Chapter 1

Introduction

1.1 The role of the pharmacist

The role of the pharmacist is changing as the focus of healthcare is changing (Hughes, Donnelly & James-Chatgilaou 2001). The quality use of medicine and achieving the best patient outcomes has become the centre of attention. In the United States it has been estimated that for every dollar spent on medications, another dollar is spent on drug related problems (Hughes *et al*). Realisation dawned that the provision of healthcare should be through a multidisciplinary team. With this realisation a new healthcare model was developed and the pharmacist's role evolved beyond that of the drug supply to one that involves a number of clinical services.

1.2 Definition of clinical pharmacy

Hughes and Hughes (2001) defines clinical pharmacy as all those activities undertaken by pharmacists in an attempt to promote rational drug therapy that is safe, appropriate and cost effective. Such activities include drug regimen review, medication administration review, patient counselling and education, and the monitoring of treatment.

In a more current definition clinical pharmacy is defined as a health science discipline in which pharmacists provide patient care that optimizes medication therapy and promotes health, wellness and disease prevention. The practice of clinical pharmacy embraces the philosophy of pharmaceutical care; it blends a caring orientation with specialized therapeutic knowledge, experience and judgement for the purpose of ensuring optimal patient outcomes. Clinical pharmacy, as a discipline, also has an obligation to contribute to the generation of new knowledge that advances health and quality of life (The American College of Clinical Pharmacy 2008).

1.3 Patient-drug related problems

The professional literature of the mid – 1960's documented many patient drug-related problems in hospitals (Bonal and Poston 1984). These patient drug related problems included things like adverse drug reactions, extended hospitalisations as a result of adverse drug events, intravenous admixture incompatibilities and drug-drug interactions. Drug related problems also include medication errors which are relatively common in hospitalised patients and can result in patient morbidity and mortality, and increased costs (Van den Bemt, Egberts, Jong-van den Berg and Brouwers 2000). The providers of clinical pharmacy in the USA reasoned that, given a chance, pharmacist's situated in patient-care areas could reduce and prevent many of the drug related problems, as proven by the study done by Kucukarslan and Peters (2003) in which they determined that having a pharmacist on ward rounds reduced preventable adverse drug events (ADE's) by 78%. They were in the fortunate position that there were some physicians, nurses and hospital administrators who were interested in enhancing drug related services and broadening the role of the pharmacist. They then assigned resources to pharmacists to see what they could do.

1.4 Need for pharmacists in medication monitoring

In South Africa the need for pharmacists in medication monitoring on ward rounds has already been explored in 1991 by Summers (1991). It was noted that it is vital for the pharmacist to see the full patient picture and in order for them to do so they had to be present in the wards where the drugs are administered.

In a recent journal article published in which it was evaluated if clinical pharmacists really improve the quality of patient care, it was evident that the clinical pharmacist's role is of utmost importance. The introduction of ward pharmacy in the 1960's led to a 40-50% reduction in errors (Dhillon, 2001). Even though this is the case, clinical services are not provided to the majority of patients, let alone all of the patients in the U.S. Even less so in South Africa.

1.5 Need for a pharmacist in the Intensive Care Unit

Evidence shows that the involvement of clinical pharmacists in the care of patients in the intensive care unit (ICU), increases the safe use of medications and decreases the cost associated with drug therapy.Weant, Armitstead, Ladha, Sasaki-Adams, Hadar and Ewend (2009) reported that that having a dedicated clinical pharmacist with critical care training going on ward rounds with a neurosurgical team significantly reduced hospital stay, re-admission rates and pharmacy costs, thus having a significant effect on clinical and economic measures in the ICU. They also advised that clinical pharmacist's participation on a multidisciplinary critical care team should be a standard of care.

According to Montazeri and Cook (1994) several reports show that the presence of a clinical pharmacist in the ICU can positively impact patient safety, outcomes and drug costs. MacLaren, Devlin, Martin, Dasta, Rudis& Bond (2006) state that pharmacists are assuming greater roles and responsibilities of patient care in the ICU and that these pharmacists are an integral member of the multidisciplinary team. They also state that the involvement of critical care pharmacists has been shown to decrease drug-related costs, prevent adverse drug events and reduce patient morbidity. According to MacLaren*et al*. (2006) the Society of Critical Care Medicine (SCCM) and other physician based organizations deem pharmacists to be an essential component for providing quality care to critically ill patients. Lastly, according to Kane, Weber and Dasta (2003), pharmacists make valuable contributions to improve clinical, economic and humanistic outcomes in patients in the ICU setting.

1.6 Cost effectiveness of a clinical pharmacist

Weant*et al*. (2009) studied the cost effectiveness of a clinical pharmacist on a neurosurgical team and proved a hospital cost saving of $1 718 260 over the two year study period. The clinical pharmacist also made 11 250 interventions over the two year study period.

1.7 Clinical morbidity

Leape and colleagues (2000) have demonstrated that the inclusion of a pharmacist on medical rounds significantly reduces clinical morbidity and economic costs resulting from preventable adverse drug reactions.

1.8 Aim

Despite the potential impact that the clinical pharmacist could have on medication safety and quality of care in the intensive care unit, very few clinical pharmacy programmes exists in South African hospitals today. There is no in-service training and very few formal posts available. It is thus clear that there was a significant need for further research on this topic in a private hospital in South Africa. This study aimed to determine whether there was a need for a clinical pharmacist in the intensive care unit. It also aimed to determine whether there was a cost-saving with a clinical pharmacist attending to the intensive care unit.

1.9 Objectives

- To determine whether there was a decrease in the rand-value of the monthly credits (medications not used by the patient and returned to the pharmacy for a credit) for the ICU pre- and post-implementation of clinical pharmacy services.
- To determine whether there was a decrease in the number of daily scripts from the ICU reaching the pharmacy pre- and post-implementation of clinical pharmacy services. To determine whether there was a decrease in the average ICU stay (a decrease in the average amount of days that the patient spends in ICU) pre- and post-implementation of clinical pharmacy services.
- To determine whether there was a decrease in the average ICU stay (a decrease in the average amount of days that the patient spends in ICU) pre- and post-clinical pharmacy services.
- To compare the total medication bill of patients pre- and post-implementation of clinical pharmacy services.
- To compare the classes of the drugs used pre- and post-implementation of clinical pharmacy services, the amount of each drug and the rand value over both years.

- To assess the occurrence of interventions performed by a pharmacist during the provision of clinical pharmacy services.
- To determine the number of interventions made during the study.

Chapter 2

Methodology

2.1 Study site

The study was conducted in the intensive care units at a private hospital in Pretoria. The intensive care units consists out of the Medical ICU (11 beds) and the Trauma ICU (17 beds).

2.2 Study design

The design of the study was quantitative and non-experimental. Data were collected retrospectively.

2.3 Study period

Patients admitted to the ICU one year before (October 2008 – September 2009) and one year after (October 2009 – September 2010) the implementation of dedicated ICU pharmacy services were retrospectively reviewed. Clinical pharmacy services were implemented from the 1st of October 2009.

2.4 Sample population

The records of all patients, adults and children, admitted to the ICU over the study period October 2008 to September 2010 were included.

2.5 Data collection

Drug therapy problem lists were used, (see Appendix C). The forms looked at the following factors:

- Prescription chart review – transcribing errors – the data base [this data base refers to the Incident Management System (IMS) on which the nurses in the ICU log any errors picked up while on duty – whether it was a transcribing error or dosing error – all errors get logged onto this system] was checked for any transcribing errors logged in the year pre- implementation of clinical pharmacy services and that was compared with the transcribing errors picked up by the clinical pharmacist post-implementation of clinical services.

- Medication review – omitted dosages, drug-drug interactions, incorrect dosages, dispensing errors and contra indicated drugs. The data base was checked for any medication related errors logged in the year pre- implementation of clinical pharmacy services and that was compared to the medication errors picked up by the clinical pharmacist post-implementation of clinical services.
- Clinical recommendations – for the year pre-implementation of clinical pharmacy services the data base was checked for any interventions made by the ICU doctors and the nursing personnel and that was compared with the interventions made by the clinical pharmacist, post-implementation of clinical pharmacy services.
- The rand-value of the monthly credits was collected on a monthly basis from the hospital statistics department, where they gather the information in computerized form. The rand-values of the different medications were made the same for both years to exclude any SEP (single exit price) increases. In other words, a standardized price was used for the drugs for the two year study period. The pricing structure for the first year was used for both years.
- The number of daily scripts reaching the pharmacy from the ICU was collected on a monthly basis from the hospital statistics department where they gather the information in computerized form. Microsoft Office Access 2007 was used.
- The number of days that the patients spent in the ICU department pre- and post-implementation of the clinical pharmacy services was collected from the hospital statistics department where they gathered the information in computerized form. Patients with the same admitting diagnosis (ICD 10 code) were grouped and compared. An ICD 10 code is defined as: International and Statistical Classification of Diseases and Related Health Problems (10^{th} Revision) Code – A World Health Organization Publication.
- The total medication bill of patients pre- and post-implementation of clinical pharmacy services was compared. Any SEP increases were excluded by standardizing the prices of the medication on each bill. This was done by deducting the SEP increase from each medication bill. Changes in formularies and drug availability were considered. Patients with the same admitting diagnosis (ICD 10 code) were grouped and compared.

  Ward Stock is defined as: medication used on a regular basis in stat (medical term used to imply urgent or rush) situations, kept by the ward for emergencies. For

example: certain antibiotics (Meronem®, Zyvoxid®), certain sedating medications like Ativan ® ampoules, local anaesthetics like Lignocaine® etc. Scheduled Drugs are defined as: Schedule 6, like Morphine®, Pethidine® etc. Some drugs scheduled from Schedule 5 are also kept.

- A breakdown of the classes of the drugs used pre- and post-implementation of clinical pharmacy services were given and the amount of each drug and the rand value over both years was explored. Once again SEP's were excluded, changes in formularies of drugs and drug availability were considered.

2.6 Data analysis

Data were analysed using appropriate descriptive statistical analysis. The number of drug therapy related problems where interventions were made was statistically expressed. It was then categorized into groups of omitted dosages, incorrect dosages, transcribing errors, drug-drug interactions and dispensing errors to see which was more prevalent.

Costs was calculated by comparing the pre-implementation of clinical pharmacy services with the post-implementation of clinical pharmacy services, taking into account the rand-value of the credits, the number of scripts from ICU reaching the pharmacy and the average hospital stay per patient. Values between pre- and post-implementation groups were compared by chi-squared tests. Averages (means) were compared by the two sample t-test. The two sample t-test was used because two separate periods of time were compared with each other, each period containing different patients. The level of significance was 0.05 (5%).

2.7 Validity, reliability and bias

The reliability of scientific research means its ability to minimize randomness in the results. In the context of the study this meant that the results from the literature and the case-study had to be identical if re-performed under identical circumstances. Identical circumstances was however not be possible, since it could not be determined which type of patients would be admitted to these units. The same type of outcome was however expected. One anticipated a decrease in credits, the amount of prescriptions reaching the pharmacy, a decrease in the ICU stay etc. The amount of interventions made depended on how efficient and experienced the clinical pharmacist was. All patients admitted during the study period

were included into the study and this prevented bias. The reliability of the study also depended on the correct documentation on patient files.

The validity of scientific research means its ability to study and measure what it is supposed to study and measure. This study was mainly based on statistical findings.

Objectivity – the study was mainly based on the outcomes of statistical data and the author's objectivity was thus not brought into question.

2.8 Ethics

The proposal was submitted to the Post Graduate Committee and ethical approval was obtained from the University of Witwatersrand Ethics Committee (see Appendix A). Permission to conduct the study was also obtained from the studies co-ordinator at the private hospital in Pretoria.

Chapter 3

Results and Discussion

3.1 Demographic Data

3.1.1 Bed Occupancy

Pre-clinical pharmacy services (Oct 2008 – Sept 2009)

The number of patients admitted to both ICU's pre-clinical pharmacy services was 508.

The bed occupancy for the period pre-clinical pharmacy services is presented in Table 3.1

Table 3.1 The bed occupancy for the year pre-clinical pharmacy services for ICU 10 and ICU 17

ICU 10		**ICU 17**
Pre-clinical pharmacy services (2008 - 2009)		**Pre-clinical pharmacy services (2008-2009)**
Month	***Bed occupancy (%)***	***Bed occupancy (%)***
Oct	82.44	58.47
Nov	68.15	73.75
Dec	41.22	81.85
Jan	56.99	76.08
Feb	94.05	63.69
Mar	87.63	70.03
Apr	87.78	61.94
May	90.86	75.94
Jun	89.26	69.03
Jul	74.73	72.98
Aug	89.43	74.6
Sep	87.22	65.97
Average	79.15	70.36

Post clinical pharmacy services (Oct 2009 – Sept 2010)

The total number of patients admitted to both ICU's in this year was 542.

The bed occupancy for the period post-clinical pharmacy services is presented in Table 3.2

Table 3.2 The bed occupancy for the year post-clinical pharmacy services for ICU 10 and ICU 17

ICU 10		**ICU 17**
Post-Clinical pharmacy services (2009-2010)		**Post-Clinical pharmacy services (2009-2010)**
Month	***Bed occupancy (%)***	***Bed occupancy (%)***
Oct	86.2	81.05
Nov	79.44	68.33
Dec	50.9	86.42
Jan	59.14	116.94
Feb	95.83	111.9
Mar	84.77	97.52
Apr	75.56	67.31
May	86.02	69.6
Jun	88.15	75.97
Jul	86.56	89.25
Aug	87.46	88.04
Sep	80.74	84.31
Average	80.06	86.39

The bed occupancy for ICU 10 (Medical ICU) was very similar for the year pre- and post-clinical pharmacy services. Bed occupancy for ICU 10 pre-clinical pharmacy services was 79.15% and for the year post-clinical pharmacy services it was 80.06%.

ICU 17 (Trauma ICU) had a higher bed occupancy in the year post-clinical pharmacy services with a percentage of 86.39%, compared to the 70.36% bed occupancy for the year pre-clinical pharmacy services. January, February and March 2009, proved to be very busy months for ICU 17, with bed occupancies of 116.94%, 111.9% and 97.52% respectively.

3.1.2 Diagnoses

ICD 10 Codes:

Table 3.3 Classification of the ICD 10 Codes

ICD 10 Code
Certain infectious & parasitic diseases (A00-B99)
Neoplasms (C00-D48)
Diseases of the blood & blood forming organs (D50-D89)
Endocrine, nutritional & metabolic diseases (E00-E90)
Mental & behavioural disorders (F00-F99)
Diseases of the nervous system (G00-G99)
Diseases of the eye & adnexa (H00-H59)
Diseases of the ear & mastoid process (H60-H95)
Diseases of the circulatory system (I00-I99)
Diseases of the respiratory system (J00-J99)
Diseases of the digestive system (K00-K93)
Diseases of the skin & subcutaneous tissue (L00-L99)
Diseases of the muscoskeletal system & connective tissue (M00-M99)
Diseases of the genitourinary system (N00-N99)
Pregnancy, childbirth & the puerperium (O00-O99)
Certain conditions originating in the perinatal period (P00-P96)
Congenital malformations, deformations & chromosomal abnormalities (Q00-Q99)
Symptoms, signs & abnormal clinical & lab findings, not elsewhere classiffied (R00-R99)
Injury, poisoning & certain other consequenses of external causes (S00-T98)
External causes of morbidity & mortality (V01-Y98)
Factors influencing health status & contact with health services (Z00-Z99)

The ICD 10 Codes were classified according to The World Health Organization's International Statistical Classification of Diseases and Related Health Problems, 10th Revision.

ICD 10 Codes of the same categories were grouped and compared, thus patients with the same type of diseases were grouped and compared, for example: patients with diseases of the digestive system (K00-K93) were grouped and compared, as were patients with diseases of the respiratory system (J00-J99) and so forth. For a full classification of the ICD 10 Codes, please see Appendix D.

