

CHAPTER 4

4. RESULTS OF STATISTICAL ANALYSIS

4.1 INTRODUCTION

The objective of this chapter is to describe the results of the statistical analysis of the time sheets completed in the Physiotherapy Department over a six-month period. This chapter also discusses the key issues identified by the statistical analysis and the probable next steps required.

4.2 CONFIDENCE INTERVAL TEST RESULTS

4.2.1 Confidence Intervals - Exercise Rehabilitation

Table 1: Confidence Intervals - Exercise Rehabilitation

In Table 1: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for exercise rehabilitation. There is also a comparison between the confidence intervals and the standard times as well as an indication as to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicated In Minutes.	Mean	Std. Deviation	N	Std. Time Vs. Confidence Interval	Lower	Upper
Adult Cardio-thoracic patients. (have undergone valve/open heart surgery)	15	18.72	6.09	74	Low	17.33	20.10
Paediatric cardio-thoracic patients (Have undergone valve/open heart surgery)	35	22.5	8.05	54	High	20.35	24.65
Acute pre discharge	15	19.84	7.24	32	Low	17.34	22.35
Thoracic surgery	35	19.42	8.52		High	16.15	22.70
Other Cardiac exercise. Test	45	31.83	13.36	30	High	27.05	36.61
Cardiac risk factor assess (in patient)	35	19.78	7.38	46	High	17.65	21.91

Std: Standard

N: The number of observations

In the exercise rehabilitation area, the standard times were mostly higher than the confidence intervals. This would indicate that either the quality of the work is not adequate or the standard times are incorrect.

4.2.2 Confidence Intervals - Intensive Care Unit (ICU)

Table 2: Confidence Intervals - Intensive Care Unit (ICU)

In Table 2: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the Intensive Care Unit. The confidence intervals are also compared with the standard times and an indication is given as to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicated In Minutes	Mean	Std. Deviation	N	Std. time Vs. Confidence Interval	Lower	Upper
Ventilated patient with complications	45	30.20	2.54	302	High	29.91	30.49
Ventilated patient without complications	30	33.26	7.47	42	Low	31.00	35.52
Non-Ventilated patient with complications	45	23.31	9.74	129	High	21.63	24.99

Std: Standard

N: The number of observations

In the ICU area, the standard times were mostly higher than the confidence intervals. This would indicate that either the quality of the work is not adequate or the standard times are incorrect.

4.2.3 Confidence Intervals – Medical

Table 3: Confidence Intervals - Medical

In Table 3: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the medical area. The confidence intervals are also compared with the standard times and an indication is given to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicated In Minutes	Mean	Std. Deviation	N	Std. time Vs. Confidence Interval	Lower	Upper
Chronic Respiratory conditions	45	36.60	10.60	259	High	35.30	37.89
Acute Respiratory condition	15	14.93	3.83	218	Within	14.42	15.44
CVA's /paraplegia	15	15.77	6.25	124	Within	14.67	16.87
Intercostal drain	30	22.55	7.06	46	High	20.51	24.59
Other neurological conditions	30	25.55	6.96	100	High	24.19	26.91

Std: Standard

N: The number of observations

CVA: cerebrovascular accident (stroke)

In the medical area, the standard times were mostly higher than the confidence intervals. This would indicate that either the quality of the work is not adequate or the standard times are incorrect.

4.2.4 Confidence Intervals – Outpatient Department (OPD) 259

Table 4: Confidence Intervals – Outpatient Department (OPD) 259

In Table 4: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the OPD 259 area. The confidence intervals are also compared with the standard times and an indication is given to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicate In Minutes	Mean	Std. Deviation	N	Std time Vs. Confidence interval	Lower	Upper
Skin disease – Psoriasis – PUVA (Light)	20	30.72	27.20	56	Low	23.60	37.84

Std: Standard

N: The number of observations

In the OPD 259 area, the standard time is lower than the confidence intervals. This would indicate that the standard time is incorrect.

4.2.5 Confidence Intervals - Surgical

Table 5: Confidence Intervals - Surgical

In Table 5: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the surgical area. The confidence intervals are also compared with the standard times and an indication is given to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicated In Minutes	Mean	Std. Deviation	N	Std. time Vs. Confidence Interval	Lower	Upper
Chronic respiratory conditions	20	26.62	7.18	147	Low	25.46	27.78
Amputees	20	22.04	7.52	112	Within	18.64	23.43
Acute Respiratory conditions	15	18.37	6.60	118	Low	17.18	19.56
Patients Mobilisation	15	16.10	5.06	153	Low	15.30	16.91
IC drains	10	18.93	2.06	117	Low	18.56	19.31

Std: Standard

N: The number of observations

IC drains: Intercostal drains

In the surgical area, the standard times were mostly lower than the confidence intervals.

