### 4.4.4 Clinical Studies

Clinical studies are conducted to determine the effectiveness a of a drug, or medical procedure in treating a disease or syndrome. In a typical clinical study a drug will be compared to a **placebo** i.e. an inert substance with the same appearance of the real drug. A group of patients will be given the real drug, and another group will be given the placebo. At the end the two groups are compared.

For a patient to know that she is taking the placebo may have a detrimental effect, whereas knowing that she is taking the real drug may all by itself have a beneficial effect. This psychological feedback may distort the comparison between the two groups. It is known that this psychological feedback can have a large effect that on patients, and for this reason clinical studies are conducted in such way that the patients don't know which of the two groups they are in, the placebo group or the real drug group. Studies conducted this way are called **blind studies**.

It has been shown that when doctors, nurses and medical personnel know which group a patient belongs to, their interactions with the patients may affect the patients response to the treatment, therefore distorting the comparison between the two groups. So, clinical studies are usually conducted in such way that the medical personnel who are in contact with the patients have no knowledge of who belong to which group. Such studies are called **double blind studies**.

In clinical studies, since future patients health and life is at risk, most statistical inferences are done with a high level of confidence. In our next example we will use a confidence level of 99.7%.

**Example 4.4.8.** *A clinical study is conducted to determine the effectiveness of a new drug in treating the symptoms associated with a certain illness. 2,500 volunteers are selected for the study and they are divided into two groups of 1,250 patients each. During the course of the study some patients withdraw from the study, others are taken out for medical complications, and others die. At the end of the study there were 1,180 patients in the placebo group and 1,047 in the drug group. Interviews with the patients and medical exams were performed to determine if the symptoms improved, or if on the contrary, they worsen or stayed the same. The results are given in Table 4.11*

*Determine, with a confidence level of* 99.7%*, if the drug is more effective than the placebo.*

| **Symptoms\ Group** | **Placebo** | **Drug** |
|---|---|---|
| Improve | 805 | 785 |
| Worsen or no change | 375 | 262 |
| Total | 1,180 | 1,047 |

Table 4.11: Results of Clinical Study

We will estimate what percentage $p$ of patients in the general population respond positively (improve) to the placebo and to the drug. This estimation will be done based on the observed percentage $\hat{p}$ for the corresponding group. We will do the calculations for both groups side by side. Recall that to have a confidence level of 99.7% for the value of $p$ we need to move 3 standard errors $\frac{\sigma}{n}$ away from $\hat{p}$.

| **Placebo** | **Drug** |
|---|---|
| Improve = 805 | Improve = 785 |
| Worse or no change = 375 | Worse or no change = 262 |
| $n = 1,180$ | $n = 1,047$ |
| $\hat{p} = \frac{805}{1180} \approx 0.6822$ | $\hat{p} = \frac{785}{1047} \approx 0.7498$ |
| Standard error | |
| $\frac{\sigma}{n} \approx 0.01355$ | $\frac{\sigma}{n} \approx 0.01339$ |
| $\hat{p} - 3\frac{\sigma}{n} \leq p \leq \hat{p} + 3\frac{\sigma}{n}$ | |
| $0.6415 \leq p \leq 0.7228$ | $0.7096 \leq p \leq 0.7899$ |

Because the intervals of possible values for $p$ in both groups overlap, we cannot conclude that $p$ for the drug group is higher than $p$ for the placebo group. In other words, there is not a statistically significant evidence that the drug does any better than the placebo. ■

Note that if we were to work under a lower confidence level, say 95% confidence, then the conclusion would be different. See Exercise 46.

**46.** *Repeat the analysis of the clinical study in Example 4.4.8 using a confidence level of* 95%*. What conclusion can you draw about the effectiveness of the drug?*