Table 3.4: Amount of patients admitted over the two-year study period

ICD 10 Code	Amount of pt's 2008-2009	Amount of pt's 2009-2010
Certain infectious & parasitic diseases (A00-B99)	17	26
Neoplasms (C00-D48)	44	91
Diseases of the blood & blood forming organs (D50-D89)	2	3
Endocrine, nutritional & metabolic diseases (E00-E90)	9	9
Mental & behavioural disorders (F00-F99)	0	0
Diseases of the nervous system (G00-G99)	16	16
Diseases of the eye & adnexa (H00-H59)	0	0
Diseases of the ear & mastoid process (H60-H95)	0	1
Diseases of the circulatory system (I00-I99)	24	30
Diseases of the respiratory system (J00-J99)	73	83
Diseases of the digestive system (K00-K93)	49	47
Diseases of the skin & subcutaneous tissue (L00-L99)	2	2
Diseases of the muscoskeletal system & connective tissue (M00-M99)	104	100
Diseases of the genitourinary system (N00-N99)	16	17
Pregnancy, childbirth & the puerperium (O00-O99)	3	12
Certain conditions originating in the perinatal period (P00-P96)	1	0
Congenital malformations, deformations & chromosomal abnormalities (Q00-Q99)	1	3
Symptoms, signs & abnormal clinical & lab findings, not elsewhere classiffied (R00-R99)	0	0
Injury, poisoning & certain other consequenses of external causes (S00-T98)	143	98
External causes of morbidity & mortality (V01-Y98)	0	0
Factors influencing health status & contact with health services (Z00-Z99)	4	4
Total	**508**	**542**

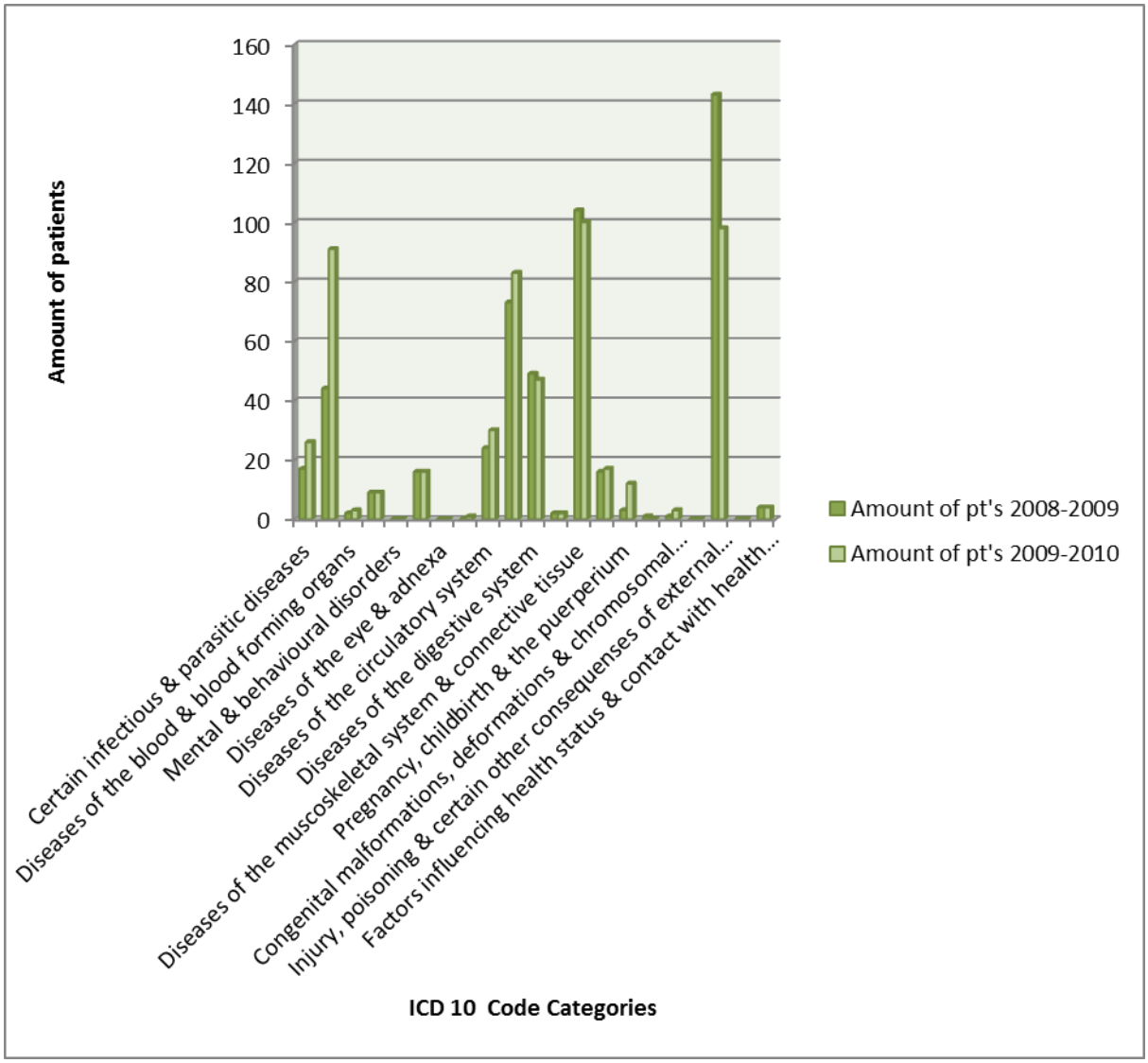


Figure 3.1: Amount of patients admitted over the two-year study period

According to the Society of Critical Care Medicine (2012), more than five million patients are admitted to the ICU's annually in the United States. The five primary ICU admission diagnoses were, in decreasing order: respiratory insufficiency or failure, postoperative management, ischemic heart disorder, sepsis and heart failure.

A total number of 508 patients were admitted in the 2008-2009 study group and 542 in the 2009-2010 study group. The five primary admission diagnoses for the 2008-2009 study group in decreasing order were: injury, poisoning and certain consequences of external causes (143 patients), diseases of the muscoskeletal system and connective tissues (104 patients), diseases of the respiratory system (73 patients), diseases of the digestive system (49 patients) and neoplasms (44 patients).

The five primary admission diagnoses for the 2009-2010 study group in decreasing order were: diseases of the muscoskeletal system and connective tissues (100 patients), injury, poisoning and certain other consequences of external causes (98 patients), neoplasms (91 patients), diseases of the respiratory system (83 patients) and diseases of the digestive system (47 patients).

3.1.3 ICU Stay

Table 3.5: Average ICU stay over the two-year study period

ICD 10 Code	Avg ICU stay 2008-2009	Avg ICU stay 2009-2010
Certain infectious & parasitic diseases (A00-B99)	9.62	7.88
Neoplasms (C00-D48)	4.17	6.28
Diseases of the blood & blood forming organs (D50-D89)	2.75	3.83
Endocrine, nutritional & metabolic diseases (E00-E90)	3.49	6.04
Mental & behavioural disorders (F00-F99)	0	0
Diseases of the nervous system (G00-G99)	3.64	4.96
Diseases of the eye & adnexa (H00-H59)	0	0
Diseases of the ear & mastoid process (H60-H95)	0	1
Diseases of the circulatory system (I00-I99)	3.08	3.2
Diseases of the respiratory system (J00-J99)	6.91	8.09
Diseases of the digestive system (K00-K93)	6.36	4.75
Diseases of the skin & subcutaneous tissue (L00-L99)	1	13
Diseases of the muscoskeletal system & connective tissue (M00-M99)	3.2	2.93
Diseases of the genitourinary system (N00-N99)	3.24	7.59
Pregnancy, childbirth & the puerperium (O00-O99)	3.83	2.27
Certain conditions originating in the perinatal period (P00-P96)	3	0
Congenital malformations, deformations & chromosomal abnormalities (Q00-Q99)	1	1.33
Symptoms, signs & abnormal clinical & lab findings, not elsewhere classiffied (R00-R99)	0	0
Injury, poisoning & certain other consequenses of external causes (S00-T98)	7.03	5.81
External causes of morbidity & mortality (V01-Y98)	0	0
Factors influencing health status & contact with health services (Z00-Z99)	2.63	4.5

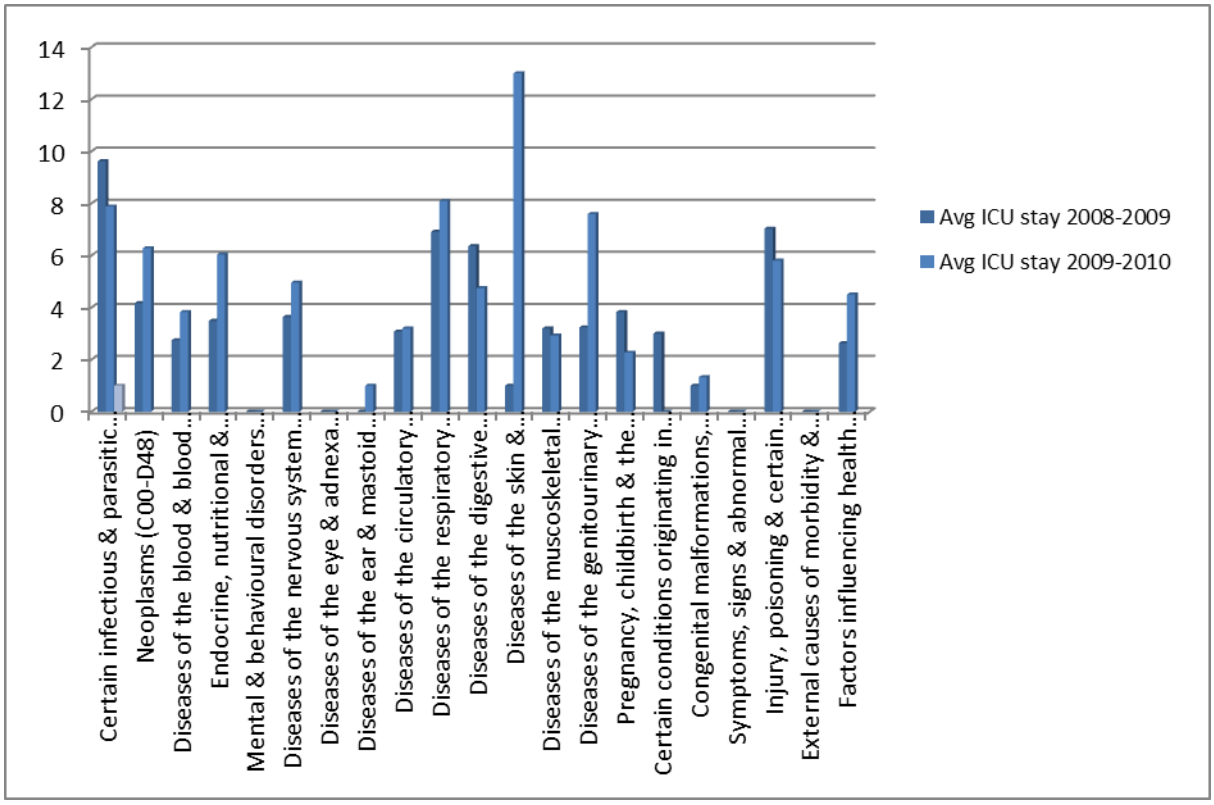


Figure 3.2: Average ICU stay over the two-year study period

Table 3.6 ICD 10 codes that had a statistically significant value for the ICU stay

ICD D381 (Neoplasm unc/unk, trachea, bronchus, lung) Days in ICU				
2008 – 2009	4	4.75	2.32	p=0.020*
2009 – 2010	8	2.19	0.96	
ICD T817 (Vascular complications following a procedure) Days in ICU				
2008 – 2009	1	3.00	N/A	p=<0.001*
2009 – 2010	2	2.00	N/A	

According to a MacLaren, Bond, Martin and Fike (2008), the length of ICU stay in critically ill patients was longer in the absence of clinical pharmacists by 7.9% ($p<0.001$, 14 248 extra days), 5.9% ($p=0.03$, 2855 extra days) and 8.1 % ($p<0.001$, 19 215 extra days) for nosocomial-acquired infections, community acquired infections and sepsis, respectively.

The five ICD 10 Code categories with the longest average ICU stay, in decreasing order for the 2008-2009 study group were: Certain infectious and parasitic diseases (9.62 days), Injury, poisoning and certain other consequences of external causes (7.03 days), Diseases of the respiratory system (6.91 days), Diseases of the digestive system (6.36 days) and Neoplasms (4.17 days).

The five ICD 10 Code categories with the longest average ICU stay, in decreasing order for the 2009-2010 study group were: Diseases of the skin and subcutaneous tissue (13 days), Diseases of the respiratory system (8.09 days), Certain infectious and parasitic diseases (7.88 days), Diseases of the genitourinary system (7.59 days) and Neoplasms (6.28 days).

There were only two statistically significant p-values for the ICU stay over the two year study period. It was for ICD 10 Code D381 (Neoplasm unc/unk, trachea, bronchus, lung) and ICD 10 Code T817 (Vascular complications following a procedure).

The total average ICU days for the year pre-clinical pharmacy services (2008-2009) were 5.56 days per patient. The total average ICU days for the year post-clinical pharmacy services (2009-2010), were 5.25 days per patient. The p-value was not statistically significant. (See Appendix E).

The slight decrease in the length of ICU stay could not be directly attributed to the presence of the pharmacist in the intensive care unit. The length of ICU stay could thus not be used as a measure of clinical outcome.

3.2 Monthly credits

The rand-value of the monthly credits was collected on a monthly basis from the hospital statistics department, where the information was gathered in computerized form.

Credits are defined as medications issued to a patient, but not administered to the patient either because:

- The patient was transferred
- The doctor changed the patient's therapy
- Excess stock, that the patient did not need, was ordered

All credits were sent back to the pharmacy accompanied by a credit note.

Table 3.7: The total amount of credits and prescriptions pre-and post-clinical pharmacy services

Pre-clinical pharmacy services			Post-clinical pharmacy services		
Month	**Amount (R) Credits**	**Total prescriptions**	**Month**	**Amount (R) Credits**	**Total prescriptions**
08-Oct	105807.56	1501	09-Oct	42682.14	1733
08-Nov	57302.71	1463	09-Nov	28938.51	1604
08-Dec	25131.31	985	09-Dec	20056.6	1007
09-Jan	17009.66	874	10-Jan	21371.98	1201
09-Feb	33605.34	1634	10-Feb	32942.32	1486
09-Mar	78477.66	1799	10-Mar	30915.6	2596
09-Apr	65900.93	1713	10-Apr	25592.3	1298
09-May	47197.35	1759	10-May	29125.6	1854
09-Jun	60111.62	1911	10-Jun	14467.1	1173
09-Jul	37002.26	1669	10-Jul	13115.8	1812
09-Aug	86323.01	1805	10-Aug	40250.9	1591
09-Sep	41551.25	1742	10-Sep	20801.5	691
Total	**655420.66**	**18855**	**Total**	**320260.35**	**18046**

Table 3.8: The mean value for the total amount of credits over the two year study period

	N	Mean (R) per month	Stddev	P value
2008 – 2009	12	54618	26323	p=0.004*
2009 - 2010	12	26688	9290.3	

* The p-value is significant

The number of items was not determined, rather the rand-value and the time spent on processing of the credits. To put the rand-value in perspective and to relate it to the time spent on credits, the staff in the pharmacy was requested to record the number of items credited and the time spent to do the credits.

It was estimated, in this independent study, that the pharmacy does approximately 170 credits per day. If it takes you approximately five minutes to check, pack away and credit the stock from the system, it totals 14.2 man-hours per day.

The total amount of credits for the year pre-clinical pharmacy services: R655 420.66 for 508 ICU patients. The total amount of credits for the year post-clinical pharmacy services: R320 260.35 for 542 ICU patients.

When good stock control is exercised, the credits should be less since the only medication ordered for the patient is the medication that the patient needs on a day to day basis. The clinical pharmacist who participated in the ward rounds, ordered medication on a 24hour basis. Only the medication necessary for the next 24hours were ordered by the clinical pharmacist.

The 508 patients pre-clinical and the 542 patient's post-clinical pharmacy services include all patients, adults and children, admitted to the intensive care unit over the study period.

The total amount of credits in the year post-clinical pharmacy services, decreased significantly ($p = 0.004$) with an amount of R335 160.30. That is a decrease of R27 930.02 per month. The total amount of credits decreased with a percentage of 48.86%, post-clinical pharmacy services. This decrease in the amount of credits equals a decrease of 6.9 hours per

day in the crediting of stock. This serves to be a huge time-saver for a pharmacy that spends approximately 14.2 man-hours on the crediting of stock per day.

However, the pharmacist could have played a bigger role in reducing the monthly credits, if it were not for the time constraints, by educating the staff about the correct ordering of medication and the productive planning for the patient's medication needs for the next 24hours. Though the staff members received in-service training while the pharmacist was on ward rounds, they never received formal training. The night-staff did not receive any training, since pharmacist ward-rounds happened during day-shift.

3.3 Number of daily scripts

The aim was to determine whether there was a decrease in the number (amount) of daily scripts from the ICU reaching the pharmacy pre- and post-clinical pharmacy services.

Number of prescriptions reaching pharmacy pre-clinical pharmacy services: 18 855 (508 patients)

Number of prescriptions reaching pharmacy post-clinical pharmacy services: 18 046 (542 patients), total decrease of 809 prescriptions.

One prescription could consist of anything between one and eight items.

Table 3.9: The mean number of prescriptions pre-and post-clinical pharmacy services

	N	Mean	Stddev	P value
2008 – 2009	12	1571.3	325.64	p=0.695
2009 - 2010	12	1503.8	489.15	

Even though the amount of prescriptions reaching the pharmacy decreased with 809 prescriptions, it was not statistically significant.

