Approaches to the Denominator Problem in Primary Care Research

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As increasing numbers of morbidity studies from family practice are published, the need for comparability is essential. This can only be accomplished through the use of age-sex specific incidence and prevalence rates. While patient visits or discrete patients visiting are often used as denominators for rate calculations, only the at-risk population reduces the variability due to practice patterns and includes those persons who do not visit during that interval. Three methods of determining the at-risk population are presented: registration, percent utilization, and episodes of illness distribution. The episode of illness approach was tested in five teaching practices and found to give results similar to the registered population only when the total population was included. No method is ideal, and the further search for testing of new approaches is important.

The family physician has a very worthwhile contribution to make in mapping out large areas of disease and dysfunction. He is the first and, in many cases, the only professional to see many problems and illnesses. Thus, he is in an excellent position to describe ambulatory illness, the factors which influence it, and its course over time. Once agreement has been reached on how to record and code our experience, it is not a difficult matter to count the number of cases of influenza, or arthritis, or complications from oral contraceptives. The problem arises when we want to express our experience in a manner that allows us to compare it with the experience of other physicians, or other countries – or even with our own previous experience – so that we can increase our knowledge of the natural history of illness. To say that 50 cases of infectious mononucleosis were seen this year tells about my experience, but little about the illness itself. The significance of this number depends on the number of patients seen this year, their age distribution and the illness experience of the community cared for. The solution to the problem of comparing data is to express findings in terms of rates which are or can be used by all concerned.

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The Denominator Problem

Comparable rates require similarly defined denominators. Easily obtainable denominator values are: the number of patient visits in one year and the number of discrete patients seen in one year. These two values can be obtained from a count of the daily register or the E-book, or they can easily be produced by a computer. Because they are so readily available, they are often used. While these two values, patient visits and patients utilizing, are useful in describing the workload of the practice, they contain too many sources of variability to allow adequate comparisons of incidence and prevalence rates among practices. The primary drawback is that the composition of a physician's yearly visits depends largely on his method of practice – that is, how often he recalls patients for follow-up and the frequency of preventive examinations. To count only those patients who were seen tells us nothing about those patients who did not visit the doctor during that interval, even though they were at risk.

I would like to offer a simple example to illustrate the confusion that might arise out of the use of these several possible denominators. Figure 1 illustrates the illness pattern of two patients in one year. Two individuals, A and B, in a single practice, experience seven and three episodes of illness, respectively, in one year. Patient A visits the doctor for two of these episodes. For one episode he is asked to return three times, and for the other he is asked to return once. Patient B does not visit the doctor for any of his episodes of illness. In the

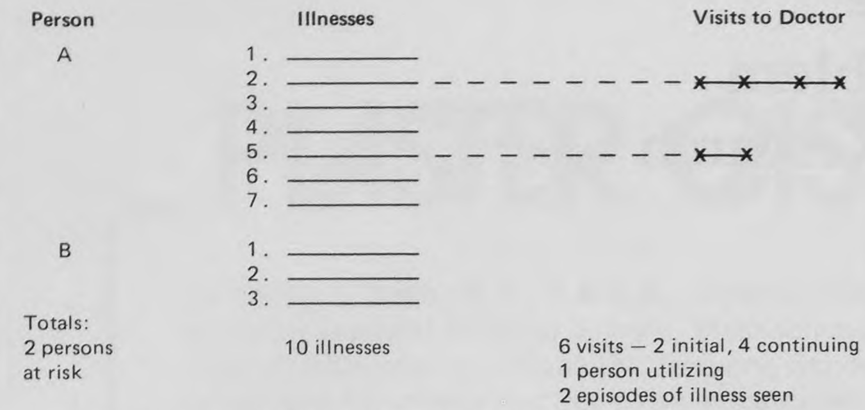


Figure 1. Illustrative Illness Behavior of Two Patients During One Year

office, we have seen and recorded A's two illnesses and six visits. What is our denominator for the expression of our experience in this year? Is it the six visits (two initial and four continuing), the one person utilizing, the two episodes of illness, or the two persons at risk? I would suggest that persons at risk is the most acceptable denominator for office morbidity studies. Ratio equations expressing office morbidity over persons at risk contain only two major sources of variation: the illness pattern of the community, which is the variable of particular interest; and the illness behavior of the individuals, which though it varies considerably from person to person tends to average out within the practice as a whole. An additional source of variation, that of differing practice composition, can be avoided through the use of age-sex specific rates.

How to Determine the At-Risk Population

To express morbidity using proper incidence and prevalence rates, the at-risk population must be known. The established method is to register the population.

1. Registration

Registration entails noting at least the age, sex, and commitment to the practice of all individuals who are under the physician's care. This is the system used in Britain where patients are registered with one physician. This is the practice age-sex register kept as a companion to the E-book.[1] The major problem with this type of age-sex register is difficulty in keeping the register current.[2] This results because of:

a) losses (those not at risk, but registered)
– patients who move without notification
– patients admitted to institutions for long-stay care
– deaths
– individuals who are away from the household (students, separations)
– use of other medical facilities

b) gains (those at risk, but not registered)
– late registration of newborns
– individuals who postpone registration until they need medical service

Registration is best for practices with little change, because updating the register is time-consuming and less accurate for practices with a high turnover. For the calculation of rates, the midyear population at risk is usually a good approximation. A reasonably accurate register at each New Year is sufficient to arrive at this figure:

$$\frac{\text{population at beginning of year} + \text{population at end of year}}{2}$$

Medical facilities that provide a total service under prepayment schedules may produce good age-sex registers from their accounting procedures. But for many physicians interested in research, registration is time-consuming, expensive, and of questionable accuracy. Other less expensive, more convenient approaches have been sought to determine the at-risk population.

