data on the use of antibiotics are crucial for the interpretation of prescribing habits, the evaluation of compliance with clinical guidelines, and the linkage with antimicrobial resistance data. Quantification of drug use does not only comprise collection and registration of data. Before starting this process, it should be considered in which way the data will be described and interpreted. The goal of the use of the data should be established beforehand. Clear decisions have to be taken on the methodology applied to this epidemiological surveillance. The data must provide the ability to measure variation in quality and quantity of use. Care has to be taken on the reliability and completeness of the data as well as the feasibility of the data collection. Methods of assessment need to be simple, rapid, and inexpensive.

Requirements for the establishment of an efficient surveillance programme include authority from the highest level of the hospital management, complete and free access to all relevant information, and clarity as to the ownership of the data generated.

Facilities must tailor surveillance systems to balance the availability of resources with priorities for data collection, population needs, and institutional objectives. Integrating the surveillance system within the framework of the

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institution's other quality improvement efforts can facilitate functional collaboration between and among programmes working to improve patient care. Readily available quantitative methods provide significant information on patterns of use and an efficient basis for planning definitive studies. This chapter describes various sources of data, different units of measurement, considerations on the frequency of data collection as well as the level of aggregation of data.

2. SOURCES OF DATA

Several sources of data are available for quantification of hospital drug use, each with its advantages and disadvantages (Chaffee *et al*., 2000; Eckert *et al*., 1991).

Pharmacy purchases can be determined from invoices or delivery documents. They allow for an overall assessment of the use in a specific institution. Data can be presented in terms of costs, number of packages purchased, or defined daily doses (DDDs). Care has to be taken as to the accuracy of the data if a pharmacy purchases for more than one institution or if there are other sources of delivery such as trial medication or free samples. Time courses of use are difficult to assess if purchases are done in large quantities at the same time. Data may overestimate use in the case where considerable quantities of drugs are returned to the manufacturer or discarded because the expiry date is reached before use. Nevertheless, purchase data are very easily accessible as they are usually readily available as management data from the finance department. They provide a rough estimate of overall use.

Pharmacy deliveries to wards or units within an institution as a source of data allow for more detailed presentation of the data. If hospital wards reflect particular groups of patients, for example, ICU-unit or oncology, delivery data reflect specific patterns of usage in these patient categories. Data can be presented in terms of costs, number of packages purchased, or DDDs. Time courses of usage are more easily detected as wards usually do not keep large stocks in advance but order drugs when needed. Again, data may not reflect actual use as drugs can be returned to the pharmacy or exchanged with other wards within the institution without administrative correction of the transaction. Also, pharmacies must be able to select specific wards for data presentation, in order to avoid spoiling of the data with deliveries to third parties, nursing homes, psychiatric institutions, or other clients. In most instances, pharmacy delivery data will be the most accessible and most accurate level of data source that is readily available in a timely fashion.

Patient prescription profiles as a source of data give an even more accurate picture of the actual use. They can be performed either as cohort studies or as complete registration of all filled prescriptions. Clearly, data collection is more labour intensive than the above-mentioned methods. However, they provide a lot more detail on patient features and actual patterns of prescribing and use. Linkage with information about indication for use and laboratory values provides even greater insight. Up to date, not many hospitals are ready to provide such detailed data, but rapid advancement of computerisation will allow more easy access to data on prescription levels in due future.

On a regional or national level, other sources of data may be available. Sales data from wholesalers to hospital pharmacies are used, often through commercial databases. Also, in this case, careful evaluation concerning the completeness of the data is necessary. Parallel import of drugs and direct deliveries to hospital pharmacies can lead to underestimation of the total use of drugs. Another useful source of data may be data from reimbursement through insurers. However, the high variability in reimbursement schemes in different countries may make interpretation and comparison of the available data more than cumbersome. Completeness of data will depend on the system and accuracy of declaration of expenses by hospitals.

3. MEASUREMENT UNITS

Different measurement units can be used to evaluate drug use. As numerator, costs, number of packages, volume in grams, number of prescriptions, or DDDs can be used.

Costs allow for an overall analysis of drug expenditures or prescription analysis of one single drug. But there are many disadvantages. Price differences between alternatives confuse the analysis. Comparisons between different institutions or countries are not possible because of different price levels. Each setting may negotiate local prices through direct negotiations. Indexing in the case of long-term studies is necessary.