This would indicate the standard times are incorrect.

4.2.6 Confidence Intervals – Neurology

Table 6: Confidence Intervals - Neurology

In Table 6: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the neurology area. The confidence intervals are also compared with the standard times and an indication is given to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicated In Minutes	Mean	Std. Deviation	N	Std. Time Vs. Confidence Intervals	Lower	Upper
CVA (Stroke)	45	30.57	15.51	233	High	28.58	32.56
Head injuries	45	31.99	16.47	115	High	28.97	34.99
Paraplegia	30	38.37	27.06	51	Low	30.94	45.79

Std: Standard

N: The number of observations

CVA: Cerebrovascular accident (Stroke)

In the neurology area, the standard times were mostly higher than the confidence intervals. This would indicate that either the quality of the work is not adequate or the standard times are incorrect.

4.2.7 Confidence Intervals – Orthopaedics

Table 7: Confidence Intervals - Orthopaedics

In Table 7: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the orthopaedic area. The confidence intervals are also compared with the standard times and an indication is given to whether the standard is higher or lower than the confidence interval.

Treatment type	Std time Indicated In Minutes	Mean	Std Deviation	N	Std. Time Vs. Confidence Intervals	Lower	Upper
Bed exercise and education 1 st treatment	30	28.02	4.86	57	High	26.76	29.28
Bed exercise and subsequent treatments	15	18.16	6.41	214	Low	17.30	19.02
Patients Mobilisation	15	24.05	7.64	210	Low	23.02	25.09
Amputees	20	22.10	8.41	60	Low	20.50	23.70

Std: Standard

N: The number of observations

In the orthopaedic area, the standard times were generally lower than the confidence intervals. This would indicate that the standard times are incorrect. The Physiotherapists in the orthopaedic area worked more overtime than the physiotherapists in any other area.

4.2.8 Confidence Intervals – Paediatrics

Table 8: Confidence Intervals - Paediatrics

In Table 8: The standard times are presented as well as the mean (average) and the confidence intervals of the actual treatment times for the paediatric area. The confidence intervals are also compared with the standard times and an indication is given to whether the standard is higher or lower than the confidence interval.

Treatment type	Std. time Indicated In Minutes	Mean	Std. Deviation	N	Std. time Vs. Confidence intervals	Lower	Upper
Respiratory – uncomplicated	15	16.31	4.98	84	Low	15.25	17.37
Respiratory – complicated	30	32.06	7.04	129	Low	30.85	33.28
Rehabilitation – exercise chronic	45	40.59	15.35	50	High	36.33	44.84
Orthopaedics	20	15.47	9.29	111	High	13.72	17.17
Neurological	60	47.52	16.36	168	High	45.04	49.99
Rehabilitation exercise – early	20	21.28	6.71	97	Within	19.49	23.07

Std: Standard

N: The number of observations

In the paediatric area, the standard times were both higher and lower than the confidence intervals. The paediatric area has some of the most experienced physiotherapists in the department. These results suggests that the standard times should be reworked across the board, because the data was gathered from experienced physiotherapists and are therefore likely to be of low variance.

4.3 Comparison Between Treatment Areas

The purpose of this section was to determine whether it was possible to standardise across treatment areas. Therefore it was required to determine whether it was statistically justifiable to conclude that the standard times of treatments should depend only upon the type of treatment. The alternative is standard times are dependent upon both the type of treatment and the treatment area where the treatment was performed. The results presented below indicate that the standard times depended upon the treatment type and the treatment area where the treatment was performed.

Although sufficient data is available in some of the tests to permit the assumption that the difference in sample means is normal we take the conservative approach of assuming that the population variances are unknown.

The P-values were calculated using the TTEST function in Excel, a two-tailed distribution was used and the type set equal to 2 for two-sample equal variance and set to 3 for two-sample unequal variance. The P-Values (Hines and Montgomery, 1980)

reported below are the minimum significance levels at which the null hypothesis (H_0) can be rejected in each case. A P-value of 0.05 corresponds to a confidence level of 95%. In all hypotheses investigated, we use a significance level of 0.05 (a standard assumption) to frame our conclusions.

