City Center Hospital Case

i. Summary and Problem Statement

City Centre Hospital (CCH) operated a large teaching hospital and had a good reputation. Within a decade, CCH came up with a number of innovations which were used internally and then sent to different hospitals. This helped CCH gain popularity and income. These innovations came from the Information System Group that helped developed new applications for the Information System Technology within the hospital.

CCH was a major, full-service, teaching hospital where patients were arranged by floors and each floor was made up of four wings. Different patient categories occupied different wings. The CCH nursing staff was assigned specific wings according to their qualifications. The 2 types of nurses were - Registered Nurses (RNs), who were University graduates, and Nursing Assistants (NAs), who were graduates from a 2-year college program.

CCH introduced a new computerized system which made it easier for nurses to streamline administrative tasks effectively. This enabled the nurses to provide more time on taking care of the patients. In order to test this system, CCH initiated an experiment in which 2 surgical wings were selected. One wing (10-Gold) had been using the new system for some time and the other wing (8-Blue) was still using the old system. For a period of 1 week, nurses working 12-hour day shifts for both the wings were provided with a diary which divided the shifts into 5 minute intervals. 24 categories of activities were listed in this diary under several headings and the time taken for the activities was recorded as precisely as possible.

During the week of data collection, diaries were completed by 36 RNs and 13 NAs on the 8-Blue wing, and 34 RNs and 12 NAs on the 10-Gold wing. The summary of this data shows the total reported time spent for each major heading, plus the reported time spent on Nurses' administration (the task most affected by the new computer system). These resulted are shown in the Excel sheet.

Also, two problems were encountered while tabulating the results. Firstly, many nurses checked more than 1 activity per 5-minute time slot. In this case time was evenly divided between the activities. As an example, if 2 activities were recorded then they occurred for 2.5 minutes each. Secondly, there were many time slots where no activity was recorded. These time slots were left uncounted with the result that the total reported activity time for many nurses was less than the 720-minute length of the shift.

It is to be determined if the new Computerized Administration System significantly helped the nurses improve their productivity or not. This can be determined based on the recorded time spent by the nurses for both the 8-Blue and 10-Gold wings. The approach for testing the system is discussed below.

ii. Analysis of the data

In order to test if the new system is effective or not based on the data collected, the time spent on Patient Care is logically a good indication of improvement. This time spent of Patient Care can be calculated for both the 8-Blue and the 10-Gold wings and checked if one is significantly different than the other. The hypothesis for this problem statement is mentioned below:

$H_0 \rightarrow$ *The time spent by nurses on Patient Care for Gold wing is $\leq$ Blue wing*
$H_1 \rightarrow$ *The time spent by nurses on Patient Care for Gold wing is $>$ Blue wing*

In order to calculate the time spent on Patient Care, the time recorded for the Direct Patient Care and the Indirect Patient Care is added and is then divided by the total time. This gives the fraction of time spent on Patient Care for the total time. In the Excel sheet, this new column is created for all the diary entries and used for testing the hypothesis.

Next, we can calculate the mean of the Patient Care Fraction for 3 variables – RN, NA and both. This will help us test all 3 scenarios for both the wings. The standard deviation for all the 3 variables will also be used for the test. The table below shows the mean, sample size and standard deviation statistic for both the wings and all the 3 test scenarios:

10-Gold Wing		8-Blue Wing	
Total Registered Nurses (RN)	34	Total Registered Nurses (RN)	36
Mean Patient Care Fraction (RN)	0.8952	Mean Patient Care Fraction (RN)	0.8968
Standard Deviation Patient Care Fraction (RN)	0.0398	Standard Deviation Patient Care Fraction (RN)	0.0522
Total Nursing Assistants (NA)	12	Total Nursing Assistants (NA)	13
Mean Patient Care Fraction (NA)	0.8735	Mean Patient Care Fraction (NA)	0.8431
Standard Deviation Patient Care Fraction (NA)	0.0776	Standard Deviation Patient Care Fraction (NA)	0.1075
Total Sample Size (N)	46	Total Sample Size (N)	49
Mean Patient Care Fraction (RN + NA)	0.8895	Mean Patient Care Fraction (RN + NA)	0.8826
Standard Deviation Patient Care Fraction (RN + NA)	0.0522	Standard Deviation Patient Care Fraction (RN + NA)	0.0738

With the above information, we can test the Hypothesis for each of the scenarios (RN, NA and RN+NA) case by case and determine if the time spent on Patient Care is different for both the wings. A test for all the 3 cases is described below:

a. Registered Nurses

Standard Deviation for Patient Care Fraction for **Gold** wing $(s_1) = 0.0398$
Mean Patient Care Fraction for **Gold** Wing $(\bar{x}_1) = 0.8952$
Sample size for **Gold** wing $(n_1) = 34$

Standard Deviation for Patient Care Fraction for **Blue** wing (s_2) = 0.0522
Mean Patient Care Fraction for **Blue** wing $(\bar{x}_2)$ = 0.8968
Sample size **Blue** wing (n_2) = 36

The Significance level (α) is chosen to be 0.05.

STEP1: $H_0 \rightarrow \bar{x}_1 \leq \bar{x}_2$ $\qquad$ $H_1 \rightarrow \bar{x}_1 > \bar{x}_2$ $\qquad\qquad$ *[1 tailed test]*

STEP2: α = 0.05

STEP3: The test static chosen here is z statistic because the sample size is > than 30

STEP4: Decision rule $\rightarrow$ For α = 0.05, if $z > 1.65$, H_0 will be rejected. This is the CRITICAL VALUE obtained from the level of significance (using the z table).