Instead of ordering the patient's medication from one (or even two) prescription charts containing all of the patient's relevant medications, the pharmacist ordered from four or five different prescription charts. Because of time constraints there was no time to transcribe the relevant medication to one single prescription chart. This also leads to errors. Say the original prescription chart contains an entry for Lasix® 20mg IVI eight hourly and the doctor changes it to Lasix® 10mg IVI eight hourly, oftentimes it happens that the nurses keep ordering from the first original entry and do not change the prescription as instructed by the doctor.

3.4 Breakdown of the classes of drugs

Table 3.10 presents the breakdown of the classes of drugs dispensed from the pharmacy for both years.

Table 3.10: The breakdown of the classes of drugs for the year pre-and post-clinical pharmacy services

2008-2009			2009-2010	
Amount (R)	**Stock Quantity**	**Class of Drug**	**Stock Quantity**	**Amount (R)**
2040.3	185	Acid Reducer	22	1528.26
47377.07	2947	Analgesics	1506	44695.68
52603.7	1247	Anti-depressants	707	50017.19
9787.28	572	Anti-emetics	572	9787.28
81326.29	544	Anti-epileptics	353	80804.34
5652.54	882	Anti-protozoal	100	1386.33
792112.8	31026	Anti-cholinergic	31020	792101.6
167165	3432	Anti-coagulants	3419	167151.1
39.35	14	Anti-histamines	9	34.26
12270.57	889	Anti-hypertensive's	56	9528.73
1196.21	657	Anti-inflammatories	14	310.46
5010925	21013	Anti-microbials	19474	4962119
76511.06	413	Anti-virals	283	75832.37
2663.08	466	Benzodiazepines	39	1770.13
136163	69	Biologicals	69	136163
26924.04	6465	Bronchodilators	295	1734.45
163332.9	1990	Cardiac	1990	163332.9
834.82	146	Cardiac glycosides	64	801.86
1027.36	26	Central analeptics	26	1027.36
8687.84	42	Cerebral	38	8666.01
160120.5	5320	Corticosteroids	4533	152738.6
88120.9	121	Cytostatic	111	88092.75
19225.85	2711	Diuretics	2348	18536.63
26210.86	7422	Electrolytes	7057	25969.93
96511.75	2058	Gastrointestinal	1081	89839.46
17099.56	401	Haemostatic	394	17064.3
21407.4	122	Hormones	120	21401.63
2003577	2926	Hyperallmentation	1751	518832.6
46914.85	443	Hypoglaecemics	418	46883.22
3774.58	717	Local anaesthetic	437	2284.65
825809.3	190	Mucolytic	106	825622.5
325786.6	653	Muscle relaxants	653	325786.6
167744.2	2888	Peptic ulcer	1109	165816.7

115.51	23	Phenothiazine	22	114.22
3425.84	16	Poison antidotes	16	3425.84
35927.87	521	Tuberculostatics	270	35435.6
35833.43	1105	Vitamins	502	33987.24
10476246.21	**100662**	**Total**	**80984**	**8880624.78**

The total stock value (Rand) for the year pre-clinical pharmacy services was R10 476 246.21. The total number of items dispensed was 100 662.

The total stock value (Rand) for the year post-clinical pharmacy services was R 8 880 624.78. The total number of items dispensed was 80 984.

The total number of items dispensed in the year post-clinical pharmacy services decreased with 19 678 items.

The stock value for the year post-clinical pharmacy services decreased with R1 595 622.

Table 3.11 presents the number of items dispensed and the mean-values for the different classes of drugs with statistically significant p-values. For the detailed results see Appendix F.

Table 3.11: Number of items dispensed with the mean stock quantity and rand value for the ICU drugs

	N	Mean	Stddev	P value
Acid reducer Stock quantity				
2008 –2009	32	5.78	5.77	p=0.001*
2009 -2010	12	1.83	1.58	
Acid reducerRand value				
2008 – 2009	32	63.76	121.6	p=0.131
2009 - 2010	12	127.4	122.8	
Analgesic Stock quantity				
2008 – 2009	1051	2.80	9.26	p=0.001*
2009 - 2010	889	1.69	2.83	
AnalgesicRand value				
2008 – 2009	1051	45.08	86.50	p=0.205
2009 - 2010	889	50.28	92.84	

Anti-Depressant Stock quantity				
2008 – 2009	606	2.06	3.54	p=0.160
2009 - 2010	402	1.76	3.15	
Anti-Depressant Rand value				
2008 – 2009	606	86.80	182.4	p=0.004*
2009 - 2010	402	124.4	213.6	
Anti-Epileptic Stock quantity				
2008 – 2009	167	3.26	3.51	p=0.372
2009 - 2010	121	2.91	2.93	
Anti-Epileptic Rand value				
2008 – 2009	167	487.0	673.8	p=0.029*
2009 - 2010	121	667.8	713.0	
Anti-Hypertensive Stock quantity				
2008 – 2009	463	1.92	2.47	p=0.986
2009 - 2010	29	1.93	3.31	
Anti-Hypertensive Rand value				
2008 – 2009	463	26.50	168.4	p=0.012*
2009 - 2010	29	328.6	604.8	
Anti-Inflammatory Stock quantity				
2008 – 2009	68	9.66	23.46	p=0.009*
2009 - 2010	9	1.56	3.00	
Anti-Inflammatory Rand value				
2008 – 2009	68	17.59	34.82	p=0.490
2009 - 2010	9	34.50	69.23	
Benzodiazepine Stock quantity				
2008 – 2009	17	2.82	2.90	p=0.028*
2009 - 2010	37	1.05	1.56	

Benzodiazepine Rand value				
2008 – 2009	17	8.49	11.67	p=0.003*
2009 - 2010	37	47.84	73.52	
Bronchodilators Stock quantity				
2008 – 2009	17	6.23	4.79	p=0.014*
2009 - 2010	100	2.95	5.05	
Bronchodilators Rand value				
2008 – 2009	17	24.82	19.33	p=0.312
2009 - 2010	100	17.34	29.23	
Cardiac Glycoside Stock quantity				
2008 – 2009	17	1.42	1.23	p=0.465
2009 - 2010	57	1.12	1.93	
Cardiac Glycoside Rand value				
2008 – 2009	17	5.01	11.49	p=0.036*
2009 - 2010	57	14.07	23.92	
Corticosteroids Stock quantity				
2008 – 2009	1392	3.82	4.12	p=0.594
2009 - 2010	1213	3.74	3.97	
Corticosteroids Rand value				
2008 – 2009	1392	115.0	139.5	p=0.050*
2009 - 2010	1213	125.9	145.3	
Gastrointestinal Stock quantity				
2008 – 2009	710	2.90	9.95	p=0.005*
2009 - 2010	592	1.83	1.71	
Gastrointestinal Rand value				
2008 – 2009	710	136.0	134.9	p=0.040*
2009 - 2010	592	151.8	141.6	

Hyperalimentation Stock quantity				
2008 – 2009	2331	1.25	1.32	p<0.001*
2009 - 2010	861	2.03	1.55	
Hyperalimentation Rand value				
2008 – 2009	2331	859.5	1073.0	p<0.001*
2009 - 2010	861	602.6	461.6	
Local Anaesthetic Stock quantity				
2008 – 2009	445	1.61	4.10	p=0.019*
2009 - 2010	404	1.08	2.30	
Local Anaesthetic Rand value				
2008 – 2009	445	8.48	23.43	p=0.061
2009 - 2010	404	5.65	20.46	
Mucolytic Stock quantity				
2008 – 2009	115	1.65	2.16	p=0.140
2009 - 2010	85	1.25	1.71	
Mucolytic Rand value				
2008 – 2009	115	7181.0	6745.5	p=0.007*
2009 - 2010	85	9713.2	6072.8	
Peptic Ulcer Stock quantity				
2008 – 2009	628	4.60	18.76	p=0.001*
2009 - 2010	574	1.93	1.72	
Peptic Ulcer Rand value				
2008 – 2009	628	267.1	247.1	p=0.142
2009 - 2010	574	288.9	267.8	
Tuberculostatics Stock quantity				
2008 – 2009	152	3.43	3.49	p=0.173
2009 - 2010	94	2.87	2.82	

Tuberculostatics Rand value				
2008 – 2009	152	236.4	341.8	p=0.003*
2009 - 2010	94	377.0	301.1	
Vitamins Stock quantity				
2008 – 2009	360	3.07	4.05	p<0.001*
2009 - 2010	258	1.94	2.05	
Vitamins Rand value				
2008 – 2009	360	99.54	178.8	p=0.041*
2009 - 2010	258	131.7	202.2	
Total ICU stock quantity				
2008 – 2009	22821	4.01	11.51	p=0.694
2009 - 2010	20434	3.96	11.10	
Total rand value				
2008 – 2009	22821	444.0	1232.2	p=0.432
2009 - 2010	20434	434.6	1251.6	

The p-values for the following classes of drugs were statistically significant:

Stock quantity significant	**P-values**	**Rand value significant**	**P-values**
Acid Reducers	0.001	Anti-Depressants	0.004
Analgesics	0.001	Anti-Epileptics	0.029
Anti-Inflammatories	0.009	Anti-Hypertensives	0.012
Benzodiazepines	0.028	Benzodiazepines	0.003
Bronchodilators	0.014	Cardiac Glycosides	0.036
Cardiac	0.038	Corticosteroids	0.05
Gastro-intestinal	0.005	Gastro-intestinal	0.04
Hyperalimentation	<0.001	Hyperalimentation	<0.001
Local anaesthetic	0.019	Mucolytic	0.007
Peptic ulcer	0.001	Tuberculostatics	0.003
Vitamins & minerals	<0.001	Vitamins & minerals	0.041

The mean total for the ICU stock quantity for 2008-2009 was 4.01 items and for 2009-2010 it was 3.96 items. The mean total for the Rand value for 2008-2009 was R444 and for 2009-2010 it was R434.60. Although it was not statistically significant, it does show a decrease in the average ICU stock quantity and a decrease in the average total Rand value.

Table 3.12 presents the classes of drugs that could not be compared

Table 3.12: Classes of drugs that could not be compared

2008-2009		2009-2010		
Amount (R)	**Stock Quantity**	**Class of Drug**	**Stock Quantity**	**Amount (R)**
151.58	235	Antacids & Comb	0	0
16.52	15	Anti-Anginal	0	0
169.34	519	Anti-Diarrhoea	0	0
4794.94	13	Diuretic	0	0
63.57	48	Anti-Gout	0	0
1632.63	1183	Anti-Parasitic	0	0
5627.5	21356	Anti-Septics	0	0
84.41	9	Anti-Smoking	0	0
254.52	905	Antitussive	0	0
51.06	127	Barbiturates	0	0
5031.49	12411	Barrier Protection	0	0
539.26	76	Beta Blockers	0	0
2110.73	1035	Chelating	0	0
150.73	44	Cholesterol	0	0
222.88	102	Common Cold	0	0
675.97	38	Debridement	0	0
1342	2524	Feeds	0	0
3981.84	1267	Fungicide	0	0
500.74	8075	Galenicals	0	0
119.56	10	Immunosuppressants	0	0
1075.3	3131	Laxatives	0	0
155.18	5	Migraine	0	0
8348.98	49500	Mouthwash	0	0
94304.95	1767	Nutritional	0	0
60.4	66	Thyroid	0	0
242.7	127	Urinary Alkalinizer	0	0
48.25	9	Urinary Antiseptics	0	0
131757.03	104597	**Total**	0	0

Some of the classes of drugs did not present in both years and thus could not be compared with each other (See Table 3.12). This could be because of protocol changes or because of certain specialities no longer practiced at the hospital (because of specialists moving to other hospitals).

Acid reducers: Even though the amount of acid reducers dispensed decreased, the Rand-value increased. This is because in the year pre-clinical pharmacy services the typical acid reducer dispensed was Zantac® ampoules at R54.04 per ampoule. Due to a protocol change in the year post-clinical pharmacy services, Losec® ampoules were now also prescribed at R189.34 per ampoule.

Analgesics: The pharmacist played an important role in reducing duplicate analgesic therapy. Less capsules and tablets were dispensed. For example, the patient is on Perfalgan® 1g ivi six hourly and then the doctor prescribes Stilpane® tablets two per os eight hourly, without stopping the Perfalgan®. This qualifies as duplicate therapy, as both products contain paracetamol.

Anti-depressants: The pharmacist played an important role in enforcing the 'home medication protocol'. This protocol entails that the patients use their home medication and it not be dispensed from pharmacy. Almost zero home medication tablets like Cilift®, Cipralex® and Lexamil®, were dispensed. This was also true for the **anti-epileptics**, the **anti-hypertensives** and the **anti-inflammatories**. The hospital has a neurosurgeon specializing in Deep Brain Stimulation and other neurological disorders including epilepsy, so most patients admitted to the ICU had their own anti-epileptic medication that they use chronically. The same with the orthopaedic patients admitted to the ICU. They were usually already on anti-inflammatory therapy. Even though the amount of anti-depressants dispensed decreased, the Rand value increased. This could be because of newer, more expensive therapies or a more detailed therapy plan, which could include more than one drug. In the case of the anti-inflammatories, there was a decrease in the amount dispensed but an increase in the rand value. This could be because a more expensive therapy was approached, or because the original products were preferred over the generic products.

Benzodiazepines: The pharmacist ensured that no benzodiazepines that was on ward stock, got issued from the pharmacy. Also, the pharmacist once again enforced the home medication protocol.

Bronchodilators: Rational issuing of bronchodilators decreased the amount dispensed. The pharmacist enforced the home medication protocol, especially regarding bronchodilator inhaler pumps. There was also a protocol change. Combivent® nebules were to be replaced by Duolin nebules.

Cardiac glycosides: The pharmacist enforced the home medication protocol. No home medication issued from the pharmacy.

Gastro-intestinal: Rational issuing of gastro-intestinal medication decreased the number dispensed. Home medication protocol was enforced. One of the gastro-enterologists insisted on Pantoloc® ampoules – no generics.

Hyperalimentation: The pharmacist played a role in ensuring that only the necessary amounts of Dipeptivan® were dispensed. When feeds were changed the necessary feeds were ordered and the other ones credited.

Local Anaesthetic: The pharmacist promoted the rational issuing of local anaesthetics.

Mucolytic: Only the necessary amounts of mucolytics were ordered.

Peptic ulcer: The pharmacist enforced the home medication protocol.

Tuberculostatics: The pharmacist enforced the home medication protocol.

Vitamins: Only the necessary amounts of vitamins were dispensed. Home medication protocol was enforced. The pharmacist also picked up that one physician prescribed Cernevit® in each vaculiter, which meant that the patient could get up to three vials of Cernevit® per day. The pharmacist spoke to the doctor and he realised that a once daily dose is sufficient. There was also a time when Cernevit® was out of stock and the pharmacy could only issue Soluvit®, which is a bit more expensive than the Cernevit®.

3.5 Total medication bill

With this objective the researcher tried to prove that, with the assistance of a clinical pharmacist, cost savings will be involved. ICD 10 Codes were categorized as described in section 3.1.2.

