In Defense of Farr and Nightingale

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TO THE EDITOR:

William Farr and Florence Nightingale can no longer defend themselves against the misrepresentation of their work on hospital statistics by Dr. Iezzoni [1]. They calculated mortality per person-time of observation, which is one of the two correct ways to calculate incidences on hospital data [2].

Incidences on hospital data can be obtained by following each patient from admission until discharge (to calculate cumulative risks) or by dividing the number of events by the total person-time spent in the hospital. A third statistic divides the number of events by the number of admissions (or discharges); this technique was advocated by Farr's critics. That this third method yields a meaningless ratio was already discerned by Farr in 1885 and by Greenwood in 1948 [3]. The ratio depends on the turn-over of patients and does not consider observation time. It is still mistakenly used in the current literature because of its unfortunate resemblance to cumulative risk [2]. An example: An intensive care unit with 100 admissions per month and a mean length of stay of 4 days might record 20 nosocomial infections, yielding a ratio of 20%; a long-stay hospital with 100 admissions per month and a mean length of stay of 14 days might also register 20 nosocomial infections, again yielding a ratio of 20%. The problem is clear: The volume of observation time is different in both situations. The incidence rate-5 infections/100 patient-days in the intensive care unit and 1.4 infections/100 patient-days in the long-stay hospital-reflects the fact that nosocomial infections occur more frequently in intensive care units than in long-stay hospitals.

Farr calculated the amount of person-time spent in hospital in different ways [3]. As a shortcut approximation, he used the number of persons present on a single day and took this as the average number of persons present during the year. This approach is similar to the calculation of population death rates, in which the number of persons present in the middle of the year is taken to be the average number present during the whole year. In later publications, Nightingale presents two calculations: the right one, using person-time denominators, and the poor one, using number of admissions. Nightingale and Farr compromised to soothe political attacks. This compromise is not the hidden "methodologic shift" that Dr. Iezzoni makes of it.

It can be understood why this calculation upset Farr's contemporaries and still upsets Dr. Iezzoni. A peculiar feature of the incidence calculated with person-time denominators is that the incidence can become larger than unity. In contrast to proportions or risks that range between 0 and unity, incidence rates range between 0 and infinity [4]. For example, for a given hospital bed that has been constantly occupied (such as a bed in an intensive care unit), three of the patients occupying that bed might have died in a year; this yields a mortality rate

of 3 deaths per patient-year or "300 per cent of numbers constantly sick," as Farr called it. Farr and Nightingale could have improved the understanding of the incidence rate by using patient-days rather than patient-years in the denominator: Three deaths per patient-year is about the same as 1 death per 100 patient-days. The use of person-years is not "intentionally skewing statistics to bolster political arguments" as Dr. Iezzoni calls it. It is simply good epidemiology.

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RESPONSE IEZZONI:

In response: I thank Drs. Vandenbroucke and Vandenbroucke-Grauls for their provocative letter. It underscores why I wrote the article, calling it "a cautionary tale." Faced with varying methodologic options, perhaps all legitimate within their own contexts, it becomes critically important to open black boxes and look inside—to understand what was done and its implications. Otherwise, misconceptions can arise.

Context is critical. Drs. Vandenbroucke and Vandenbroucke-Grauls adopt a classic epidemiologic perspective, in which exposure per unit of time is the fundamental quantity that informs inferences. In that context, their assertions are reasonable. My comments were framed within the current enthusiasm for publishing "report cards" on hospitals. In this setting, "mortality rates" purportedly shed insight into hospital quality—the belief of Nightingale and Farr. The exposure of interest is an entire "care package" (for example, coronary artery bypass graft surgery) provided during a hospitalization. The public is more interested in outcomes at the end of that care than in deaths per unit of time in the hospital.

In 1864, Farr's critics furnished numerous examples of how his calculation was misleading, given the common English meaning of "death rate." I offer one example from my own hospital. Last year, there were 366 myocardial infarction admissions; 29 ended in death. On an average day, roughly eight patients who had had myocardial infarction were hospitalized. By using Farr's approach, our mortality rate is 362% [29/(8 X 100)], or 3.62 deaths per patient-year. Not only is a 362% death rate confusing, but it also does not address the public's real concern—what is the outcome at the end of care for a heart attack? By using the approach

of Farr's critics, our mortality rate is 7.9% [29/(366 X 100)]. Suppose a competing teaching hospital had an identical 366 admissions for infarction and 29 deaths but kept its patients twice as long, with an average daily census of 16 patients. With Farr's method, the mortality rate of this hospital is 181% [29/ (16 X 100)], or 1.81 deaths per patient year. Is that hospital's heart attack care twice as good as ours?

As I indicated in my paper, the approach of Farr's critics certainly fails to hold constant the window of observation. A current solution is examining mortality 30 days after admission rather than in-hospital deaths, data permitting. In the heated letter exchange between Farr and his critics, however, Bristowe made a key point: "If Dr. Farr had made his calculations about Hospitals in a tentative spirit, with the object of ascertaining whether they were likely to lead to any useful results, he would have acted in a way to which no exception could have been taken" (1). Even today, regardless of how hospital death rates are calculated, their true meaning often remains elusive.

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Reference
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A Return to Farr and Nightingale

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In her response to our defense of Farr and Nightingale [1], Dr. Iezzoni fails to distinguish between two issues: the correct calculation of the incidence rate and the comparability of data across hospitals. In her original contribution, Dr. Iezzoni had accused Farr and Nightingale of using the wrong method of calculation and thereby making the wrong comparison [2].

We are amazed by the first part of her counterexample, the myocardial infarction rate of 326%. We gave exactly this example in our letter and at the same time indicated the solution: a 326% death rate per patient-year amounts to 0.9 deaths per 100 patient-days, which is not confusing.

Next comes the comparability of incidence rates between hospitals. In 1948, Greenwood stated that even if one uses the right denominator (as Farr and Nightingale did), comparisons between hospital statistics remain hazardous [3]. We have discussed this problem elsewhere [4]. One factor that Dr. Iezzoni mentions is a difference in length of stay between hospitals. When length of follow-up is related to mortality, which it almost always is, the simple solution is to stratify by time. That is done routinely, for example, by Cox proportional-

hazards models that estimate hazard rates (which are ratios of incidence rates by the day!). When person-time denominators are used over longer periods of time, follow-up is subdivided into "first week," "second week," and so on. This adjustment for length of stay has nothing to do with the calculation of incidence. Of course, the solution proposed by Dr. Iezzoni-to use a fixed time interval-is an excellent one. It permits one to calculate either incidence rates or cumulative incidences afterward.

Did Farr and Nightingale have political motives? Of course they did; they bore a grudge against certain hospitals with poor ventilation and sanitation [5]. In this, they resemble Dr. Iezzoni, who militates (rightly) against the simplistic use of between-hospital comparisons [5]. Might Farr and Nightingale's zeal have led them to throw caution to the wind when publishing comparisons that proved how right they were? Not unlikely. In the end, were they right by insisting on reforms? Most probably. That, and not the way in which they did their calculations, is the heart of the argument.

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