STEP5: Calculation of the z statistic:
$$z = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}}} = \frac{0.8952 - 0.8968}{\sqrt{\frac{0.0398^2}{34} + \frac{0.0522^2}{36}}} = \boldsymbol{-0.148}$$

Since the above value does not fall in the rejection region, $\boldsymbol{H_0}$ **is NOT REJECTED**. There is no evidence for the increase in the time spent for Patient Care in case of Registered Nurses for the Blue and the Gold wings. Thus, **the new computer system has not been effective for the case of Registered Nurses.**

b. Nursing Assistants

Standard Deviation for Patient Care Fraction for **Gold** wing (s_1) = 0.0776
Mean Patient Care Fraction for **Gold** Wing $(\bar{x}_1)$ = 0.8735
Sample size for **Gold** wing (n_1) = 12

Standard Deviation for Patient Care Fraction for **Blue** wing (s_2) = 0.1075
Mean Patient Care Fraction for **Blue** wing $(\bar{x}_2)$ = 0.8431
Sample size **Blue** wing (n_2) = 13

The Significance level (α) is chosen to be 0.05.

STEP1: $H_0 \rightarrow \bar{x}_1 \leq \bar{x}_2$ $\qquad$ $H_1 \rightarrow \bar{x}_1 > \bar{x}_2$ $\qquad\qquad$ *[1 tailed test]*

STEP2: α = 0.05

STEP3: The test static chosen here is t statistic because the sample size is < than 30

STEP4: Decision rule $\rightarrow$ For α = 0.05, if $t > 1.71387$, H_0 will be rejected. This is the CRITICAL VALUE obtained from the level of significance and the degree of freedom. The degree of freedom here is 23 (i.e., total no. of observations -1).

STEP5: The calculation of the t statistic is a two-step process:

We first find the pooled sample variance using the formula:
$$s_p{}^2 = \frac{(n_1-1)s_1{}^2+(n_2-1)s_2{}^2}{n_1+n_2-2} = \frac{(12-1)0.0776^2+(13-1)0.1075^2}{13+12-2} = 0.0089$$

Next, we find the t statistic using the formula:
$$t = \frac{\overline{x_1}-\overline{x_2}}{\sqrt{s_p{}^2(\frac{1}{n_1}+\frac{1}{n_2})}} = \frac{0.8735-0.8431}{\sqrt{0.0089(\frac{1}{13}+\frac{1}{12})}} = \mathbf{2.231}$$

Since the above value falls in the rejection region, H_0 **is REJECTED**. There is an increase in the time spent by the Gold wing nursing assistants on patient care compared to the Blue wing nursing assistants. Thus, **the new computer system has been effective for the case of Nursing Assistants.**

c. Registered Nurses and Nursing Assistants

Standard Deviation for Patient Care Fraction for **Gold** wing (s_1) = 0.8895
Mean Patient Care Fraction for **Gold** Wing $(\bar{x}_1)$ = 0.0522
Sample size for **Gold** wing (n_1) = 46

Standard Deviation for Patient Care Fraction for **Blue** wing (s_2) = 0.0738
Mean Patient Care Fraction for **Blue** wing $(\bar{x}_2)$ = 0.8826
Sample size **Blue** wing (n_2) = 49

The Significance level (α) is chosen to be 0.05.

STEP1: $H_0 \rightarrow \bar{x}_1 \leq \bar{x}_2$ $\qquad$ $H_1 \rightarrow \bar{x}_1 > \bar{x}_2$ $\qquad\qquad$ *[1 tailed test]*

STEP2: α = 0.05

STEP3: The test static chosen here is z statistic because the sample size is > than 30

STEP4: Decision rule $\rightarrow$ For α = 0.05, if $z > 1.65$, H_0 will be rejected. This is the CRITICAL VALUE obtained from the level of significance (using the z table).

STEP5: Calculation of the z statistic:
$$z = \frac{\overline{x_1}-\overline{x_2}}{\sqrt{\frac{s_1{}^2}{n_1}+\frac{s_2{}^2}{n_2}}} = \frac{0.8895-0.8826}{\sqrt{\frac{0.0522^2}{46}+\frac{0.0738^2}{49}}} = \mathbf{0.53}$$

Since the above value does not fall in the rejection region, H_0 **is NOT REJECTED**. There is no evidence for the increase in the time spent for Patient Care in case of both the Registered Nurse and Nursing Assistants for the Blue and the Gold wings. Thus, **the new computer system has not been effective for the case of both the Nurses combined.**

iii. Conclusion

For the above analysis, nurses were first identified as Registered Nurse (RN) or a Nursing Assistant (NA). After calculating the mean and standard deviations for the fraction of time spent on patient care, the null hypothesis that the new computerized system increased the time spent of patient care was tested. It was found out that **the mean fraction of time spent performing nursing activities increased for NAs in the new system (10-Gold), and there was no evidence that it had increased for the RNs, at a 95% confidence interval.** Also, **for the group as a whole (RNs and NAs), there is no evidence that the computerized system had increased the performance of nursing activities.** The hypothesis testing proves that the new system had not increased the performance as expected. This situation should be noticed by the CCH and appropriate action should be taken accordingly.

** Check the Excel sheet for detailed calculations of the above report.