Table 3.13: The ICU drug totals for the two-year study period

ICD 10 Code	ICU Drug Total 2008-2009	ICU Drug Total 2009-2010
Certain infectious & parasitic diseases (A00-B99)	1034997	757094.35
Neoplasms (C00-D48)	1035721	4117639.54
Diseases of the blood & blood forming organs (D50-D89)	29889	45060.64
Endocrine, nutritional & metabolic diseases (E00-E90)	149997	243485.41
Mental & behavioural disorders (F00-F99)	0	0
Diseases of the nervous system (G00-G99)	169891	477627
Diseases of the eye & adnexa (H00-H59)	0	0
Diseases of the ear & mastoid process (H60-H95)	0	106.49
Diseases of the circulatory system (I00-I99)	300736	354557.07
Diseases of the respiratory system (J00-J99)	3209535	2208234.3
Diseases of the digestive system (K00-K93)	1868520	1180173.95
Diseases of the skin & subcutaneous tissue (L00-L99)	2915	166906.74
Diseases of the muscoskeletal system & connective tissue (M00-M99)	1263806	629273.9
Diseases of the genitourinary system (N00-N99)	257683	542066.79
Pregnancy, childbirth & the puerperium (O00-O99)	72335	115860.34
Certain conditions originating in the perinatal period (P00-P96)	10520	0
Congenital malformations, deformations & chromosomal abnormalities (Q00-Q99)	297	2720.19
Symptoms, signs & abnormal clinical & lab findings, not elsewhere classiffied (R00-R99)	0	0
Injury, poisoning & certain other consequenses of external causes (S00-T98)	5137579	2146470.88
External causes of morbidity & mortality (V01-Y98)	0	0
Factors influencing health status & contact with health services (Z00-Z99)	19266	43057.8
Total	14563687	13030335.39

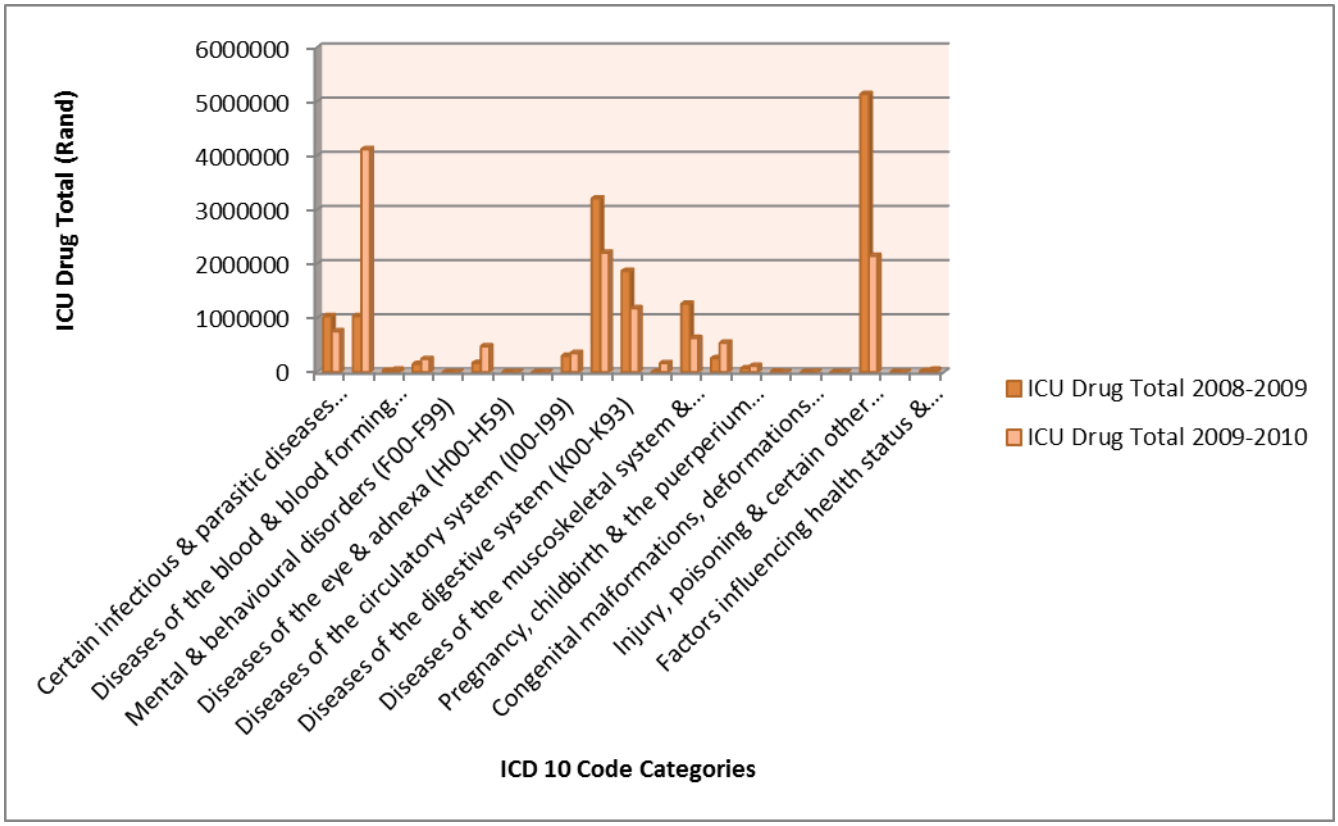


Figure 3.3: ICU drug totals for the two-year study period

In the assessment of the impact of a paediatric clinical pharmacist in the paediatric intensive care unit it was established that a total direct cost saving for the study period was $1,977 (Krupicka, Bratton, Sonnenthal& Goldstein 2002). This amount was then extrapolated to direct cost savings per year which totalled $9,135/year. Indirect savings from educational activities, avoidance of medication errors and the optimization of medical therapies represent an additional non-quantifiable amount.

In the examination of the clinical and economic outcomes involving pharmacists in the direct care of critically ill patients with infections, it was established that ICU's that did not have clinical pharmacists had greater total Medicare billings of 12% ($p<0.001$, $224 694 784 extra billing charges), 11.9% ($p<0.001$, $32 240 378 extra billing charges), and 12.9% ($p<0.001$, $224 694 784 extra billing charges for nosocomial-acquired infections, community-acquired infections and sepsis, respectively (MacLaren*et al.* 2008).

Weant*et al.* (2009) reported that the average pharmacy and intravenous therapy cost per patient between the pre-and post-implementation of clinical pharmacy services, decreased from $4833 to $3239, resulting in a total savings of $1,718,260 over the duration of the study period.

The ICU drug total for the year pre-clinical pharmacy services was R14 563 687. The ICU drug total for the year post-clinical pharmacy services was R13 030 335.39. The total decreased with R1 533 351.61. That is a cost saving of R127 779.30 per month.

When you compare the breakdown of the classes of drugs (R10 476 246.21) (see Table 3.10) with the total medication bill (R14 563 687) (ICU drug total, Table 3.13), it does not correlate (R14 563 687 – R10 476 246.21 = R4 087 440.79). This amount accounts for the ward stock dispensed to the patients, as well as the scheduled drugs dispensed to the patients in the year pre-clinical pharmacy services.

R13 030 335.39 – R8 880 624.78 = R4 149 710.61 (ward stock and scheduled drugs dispensed to patients in the year post-clinical pharmacy services.

The ICD 10 Code categories with the highest total medication bill, in decreasing order for the 2008-2009 study group were: Injury, poisoning and certain other consequences of external causes (R5 137 579), Diseases of the respiratory system (R3 209 535), Diseases of the digestive system (R1 868 520), Diseases of the muscoskeletal system and connective tissues (R1 263 806) and Neoplasms (R1 035 721).

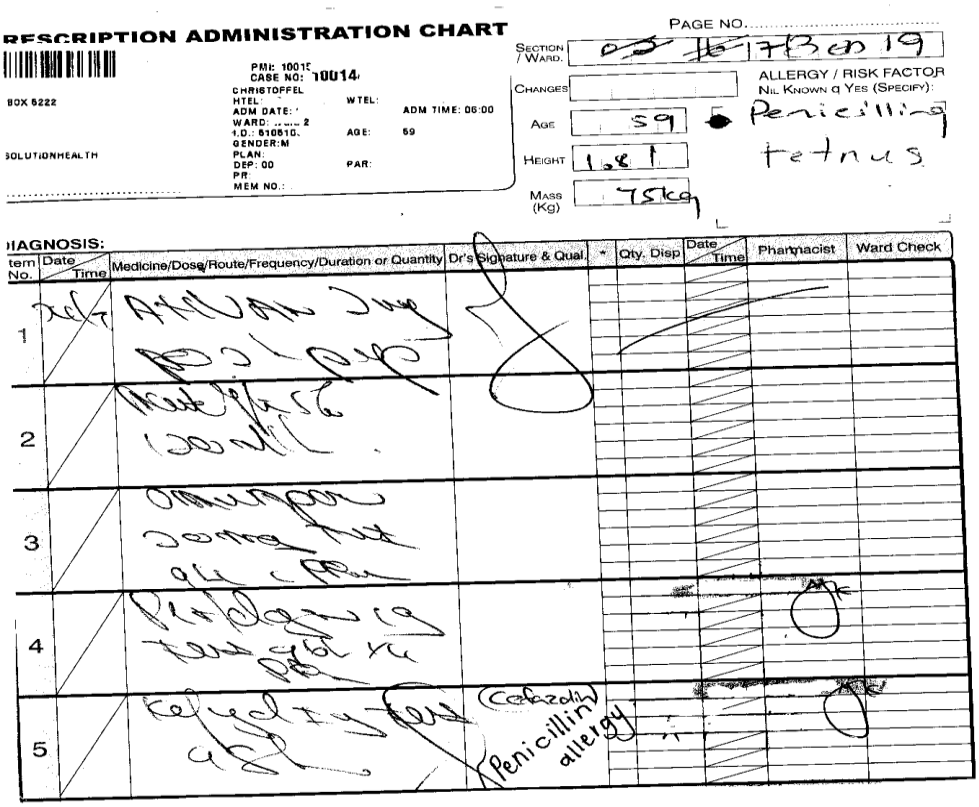
The ICD 10 Code categories with the highest total medication bill, in decreasing order for the 2009-2010 study group were: Neoplasms (R4 117 639.54), Diseases of the respiratory system (R2 208 234.3), Injury, poisoning and certain other consequences of external causes (R2 146 470.88), Diseases of the digestive system (R1 180 173.95) and Certain infectious and parasitic diseases (R757 094.35).

The ICD 10 Code categories with a longer ICU stay, tended to have a higher total medication bill. The only ICD 10 Code Category that did not have a long ICU stay, but a high total medication bill was category A00-B99 (Certain infectious and parasitic diseases, 2009-2010 study group), with an average ICU stay of 70.88 days.This could be because a patient with a severe case of malaria was admitted. These type of patients tend to have higher total medication bills, because of disease complications etc.

3.6 Interventions made by the clinical pharmacist

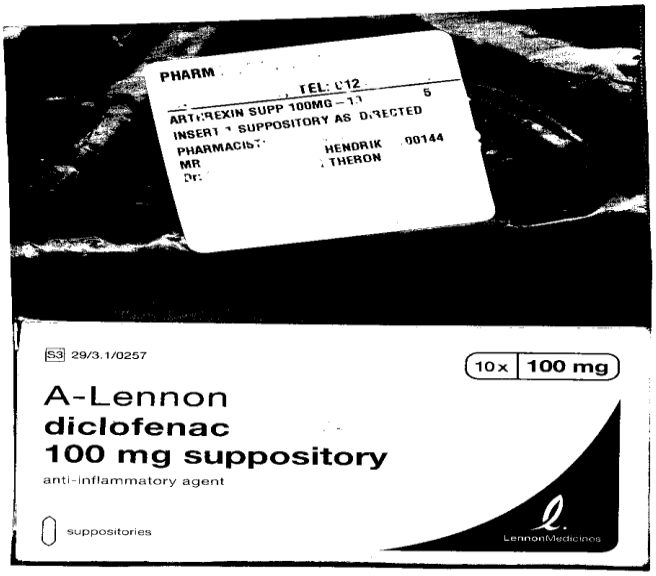
Definition and examples of interventions:

Allergies: This refers to the patient's allergies to certain medications that are noted on the patient's flow chart and prescription charts. An intervention is made when the allergies are not noted on the flow chart or the prescription
charts.



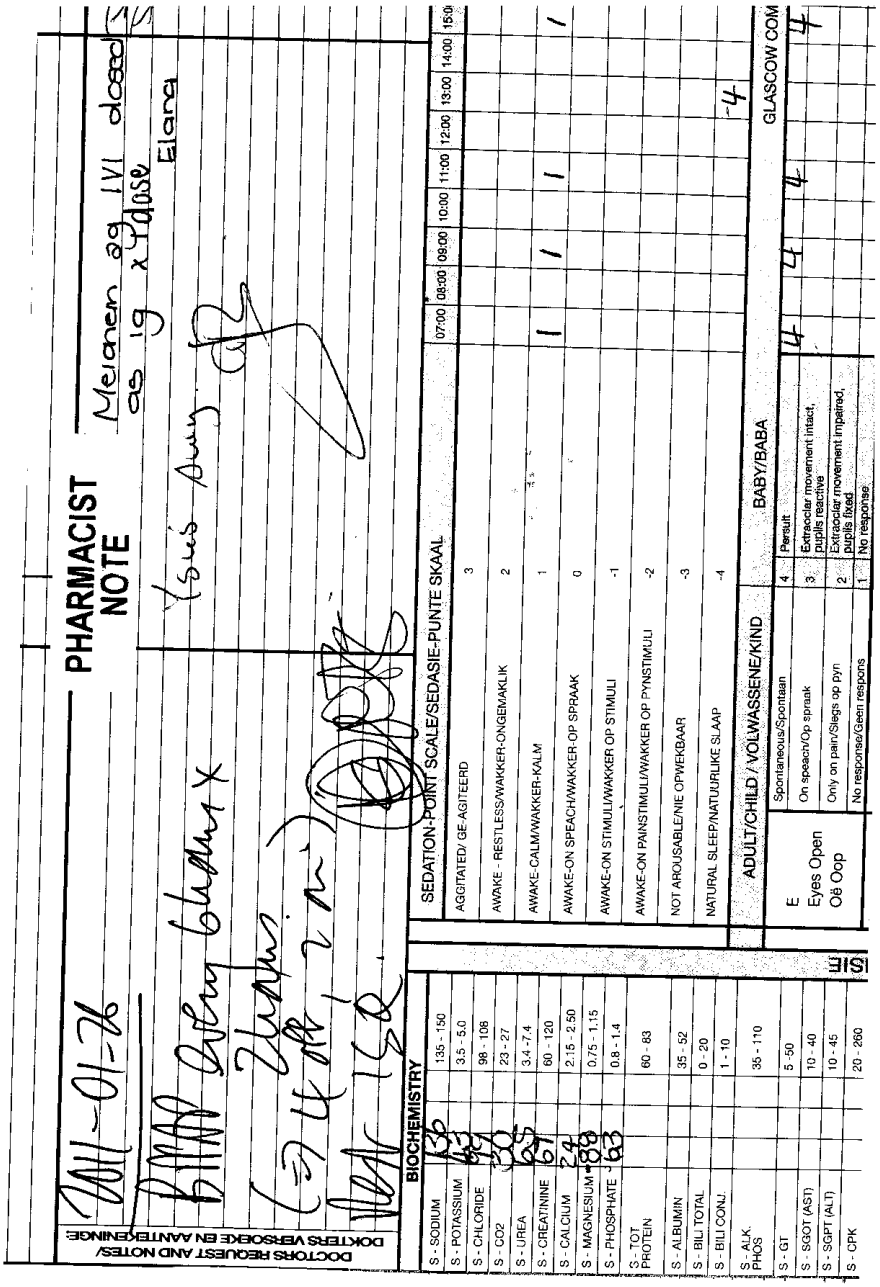
Clinical recommendations: This refers to a recommendation from the clinical pharmacist to the attending doctor about a patient's medication.

Dispensing errors: This refers to an error from the pharmacy. Certain medications are requested and the incorrect medication gets dispensed.



In the example above Arthrexin® suppositories were requested, but diclofenac suppositories were dispensed.

Dosing errors: This error occurs for example when Meronem® 2g IVI is prescribed. They are manufactured in 1g vials. To administer 2g to a patient one needs to administer two vials. Dosing errors occur frequently and only one vial, thus 1g, is administered.



Duplicate therapy: This type of error occurs when medication with the same active ingredient gets prescribed simultaneously. For example Perfalgan® 1g IVI six hourly together with Myprodol® caps two per os eight hourly. Both contain paracetamol. The maximum dose of paracetamol in 24hours is 4g. Another example is for instance when Synap Forte® tablets and Stopayne® capsules get prescribed simultaneously.

Transcribing errors: This error occurs when the nursing staff transcribes an item incorrectly. For example Augmentin® 1.2g IVI eight hourly is transcribed as Augmentin® 1g IVI eight hourly or Clexane® 40mg SC daily is not transcribed to the next day's flow chart at all or Diflucan® 400mg IVI twice daily is transcribed as Diflucan® 400mg IVI six hourly.

3.6.1 Interventions performed pre-and post-clinical pharmacy services

Table 3.14: Type and amount of interventions performed pre-and post-clinical pharmacy services

	Pre-clinical pharmacy services		***Post-clinical pharmacy services***	
Percentage	**Amount of interventions**	**Type of intervention**	**Amount of interventions**	**Percentage**
0	0	Allergies	5	1.44
0	0	Clinical recommendations	6	1.72
49.53	52	Dispensing errors	3	0.86
40	42	Dosing errors	254	72.78
0	0	Duplicate therapy	28	8.01
10.47	11	Transcribing errors	53	15.19
100	**105**	**Total**	**349**	**100**

Hunfeld,Melief, van Hest&Bosma (2010) reported a total of 342 clinical interventions in the ICU. Interventions were made in 66% of the patients. The kind of interventions made were: start drug (18%), stop drug (15%), reduction of dosage (3%), increase of dosage (4%), toxicology (12%), interaction (6%), contra-indication (9%), adverse events (3%), double medication (4%), switch in accordance to guidelines (6%), software (2%), dose reduction because of renal failure (6%) and other [for example, infusion incompatibility or administration by feeding tube (13%)]. Classes of drugs most involved were: antibiotics, gastro-intestinal drugs and anticoagulants.