Number of packages may be independent of sales prices, but may still differ depending on the manufacturer or the country of purchase. This will greatly complicate comparisons.

Assessment of the quantitative volume of use in terms of grams allows only evaluation of the use of one drug at a time. Drugs with a low potency have a larger fraction of the total, not reflecting actual greater use or more frequent prescribing.

The number of prescriptions gives an accurate reflection of the number of patients exposed to a drug, and allows for evaluation of the frequency with which

certain drugs are prescribed. It is also a valuable measure when evaluating prophylactic use of antibiotics. A major disadvantage is that, often, the amount of drug used is not known. Also calculations are done more than once for patients receiving more than one prescription or multiple drug regimens.

The use of DDDs as a unit of measurement helps to avoid many of the above-mentioned drawbacks. (Natsch *et al*., 1998). The system of DDDs has been developed by the World Health Organisation (WHO, 2003). It provides a convenient tool that allows comparisons between different settings, regions, or even countries. A DDD is assigned to every chemical substance, reflecting an international compromise based on the average dosage for the most common indications in adult patients with normal organ function. This is a technical unit of measurement and does not necessarily reflect the recommended or actual dose used. The quality of the results is completely dependent upon strict adherence to the method. Therefore, the system must be used without any adaptations. But the method is independent of sales prices or package sizes and allows for long-term epidemiological studies. Also with DDDs, there are some disadvantages. For some antimicrobials, there are still no DDDs defined; also, for combination preparations, this is a problem. For some antimicrobials, different DDDs are assigned, depending on the route of administration. Conclusions on prescribed dosages and duration of treatment may not be made, particularly not in children or patients with impaired organ function. Also, in the case of prophylactic use of antimicrobials, the use of DDDs has its drawbacks. For amoxicillin and amoxicillin/clavulanic acid, the DDD differs greatly from the actually prescribed doses in inpatients. High consumption of these two antibiotics can, therefore, considerably influence the total use expressed in DDDs. The Collaborating Centre for Drug Statistics of WHO revises the DDDs once in a while. While this allows adjustments in the case of great differences of DDDs from actually prescribed dosages, it makes it difficult to follow data for longer periods of time. Therefore, when using DDDs, it is very important to always state which edition of the DDD system has been applied for calculating the data. The most recent information can be currently found easily on the Internet (http://www.whocc.no/atcddd/).

As denominator, in the community, usually DDDs/1,000 inhabitants/day are calculated. In hospitals, usually DDDs/100 bed-days are used. For better comparison, it is now being discussed that we should calculate in-hospital use per 1,000 bed-days. In either case, the number of bed-days has to be calculated with great care.

There are two ways to do so:

1. Number of beds × occupancy rate
2. Number of hospitalisations × length of stay

But also for length of stay, different definitions are used:

1. the day of admission as well as the day of discharge count each for an extra day
2. the day of admission plus the day of discharge count together for one extra day

These calculations give an estimate of the ecological pressure of antimicrobials as they quantify overall use in the population. A simple calculation program named ABC Calc—Antibiotic Consumption Calculator—has been developed and can be downloaded from the Internet free of charge (http://www.escmid.org/sites/index.asp and go to: study groups; ESGAP; News & activities) For measuring patient exposure, the percentage of patients exposed to antimicrobials can be evaluated. Alternatively, the number of prescriptions gives a rough estimate of exposure. Another measure for exposure is the calculation of the number of days that patients are on antimicrobial treatment, calculated per 1,000 patient-days.

Whatever denominator is chosen, the total population has to be defined clearly. For reasons of comparison of data between different settings, it is very important that all variables are defined as carefully as possible.

4. FREQUENCY OF DATA COLLECTION

Whatever source of data is used, a decision has to be taken as to which data are collected as an ongoing process. This is preferably done as part of a wider quality assurance programme. As an alternative, subsets of data could be collected. In this case, it should be carefully evaluated if the dataset is representative of the overall use, allowing for extrapolation of the data to the total population studied. Careful validation of this process is a prerequisite for high quality data.

