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LEADERS IN QUALITY STATISTICS

# Keeping **TAB**

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## The one-sample t-test using MINITAB

By Keith M. Bower, M.S.

MINITAB's one-sample t-test procedure can help you compare the mean (average) of a population with some hypothesized value, such as a business target. For example, you may wish to test the null hypothesis,  $H_0 : \mu = \text{target}$ , versus an alternative hypothesis such as  $H_1 : \mu \neq \text{target}$ .

The t-test was originally developed by the English statistician W.S. Gosset (1876-1937) while working for an Irish brewery. Gosset published under the pseudonym "Student," as secrecy was widely practiced in industrial circles (Plackett and Barnard [1990]<sup>1</sup>).

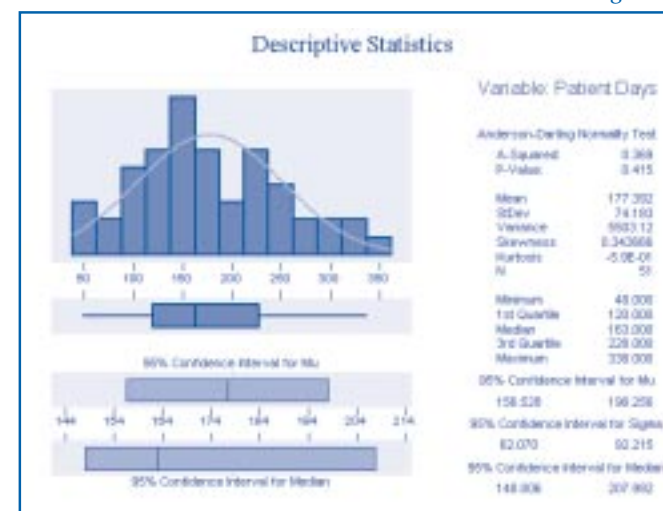
For this example, a subset of data from Smith, Piland, and Fisher [1992]<sup>2</sup> is used that deals with a sample of the licensed nursing facilities in New Mexico, United States, in 1988. All data,

hypothesis tests, and MINITAB output refer to the number of annual medical in-patient days in hundreds. In particular, for illustrative purposes, the null hypothesis,  $H_0 : \mu = 200$ , versus the alternative hypothesis,  $H_1 : \mu \neq 200$ , is investigated.

An assumption for the one-sample t-test procedure is that the underlying distribution of the population is Normal. When the assumption of Normality is violated, the procedure still works well if the underlying distribution is symmetric, unimodal, and continuous (Hogg and Tanis [1997]<sup>3</sup>). If the distribution is highly skewed, a nonparametric procedure such as the one-sample sign test may be preferred.

Figure 1 shows that you are unable to reject the null hypothesis of Normality at the  $\alpha = 0.05$  level, as the Anderson-Darling test statistic has a p-value of 0.415, which is greater than 0.05. A one-sample t-test will now be performed.

Figure 1



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As the MINITAB output in Figure 2 exhibits, you are able to reject the null hypothesis,  $H_0: \mu = 200$ , at the  $\alpha = 0.05$  level, as the p-value of 0.034 is less than 0.05.

Now that the null hypothesis has been rejected, it may be useful to have some appreciation of a reasonable range of values for the true number of annual medical in-patient days for this population.

Note that the null hypothesis was tested using a significance level of  $\alpha = 0.05$ . A  $100*(1 - \alpha)\%$  confidence interval, i.e. a 95% confidence interval, is also reported in the output in Figure 2 and displayed in Figure 3. You may be 95% confident that the true mean number of annual medical in-patient days (in hundreds) is between 156.5 and 198.3. Note that 200 does not fall inside this confidence interval, which corresponds to rejection of the null.