The total amount of interventions made before clinical pharmacy services were rendered, were 105. These interventions were performed by nursing staff and attending doctors.

The most prevalent intervention pre-clinical pharmacy services were dispensing errors. Dosing errors were also very prevalent. Data were retrospectively obtained from the

Hospital's IMS (Incident Management System) on which the nurses log any errors occurring during the time that they are on duty.

The total amount of interventions made by the clinical pharmacist was 349. The most prevalent errors were dosing errors (72.78%). There were also a large number of transcribing (15.19%) and duplicate therapy (8.01%) errors.

The total number of dosing errors was 254. The number of dosing errors is listed in Table 3.15.

Table 3.15: Total number of dosing errors per drug

Drug	Number of dosing errors	Percentage
Bactrim IV	10	3.94
Cefazolin IV	8	3.15
Colimycin IV	17	6.70
Cyklokapron IV	10	3.94
Diflucan IV	29	11.42
Klacid KL Tablets	2	0.79
Meronem IV	34	13.38
Slow K tablets	9	3.55
Tavanic IV	8	3.15
Tienam IV	8	3.15
Vfend Tablets	4	1.54
Zelitrex Tablets	5	1.97
Zovirax IV	7	2.76
Other	103	40.56
Total	**254**	**100.00**

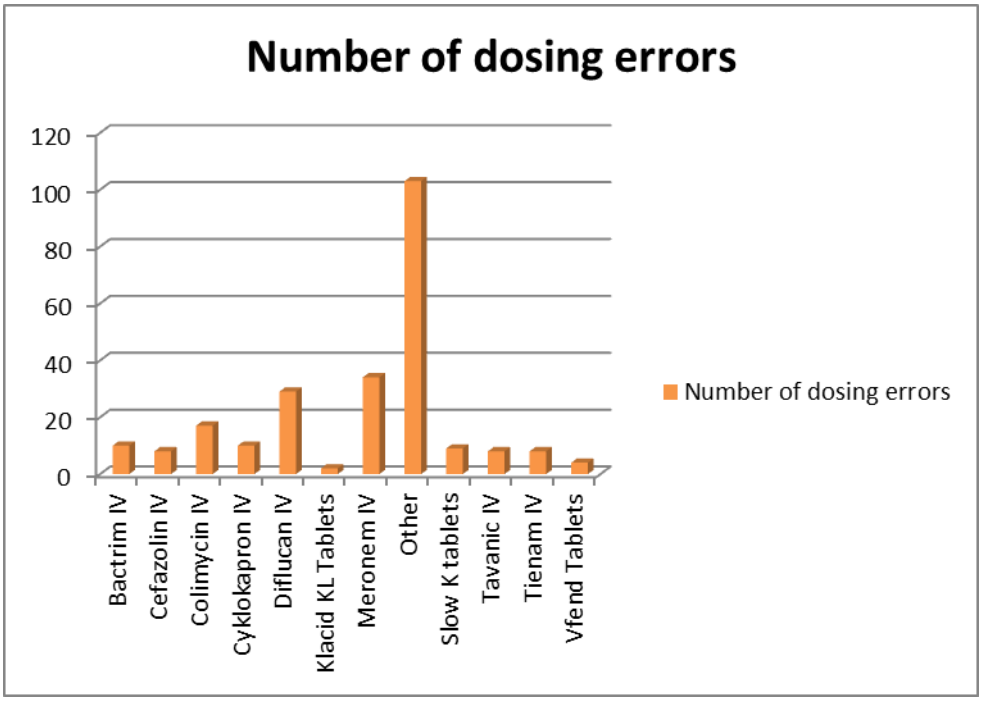


Figure 3.4: Number of dosing errors graphically displayed

Most medications dosed incorrectly were antibiotics (76.82%). The antibiotics dosed incorrectly most frequently were:

- Meronem (22.52%)
- Diflucan (19.21%)
- Colimycin (11.26%)

Under-dosing of antibiotics could lead to antibiotic resistance and to poor patient outcomes (Miruna& Martin 2008).

With the clinical pharmacist on duty, a total number of three dispensing errors were made (not necessarily while the clinical pharmacist was on duty), in contrast to the 52 dispensing errors made in the previous year.

The 'Other' drugs referred to in Table were mostly tablets and their breakdown is presented in Table 3.17.

Table 3.16: The breakdown of the 'other' drugs found in Table 3.15

Drug	Number of dosing errors	Percentage
Cellcept caps	2	1.95
Concor 5mg tabs	4	3.89
Coversyl 4mg tabs	2	1.95
Cyklokapron tabs	2	1.95
Diotroxin tabs	2	1.95
Eltroxin 100ug tabs	2	1.95
Eltroxin 50ug tabs	4	3.89
Euthyrox tabs	8	7.75
Folic Acid tabs	2	1.95
Klacid KL tabs	4	3.89
Lasix tabs	2	1.95
Lipitor tabs	2	1.95
Lyrica tabs	2	1.95
Metricorten tabs	4	3.89
Pulmison 20mg tabs	14	13.36
Puricos tabs	2	1.95
Ridaq tabs	2	1.95
Rimactane 600mg caps	2	1.95
Serlife caps	2	1.95
Slow K tabs	6	5.92
Tamiflu caps	2	1.95
Tavanic tabs	2	1.95
Tertroxin tabs	2	1.95
Texa tabs	2	1.95
Titralac tabs	2	1.95
Ursotan tabs	2	1.95
Venlor caps	4	3.89
V-fend tabs	8	7.75
Zantac susp	1	0.97
Zelitrex 500mg tabs	8	7.75
Total	**103**	**100**

Examples of interventions made by the clinical pharmacist:

Allergies

- Nil allergies noted on flow chart or prescription chart: three cases

- Paracetamol allergy (paracetamol prescribed): one case
- Penicillin allergy (penicillin prescribed): one case

Dispensing errors

- Serencace® 20mg IVI dispensed instead of Serenace® 5mg IVI
- Konakion® Paediatric dispensed instead of Konakion® 10mg
- Arthrexin® suppositories dispensed instead of diclofenac suppositories

Duplicate therapy

Product	***Number of interventions***
Perfalgan® &Lentogesic®	11
Perfalgan® &Tramacet®	2
Stilpane® &Perfalgan®	2
Synap Forte® &Lentogesic®	1
Synap Forte® &Perfalgan®	12
Total	**28**

Clinical recommendations

- Patient on five days of Tamiflu®, course completed, suggest we stop. Doctor complied.
- Doctor prescribed Zyvoxid® 600mg IVI six hourly. Phoned doctor and he changed it to BD (twice daily).
- Cefazolin® 1g incorrectly prescribed. Protocol states 2g IVI eight hourly for adults. Phoned doctor and he changed it.
- Patient on Serenace® 5mg IVI six hourly, Librium per *os* (per mouth) daily and Ativan® 4mg IVI eight hourly. Pharmacist recommended the Serenace® be stopped and doctor complied.

Time constraints limited the clinical pharmacist in investigating and documenting interventions. Because of the lack in knowledge and experience of the clinical pharmacist in performing ward rounds and making interventions etc., the pharmacist did not always have the confidence to render some services or to approach some members of the multidisciplinary healthcare team. The lack of mentorship played a role in the performance of interventions and clinical services or the lack thereof.

Chapter 4

Limitations:

- **ICU stay:** Because of limitations in the study the decrease in the ICU stay could not be directly attributed to the clinical pharmacist and could thus not be used as a measure of clinical outcome.
- **Breakdown of the classes of drugs:** Not all of the classes of drugs could be compared with each other.
- **Time constraints:** Time constraints limited the pharmacist in rendering some of the services as well as in expanding clinical pharmacy services. For example: if not for the time constraints, the pharmacist could have played a bigger role in reducing the monthly credits and the pharmacist could have played a bigger role in reducing the number of daily scripts reaching the pharmacy, if she had had more time.
- **Knowledge and experience:** The lack of knowledge and experience of the clinical pharmacist played a role in her performance of some of the clinical pharmacy services.
- **Mentorship:** The lack of mentorship also played a role in the performance of some of the clinical pharmacy services.
- **Buy-in**: The buy-in from physicians and other healthcare team members played a role in the performance of some of the clinical pharmacy services.

Chapter 5

Recommendations:

- **ICU stay:** Select a smaller and more similar sample population (for example, focus on one disease) within the ICU setting, so that the patients can be compared more easily.

  Select one factor in which the clinical pharmacist could have a definitive impact (like the sedation protocol in the Marshall, Finn & Theodore (2008) study), and investigate that further with the focus on the length of ICU stay.
- **Monthly credits:** The time spent and the number of items credited should be formally evaluated in a study.
- **Training:** Educate the staff about the ordering of the correct amounts of medication and planning the patient's medication needs for the next 24hours.
- **Breakdown of the classes of drugs:** Choose one or two classes of drugs and focus on the chosen groups.
- **Total medication bill:** Choose smaller sample sizes, for example one group of patients with the same disease or ICD 10 code. Select a factor in which the clinical pharmacist could have a definite impact and investigate that further with the focus on the decrease in total medication bill.
- **Time:** Make enough time available to the pharmacist to spend in the ICU, to attend to clinical pharmacy services and to also expand clinical pharmacy services.
- **Mentorship:** Appoint a mentor to the clinical pharmacist. This could be a physician or a qualified and experienced clinical pharmacist.
- **Educate:** Train and educate the clinical pharmacist in the areas he/she will perform clinical pharmacy services, for example reading and understanding blood results.In order for clinical pharmacists in South Africa to achieve these outcomes, they will need outcome-oriented education and development. Pharmacy education programmes will have to be adjusted to include and encompass these outcomes.
- **Buy-in:** Get the buy-in from physicians and other members of the healthcare team. This is important as it influences the performance of certain clinical pharmacy services. The other members of the multidisciplinary healthcare team (nursing personnel, dieticians, physicians, physiotherapists etc), will have to incorporate the

pharmacist into their team and use the pharmacist's knowledge and skills and also educate the pharmacist where the need arises.

Chapter 6

Conclusion:

- The clinical pharmacist plays an important role in the Intensive Care Units. They play a role in cost-saving as well as in the overall wellbeing of the patient.
- Clinical pharmacists are a part of the multidisciplinary healthcare team. They are assuming greater roles and responsibilities in the ICU and are directly involved as caregivers to the critically ill.
- The presence of a pharmacist on ward-rounds as a member of the multidisciplinary healthcare team was associated with a decrease in monthly credits with a decrease of R335 160.30 post clinical pharmacy services. There was also a decrease in the number of daily scripts reaching the pharmacy from the ICU, with 809 less prescriptions reaching the pharmacy. The total number of items dispensed in the year post-clinical pharmacy services decreased with 19 678 items. The stock value for the year post-clinical pharmacy services decreased with R1 595 622. The ICU drug total decreased with R1 535 077.34.
- This would suggest that there is a need for clinical pharmacy services in a private hospital. It would also suggest that there are cost-savings involved with the rendering of clinical pharmacy services by a clinical pharmacist.
  Finally, in the words of Bonal, J and Poston JW (1984):
  "A career in clinical pharmacy is an open-ended opportunity for those who seek its rewards".

Chapter 7

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UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ms Elana van Huyssteen

CLEARANCE CERTIFICATE	**M10429**
PROJECT	An Assessment of the Impact of a Clinical Pharmacist on an Intensive Care Unit at a Private Hospital
INVESTIGATORS	Ms Elana van Huyssteen.
DEPARTMENT	Department of Pharmacy & Pharmacology
DATE CONSIDERED	30/04/2010
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 23/09/2010 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Prof AGS Gous

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

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08 November 2010

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Dear Ms Van Huyssteen

An assessment of the impact of a clinical pharmacist on an intensive care unit at a private hospital

It is with pleasure that we inform you that your application to conduct research on; An assessment of the impact of a clinical pharmacist on an intensive care unit at a private hospital, at Netcare Pretoria East Hospital, has been successful, subject to the following:

i) All information with regards to Netcare will be treated as confidential.

ii) Netcare's name will not be mentioned without written consent from the Academic Board of Netcare.

iii) Where Netcare's name is mentioned, the research will not be published without written consent from the Academic Board of Netcare.

iv) A copy of the research will be provided to Netcare once it is finally approved by the tertiary institution, or once complete.

v) All legal requirements with regards to patient rights and confidentiality will be complied with.

DRUG THERAPY PROBLEM LIST		PATIENT STICKER DATE OF ADMISSION ALLERGIES DIAGNOSIS SEVERITY & COMPLICATIONS
PRESCRIPTION CHART REVIEW		
DATE:	DESCRIPTION OF PROBLEM	PROPOSED ACTION OR INTERVENTION
MEDICATION REVIEW		
DATE	DESCRIPTION OF PROBLEM	PROPOSED ACTION OR INTERVENTION
CLINICAL RECOMMENDATIONS		

DATE	DESCRIPTION OF PROBLEM	PROPOSED ACTION OR INTERVENTION

APPENDIX D
ICD 10 Code
A09 Diarrhoea & gastroenteritis of presumed infectious origin
A169 Major respiratory procedures W MCC
A17.0 Tuberculosis Meningitis
A419 Septicaemia W MCC
B012 Respiratory infections and inflammations W MCC
B019 Varicella without complication
B05.8 Measles with other complications
B349 Critical care for long term ventilation W MCC
B45.1 Cerebral Cryptococcus
B50.9 Plasmodium Falciparum malaria, unspecified
B54 Unspecified malaria
C15.9 Malignant neoplasm, oesophagus, unspecified
C152 Malignant neoplasm, abdominal part of oesophagus
C170 Major stomach, oesophageal and duodenal procedures
C18.8 Malignant neoplasm, overlapping lesion of colon
C18.9 Malignant neoplasm, colon, unspecified

C180 Minor stomach, oesophageal and duodenal procedures WCC
C181 Major small and large bowel procedures W MCC
C22.9 Malignant neoplasm, liver, unspecified
C25.9 Malignant neoplasm, pancreas, unspecified
C252 Other hepatobiliary& pancreas procedures W CC
C34.9 Malignant neoplasm, bronchus or lung, unspecified
C400 Lower extremity &humerus procedures except hip, knee, foot, femur
C48.0 Malignant neoplasm, retro peritoneum
C49.1 Malignant neoplasm, connective & soft tissue of upper
C49.2 Malignant neoplasm, connective & soft tissue of lower
C531 Female productive system malignancy
C61 Malignant neoplasm of prostate
C64 Major kidney and urinary tract disorders
C66 Malignant neoplasm of urethra
C70.1 Malignant neoplasm, spinal meninges
C71.0 Malignant neoplasm, cerebrum, except lobes & ventricles
C71.9 Malignant neoplasm, brain, unspecified
C710 Malignant neoplasm, cerebrum, except lobes & ventricles
C73 Thyroid, parathyroid and thyroglossal procedures
C79.0 Secondary malignant neoplasm of kidney
C79.3 Secondary malignant neoplasm of brain and cerebral
C80 Myeloprolific disorder
C81.9 Hodgkin's disease, unspecified
C83.3 Large cell diffuse
C83.7 Burkett's tumour
C83.8 Other types of diffuse non-Hodgkin's lymphoma
C84.2 T-zone lymphoma
C84.5 Other & unspecified T-cell lymphomas
C85.9 Non-Hodgkin's lymphoma, unspecified type
C88.0 Waldenstrom'smacroglobulinaemia
C90.0 Multiple myeloma
C91.1 Chronic lymphocytic leukaemia
C92.0 Acute myeloid leukaemia
C92.4 Acute promelocytic leukaemia
C93.1 Chronic monocytic leukaemia
C969 Lymphoma and non-acute leukaemia W MCC
D32.0 Benign neoplasm, cerebral meninges
D32.9 Benign neoplasm, meninges, unspecified
D361 Benign neoplasm, peripheral nerves & autonomic
D38.1 Neoplasm unc/unk, trachea, bronchus & lung
D380 Tracheostomy for head and neck diagnosis
D42.0 Neoplasm unc/unk, cerebral meninges

