Using Bayes' nomogram to help interpret odds ratios

Introduction

In certain scenarios, the odds ratio (OR) provides an unbiased estimate of the rate ratio in case control studies.[1] However, the OR is also frequently used to estimate the risk ratio (relative risk) (RR) of an outcome in the presence of a risk factor. The degree of error in this estimate is frequently small, but can sometimes be substantial. The OR as an estimate of the RR always overestimates the effect of the exposure (results in an estimate further away from 1). The degree of divergence between the OR and the RR depends on the size of the OR and the probability of the outcome of interest (table).[2–4] Given the value of the baseline risk and the estimate of the OR, the RR can be estimated by the use of a formula.[3 5] However, the formula may be inconvenient and cumbersome for readers and users of epidemiological information. A nomogram is a graphical calculator that is a useful and convenient way to perform common calculations without the need to remember formulae. The use of the Bayes' nomogram[6] has simplified the use of diagnostic test information[7–8] and is now frequently used by physicians who may be unaware of the formula involved in the conversion. In this editorial, we show that the Bayes' nomogram, typically associated with likelihood ratios, can also be used to calculate the RR given the OR and the baseline risk.

Method

Our method uses 2 steps to convert from OR to RR, given a baseline risk. The first step uses Bayes' nomogram (figure).[6] Using a straight edge on the nomogram, line up the baseline probability of an event on axis A, with the OR on axis B, and read off the postexposure probability on axis C. The postexposure probability divided by the baseline probability then yields the RR. Thus, with available information on the OR from epidemiological studies and the baseline risk, Bayes' nomogram calculates the postexposure risk in the presence of the risk factor. Knowledge of the postexposure risk also allows easy and accurate calculation of the absolute risk difference and the number needed to treat (NNT)[9] or the number needed to harm (NNH).[10]

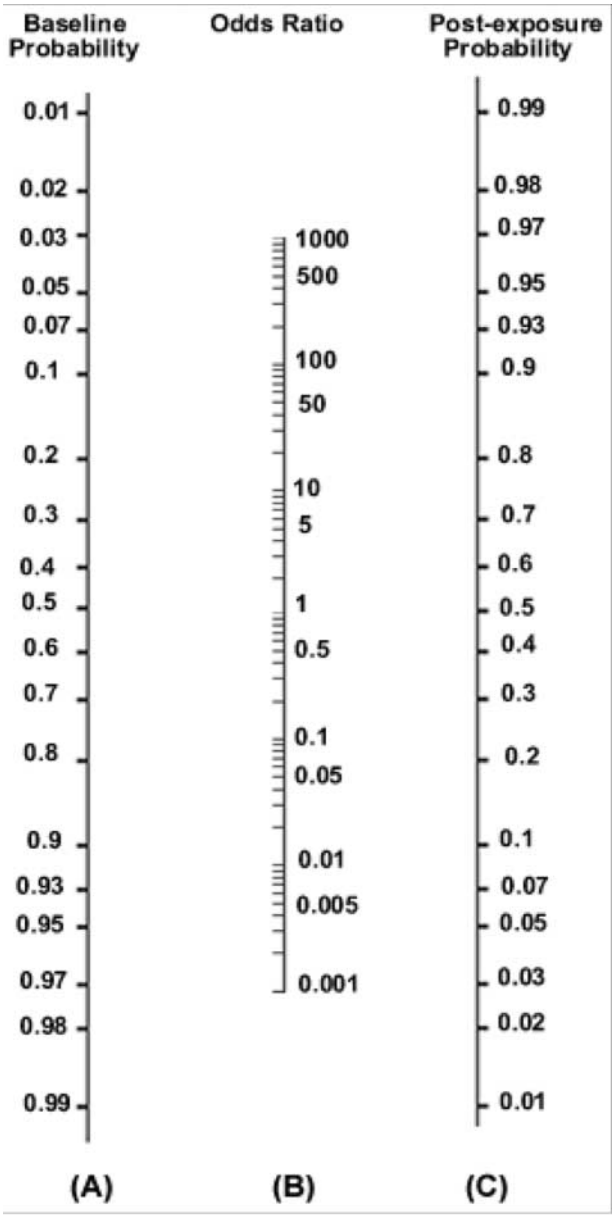
We present 2 examples to show the use of Bayes' nomogram to calculate postexposure probability, RR, absolute risk difference, and NNH.

*Degree of divergence between odds ratios (ORs) and relative risks (RRs)**

Baseline risk	Relative risk			
	0.5	0.75	2	4
5%	0.49	0.74	2.11	4.75
10%	0.47	0.73	2.25	6.0
20%	0.44	0.70	2.67	16.0
50%	0.33	0.60	NA	NA
70%	0.23	0.47	NA	NA

*NA = not available (ie, not calculable).