2. Percent Utilization

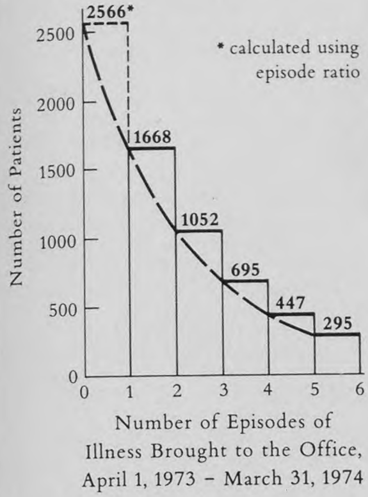
This method entails multiplying the number of patients utilizing by a correction factor to determine the population at risk. The correction factor is determined for an area by a separate study or through analysis of health insurance statistics. In Saskatchewan, Dr. John Garson has used this approach to produce an at-risk denominator for a morbidity study involving 23 physicians from all parts of the province.[3] The provincial insuring agency records can be analyzed to determine what percent of the population sees their general practitioner. In Britain, 67 percent of the population are seen annually, with variation according to the different age and sex groups.[4] In the teaching practices of the University of Western Ontario, this figure varies between 70 and 75 percent. By noting the number of patients of each age and sex group seen during the study and multiplying by the appropriate correction factor, the number of people at risk can be calculated. This approach is being considered for multicentered studies, where utilization statistics are available from government-operated, prepaid medical care insurance plans.

3. Episodes of Illness Rate

Dr. James Kilpatrick of Virginia Commonwealth University, while analyzing the data from the Second National British Morbidity Survey, uncovered an intriguing relationship.[5] He noted that the numbers of patients seen with one, two, three, etc, episodes of illness bear a constant relationship to each other. The ratio of successive episode frequencies is constant. This is a unique property of the geometric distribution. For those interested in the mathematics:

If $f(e)$ represents the frequency of individuals with e episodes, the geometric distribution specifies that $f(e) = (1 - q)\, q^e$ ($e = 0, 1, 2, \ldots$) where q is the constant ratio between successive frequencies; ie, $q = f(e + 1)/f(e)$. Note that $(1 - q)$ is the frequency of individuals with zero episodes.[5]

Figure 2
DISTRIBUTION OF EPISODES OF ILLNESS – for one year – St. Joseph's Family Medical Centre – London, Ontario (excluding prophylactic procedures & prenatal care)



For the purposes of the Second National Morbidity Survey, any face-to-face contact between doctor and patient is counted as a consultation. An episode of illness, on the other hand, is defined as a period of illness for which there were one or more consultations. Episodes tend to reflect the number of problems seen by the general practitioner.

Dr. Donald Crombie of the Birmingham Research Unit of the Royal College of General Practitioners, has applied this principle to the reported episode rates of 50 general practices with verified registered populations.[6] The calculated populations came to within five percent of the registered populations in 49 cases. In the 50th, the physician was known to be a poor recorder and the result was markedly deviant. Since there is no known theoretical reason that the episode rate should take the form of a geometric distribution, we wondered if this finding was specific to practice in Great Britain. Perhaps in North America, with our different methods of practice and different population, the relationship would not be found.

To explore the validity of the episode rate, we used this approach on our registered population at one family medical center of the University of Western Ontario, London, Ontario. It necessitated calculating episodes of illness. This was possible because each presentation of a problem is categorized as being either the initiation of a new episode or as one visit in a continuing episode.[7] Figure 2 shows our results for all visits between April 1, 1973, and March 31, 1974. The average ratio between episode frequencies is .65. By using the relationship:

$$\frac{\text{Persons with one episode}}{\text{Persons with zero episodes}} = .65$$

the number of people that presented zero episodes of illness was calculated and, by adding this value to the previously known number of persons utilizing the center, a total number of persons at risk was obtained (7,182). The calculated result for the total population was one percent higher than our registered 1973 year-end population (7,102). From Table 1, it is seen that the ratios for the total population are consistent. With the smaller numbers involved in the male and female categories, variability is more pronounced. Our initial results are encouraging for this approach.

Table 1. Episode Ratios and Estimated At-Risk Population of the Family Medical Center for Period April 1, 1973 to March 31, 1974

	Ratio of Successive Episode Frequencies				Episode Rate Estimate of At-Risk population	Registered Population December 1973
	2/1	3/2	4/3	5/4		
Total Population	.63	.66	.64	.66	7,182	7,102
Males Only	.58	.66	.55	.70	3,119	3,242
Females Only	.68	.66	.71	.64	4,073	3,856

Conclusions

The following points can be made concerning the state of the art on this subject:

1. Attention to the denominator, its type and composition is important for comparability of results in morbidity studies.
2. The population at risk is the most satisfactory denominator.
3. Registration is the best present method of determining the at-risk population, but problems may exist in its accuracy and it is time-consuming.
4. New methods of denominator determination are needed before family practice research can involve the majority of practicing physicians in morbidity studies.
5. The Episode Rate and Utilization Correction Factor are two untested methods that offer promise.

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