D42.9 Neoplasm unc/unk, meninges, unspecified
D43.0 Neoplasm unc/unk, brain, supratentorial
D43.2 Neoplasm unc/unk, brain, unspecified
D431 Craniotomy
D432 Craniotomy
D44.0 Neoplasm unc/unk, thyroid gland
D48.0 Neoplasm unc/unk, bone & articular cartilage
D48.3 Neoplasm unc/unk, retro peritoneum
D489 Myeloprolific disorder and poorly differentiated neoplasm
D509 Red blood cell disorders except sickle cell anaemia
D61.3 Idiopathic aplastic anaemia
D61.9 Aplastic anaemia, unspecified
D739 Spleen procedures W CC
D869 Sarcoidosis, unspecified
E10.1 Insulin-dependent diabetes mellitus with keto-acidosis
E102 Insulin-dependent diabetes mellitus with renal complications
E11.9 Non-insulin dependent diabetes mellitus without complications
E162 Diabetes & nutritional & miscellaneous metabolic disorders WCC
E23.7 Disorders of pituitary gland, unspecified
E237 Adrenal & pituitary procedures
E86 Hypovolemia& Electrolyte disorders
E87.1 Hypo-osmolality &hyponatraemia
E87.8 Other disorders of electrolyte & fluid balance
E872 HIV W Major HIV Related Diagnosis
E880 Other endocrine, nutritional & metabolic procedures
G03.9 Meningitis, unspecified
G06.0 Intracranial abscess and granuloma
G20 Parkinson's disease
G250 Craniotomy
G40.9 Epilepsy, unspecified
G406 Seizures W MCC
G459 Transient cerebral ischemic attack, unspecified
G473 Craniotomy
G50.0 Trigeminal neuralgia
G50.1 Atypical facial pain
G61.0 Guillain-Barre Syndrome
G71.0 Muscular dystrophy
G83.4 Caudaequina syndrome
G91.9 Hydrocephalus, unspecified
G911 Q780 Craniotomy
G93.6 Cerebral oedema
G93.9 Disorder of brain, unspecified

H60.0 Abscess of external ear
I10 Hypertension W MCC
I21.1 Acute transmural myocardial infarction of inferior wall
I21.9 Acute Myocardial infarction, unspecified
I26.9 Pulmonary embolism without mention of acute
I442 Cardiac arrhythmia & conduction disorders
I46.0 Cardiac arrest with successful resuscitation
I469 Cardiac arrest, unexplained
I48 Atrial fibrillation and flutter
I50.1 Left ventricular failure
I50.9 Heart failure, unspecified
I519 Other circulatory system diagnoses
I608 Critical care for long term mechanical ventilation
I61.9 Intracerebral haemorrhage, unspecified
I614 Craniotomy
I62.0 Subdural haemorrhage (acute)(nontraumatic)
I62.9 Intracranial haemorrhage (nontraumatic), unspecified
I63.3 Cerebral infarction due to thrombosis of cerebral artery
I64 Stroke, not specified
I66.9 Occlusion and stenosis of unspecified cerebral artery
I67.1 Cerebral aneurysm, nonruptured
I702 Other vascular procedures
I71.3 Abdominal aortic aneurysm, ruptured
I95.9 Hypotension, unspecified
J03.9 Acute tonsillitis, unspecified
J06.0 Acute laryngopharyngitis
J15.7 Pneumonia due to Mycoplasma pneumonia
J152 Non-major respiratory procedures
J18.0 Bronchopneumonia, unspecified
J188 A169 Pneumonia long term mechanical ventilation
J189 Pneumonia, unspecified
J21.9 Acute bronchiolitis, unspecified
J40 Bronchitis, not specified as acute or chronic
J43.9 Emphysema, unspecified
J44.9 Chronic obstructive pulmonary disease, unspecified
J441 Chronic obstructive pulmonary disease
J459 Asthma & Bronchiolitis
J628 Non-major respiratory procedures
J69.0 Pneumonitis due to food & vomit
J698 Respiratory infections and inflammations
J80 Adult respiratory distress syndrome
J81 Respiratory systems signs, symptoms & other diagnoses

J84.1 Other interstitial pulmonary diseases with fibrosis
J860 Non-major respiratory procedures
J90 Pleural effusion, not elsewhere specified
J929 Respiratory system signs, symptoms & other diagnoses
J94.2 Haemothorax
J960 Respiratory failure
J98.4 Other disorders of lung
J98.9 Respiratory disorder, unspecified
K122 Tracheostomy for head and neck diagnoses
K210 Major stomach, oesophageal & duodenal procedures
K222 Oesophageal disorders with scope
K25.0 Gastric ulcer, acute with haemorrhage
K25.6 Gastric ulcer, chronic/unspecified with both haemorrhage
K25.9 Gastric ulcer, unspecified as acute/chronic without haemorrhage
K26.1 Duodenal ulcer, acute with perforation
K26.4 Duodenal ulcer, chronic/unspecified with haemorrhage
K27.9 Peptic ulcer, unspecified as acute/chronic without haemorrhage
K274 Major stomach, oesophageal & duodenal procedures
K29.7 Gastritis, unspecified
K31.9 Disease of stomach and duodenum, unspecified
K35.1 Acute appendicitis with peritoneal abscess
K350 Acute appendicitis with generalized peritonitis
K359 Appendiceal procedures
K40.9 Unilateral/unspecified inguinal hernia, without obstruction
K43.0 Ventral hernia without obstruction, without gangrene
K43.9 Ventral hernia without obstruction/gangrene
K449 Major stomach, oesophageal & duodenal procedures
K509 Major small & large bowel procedures
K51.0 Ulcerative (chronic) enterocolitis
K51.9 Ulcerative colitis, unspecified
K550 Major small & large bowel procedures
K56.6 Other and unspecified intestinal obstruction
K57.9 Diverticular disease of intestine, part unspecified
K578 Major small & large bowel procedures
K62.5 Haemorrhage of anus & rectum
K63.9 Disease of intestine, unspecified
K72.9 Hepatic failure, unspecified
K75.9 Inflammatory liver disease, unspecified
K76.9 Liver disease, unspecified
K80.8 Other cholelithiasis
K81.9 Cholecystitis, unspecified
K83.1 Obstruction of bile duct

K858 Disorders of pancreas except malignancy
K859 Disorders of pancreas except malignancy
K86.3 Pseudocyst of pancreas
K91.8 Other post procedural disorders of digestive system
K92.0 Haematemesis
K92.1 Melaena
K922 Critical care for long term mechanical ventilation
L03.1 Cellulitis of other parts of limb
L511 Bulluos erythema multiforme
L89 Skin graft &/ debridement & drainage for skin ulcer
L989 Other skin, subcutaneous tissue procedures
M1396 Major joint replacement or reattachment of lower extremity
M16.9 Coxarthrosis, unspecified
M160 Primary coxarthrosis, bilateral
M161 Other primary coxarthrosis
M17.0 Primary gonarthosis, bilateral
M17.1 Other primary gonarthrosis
M19.01 Primary arthrosis of other joints, shoulder region
M2390 Internal derangement of knee, unspecified, multiple sites
M25.55 Pain in joint, pelvic/thigh
M25.56 Pain in joint, lower leg
M2535 Major joint replacement or reattachment of lower extremity
M2555 Pain in joint pelvic/thigh
M2556 Pain in joint, lower leg
M301 Unrelated O.R Procedures
M40.14 Other secondary kyphosis, thoracic region
M4110 Spinal fusion except cervical with spinal curvature
M4129 Combined anterior/posterior spinal fusion
M4159 Spinal fusion except cervical with spinal curvature
M4316 Spinal fusion except cervical without spinal curvature
M47.22 Other spondylosis with radiculopathy, cervical region
M47.26 Other spondylosis with radiculopathy, lumbar region
M4723 Critical care for long term mechanical ventilation
M4724 Combined anterior/posterior spinal fusion
M48.02 Spinal stenosis, vertical region
M48.04 Spinal stenosis, thoracic region
M48.05 Spinal stenosis, thoracolumbar region
M48.06 Spinal stenosis, lumbar region
M4807 Combined anterior/posterior spinal fusion
M50.1 Cervical disc disorder with radiculopathy
M50.2 Other cervical disc displacement
M51.2 Other specified intervertebral disc displacement

M511 Spinal fusion except cervical without spinal curvature
M5464 Combined anterior/posterior spinal fusion
M6245 Hip & femur procedures except major joints
M6597 Wound debridement & skin graft except hand
M71.38 Other bursal cyst, other site
M72.56 Fasciitis, not elsewhere classified, lower leg
M75.1 Rotator cuff syndrome
M8795 Wound debridement & skin graft except hand
M96.0 Pseudoarthrosis after fusion or arthrodesis
N10 Kidney & urinary tract infections
N12 Kidney & urinary tract infections
N132 Urethral & transurethral procedures
N17.8 Other acute renal failure
N17.9 Acute renal failure, unspecified
N18.9 Chronic renal failure, unspecified
N19 Kidney & urinary tract malignancy & renal failure
N28.8 Other specified disorders of kidney & urethra
N390 Kidney & urinary tract infections
N41.9 Inflammatory disease of prostate, unspecified
N42.9 Disorders of prostate, unspecified
N83.2 Other & unspecified ovarian cysts
N85.9 Noninflammatory disorder of uterus, unspecified
N950 Uterine & adnexa procedures for CA in situ
O00.9 Ectopic pregnancy, unspecified
O001 Ectopic pregnancy procedure
O14.0 Moderate pre-eclampsia
O16 Unspecified maternal hypertension
O44.0 Placenta praevia specified as without haemorrhage
O44.1 Placenta praevia with haemorrhage
O60.1 Preterm labour with preterm delivery
O73.0 Retained placenta without haemorrhage
O82.1 Delivery by emergency caesarean section
O829 Caesarean delivery
O88.2 Obstetric blood-clot embolism
O98.4 Viral hepatitis complete pregnancy, childbirth
O99.5 Dis respiratory cyst complete pregnancy, childbirth
P229 Neonate major procedure
Q01.9 Encephalocele, unspecified
Q750 Craniosynostosis
Q78.1 Polyostotic fibrous dysplasia
S00.9 Superficial injury of head, part unspecified
S01.3 Open wound of ear

S01.5 Open wound of lip and oral cavity
S01.8 Open wound of other parts of head
S02.10 Fracture base of scull, closed
S02.11 Fracture of base of skull, open
S02.3 Fracture of orbital floor, closed
S02.4 Fracture of molar and maxillary bones, closed
S02.60 Fracture of mandible, closed
S0280 Other procedures for multiple significant trauma
S0290 Craniotomy, spine, hip & major limb procedure for multiple significant trauma
S06.40 Epidural haemorrhage, without open wound
S06.50 Traumatic subdural haemorrhage, without open wound
S06.80 Other intracranial injuries, without open wound
S06.90 Intracranial injury, unspec, without open wound
S0600 Concussion
S0610 Other procedures for multiple significant trauma
S0660 Head trauma & other nervous system procedures
S10.9 Superficial injury of neck, part unspecified
S11.7 Multiple open wounds of neck
S119 Skin graft &/ debridement & drainage for other diagnoses
S12.70 Multiple fractures of cervical spine, closed
S12.90 Fracture of neck, part unspec, closed
S1220 Combined anterior/posterior spinal fusion
S202 Skin graft &/ debridement & drainage for other diagnoses
S211 Skin, subcutaneous tissue procedures for trauma
S219 Open wound of thorax, part unspecified
S22.00 Fracture of thoracic vertebra, closed
S22.20 Fracture of sternum, closed
S22.30 Fracture of rib, closed
S22.40 Multiple fractures of ribs, closed
S2210 Spinal fusion except cervical without spinal curvature
S2250 Major chest trauma
S27.3 Other injuries of lung, without open wound
S2700 Other procedures for multiple significant trauma
S2720 Non-major respiratory procedures
S31.8 Open wound of other &unspec parts of lumbar spine & pelvis
S32.40 Fracture of acetabulum, closed
S32.80 Fracture of other unspecified parts of lumbar spine & pelvis
S355 Other procedures for multiple significant trauma
S359 Other procedures for multiple significant trauma
S36.10 Disorders of liver except malignant, cirrhosis or alcoholic hepatitis
S3700 Craniotomy, spine, hip & major limb procedure for multiple significant trauma
S42.00 Fracture of clavicle, closed

S4220 Major shoulder or elbow joint procedure
S4230 Critical care for long term mechanical ventilation
S5200 Fractures, sprains, strains & dislocations except femur,hip,pelvis
S5270 Craniotomy, spine, hip & major limb procedure for multiple significant trauma
S5271 Major shoulder or elbow joint procedures
S6200 Other procedures for multiple significant trauma
S707 Unrelated O.R procedures
S72.00 Fracture of neck of femur, closed
S72.40 Fracture of lower end of femur, closed
S72.90 Fracture of femur, part unspecified, closed
S7210 Major joint replacement or reattachment of lower extremity
S7230 Craniotomy, spine, hip & major limb procedure for multiple trauma
S7231 Shoulder, elbow/ fore-arm procedure
S7291 Other procedures for multiple significant trauma
S80.9 Superficial injury of lower leg, unspecified
S81.0 Open wound of knee
S819 Trauma to the skin
S82.01 Fracture of patella, open
S8211 Hip & femur procedures
S8291 Knee procedures
S910 Skin graft &/ debridement & drainage for other diagnoses
T17.9 Foreign body in respiratory tract, part unspecified
T202 Non-extensive, non-full thickness burns
T203 Non-extensive, full thickness burns with skin graft/ inhalation injury
T213 Non-extensive, full thickness burns with skin graft/inhalation injury
T220 Unrelated O.R procedure, extensive procedure unrelated to principal diagnosis
T221 Non-extensive full thickness burns
T223 Non-extensive full thickness burns with skin graft/ inhalation injury
T242 Burn second degree hip & lower limb except ankle
T275 Respiratory system signs, symptoms & other diagnoses
T38.3 Poisoning, insulin & oral hypoglycaemic
T39.1 Poisoning, 4-aminophenol derivatives
T393 Poisoning & toxic effects of drugs
T40.5 Poisoning, cocaine
T40.6 Poisoning, other & unspecified narcotics
T42.4 Poisoning, benzodiazepines
T426 Poisoning & toxic effects of drugs
T43.0 Poisoning, tricyclic & tetracyclic antidepressants
T43.2 Poisoning , other and unspecified antidepressants
T439 Poisoning & toxic effects of drugs
T45.5 Poisoning, anticoagulants
T50.9 Poisoning, other & unspecified drugs

T52.3 Toxic effects, glycol
T54.9 Toxic effect, corrosive substance, unspecified
T60.0 Toxic effect, organophosphate &carbamate insecticide
T60.8 Toxic effect, other pesticides
T81.0 Haemorrhage & haematoma complicating a procedure
T81.4 Infection following a procedure, not elsewhere classified
T81.7 Vascular complications following a procedure
T81.8 Other complications of procedures, not elsewhere classified
T81.9 Unspecified complication of procedure
T813 Other procedures for injuries & complications
T84.5 Infection & inflammatory reaction due to internal joint procedure
T84.6 Infection & inflammatory reaction due internal fixation device
T859 Complications of treatment
Z43.3 Attention to colostomy
Z529 Other factors influencing health status
Z538 Other factors influencing health status
Z99.1 Dependence on respirator

	N	Mean	Std dev	P value
ICD A09 Days in ICU				
2008 – 2009	1	1.00	N/A	p=0.476
2009 – 2010	3	4.83	3.82	
ICD A09 Stock value				
2008 – 2009	1	2202.4	N/A	p=0.640
2009 – 2010	3	21434.0	30496.9	
ICD A169 Days in ICU				
2008 – 2009	4	14.25	7.87	p=0.545
2009 – 2010	5	10.00	11.28	
ICD A169 Stock value				

2008 – 2009	4	80727.2	57370.0	p=0.214
2009 – 2010	5	33634.6	46483.9	
ICD A419 Days in ICU				
2008 – 2009	8	6.44	5.85	p=0.768
2009 – 2010	10	5.55	6.52	
ICD A419Stock value				
2008 – 2009	8	31392.9	30139.4	p=0.747
2009 – 2010	9	26847.2	26985.4	
ICD B54 Days in ICU				
2008 – 2009	2	26.50	9.19	p=0.078
2009 – 2010	2	4.00	2.12	
ICD B54 Stock value				
2008 – 2009	2	187896	177670	p=0.386
2009 – 2010	2	6449.6	3783.5	
ICD C188 Days in ICU				
2008 – 2009	2	1.25	1.06	p=0.240
2009 – 2010	5	2.40	1.02	
ICD C188 Stock value				
2008 – 2009	2	3614.5	1716.2	p=0.616
2009 – 2010	5	6116.9	6195.4	
ICD C61 Days in ICU				
2008 – 2009	2	2.25	1.06	p=0.406
2009 – 2010	1	0.50	N/A	
ICD C61 Stock value				
2008 – 2009	2	2532.6	2403.9	p=0.692
2009 – 2010	1	985.8	N/A	
ICD C710 Days in ICU				

