If the first selection *does not* result in a generic pill, then there are still 2 generic pills in the remaining 19, and the probability of a "success" (a generic pill) changes to

$$P(\text{generic on trial } 2 | \text{no generic on trial } 1) = 2/19$$

Therefore the trials are dependent and the sampling does not represent a binomial experiment.

Think about the difference between these two examples. When the sample (the n identical trials) came from a large population, the probability of success p stayed about the same from trial to trial. When the population size N was small, the probability of success p changed quite dramatically from trial to trial, and the experiment *was not* binomial.

RULE OF THUMB

If the sample size is large relative to the population size—in particular, if $n/N \geq .05$—then the resulting experiment is not binomial.

In Chapter 4, we tossed two fair coins and constructed the probability distribution for x, the number of heads—a binomial experiment with $n = 2$ and $p = .5$. The general binomial probability distribution is constructed in the same way, but the procedure gets complicated as n gets large. Fortunately, the probabilities $p(x)$ follow a general pattern. This allows us to use a single formula to find $p(x)$ for any given value of x.

THE BINOMIAL PROBABILITY DISTRIBUTION

A binomial experiment consists of n identical trials with probability of success p on each trial. The probability of k successes in n trials is

$$P(x = k) = C_k^n p^k q^{n-k} = \frac{n!}{k!(n-k)!} p^k q^{n-k}$$

for values of $k = 0, 1, 2, \ldots, n$. The symbol C_k^n equals

$$\frac{n!}{k!(n-k)!}$$

where $n! = n(n-1)(n-2) \cdots (2)(1)$ and $0! \equiv 1$.

The general formulas for μ, σ^2, and σ given in Chapter 4 can be used to derive the following simpler formulas for the binomial mean and standard deviation.

MEAN AND STANDARD DEVIATION FOR THE BINOMIAL RANDOM VARIABLE

The random variable x, the number of successes in n trials, has a probability distribution with this center and spread:

$$\begin{aligned} \text{Mean:} \quad & \mu = np \\ \text{Variance:} \quad & \sigma^2 = npq \\ \text{Standard deviation:} \quad & \sigma = \sqrt{npq} \end{aligned}$$