The table lists the ORs corresponding to various RRs and baseline risks. Notice that as the baseline risk increases, and as the RR is further from 1, the degree of divergence between the OR and the RR increases. Regardless of the magnitude of the RR, the OR is always further from 1 than the RR.



Nomogram to calculate postexposure probability given estimates of the odds ratio and baseline probability. This nomogram is equivalent to the Bayes' nomogram, but with different labels.

Example 1

We are interested in estimating the risk for precipitating heart failure in an older man who has started taking nonsteroidal anti-inflammatory drugs (NSAIDs) for arthritis. Our search reveals a recent case control study[11] suggesting an OR of 10.5 for developing heart failure associated with the use of NSAIDs by patients with a history of heart disease. To apply this information, we need to estimate our patient's baseline risk of heart failure. To do this, we use the equations derived by Kannel *et al* based on the Framingham database.[12] Using the example

given in that article of the 60 year old man with documented coronary disease who had a vital capacity of 2.5 l, systolic blood pressure of 160 mm Hg, heart rate of 85 beats/min, and evidence of left ventricular hypertrophy on electrocardiogram and cardiomegaly on chest radiogram, this patient's 4 year risk of heart failure is 34%. His 1 year risk is thus approximately 8.5%. Using Bayes' nomogram (figure), we anchor a straight edge at 0.085 (baseline risk) on axis A and direct it through axis B at 10.5 (OR). The postexposure risk can be read off axis C as 0.49, or a 49% chance of developing heart failure over 1 year after starting NSAIDs. The RR is then estimated by dividing the post-test probability, 49%, by the pretest probability, 8.5%, to get the RR of 5.8 (not an RR of 10.5 as some would misinterpret the OR). The absolute risk difference is 0.49 − 0.085 = 0.405. The NNH is the reciprocal of the absolute risk difference of 0.405, which is approximately 2.5. Thus, 5 such patients exposed to NSAIDs for a year would be expected to result in 2 new cases of heart failure.

Example 2

A meta-analysis compared endoscopic ligation with sclerotherapy for the treatment of esophageal variceal bleeding.[13] The overall rebleeding risk with sclerotherapy in the 7 included studies was 47%; the OR was 0.52 (95% CI 0.37 to 0.74) in favour of ligation therapy. Although it might be tempting to interpret this as a 48% relative risk reduction (RRR), this is not accurate. Using Bayes' nomogram and anchoring the straight edge at 0.47 (baseline risk) on axis A and 0.52 on axis B (OR), we read 0.32 on axis C, which is the probability of rebleeding with ligation (postexposure risk). To determine the RR associated with ligation compared with sclerotherapy, we divide 0.32 by 0.47, giving an answer of 0.68. This means that the RR is 0.68 and the RRR is 32% (1 − 0.68), not the 48% we would erroneously get if we equated the OR and RR without regard for the baseline risk and magnitude of the OR.

Discussion

ORs are frequently interpreted as RRs. Although the 2 are often very close, if the baseline risk is >10–20% and the magnitude of the OR is far from 1, the divergence can be substantial. In these cases, we have shown how a Bayes' nomogram can be used to conveniently calculate more accurate estimates of the RRs. Please note, however, that since the nomogram axes are on the logarithmic scale, interpolation requires some care. Numbers greater than a given mark on the scale will be further away than would be predicted by using a linear scale. Given the fact that the likelihood ratio is a form of OR, and indeed that the positive likelihood ratio divided by the negative likelihood ratio gives the OR, it is not surprising that the nomogram should be suitable for this purpose. However, in our experience with teaching evidence-based medicine, it is an application of Bayes' nomogram that is not commonly known or used.

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Antihypertensive drugs decrease mortality, coronary events, and stroke in elderly persons [abstract]. *Evidence-Based Medicine* 1996 May-Jun;**4**:105. Abstract of: Pearce KA, Furberg CD, Rushing J. Does antihypertensive treatment of the elderly prevent cardiovascular events or prolong life? A meta-analysis of hypertension treatment trials. *Arch Fam Med* 1995;**4**:943–50.

Citation for material taken from a commentary to an article

Olds D. Commentary on "Home visiting programmes reduce childhood injury." *Evidence-Based Medicine* 1996 May-Jun;**4**:112. Comment on: Roberts I, Kramer MS, Suissa S. Does home visiting prevent childhood injury? A systematic review of randomised controlled trials. *BMJ* 1996;**312**:29–33.

Journals reviewed for this issue*

Acta Obstet Gynecol Scand
Age Ageing
Am J Cardiol
Am J Med
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Am J Psychiatry
Am J Public Health
Am J Respir Crit Care Med
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