4.3.1 Comparison of treatment of chronic respiratory conditions in the Medical and Surgical areas

The mean value of the treatment sample (and standard deviation in parentheses) were as follows:

- Medical area: 36.60 (10.60) min, n = 259.
- Surgical area: 26.62 (7.18) min, n = 147

H_0 : average time spent on chronic respiratory conditions in the Medical area = average time spent on chronic respiratory conditions in the Surgical area.

H_1 : average time spent on chronic respiratory conditions in the Medical area > average time spent on chronic respiratory conditions in the Surgical area.

If the population variances are equal the P-value is $P = 7.603E-22 < 0.05$. If the variances are unequal the P-value is $P = 9.715E-26 < 0.05$. In either case the P-values are smaller than 0.05. Therefore we can reject the null hypotheses with 95% confidence and conclude that the average time spent on chronic respiratory conditions

in the medical area was higher than the average time spent on chronic respiratory conditions in the surgical area.

The reason for this result is that patients in the medical areas are mostly chronic respiratory patients with superimposed lung infections. Chronic respiratory treatments in the surgical areas are mostly for patients with a chronic lung disease that were operated on for some other reason. In this instance physiotherapy is then required mostly to treat the effects of the anaesthesia on the existing lung diseases and to prevent possible lung complications.

4.3.2 Comparison of treatment of acute respiratory conditions in the Medical and Surgical areas

The mean value of the treatment sample (and standard deviation in parentheses) were as follows:

- Surgical area: 18.37 (6.60) min, n = 218
- Medical area: 14.93 (3.82) min, n = 118

H_0 : average time spent on acute respiratory conditions in the surgical area = average time spent on acute respiratory conditions in the medical area

H_1 : average time spent on acute respiratory conditions in the surgical area > average time spent on acute respiratory conditions in the medical area

If the variances are equal the P-value is $P = 3.745E-09 < 0.05$. If the variances are unequal the P-value is $P = 5.291E-07 < 0.05$. In either case the P-values are smaller than 0.05. Therefore one can reject the null hypotheses with 95% confidence, and conclude that the average time spent on acute respiratory conditions in the surgical area was higher than the average time spent on acute respiratory conditions in the medical area.

The reason for this result could be that in the surgical area a patient with an acute respiratory condition is normally a patient that developed a lung complication during or after surgery and therefore requires and will respond to intensive physiotherapy. In the medical area an acute respiratory condition is normally related to an acute lung disease, patients are very ill and physiotherapists are not able to spend as much time with them as with a patient with a respiratory complication. The results for the treatment times of acute lung treatments in the surgical and medical areas are opposite to the results for treatment times of chronic lung treatment in the same two areas. Acute lung treatment times are longer in the surgical area than in the medical area while chronic lung treatment times are longer in the medical area than in the surgical area.

4.3.3 Comparison of treatment of neurological patients in the Paediatric and Medical areas

The mean value of the treatment sample (and standard deviation in parentheses) were as follows:

- Paediatric area: 47.52 (16.36) min, n = 168
- Medical area: 25.55 (6.96) min, n = 100

H_0 : average time spent on neurological patients in the medical area = average time spent on neurological patients in the paediatric area.

H_1 : average time spent on neurological patients in the paediatric area > average time spent on neurological patients in the medical area.

If the variances are equal then the P-value is $P = 2.06E-29$. If the variances are unequal, the P-value is $P = 1.51E-37$. In either case, the P-values are microscopic. Therefore, we can reject the null hypotheses with 95% confidence and conclude that the average time spent on neurological patients in the paediatric area was higher than the time spent on neurological patients in the medical area.

The reason for the result is that the neurological patients in the medical area are usually still unstable e.g. immediate period after having had a stroke. Physiotherapy in these cases would be limited and doing passive movements and ensuring that the positioning

of patients is adequate, would often be the only requirements. Once these patients are stabilised, they are moved to the neurological wards or outpatient areas.

In paediatric neurology children may have acute brain injury or a chronic condition such as cerebral palsy. In chronic cases they may have been hospitalised due to severe fitting or because they have not been treated previously. These children are stable and the physiotherapist spends much more time with them. Intensive physiotherapy to neurologically affected paediatric patients often have a more rewarding outcome than in the adult patient population.

4.3.4 Comparison of treatment of amputee patients in the Orthopaedic and Surgical areas

The mean value of the treatment sample (and standard deviation in parentheses) were as follows:

- Orthopaedic area: 18.31 (8.41) min, n = 60.
- Surgical area: 22.04 (7.52) min, n = 112.

H_0 : average time spent on amputee patients in the orthopaedic area = average time spent on amputee patients in the surgical area.

H_1 : average time spent on amputee patients in the orthopaedic area > average time spent on amputee patients in the surgical area.