Another point to consider is the time interval in which data are collected and presented. Most hospitals will only be able to present consumption data on a yearly basis. This is usually the unit, in which management and financial data are presented. Some, however, are able to present data on a more detailed level like quarterly or monthly units. This is more laborious to deal with, but for a close link to resistance data, more detailed data are preferred (Lopez-Lozano *et al*., 2000; Monnet *et al*., 2001). A major disadvantage is that sample sizes will become very small and this can affect validity of the data in a negative way. It will allow performance of time-series analysis and modelling and forecasting development of resistance linked to antibiotic consumption. If prescription or consumption data are taken as the basis for data collection, data

will primarily be generated on a daily basis. This will need a lot of computer memory to store and handle data. When aggregating the data and discarding the original source, consequences for future analysis have to be carefully analysed well in advance.

5. LEVEL OF AGGREGATION OF ANTIMICROBIALS

Besides DDDs, the WHO collaborating centre for drug statistics has developed the Anatomical Therapeutical Chemical Classification system (ATC). This is a comprehensive and logical classification system developed to categorise drug substances, which were divided into different groups according to the organ or system on which they act (anatomic), and then according to their therapeutic, pharmacological, and chemical characteristics. It leads to a 5-level hierarchical code assigned to each chemical substance. An example is shown below.

ATC code	ATC level	Description
J	Main anatomic group	General anti-infective agents for systemic use
J01	Therapeutic group	Antibacterial agents for systemic use
J01M	Pharmacological group	Quinolone antibacterial agents
J01MA	Pharmacological subgroup	Fluoroquinolones
J01MA02	Chemical substance	Ciprofloxacin

Computer systems should allow for aggregation of data on different levels according to the research question. If use of a single chemical substance is analysed, analysis on ATC-level 5 should be possible, whereas if a whole pharmacological (sub)group is analysed, aggregation on ATC-level 3 or 4 should be possible.

A major disadvantage of the system is that its first level is based on an anatomical classification. As a consequence, substances used for different disease states are classified in different categories and therefore get more than one ATC code. This is especially relevant in the case of antimicrobials. ATC group J comprises systemic use of antimicrobial agents. Agents specifically used for gastrointestinal or genitourinary diseases are classified in the respective ATC groups. Antimicrobials also used for skin-, eye-, or ear-diseases are also classified in these ATC groups. In general, most interest is focused on systemic use of antimicrobial agents, as this is believed to be most relevant in relation to development of resistance. While performing data collection, it is important to clearly state which categories are excluded from analysis. Despite some disadvantages, and alternatives proposed (Bjornsson, 1996; Pahor *et al*., 1994), the ATC classification is now widely used and should be chosen as a major classification system.

Besides aggregation based on chemical and anatomical classification, use of antimicrobials can be classified and aggregated according to other criteria. Within a hospital, it is advisable to at least subclassify use per ward or department, preferably linked to special patient categories. Allocation according to the medical specialist gives even more insight into the prescription patterns. Other classifications may be done into prophylactic and therapeutic use, or into parenteral, oral, and local use of antimicrobials. The most sophisticated classification is a registration per indication. But this asks for a linkage with an electronic patient profile, which is not yet widely and easily available in hospitals. In outpatients, these systems become more easily available, often through prescription registration of pharmacies, general practitioners, or insurers. Hospitals should focus on rapid development of these systems in the future.

6. CONCLUSIONS

Data will be used for surveillance of use and feedback to prescribers. They can support development of policies and guidelines. Thereafter, data collections can help monitoring adherence to them and help identify weaknesses in the system or the implementation process.

Increasingly, healthcare institutions are being asked to benchmark or compare their performance data to other similar institutions. This may be a more complex and difficult undertaking than is immediately obvious, because the data may be affected by a variety of factors, some of which, such as the underlying health status of the population served by the institution, are outside the control of the institution. However, ongoing monitoring and benchmarking have been used to implement quality improvement activities. The influence of case-mix and severity-of-illness of the population being studied has to be controlled. Variations in length of stay can also have great influence on interpretation of data, as it can reflect less severely ill-patients but also more intense treatment and earlier discharge in case of shortage of hospital beds. In the latter case, use will increase per bed-day, but not if calculated per patient or admission. Possibly risk stratification can be applied to correct for these influences. The consequences of these effects for the ecological pressure of antimicrobials and selection of resistance are discussed in other chapters.

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