2008 – 2009	6	1.67	0.41	p=0.363
2009 – 2010	4	1.00	N/A	
ICD C710 Stock value				
2008 – 2009	6	13020.2	29628.6	p=0.367
2009 – 2010	3	1032.8	721.8	
ICD C719 Days in ICU				
2008 – 2009	5	2.20	2.17	p=0.418
2009 – 2010	5	1.30	0.67	
ICD C719 Stock value				
2008 – 2009	5	4350.9	6346.7	p=0.710
2009 – 2010	4	7011.8	14075.8	
ICD C793 Days in ICU				
2008 – 2009	2	1.00	N/A	N/A
2009 – 2010	3	1.00	N/A	
ICD C793 Stock value				
2008 – 2009	2	1001.9	117.9	p=0.803
2009 – 2010	3	1150.9	730.2	
ICD C859 Days in ICU				
2008 – 2009	1	4.00	N/A	p=0.485
2009 – 2010	7	7.43	4.31	
ICD C859 Stock value				
2008 – 2009	1	6585.8	N/A	p=0.440
2009 – 2010	7	55276.0	55021.5	
ICD D320 Days in ICU				
2008 – 2009	1	1.00	N/A	N/A
2009 – 2010	1	1.00	N/A	
ICD D320 Stock value				

2008 – 2009	1	973.7	N/A	N/A
2009 – 2010	0	N/A	N/A	
ICD D381 Days in ICU				
2008 – 2009	4	4.75	2.32	p=0.020*
2009 – 2010	8	2.19	0.96	
ICD D381 Stock value				
2008 – 2009	4	24342.3	24652.6	p=0.157
2009 – 2010	6	1186.6	761.6	
ICD D430 Days in ICU				
2008 – 2009	3	2.50	1.50	p=0.478
2009 – 2010	1	1.00	N/A	
ICD D430 Stock value				
2008 – 2009	3	16349.7	20690.6	p=0.582
2009 – 2010	1	822.7	N/A	
ICD D432 Days in ICU				
2008 – 2009	3	1.00	N/A	p=0.170
2009 – 2010	8	1.25	0.46	
ICD D432 Stock value				
2008 – 2009	3	1169.2	827.8	p=0.417
2009 – 2010	8	1901.5	1373.5	
ICD E101 Days in ICU				
2008 – 2009	3	5.17	6.79	p=0.774
2009 – 2010	2	7.25	8.13	
ICD E101 Stock value				
2008 – 2009	2	31852.5	42995.6	p=0.654
2009 – 2010	2	14440.5	19354.3	
ICD E237 Days in ICU				

2008 – 2009	1	1.00	N/A	N/A
2009 – 2010	1	1.50	N/A	
ICD E237Stock value				
2008 – 2009	0	N/A	N/A	N/A
2009 – 2010	1	37.55	N/A	
ICD G20 Days in ICU				
2008 – 2009	1	7.50	N/A	N/A
2009 – 2010	1	8.00	N/A	
ICD G20 Stock value				
2008 – 2009	1	57928.7	N/A	N/A
2009 – 2010	1	69161.7	N/A	
ICD G409 Days in ICU				
2008 – 2009	5	2.60	2.58	p=0.517
2009 – 2010	2	1.25	0.35	
ICD G409 Stock value				
2008 – 2009	5	8116.6	11261.3	p=0.482
2009 – 2010	2	1718.2	907.7	
ICD G939 Days in ICU				
2008 – 2009	5	1.60	1.34	p=0.438
2009 – 2010	2	2.75	2.47	
ICD G939 Stock value				
2008 – 2009	5	4698.0	7208.4	p=0.548
2009 – 2010	2	9028.1	10743.9	
ICD I269 Days in ICU				
2008 – 2009	4	5.87	4.21	p=0.631
2009 – 2010	4	4.37	4.17	
ICD I269 Stock value				

2008 – 2009	3	34901.7	16042.5	p=0.556
2009 – 2010	4	23194.9	28561.6	
ICD I509 Days in ICU				
2008 – 2009	7	2.07	1.13	p=0.365
2009 – 2010	3	3.00	2.00	
ICD I509 Stock value				
2008 – 2009	7	9042.3	7874.2	p=0.955
2009 – 2010	3	9400.4	11270.9	
ICD I620 Days in ICU				
2008 – 2009	1	1.00	N/A	N/A
2009 – 2010	2	1.00	N/A	
ICD I620 Stock value				
2008 – 2009	1	24805.1	N/A	p=0.022*
2009 – 2010	2	615.0	672.8	
ICD I64 Days in ICU				
2008 – 2009	2	1.00	N/A	p=0.107
2009 – 2010	7	3.86	3.99	
ICD I64 Stock value				
2008 – 2009	2	1121.8	662.8	p=0.250
2009 – 2010	6	18556.8	18356.7	
ICD I671 Days in ICU				
2008 – 2009	2	3.50	0.71	p=0.212
2009 – 2010	1	1.00	N/A	
ICD I671 Stock value				
2008 – 2009	2	4623.0	2547.0	p=0.740
2009 – 2010	1	3274.4	N/A	
ICD J189 Days in ICU				

2008 – 2009	33	310.01	12.04	p=0.606
2009 – 2010	45	8.57	12.31	
ICD J189 Stock value				
2008 – 2009	33	44987.6	61990.2	p=0.217
2009 – 2010	44	29358.0	48134.1	
ICD J439 Days in ICU				
2008 – 2009	1	1.00	N/A	N/A
2009 – 2010	1	8.50	N/A	
ICD J439 Stock value				
2008 – 2009	1	2781.9	N/A	N/A
2009 – 2010	1	9303.8	N/A	
ICD J449 Days in ICU				
2008 – 2009	12	6.21	6.92	p=0.380
2009 – 2010	6	3.50	3.13	
ICD J449 Stock value				
2008 – 2009	11	14664.7	24200.2	p=0.368
2009 – 2010	6	7141.7	8467.3	
ICD J459 Days in ICU				
2008 – 2009	3	6.67	6.90	p=0.897
2009 – 2010	1	5.50	N/A	
ICD J459 Stock value				
2008 – 2009	3	16555.8	20979.7	p=0.911
2009 – 2010	1	13510.8	N/A	
ICD J690 Days in ICU				
2008 – 2009	1	2.00	N/A	p=0.511
2009 – 2010	3	5.00	3.28	
ICD J690 Stock value				

2008 – 2009	1	3113.2	N/A	p=0.428
2009 – 2010	3	23069.0	17514.9	
ICD J80 Days in ICU				
2008 – 2009	7	10.50	13.15	p=0.850
2009 – 2010	3	12.50	19.06	
ICD J80 Stock value				
2008 – 2009	7	65283.6	104782	p=0.969
2009 – 2010	3	68210.0	112359	
ICD J841 Days in ICU				
2008 – 2009	1	3.00	N/A	N/A
2009 – 2010	1	1.00	N/A	
ICD J841 Stock value				
2008 – 2009	1	6109.8	N/A	N/A
2009 – 2010	1	3222.1	N/A	
ICD J90 Days in ICU				
2008 – 2009	2	21.5	26.16	p=0.482
2009 – 2010	5	1.90	0.65	
ICD J90 Stock value				
2008 – 2009	2	151746	207768	p=0.496
2009 – 2010	5	3211.1	3914.5	
ICD J989 Days in ICU				
2008 – 2009	3	20.67	18.51	p=0.225
2009 – 2010	8	2.12	0.99	
ICD J989 Stock value				
2008 – 2009	3	118962	129614	p=0.274
2009 – 2010	5	7281.7	14238.7	
ICD K259 Days in ICU				

2008 – 2009	1	15.00	N/A	N/A
2009 – 2010	1	3.00	N/A	
ICD K259 Stock value				
2008 – 2009	1	59671.3	N/A	N/A
2009 – 2010	1	2460.0	N/A	
1CD K350 Days in ICU				
2008 – 2009	1	3.00	N/A	N/A
2009 – 2010	1	12.00	N/A	
ICD K350 Stock value				
2008 – 2009	1	8032.2	N/A	N/A
2009 – 2010	1	71562.3	N/A	
ICD K439 Days in ICU				
2008 – 2009	4	6.88	7.76	p=0.686
2009 – 2010	4	5.13	2.75	
ICD K439 Stock value				
2008 – 2009	4	28580.5	40997.0	p=0.810
2009 – 2010	4	22570.4	24558.2	
ICD K566 Days in ICU				
2008 – 2009	15	6.60	8.46	p=0.185
2009 – 2010	6	3.17	2.94	
ICD K566 Stock value				
2008 – 2009	15	52922.0	80976.4	p=0.096
2009 – 2010	5	13340.3	18569.7	
ICD K579 Days in ICU				
2008 – 2009	2	3.75	1.77	p=0.441
2009 – 2010	2	6.00	2.82	
ICD K579 Stock value				

2008 – 2009	2	13121.1	12288.2	p=0.190
2009 – 2010	2	48281.0	22341.4	
ICD K625 Days in ICU				
2008 – 2009	1	2.50	N/A	p=0.667
2009 – 2010	2	3.25	1.06	
ICD K625 Stock value				
2008 – 2009	1	2192.5	N/A	p=0.460
2009 – 2010	2	26192.0	17280.3	
ICD K639 Days in ICU				
2008 – 2009	1	18.50	N/A	N/A
2009 – 2010	1	7.00	N/A	
ICD K639 Stock value				
2008 – 2009	1	33161.9	N/A	N/A
2009 – 2010	1	32074.2	N/A	
ICD K729 Days in ICU				
2008 – 2009	4	3.87	2.39	p=0.852
2009 – 2010	3	3.50	2.64	
ICD K729 Stock value				
2008 – 2009	4	31414.6	23128.5	p=0.594
2009 – 2010	3	23201.8	9494.4	
ICD K759 Days in ICU				
2008 – 2009	2	2.50	0.71	p=0.425
2009 – 2010	2	7.50	7.07	
ICD K759Stock value				
2008 – 2009	2	8902.1	6473.8	p=0.323
2009 – 2010	2	71103.8	67371.4	
ICD K769 Days in ICU				

2008 – 2009	3	6.33	6.33	p=0.936
2009 – 2010	1	7.00	N/A	
ICD K769 Stock value				
2008 – 2009	3	60232.7	68917.1	p=0.636
2009 – 2010	1	104212	N/A	
ICD K819 Days in ICU				
2008 – 2009	3	3.33	1.15	p=0.134
2009 – 2010	3	1.83	0.76	
ICD K819 Stock value				
2008 – 2009	3	14976.6	7704.0	p=0.202
2009 – 2010	2	4980.6	4109.6	
ICD M160 Days in ICU				
2008 – 2009	1	5.00	N/A	N/A
2009 – 2010	1	12.00	N/A	
ICD M160 Stock value				
2008 – 2009	1	8150.0	N/A	N/A
2009 – 2010	1	30564.5	N/A	
ICD M171 Days in ICU				
2008 – 2009	2	1.75	0.35	p=0.668
2009 – 2010	3	2.17	1.15	
ICD M171 Stock value				
2008 – 2009	2	4726.2	3015.5	p=0.286
2009 – 2010	3	323.3	287.0	
ICD M2555 Days in ICU				
2008 – 2009	5	2.60	0.42	p=0.501
2009 – 2010	5	3.10	1.47	
ICD M2555 Stock value				

2008 – 2009	5	3873.5	1903.1	p=0.913
2009 – 2010	5	3687.3	3157.3	
ICD M2556 Days in ICU				
2008 – 2009	8	2.00	1.19	p=0.985
2009 – 2010	5	3.10	1.14	
ICD M2556 Stock value				
2008 – 2009	8	2941.7	1765.9	p=0.520
2009 – 2010	5	5038.8	6558.3	
ICD M4110 Days in ICU				
2008 – 2009	1	5.50	N/A	N/A
2009 – 2010	1	0.50	N/A	
ICD M4110 Stock value				
2008 – 2009	1	13527.2	N/A	N/A
2009 – 2010	1	2797.6	N/A	
ICD M4726 Days in ICU				
2008 – 2009	1	2.50	N/A	p=0.923
2009 – 2010	9	2.39	1.05	
ICD M4726 Stock value				
2008 – 2009	1	2602.7	N/A	p=0.594
2009 – 2010	6	5578.4	4843.6	
ICD M4802 Days in ICU				
2008 – 2009	1	8.50	N/A	N/A
2009 – 2010	1	3.50	N/A	
ICD M4802 Stock value				
2008 – 2009	1	33173.8	N/A	N/A
2009 – 2010	1	1096.9	N/A	
ICD M4805 Days in ICU				

2008 – 2009	1	11.50	N/A	N/A
2009 – 2010	1	5.00	N/A	
ICD M4805 Stock value				
2008 – 2009	1	66567.6	N/A	N/A
2009 – 2010	1	5475.2	N/A	
ICD M501 Days in ICU				
2008 – 2009	1	4.00	N/A	N/A
2009 – 2010	1	2.00	N/A	
ICD M501 Stock value				
2008 – 2009	1	14778.6	N/A	N/A
2009 – 2010	1	13.71	N/A	
ICD M502 Days in ICU				
2008 – 2009	2	1.25	0.35	p=0.667
2009 – 2010	1	1.50	N/A	
ICD M502 Stock value				
2008 – 2009	2	6858.1	6669.7	p=0.571
2009 – 2010	1	334.3	N/A	
ICD M960 Days in ICU				
2008 – 2009	2	2.75	2.47	p=0.751
2009 – 2010	1	1.50	N/A	
ICD M960 Stock value				
2008 – 2009	2	5928.9	6938.4	p=0.694
2009 – 2010	1	1505.8	N/A	
ICD N179 Days in ICU				
2008 – 2009	2	3.50	0.71	p=0.405
2009 – 2010	7	8.00	6.84	
ICD N179 Stock value				

2008 – 2009	2	17126.0	5074.2	p=0.658
2009 – 2010	7	27729.4	30813.5	
ICD N189 Days in ICU				
2008 – 2009	4	5.12	3.94	p=0.064
2009 – 2010	2	16.50	7.78	
ICD N189 Stock value				
2008 – 2009	4	38997.6	45130.9	p=0.381
2009 – 2010	2	73370.9	19981.2	
ICD N419 Days in ICU				
2008 – 2009	2	1.50	0.71	p=0.553
2009 – 2010	2	1.00	0.71	
ICD N419 Stock value				
2008 – 2009	2	1404.4	34.1745	p=0.907
2009 – 2010	2	1455.4	545.2	
ICD N429 Days in ICU				
2008 – 2009	1	1.67	N/A	N/A
2009 – 2010	1	1.00	N/A	
ICD N429 Stock value				
2008 – 2009	1	8926.7	N/A	N/A
2009 – 2010	1	1085.0	N/A	
ICD O441 Days in ICU				
2008 – 2009	1	3.00	N/A	N/A
2009 – 2010	1	5.50	N/A	
ICD O441 Stock value				
2008 – 2009	1	23044.5	N/A	N/A
2009 – 2010	1	26536.0	N/A	
ICD Q750 Days in ICU				

2008 – 2009	1	1.00	N/A	N/A
2009 – 2010	1	2.00	N/A	
ICD Q750 Stock value				
2008 – 2009	1	297.5	N/A	N/A
2009 – 2010	1	2171.9	N/A	
ICD S009 Days in ICU				
2008 – 2009	1	14.50	N/A	N/A
2009 – 2010	1	25.00	N/A	
ICD S009 Stock value				
2008 – 2009	1	53205.0	N/A	N/A
2009 – 2010	1	73767.5	N/A	
ICD S018 Days in ICU				
2008 – 2009	3	7.67	9.81	p=0.658
2009 – 2010	1	13.50	N/A	
ICD S018 Stock value				
2008 – 2009	3	34347.6	51394.7	p=0.867
2009 – 2010	1	45584.9	N/A	
ICD S0210 Days in ICU				
2008 – 2009	3	6.17	6.37	p=0.547
2009 – 2010	2	12.25	14.49	
ICD S0210 Stock value				
2008 – 2009	3	41880.9	57074.8	p=0.942
2009 – 2010	2	45806.8	50437.0	
ICD S0260 Days in ICU				
2008 – 2009	2	12.75	5.30	p=0.406
2009 – 2010	1	4.00	N/A	
ICD S0260 Stock value				

2008 – 2009	2	51248.5	29687.7	p=0.404
2009 – 2010	1	1940.6	N/A	
ICD S0650 Days in ICU				
2008 – 2009	4	4.00	2.00	p=0.154
2009 – 2010	2	4.75	5.30	
ICD S0650 Stock value				
2008 – 2009	4	26817.4	15715.3	p=0.382
2009 – 2010	1	44755.0	N/A	
ICD S0680 Days in ICU				
2008 – 2009	3	5.67	4.75	p=0.368
2009 – 2010	4	18.25	21.17	
ICD S0680 Stock value				
2008 – 2009	3	25224.4	26224.2	p=0.398
2009 – 2010	4	71504.6	81949.2	
ICD S1270 Days in ICU				
2008 – 2009	1	24.00	N/A	N/A
2009 – 2010	1	2.00	N/A	
ICD S1270 Stock value				
2008 – 2009	1	111279	N/A	N/A
2009 – 2010	1	1991.9	N/A	
ICD S1290 Days in ICU				
2008 – 2009	2	5.25	1.06	p=0.067
2009 – 2010	1	17.50	N/A	
ICD S1290 Stock value				
2008 – 2009	2	17559.2	16957.5	p=0.913
2009 – 2010	1	14719.1	N/A	
ICD S2200 Days in ICU				

