An Introduction to Epidemiology and Infection Control Practice

We have written this article to explain the role of epidemiology in hospital infection control practice. It is the first of a five part series beginning with an explanation of epidemiological principles and examples of how these principles can be applied to infection control practice.

What is epidemiology?

Most infection control practitioners use and hear the term Epidemiology every day. It was first used by Hippocretes (460 - 377BC). But what does it mean and how is it used? More often than not, the term Epidemiology is used in its narrowest meaning – estimating the frequency and distribution of hospital-acquired infections in patients and staff. As there are many epidemiologists, so are there definitions of epidemiology. Epidemiology is not only surveillance of hospital acquired infections, it is a scientific methodology with which to investigate and analyse an exposure (e.g. cardiac surgery) and an outcome (e.g. surgical site infection [SSI]).

Generally, the purpose of hospital epidemiology can be categorised into five groups:

1. to gather reliable and valid data with which to measure hospital-acquired infection (surveillance);
2. to identify and explain the cause of hospital-acquired infections by analysing risk factors (exposure and mode of transmission factors);
3. to determine whether the rate of hospital-acquired infections is consistent with current scientific knowledge (limited comparisons);
4. to provide a basis from which to develop programmes to control and prevent the spread of infection in hospital (usually based on surveillance);
5. to gather reliable and valid data with which to measure the quality of care in subgroups of hospital patients (outcome indicators).

Each of these five categories has a methodological rigour that, if used, will improve the accuracy of the identification of the cause, source and distribution of hospital-acquired infections. (Each will be explained in more detail in later series.) When an infection control practitioner (ICP) uses epidemiological methods to collect data to calculate an estimate of infection no subjective judgement or guess is made because the method of data collection and analysis has to be uniform and in accordance with a protocol. The methodology enables the ICP to have confidence in the validity, reliability and generalisability of the result.

Validity:

First, let's examine the concept of validity and its relation to the definition of infection. Validity refers to the degree to which a definition of a hospital-acquired infection measures what it purports to measure. That is, does the definition of SSI include clinical and diagnostic criteria for an infection? For example, if the definition of SSI only includes the presence of purulent discharge then the definition is not wholly valid – SSI should include other clinical signs and symptoms of infection.

Reliability:

The concept of reliability can be examined in the context of the way you collect data and how the collection effects the quality of the data. Reliability of nosociamial infection data relates to the ICP's ability to correctly categories a patient with or without an infection. If an ICP categorise a surgical site as infected or not infected the same way under similar conditions on a second occasion then the data would be said to have good reliability. Reliability equals consistency or repeatability.

Example 1. If the ICP were to randomly miscategorise infected and uninfected SSI from time to time then the effect on the estimates would be significant.

Example 2. However, if the ICP were to categorise an uninfected SS as infected (or vice versa) consistently, then the resultant infection rates would be over (or under) estimated.

Example 3. If the ICP were to change the definition of infection during the year and count the SSI as not infected where he/she had previously categorised it as infected then resultant rates of infection between the different periods could not be compared.

You would not be able to rely on results in Examples 2 and 3 to reflect the true estimates of SSI. Data are reliable if they are repeatable. Repeatability, however, does not guarantee a valid result. Example 2 is a reliable measurement but not a valid measurement of the infection.

Data must be both valid and reliable.

A valid and reliable definition of SSI is one which is clinically relevant and repeatable so that infections will neither be under – or over-estimated. (Methodological issues relevant to each of the five categories will be described in more detail in the next issue of the journal.)

How does epidemiology enhance infection control practice?

In Australian hospitals, the Infection Control Practitioners (ICP) spends the majority of their time gathering data for surveillance. Data are usually totalled and presented as monthly, quarterly and annual rates, for example, the number of bacteraemia per 10,000 admissions. If the definition of a bacteraemia is not reliable, or you are not consistent in your method of applying the definition, then your surveillance data are meaningless. Adopting epidemiological rigour, will not increase your work load. It is a methodology with which you will collect the numerator (hospital-acquired infections) as well as the denominator (all those at-risk of becoming infected).

If we use the example of collecting

and analysing data for a rate of primary bacteraemia you would consider the following methodological issues:

1. The numerator will be effected by the definition you apply (validity). It will need to be valid – that is, the definition should include all relevant signs and symptoms and diagnostic criteria (see the National Nosocomial Infection Surveillance System – NNIS);
2. You will need to be able to use the definition, who is infected or not infected, consistently thereby gathering numerator and denominator data accurately;
3. The rates should reflect the distribution of bacteraemia in a population who is at risk of developing bacteraemia. Therefore, the denominator should not include all day-only, psychiatric or rehabilitation patients. It should include only patients who are at-risk of developing a primary bacteraemia, those with an intravenous device. Counting the numbers of patients who had an IV device is difficult and the methodology has not yet been perfected;
4. Rates express a frequency of an occurrence, in this example, of primary bacteraemia, in a defined population during a specified time period. The rate of primary bacteraemia should reflect the speed at which the infection develops as well as taking into account some important risk factors – eg. the device days. Therefore, the number of days an IV device is in-situ should be collected. The methodology for the collection of these data will need to be as reliable as possible and applied consistently for each patient at-risk. It would be advisable to choose specific wards to measure the development of primary bacteraemia and device day for your surveillance;
5. Time period – if your rate has increased over the last two years can you safely conclude that your intervention or something has caused this result? First, has the definition of infection changed over the time period? If so, is the new definition a more sensitive definition, thereby identifying more true infections. Second, did different ICP's collect the data? This could adversely effect the reliability, causing an over-(or under) estimation of infection. Third, has the patient population at-risk changed? Was there a policy change determining who is given intravenous therapy/treatment? Are these patients sicker and have a greater risk of developing infection?

The next part will describe the different methods of improving evidence of causation.

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