CHAPTER 3

Risk-Adjusted Comparisons

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Abstract

Infection preventionists often seek to make external comparisons when reviewing their hospital's healthcare-associated infection data. While previous methods involved the use of risk-stratified rates, recent methods employed by the U.S. Centers for Disease Control and Prevention include the use of a risk-adjusted summary measure called the standardized infection ratio (SIR). In utilizing the results of statistical inference, hospitals can determine if their HAI experience, by way of the SIR, is different from the national baseline. Such results can help assess success of prevention efforts, as well as prioritize additional prevention activities based on both statistical and practical significance. This chapter will focus on the methods used to calculate the SIRs and how a hospital can interpret the SIR along with statistical evidence.

BACKGROUND

When communicating their hospital's healthcare-associated infection (HAI) experience to internal committees, infection preventionists (IPs) are often asked, "How do we compare to other hospitals in the U.S.? How has our HAI incidence changed over time? What is our hospital's overall rate?" Using annual reports from the U.S. Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network (NHSN), IPs can compare their hospital's device-associated infection rates to those published by NHSN for each physical patient care location in their hospital. While location-specific or procedure-specific rates are useful tools in assessing HAI experience, the hospital's administration may prefer to receive a single measurement per HAI type for the entire hospital. When this is the case, overall rates are never the best option, as they are not risk-adjusted when pooling data for the hospital as a whole. Instead, the standardized infection ratio (SIR) is a risk-adjusted scalable metric that can be used to achieve the desired goal.

This chapter will focus on the risk adjustment methods employed by NHSN, as well as the use and interpretation of the SIR, for three types of HAIs: device-associated infections such as catheter-associated urinary tract infections (CAUTIs), procedure-associated infections such as surgical site infections (SSIs), and laboratory identified (LabID) events such as *Clostridium difficile* infection (CDI) LabID events.

Methods

The SIR is a risk-adjusted summary measure used to track HAIs at a national, state, or local level over time. The SIR adjusts for patients of varying risk within each facility. The method of calculating an SIR

is similar to the method used to calculate the Standardized Mortality Ratio (SMR), a summary statistic widely used in epidemiology and public health to analyze mortality data. In HAI data analysis, the SIR is a ratio of the actual number of HAIs reported to the predicted number according to the baseline U.S. experience (i.e., NHSN aggregate data are used as the standard population), adjusting for several risk factors that are significantly associated with differences in infection incidence.

Formula 1.

$$SIR = \frac{Observed\ (O)}{Expected\ (E)}$$

As a ratio, the numerical value of the SIR conveys either an equivalency between the numerator and denominator, in which case the SIR is 1, or a difference, in which case the numerator is higher or lower than the denominator. An SIR greater than 1 indicates that more HAIs were observed than expected, taking into account variation in the types of patients followed; conversely, an SIR less than 1 indicates that fewer HAIs were observed than expected. The term expected can also be interpreted as the predicted number of infections estimated from the baseline data. For the remainder of this chapter, the term "predicted" will be used in place of "expected."

The number of predicted HAIs is based on a calculation that depends on the type of HAI being measured, as well as the level of risk adjustment performed. Note that for those who report these data to NHSN, the number of predicted infections, as well as the SIR, is calculated for the hospital. The methods described in this section are intended to provide insight into the calculations performed by NHSN so as to allow for more informed interpretation of a hospital's data. These methods assume use of NHSN data as the source for external comparisons.

Device-associated infections
SIRs for device-associated (DA) infections allow data to be summarized by more than a single location, adjusting for differences in the incidence of infection among the location types. For example, an infection preventionist (IP) could obtain a single CAUTI SIR, adjusting for all locations reported, or obtain one CAUTI SIR for only intensive care units (ICUs) or only non-ICU locations in the facility. Additionally, the CAUTI SIR may be an easier measure to discuss among internal and external stakeholders.

For DA infections, the number predicted is calculated from baseline data, which are published pooled means of infection rates, stratified by patient care location.[1,2] The example below will focus on CAUTI data; however the same methods can be applied to other device-associated infections (e.g., central line-associated bloodstream infections).

> **Example 1:** *Calculating the number of predicted CAUTI*
> Suppose the infection surveillance team in Hospital A has collected and entered CAUTI data for a single ICU and a single ward location. They would like to calculate the CAUTI SIR but first need to determine the predicted number of infections. There are two locations in this example; however, the methods are the same regardless of the number of locations. The data they have collected appear in Table 3.1.