If the variances are equal then the P-value is $P = 0.0023$. If the variances are unequal, the P-value is $P = 0.0024$. In either case the P-values are smaller than 0.05. Therefore we can reject the null hypotheses with 95% confidence and conclude that the average time spent on amputee patients in the area of orthopaedics was higher than the average time spent with amputee patients in the area of surgery. In this instance the average values are basically exactly the same although the confidence intervals are large. The large interval could be the cause of this result.

In the surgical and orthopaedic treatment areas there is not much difference in the actual treatment of patients and therefore it would be expected that the treatment times would be the same as the averages indicate. It is however possible that there may be a small difference. In the surgical area, amputation is normally due to vascular disease. These patients are normally ill and older. In the area of orthopaedics, amputations are normally due to trauma e.g. a motorcycle accident and the patient is usually younger and capable of doing more exercises and for longer periods of time.

4.3.5 Comparison of treatment of mobilising patients in the Orthopaedic and Surgical areas

The mean value of the treatment sample (and standard deviation in parentheses) were as follows:

- Orthopaedic area: 24.05 (7.64) min, n = 210.
- Surgical area: 16.10 (5.06) min, n = 153.

H_0 : average time spent on mobilisation patients in the orthopaedic area = average time spent on mobilisation patients in the surgical area.

H_1 : average time spent on mobilisation patients in the orthopaedic area > average time spent on mobilisation patients in the surgical area.

If the variances are equal the P-value is $P = 2.446E-25$. If the variances are unequal the P-value is $P = 6.259E-28$. In either case the P-values are much smaller than 0.05. Therefore, we can reject the null hypotheses with 95% confidence. This is in favour of the alternative conclusion indicating average time spent on mobilisation of patients in the orthopaedic area was higher than the average time spent on mobilisation of patients in the surgical area.

The reason for the result is that: mobilising a patient in the orthopaedic area involves teaching the patient to walk, as he/she usually needs an aid to walk. Mobilising a patient in the surgical area is mostly a patient that the physiotherapist needs to assist in getting up to walk, after they had a surgical incision, in order to optimise their recovery. Crutches and other aids are rarely indicated.

4.4 DIRECT PATIENT CARE VERSUS INDIRECT PATIENT CARE

Table 9: % Direct Patient Care, Indirect Patient Care and Other

In Table 9: the percentage of time spent on each section direct, indirect or “other activities” in each treatment area is provided.

Treatment Area	% Time – Direct patient care	% Time – Indirect patient care	Other activities
Exercise rehabilitation	41.63%	13.55%	44.83%
ICU	71.81%	9.32%	18.87%
Medical	62.38%	19.84%	17.78%
OPD	69.10%	14.02%	16.89%
Surgical	72.40%	11.77%	15.83%
Neurological	44.85%	23.07%	32.08%
Orthopaedic	52.22%	24.88%	22.34%
Paediatric	59.93%	17.15%	22.52%
Average	59.29%	16.70%	23.89%

ICU: Intensive Care Unit

OPD: Out patients' department

Based on the results from the timesheets the average time spent on direct patient care is 59.29%, for indirect patient care the average is 16.70% and the average for other is 23.89%

4.4.1 Explanations for the difference in the percentage between direct and indirect patient care in the various treatment areas

In the exercise rehabilitation area, more time is spent on education and teaching patients how to cope with their chronic diseases. The more effectively patients manage their own diseases, the lower the chances of re-hospitalisation are.

In the Intensive Care Units (ICU), patients are critically ill. Direct patient care forms the largest part of the physiotherapy treatment. Of all the treatment areas, one expects direct patient care to be the highest in these areas. Very little education is possible to the patient but some instructions would be given to staff and family members of patients. The only other component of indirect patient care relevant here is the interaction with the doctors and nurses.

In the medical area, patients are ill and frequently have chronic diseases (e.g. patients with AIDS and a superimposed pneumonia). Direct patient care could be high. There should however be emphasis on education and teaching patients to manage their disease. It seems as if due to time constraints the education and management component is being neglected in this area. This is a problem because if the education and management component were taken care of efficiently re-hospitalisation could possibly be decreased.

In the surgical area, not as much education and management is required. Typically, the problem would be a once-off problem that needs surgical intervention, but is not a chronic problem that requires management over extended periods of time.

In the neurological area much time is spent during the treatment on education of the patient and teaching the caregiver to manage the disease, these patients often have a severe residual disability. Hospitalised patients are more acute and therefore it is to be expected that the direct patient care would be higher than the indirect patient care.

