Letter to the Editor

Caution Should Be Exercised When Using the Standardized Infection Ratio

To the Editor:

Use of the National Nosocomial Infections Surveillance (NNIS) System index has become standard procedure for surveillance of nosocomial infection among surgical patients. Gustafson[1] advocated estimation of a standardized infection ratio (SIR) to adjust for differing distributions of intrinsic risk of infection. The SIR is computed by dividing the observed number of infections by the expected number of infections. The expected number of infections is estimated by multiplying the NNIS System index score-specific infection rates by the numbers of patients in the corresponding strata and then summing.

The SIR is increasingly being used to compare specific hospital rates with U.S. benchmark rates[2-4] and to trace the evolution of rates at one or multiple hospitals over time.[5] It is appropriate for comparing one hospital's rate with a benchmark rate, but what about interhospital comparisons or intrahospital comparisons over time? Does a hospital with a SIR of 1.5 have a better rate than a hospital with a SIR of 1.7? Likewise, does an increase from 1.5 to 1.7 over time reflect deterioration? To answer these questions, some hypothetical but realistic data might be helpful.

The table contains the rate of surgical-site infection stratified by NNIS System index level.[6] The infection data for case 2 have been taken from a group of Spanish hospitals.[5] The figures have been rounded and extrapolated to 10,000 patients to facilitate calculations. Regarding the infection data for case 1, the distribution of patients according to the NNIS System index has been taken from a Spanish hospital[7] not included in reference 5. The infection rates were obtained by adding infections to yield rates close to the next highest integer of those given in case 1 (ie, 2% vs 1.5% for NNIS System index level 1 and 6% vs 5.8% for NNIS System index level 2). The infection rate for each level of the NNIS System index is worse in case 1 than in case 2. The numbers of expected infections in each case were obtained by multiplying the reference rates (given by the NNIS System) by the number of patients in each stratum of the NNIS System index.

The infection rates in case 1 are higher than those in case 2, but the patients' intrinsic risk of infection is higher in case 2 than in case 1. Case 2 has an infection rate that is a relative 25% higher than that in case 1 (4.5% vs 3.6%). The SIR for case 2 is slightly higher than that for case 1 (1.859 vs 1.846), suggesting that the situation is worse than that of case 1. In fact, stratum-specific infection rates are better in case 2 than in case 1; if the SIR had adjusted for patients' intrinsic risk of infection, the adjusted infection rate should have been lower in case 2 than in case 1. The SIR performs some adjustment as the initial relative difference between crude overall rates was 25% and this was reduced with the SIR. If all of the stratum-specific rates of population A are lower than those of population B, any adequate procedure to adjust for the difference should yield a lower adjusted rate for population A than for population B, but this does not happen with the SIR.

Suppose that case 1 and case 2 represent different time periods for the same hospital (perhaps 1990 and 2000), and that stratum-specific infection rates do not change over time. If patients' intrinsic risk of infection increases over time (as can occur in hospitals), however, the SIR will be higher. If stratum-specific infection rates for case 1 were made equal to those for case 2, the SIR for case 1 would be 1.62 as compared with 1.859 for case 2, for a relative increase of 14.8%. The conclusion would again be erroneous; it would imply that the infection rate increased independent of patients' intrinsic risk of infection when, in fact, this factor has not been neutralized by the use of the SIR.

This example illustrates that indirect standardization is a misleading procedure for controlling differences in patients' intrinsic risk of infection (or any other confounding factor). This problem was first described by Yule 70 years ago.[8] For adequate comparison of rates of different populations controlling for any confounding factor, all of them should use the same standard or reference population, which gives a common distribution for the interfering variable.[9] In the SIR (and other indirect standardization procedures), stratum-specific rates of a reference population are applied to the strata of different populations. If the distribution of the interfering variable changes in the populations to be compared, the influence of the variable is not completely removed and residual confounding persists. On the contrary, in direct standardization, the stratum-specific rates of a target population are applied to the strata of the standard population: all estimates use the same standard and the interfering variable is completely neutralized.

The SIR can be advocated when the numbers of a hospital are small, thus making infection rates unreliable; however, this procedure does not ensure reliability in the observed number of infections. It has been shown that indirect standardization should be avoided when direct standardization can be applied, even with unreliable rates.[10] To achieve the goal of appropriate comparisons between different hospitals or across time, a standard distribution of the NNIS System index should be given (eg, as with the "standard world population" used to adjust cancer rates by age and gender). This standard should be used to report adjusted rates for surgical-site infection.

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TABLE
ESTIMATION OF STANDARDIZED INFECTION RATIOS IN TWO CASES

		Case 1*				Case 2†			
NNIS System Level	NNIS System Rate (a)	No. of Patients (n)	No. of Observed Infections	Rate	No. of Expected Infections (a × n)	No. of Patients (n)	No. of Observed Infections	Rate	No. of Expected Infections (a × n)
0	1.40%	7,100	142	2.0%	99.40	6,000	90	1.5%	84.00
1	2.95%	2,400	144	6.0%	70.80	2,700	157	5.8%	79.65
2	4.94%	450	68	14.9%	22.23	1,000	141	14.1%	49.40
3	9.50%	50	11	22.0%	4.75	300	61	20.3%	28.50
Total		10,000	364	3.6%	197.18	10,000	449	4.5%	241.55

NNIS = National Nosocomial Infections Surveillance.
*Standardized infection ratio (SIR): 364 ÷ 197.18 = 1.846.
†SIR: 449 ÷ 241.55 = 1.859.

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