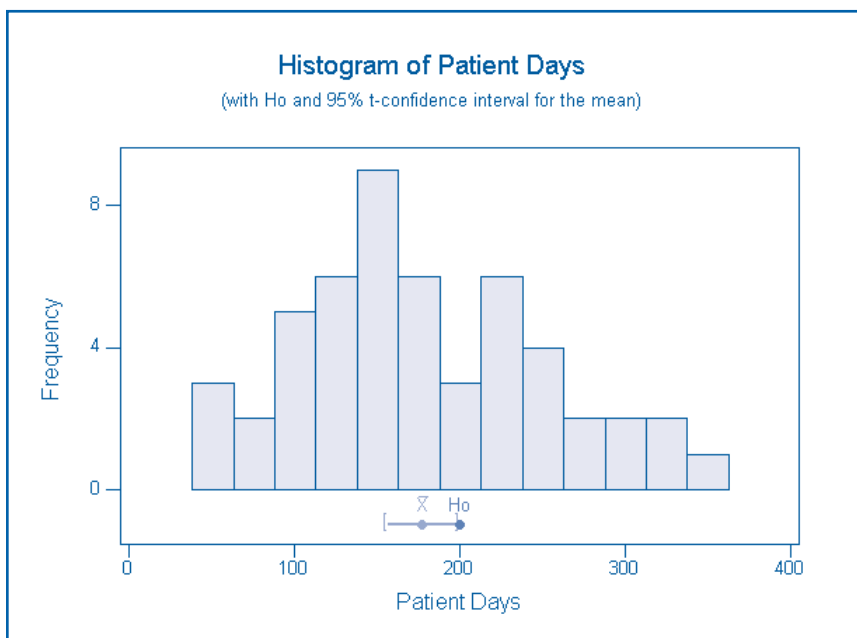
When testing a 2-sided alternative hypothesis, as in this example, the results from the t-test and whether the hypothesized mean is covered in the 2-sided confidence interval will be identical. Note that a confidence interval either does or does not contain the true mean,  $\mu$ . However, theoretically, if many such intervals were created (taking samples of size 51 from this population), about 95% of them would contain the true mean,  $\mu$ .

Use the one-sample t-test to investigate the mean of a population. If you want to investigate the means from two independent populations, use the two-sample t-test. For the comparison of means from two or more independent populations, use the ANOVA procedure.

Figure 2

One-Sample T: Patient Days				
Test of mu = 200 vs mu not = 200				
Variable	N	Mean	StDev	SE Mean
Patient Days	51	177.4	74.2	10.4
Variable	95.0% CI		T	P
Patient Days	( 156.5, 198.3 )		-2.18	0.034

Figure 3



<sup>1</sup> Plackett, R.L., Barnard, G.A. (1990). 'Student': A Statistical Biography of William Sealey Gosset: Based On Writings By E.S. Pearson. Oxford University Press.

<sup>2</sup> Smith, H.L., Piland, N.F., Fisher, N. (Winter, 1992). "A Comparison of Financial Performance, Organizational Characteristics, and Management Strategy Among Rural and Urban Nursing Facilities", Journal of Rural Health.

<sup>3</sup> Hogg, R.V., Tanis, E. (1997). Probability and Statistical Inference, Fifth Edition. Prentice-Hall, Inc.

*Keith M. Bower, M.S., is a Technical Training Specialist with Minitab Inc. Keith's main interests lie in SPC, especially control charting, capability indices, and in business statistics.*



# New MINITAB partnerships bring you more value

**Those who attended this year's Annual Quality Congress in Indianapolis were probably struck by how widespread the use of MINITAB has become in the quality industry. The MINITAB name was everywhere you turned at AQC 2000 – seen on conference bags and lanyards, referenced in numerous sessions on Six Sigma success stories, and displayed in other vendors' booths. Yes, that's right, in other vendors' booths. We're actively pursuing relationships with complementary applications in order to bring you more complete solutions.**

We've worked hard to make MINITAB the best statistical analysis tool on the market for quality professionals, and as a result, MINITAB has become the standard statistics package for the vast majority of Six Sigma programs. But we realize that MINITAB is just one tool that has to fit into a bigger solution. As we work towards integrating seamlessly into your IT environment, we're developing partnerships that will deliver complementary capabilities and better access to data. Following is a summary of our current partners that have built interfaces to MINITAB.

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[www.micrografx.com](http://www.micrografx.com)  
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