In the outpatient (OPD) area patients attend for specific treatments. A large percentage of the physiotherapist's time is for direct patient care although education is also important. Physiotherapists present the education component mostly to groups of outpatients and therefore this takes up a smaller percentage of their time.

In the orthopaedic area direct and indirect patient care are equally important. Much education and teaching management of the condition happen while treating the patient directly. It is the hospital policy to discharge patients as soon as possible and therefore there is not always time available to spend enough time on indirect patient care as would be desirable.

In the area of paediatrics, education and management of the patient's caregiver is vital. The physiotherapist educates and teaches the caregiver to manage the patient whilst

treating the patient and therefore allocates the time as direct patient care. This type of intervention is possible in the paediatric wards because parents and caregivers ideally spend most of the day with the patients. More critical direct care is required for patients with severe burns or trauma and very little indirect patient care is then required.

4.5 LOAD AND CAPACITY

The purpose of this section is to determine the amount of work or the load that needs to be performed daily and the capacity or the amount of physiotherapy time available to deal with the load.

Table 10: Load and Capacity

In Table 10 the columns are:

Average number of patients not treated: This is the number of patients that physiotherapists could not treat due to time constraints.

Average Number of treatments per day per treatment area: This is the average number of treatments each area needs to perform daily. It sometimes happened that a patient required more than one treatment from a physiotherapist per day. Therefore, this table indicates the number of treatments and not the number of patients treated.

Average time required per day per treatment area: This is the average time in minutes that each area is busy with some form of treatment (direct patient care).

Average time required per day - including the patients not treated: This is the average time, in minutes, required for treatments to ensure that all patients were

treated. (Calculated from the average number of treatments per day plus the average number of patients not treated per day)

Average Treatments per day per physiotherapists: This is the average number of treatments each physiotherapist in the various areas performed daily.

Treatment Area	Avg. no. of patients not treated	Avg. no of treatments/ day/ area	Avg. time required/ day/ area	Avg. time required/ day incl. Patients not treated	Avg. no. of treatments/ day/ physiotherapist
Exercise rehabilitation	0.22	4.26	141.23	141.23	4.26
ICU	0.25	37.65	774.78	3564.33	8.19
Medical	0.38	16.69	372.74	666.10	9.34
OPD	-	8.26	326.29	548.10	6.12
Surgical	-	16.12	317.53	317.53	16.12
Neurological	3.09	22	452.23	1302.25	7.64
Orthopaedic	0.49	28.91	596.96	2003.13	8.62
Paediatric	0.65625	21.69231	611.06	1711.54	7.75
Total		155.5823	3592.82	10254.21	68.04
Average		19.4478	449.1025	1281.776	8.505

OPD: Outpatient Department

Based on the information as stated in table 10 it is apparent that the total number of minutes required to treat all the patients within the department were 10254.21 minutes. The time required is for daily treatment, on average, for all the treatment areas.

4.5.1 Required Capacity

In the study performed by Hospital and the WITS University (De Charmoy and Eales, 2000) the load was determined and the results obtained were that there were on a given day 746 patients of those 394 of them required physiotherapy treatment. It was determined that these patients required 132 hours of treatment. Based on their assumption that the Physiotherapists spent 45% of their time on direct patient care they therefore would require 36.5 full time physiotherapists.

Based on the results obtained over a six months period, the number of hour's patients for which treatment was required, daily, was 171 hours (Total minutes for all the treatment areas 10254.21). Based on the previous calculation that indicated that an average of 59.29% of the physiotherapists' time was spent on direct patient care, the department would therefore require 34 full time physiotherapists ($171 / 0.5929 / 8.5 =$ Number of full time physiotherapists)

4.6 CONCLUSION

Based on the supervisor's opinions that treatments are not adequate where the time spent on patients was less than the standard time indicated, the results of this study

indicates that the quality of the treatments patients received requires further investigation.

The standard times are not correct. This study could be used to determine more accurate standard times to enable the supervisors to have more accurate expectations of performance times.

The comparison made of similar treatments in different treatment areas indicated that in all cases the treatment times were different. Therefore, it would not be possible to standardise across treatment areas.

In conclusion it can be said that since physiotherapists spend an average of 59% of their time on direct patient care, 171 hours would require 34 full-time physiotherapists at the Johannesburg Hospital to effectively treat the patients seen by them in the period over which the study took place. This is a clear indication that there is a need for more Physiotherapists in the department. The current complement of physiotherapy staff is 18 full time physiotherapists; the department is understaffed by 46%.