2008 – 2009	1	6.50	N/A	N/A
2009 – 2010	1	12.00	N/A	
ICD S2200 Stock value				
2008 – 2009	1	17917.3	N/A	N/A
2009 – 2010	1	51653.5	N/A	
ICD S2230 Days in ICU				
2008 – 2009	2	2.00	2.12	p=0.565
2009 – 2010	3	4.17	4.25	
ICD S2230 Stock value				
2008 – 2009	2	5535.9	4383.7	p=0.529
2009 – 2010	3	11544.1	10921.4	
ICD S2240 Days in ICU				
2008 – 2009	1	2.00	N/A	p=0.879
2009 – 2010	2	1.75	1.06	
ICD S2240 Stock value				
2008 – 2009	1	850.0	N/A	p=0.493
2009 – 2010	2	1193.8	275.1	
ICD S318 Days in ICU				
2008 – 2009	2	7.75	9.54	p=0.452
2009 – 2010	2	4.50	3.53	
ICD S318 Stock value				
2008 – 2009	2	67312.9	91635.3	p=0.739
2009 – 2010	2	42481.0	7106.7	
ICD S3240 Days in ICU				
2008 – 2009	1	4.00	N/A	p=0.566
2009 – 2010	3	13.67	12.29	
ICD S3240 Stock value				

2008 – 2009	1	17668.2	N/A	p=0.717
2009 – 2010	3	57570.0	82715.6	
ICD S3280 Days in ICU				
2008 – 2009	2	16.75	19.44	p=0.206
2009 – 2010	2	3.25	3.18	
ICD S3280 Stock value				
2008 – 2009	2	84157.8	75141.3	p=0.363
2009 – 2010	2	1359.9	1298.3	
ICD S3610 Days in ICU				
2008 – 2009	1	5.00	N/A	p=0.855
2009 – 2010	2	4.00	3.53	
ICD S3610 Stock value				
2008 – 2009	1	1922.8	N/A	p=0.537
2009 – 2010	2	10323.2	7711.1	
ICD S4200 Days in ICU				
2008 – 2009	2	12.50	12.73	p=0.609
2009 – 2010	2	6.75	4.59	
ICD S4200 Stock value				
2008 – 2009	2	94587.3	127630	p=0.504
2009 – 2010	2	21237.6	14259.1	
ICD S7200 Days in ICU				
2008 – 2009	14	4.61	3.28	p=0.698
2009 – 2010	9	5.27	4.93	
ICD S7200 Stock value				
2008 – 2009	14	15315.2	20152.7	p=0.386
2009 – 2010	9	9999.8	7853.2	
ICD S7290 Days in ICU				

2008 – 2009	7	8.86	8.30	p=0.283
2009 – 2010	4	3.87	2.72	
ICD S7290 Stock value				
2008 – 2009	7	55064.6	65413.7	p=0.120
2009 – 2010	4	9887.2	10985.9	
ICD T391 Days in ICU				
2008 – 2009	2	1.50	0.71	p=0.454
2009 – 2010	1	0.50	N/A	
ICD T391 Stock value				
2008 – 2009	2	4842.9	N/A	N/A
2009 – 2010	1	3426.0	N/A	
ICD T405 Days in ICU				
2008 – 2009	1	0.50	N/A	N/A
2009 – 2010	1	2.50	N/A	
ICD T405 Stock value				
2008 – 2009	1	N/A	N/A	N/A
2009 – 2010	1	6197.0	N/A	
ICD T424 Days in ICU				
2008 – 2009	4	3.87	2.14	p=0.081
2009 – 2010	4	1.12	0.25	
ICD T424 Stock value				
2008 – 2009	4	7844.1	7465.0	p=0.150
2009 – 2010	4	668.4	580.4	
ICD T430 Days in ICU				
2008 – 2009	1	2.50	N/A	N/A
2009 – 2010	1	1.00	N/A	
ICD T430 Stock value				

2008 – 2009	1	2652.2	N/A	N/A
2009 – 2010	1	2062	N/A	
ICD T432 Days in ICU				
2008 – 2009	1	1.50	N/A	N/A
2009 – 2010	1	1.50	N/A	
ICD T432 Stock value				
2008 – 2009	1	445.9	N/A	N/A
2009 – 2010	1	4909.1	N/A	
ICD T509 Days in ICU				
2008 – 2009	4	2.12	1.31	p=0.186
2009 – 2010	2	1.00	N/A	
ICD T509 Stock value				
2008 – 2009	4	14587.8	18210.1	p=0.421
2009 – 2010	2	1913.5	2560.4	
ICD T600 Days in ICU				
2008 – 2009	1	5.00	N/A	p=0.512
2009 – 2010	2	2.50	2.12	
ICD T600 Stock value				
2008 – 2009	1	18061.3	N/A	p=0.353
2009 – 2010	2	7697.4	5236.8	
1CD T810 Days in ICU				
2008 – 2009	1	4.00	N/A	p=0.333
2009 – 2010	2	3.25	0.354	
ICD T810 Stock value				
2008 – 2009	1	8195.3	N/A	p=0.954
2009 – 2010	2	8926.6	8295.2	
ICD T814 Days in ICU				

2008 – 2009	3	9.33	6.93	p=0.730
2009 – 2010	4	12.00	10.96	
ICD T814 Stock value				
2008 – 2009	3	50665.4	58761.8	p=0.757
2009 – 2010	4	67419.2	72311.8	
ICD T817 Days in ICU				
2008 – 2009	1	3.00	N/A	p=<0.001*
2009 – 2010	2	2.00	N/A	
ICD T817 Stock value				
2008 – 2009	1	29670.2	N/A	p=0.033*
2009 – 2010	2	918.7	1235.9	
ICD T819 Days in ICU				
2008 – 2009	10	6.65	7.67	p=0.752
2009 – 2010	6	5.50	5.23	
ICD T819 Stock value				
2008 – 2009	10	43067.2	46770.2	p=0.530
2009 – 2010	6	29166.0	30766.9	
Total ICU days				
2008 – 2009	512	5.56	7.23	p=0.510
2009 – 2010	547	5.25	7.83	
Total amount ICU drugs				
2008 – 2009	497	29545.6	52134.5	p=0.208
2009 – 2010	525	25054.2	61665.5	

APPENDIX F:

	N	Mean	Stddev	P value
Acid reducer Stock quantity				
2008 – 2009	32	5.78	5.77	p=0.001*
2009 - 2010	12	1.83	1.58	
Acid reducer Rand value				
2008 – 2009	32	63.76	121.6	p=0.131
2009 - 2010	12	127.4	122.8	
Analgesic Stock quantity				
2008 – 2009	1051	2.80	9.26	p=0.001*
2009 - 2010	889	1.69	2.83	
Analgesic Rand value				

2008 – 2009	1051	45.08	86.50	p=0.205
2009 - 2010	889	50.28	92.84	
Ant cholinergic Stock quantity				
2008 – 2009	1850	16.77	31.83	p=0.989
2009 - 2010	1848	16.78	31.85	
Ant cholinergic Rand value				
2008 – 2009	1850	428.2	1126.2	p=0.990
2009 - 2010	1848	428.6	1126.8	
Anticoagulant Stock quantity				
2008 – 2009	1942	1.77	1.69	p=0.968
2009 - 2010	1937	1.76	1.69	
Anticoagulant Rand value				
2008 – 2009	1942	86.08	133.0	p=0.960
2009 - 2010	1937	86.29	133.10	
Antidepressant Stock quantity				
2008 – 2009	606	2.06	3.54	p=0.160
2009 - 2010	402	1.76	3.15	
Antidepressant Rand value				
2008 – 2009	606	86.80	182.4	p=0.004*
2009 - 2010	402	124.4	213.6	
Ant emetic Stock quantity				
2008 – 2009	415	1.38	3.01	p=0.974
2009 - 2010	413	1.38	3.00	
Ant emetic Rand value				
2008 – 2009	415	23.58	103.6	p=0.987
2009 - 2010	413	23.70	103.5	
Antiepileptic Stock quantity				

2008 – 2009	167	3.26	3.51	p=0.372
2009 - 2010	121	2.91	2.93	
Antiepileptic Rand value				
2008 – 2009	167	487.0	673.8	p=0.029*
2009 - 2010	121	667.8	713.0	
Antihistamine Stock quantity				
2008 – 2009	6	2.33	3.33	p=0.800
2009 - 2010	5	1.80	3.42	
Antihistamine Rand value				
2008 – 2009	6	6.56	12.25	p=0.971
2009 - 2010	5	6.85	13.67	
Antihypertensive Stock quantity				
2008 – 2009	463	1.92	2.47	p=0.986
2009 - 2010	29	1.93	3.31	
Antihypertensive Rand value				
2008 – 2009	463	26.50	168.4	p=0.012*
2009 - 2010	29	328.6	604.8	
Anti-inflammatory Stock quantity				
2008 – 2009	68	9.66	23.46	p=0.009*
2009 - 2010	9	1.56	3.00	
Anti-inflammatory Rand value				
2008 – 2009	68	17.59	34.82	p=0.490
2009 - 2010	9	34.50	69.23	
Antimicrobial Stock quantity				
2008 – 2009	5659	3.71	5.58	p=0.141
2009 - 2010	5455	3.57	4.65	
Antimicrobial Rand value				

2008 – 2009	5659	885.5	1499.7	p=0.398
2009 - 2010	5455	909.6	1517.8	
Antiprotozoal Stock quantity				
2008 – 2009	181	4.87	13.07	p=0.951
2009 - 2010	20	5.00	8.18	
Antiprotozoal Rand value				
2008 – 2009	181	31.23	50.77	p=0.165
2009 - 2010	20	69.31	117.0	
Antiviral Stock quantity				
2008 – 2009	17	5.82	6.03	p=0.410
2009 - 2010	63	4.49	5.84	
Antiviral Rand value				
2008 – 2009	17	1105.9	1291.5	p=0.784
2009 - 2010	63	1306.5	164.6	
Benzodiazepine Stock quantity				
2008 – 2009	17	2.82	2.90	p=0.028*
2009 - 2010	37	1.05	1.56	
Benzodiazepine Rand value				
2008 – 2009	17	8.49	11.67	p=0.003*
2009 - 2010	37	47.84	73.52	
Biological Stock quantity				
2008 – 2009	17	1.29	0.98	p=0.890
2009 - 2010	55	1.25	1.04	
Biological Rand value				
2008 – 2009	17	2553.8	471.5	p=0.890
2009 - 2010	55	2475.7	2052.8	
Bronchodilators Stock quantity				

2008 – 2009	17	6.23	4.79	p=0.014*
2009 - 2010	100	2.95	5.05	
Bronchodilators Rand value				
2008 – 2009	17	24.82	19.33	p=0.312
2009 - 2010	100	17.34	29.23	
Cardiac Stock quantity				
2008 – 2009	17	0.82	2.32	p=0.038*
2009 - 2010	931	2.14	5.50	
Cardiac Rand value				
2008 – 2009	17	79.89	236.3	p=0.121
2009 - 2010	931	175.4	393.3	
Cardiac glycoside Stock quantity				
2008 – 2009	17	1.42	1.23	p=0.465
2009 - 2010	57	1.12	1.93	
Cardiac glycoside Rand value				
2008 – 2009	17	5.01	11.49	p=0.036*
2009 - 2010	57	14.07	23.92	
Central analeptics Stock quantity				
2008 – 2009	12	2.17	4.84	p=1.000
2009 - 2010	12	2.17	4.84	
Central analeptics Rand value				
2008 – 2009	12	85.61	137.7	p=1.000
2009 - 2010	12	85.61	137.7	
Cerebral Stock quantity				
2008 – 2009	17	2.06	4.90	p=0.899
2009 - 2010	17	2.23	2.84	
Cerebral Rand value				

2008 – 2009	17	422.1	568.6	p=0.676
2009 - 2010	17	509.8	643.3	
Corticosteroids Stock quantity				
2008 – 2009	1392	3.82	4.12	p=0.594
2009 - 2010	1213	3.74	3.97	
Corticosteroids Rand value				
2008 – 2009	1392	115.0	139.5	p=0.050*
2009 - 2010	1213	125.9	145.3	
Cytostatic Stock quantity				
2008 – 2009	110	1.10	2.76	p=0.823
2009 - 2010	109	1.01	2.64	
Cytostatic Rand value				
2008 – 2009	110	801.1	2620.6	p=0.984
2009 - 2010	109	808.2	2631.6	
Diuretics Stock quantity				
2008 – 2009	1024	2.65	3.97	p=0.669
2009 - 2010	914	2.57	4.08	
Diuretics Rand value				
2008 – 2009	1024	18.78	100.7	p=0.749
2009 - 2010	914	20.28	106.4	
Electrolyte replacement Stock quantity				
2008 – 2009	2052	3.62	6.12	p=0.507
2009 - 2010	2020	3.49	5.74	
Electrolyte replacement Rand value				
2008 – 2009	2052	12.77	28.70	p=0.927
2009 - 2010	2020	12.86	28.93	
Gastrointestinal Stock quantity				

2008 – 2009	710	2.90	9.95	p=0.005*
2009 - 2010	592	1.83	1.71	
Gastrointestinal Rand value				
2008 – 2009	710	136.0	134.9	p=0.040*
2009 - 2010	592	151.8	141.6	
Haemostatic Stock quantity				
2008 – 2009	166	2.41	4.01	p=0.916
2009 - 2010	160	2.46	4.03	
Haemostatic Rand value				
2008 – 2009	166	103.0	248.1	p=0.895
2009 - 2010	160	106.7	251.9	
Hormones Stock quantity				
2008 – 2009	63	1.94	2.55	p=0.998
2009 - 2010	62	1.94	2.57	
Hormones Rand value				
2008 – 2009	63	339.8	459.8	p=0.948
2009 - 2010	62	345.2	461.5	
Hyperallmentation Stock quantity				
2008 – 2009	2331	1.25	1.32	p<0.001*
2009 - 2010	861	2.03	1.55	
Hyperallmentation Rand value				
2008 – 2009	2331	859.5	1073.0	p<0.001*
2009 - 2010	861	602.6	461.6	
Hypo-glaecemics Stock quantity				
2008 – 2009	424	1.04	1.61	p=0.805
2009 - 2010	410	1.02	1.33	
Hypo-glaecemics Rand value				

2008 – 2009	424	110.6	96.56	p=0.579
2009 - 2010	410	114.3	96.05	
Local Anesthetic Stock quantity				
2008 – 2009	445	1.61	4.10	p=0.019*
2009 - 2010	404	1.08	2.30	
Local Anesthetic Rand value				
2008 – 2009	445	8.48	23.43	p=0.061
2009 - 2010	404	5.65	20.46	
Mucolytic Stock quantity				
2008 – 2009	115	1.65	2.16	p=0.140
2009 - 2010	85	1.25	1.71	
Mucolytic Rand value				
2008 – 2009	115	7181.0	6745.5	p=0.007*
2009 - 2010	85	9713.2	6072.8	
Muscle relaxants Stock quantity				
2008 – 2009	246	2.65	4.94	p=1.000
2009 - 2010	246	2.65	4.94	
Muscle relaxants Rand value				
2008 – 2009	246	1324.3	2725.3	p=1.000
2009 - 2010	246	1324.3	2725.3	
Peptic ulcer Stock quantity				
2008 – 2009	628	4.60	18.76	p=0.001*
2009 - 2010	574	1.93	1.72	
Peptic ulcer Rand value				
2008 – 2009	628	267.1	247.1	p=0.142
2009 - 2010	574	288.9	267.8	
Phenothiazine Stock quantity				

2008 – 2009	17	1.35	3.41	p=0.986
2009 - 2010	16	1.37	3.51	
Phenothiazine Rand value				
2008 – 2009	17	6.79	16.39	p=0.953
2009 - 2010	16	7.14	16.87	
Tuberculostatics Stock quantity				
2008 – 2009	152	3.43	3.49	p=0.173
2009 - 2010	94	2.87	2.82	
Tuberculostatics Rand value				
2008 – 2009	152	236.4	341.8	p=0.003*
2009 - 2010	94	377.0	301.1	
Vitamin minerals Stock quantity				
2008 – 2009	360	3.07	4.05	p<0.001*
2009 - 2010	258	1.94	2.05	
Vitamin minerals rand value				
2008 – 2009	360	99.54	178.8	p=0.041*
2009 - 2010	258	131.7	202.2	
Total ICU stock quantity				
2008 – 2009	22821	4.01	11.51	p=0.694
2009 - 2010	20434	3.96	11.10	
Total rand value				
2008 – 2009	22821	444.0	1232.2	p=0.432
2009 - 2010	20434	434.6	1251.6	