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Adaptation to current needs for Emergency Room of Steve Biko Academic Hospital

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Executive summary

This document gives an overview of the project entitled: Adaptation to current needs for the Emergency Room of the Steve Biko Academic Hospital (formerly Pretoria Academic Hospital). The project concerns the adaptation of the Steve Biko Academic Hospital's Emergency Department to current needs. Resource availability and limitations as well as the services working with the emergency department will be considered when possible changes are analysed and recommended.

Different tools and techniques will be discussed for use in the improvement of the care given to the patients at the Steve Biko Academic Hospital's emergency room.

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Chapter 1

1.1 Introduction and background

> *"At this hospital artificial barriers will fall away in suffering, and the difference between race, creed and class will lose its significance and we will fight together to give health to those who walk in the streets as well as those who live in luxury. It will also be a place of joy – besides suffering – as a result of those who recovered from disease."*

These are the words of Mr Jan Hendrik Hofmeyr, who laid the foundation stone of the Pretoria General Hospital on 22 April 1927.

In 1889 the plans for the "Volkshospitaal" was submitted by Mr S Werda the Government Engineer and Architect. The opening ceremony took place on 10 October 1891, on President SPJ Kruger's birthday. The Volkshospitaal provided 130 beds for both black and white patients. The capacity increased during the years to a total of 194 beds. In 1922 the Pretoria City Council authorised the erection of the £300 000 Pretoria General Hospital.

In 1967 the Pretoria General Hospital's name changed to the HF Verwoerd Hospital, in 1999 to Pretoria Academic Hospital and in 2008 to the Steve Biko Academic Hospital. The new 800-bed facility has only been fully operational since April 2006. Completion of the facility in 2004 was done at a total cost of R1.2billion. The old Pretoria Academic Hospital was revamped to become the Tshwane District Hospital.

The Steve Biko Academic Hospital is located some 800m from the original Pretoria Academic Hospital. The facility has an 832 bed capacity of which 53 are in the Intensive Care Unit and 21 are high care beds. A total of six entrances lead to 80 consultation rooms and 22 operating theatres.

More than 50 departments and clinics operate from the facility. These include clinics, surgeries, pharmacy and emergency facilities.

The facility was originally conceived a low turnaround, high specialty 1200-bed facility. This objective changed during the building of the facility. Currently it is used as a higher volume health care facility. The hospital is still a tertiary health care facility so specialised care is provided.

The Steve Biko Academic Hospital has one of the largest and best equipped public emergency departments (ED) in Gauteng and possibly South Africa. The emergency room (ER) has an expandable capacity with the potential to expand to 60 beds in a disaster

situation. Only patients of priority 1 or 2 are seen at the ER. These are patients who are in need of specialised medical care; their situation has a high probability of becoming life threatening within two hours.

The increase in the number of casualty patients puts the entire hospital under pressure. Departments and facilities such as Surgery and the ER are the worst affected.

Waiting for beds in other departments to open, results in the overcrowding of the ER. Service systems on which the ER is dependent (e.g. laboratories for blood test results and administrative procedures) limit the ER by causing increased waiting times.   Limited resources and staff put further strain on the ED inhibiting the ER function as intended to.

All of these challenges will be addressed in the course of the project.

1.2 Project aim

The objective is to increase patient throughput and decrease the time patients spend in the ER. By recommendation and implementation of changes and to the ER and its services the aim is ultimately to improve the hole emergency care system.

The adaptation and implementation of these changes should enable the ER to cope with the increased number of admissions and reductions in resources.

1.3 Project scope

Bottlenecks and limitations in the system will be thoroughly investigated. The impact and feasibility of the suggested implementation or upgrading of systems and services (internal or external) will be analysed.

Initial analysis of the emergency care system will reveal problems and challenges.

The problems will be investigated by methods such as statistical analysis, interviews, meeting with staff involved and time studies. As a result of investigation the causes of the problems will be revealed.

By assessing the impact each cause has on the ER as a whole the main priorities will be established. Further investigation on the identified problem causes will be done. These investigations will aim to resolve or minimize the impact on the ER of the causes.

The tools used for the solution of the problems will be selected according to what is the most appropriate to solve the specific problem.

Only problems directly affecting the ER will be analysed in the case of problems caused from external factors.

Chapter 2

> *"Hospital care processes are considered to be rather complex as compared to processes in industry or most other types of service organisations."* (Vissers, et al., 2005)

2.1 Literature review

This statement can be seen as one of the reasons why, compared to various other industries, less work is being done on the improvement of healthcare. Although the research and management community has never experienced difficulty in resolving complex and intricate problems, the medical field has simply not been a priority.

It is believed that this is because of the perception that medicine is the sole responsibility and playing field of medical practitioners and personnel with medical training.

This perception is changing as healthcare is increasingly seen as a service where the interests of patients as clients and their insistence on acceptable levels of service require increasing consideration. Resource limitations conflict with the need to improve care. Thus alternative measures need to be introduced to solve the problems created by current conditions.

2.1.1 Levels of planning

Different levels of planning are employed throughout the entire healthcare system. This entails decisions from parliament at the very top to the nurse administering routine drugs to a patient. For an effective solution to each problem in the system the appropriate level of decision needs to be addressed in the planning and solving of the relevant problem.

Planning in a hospital can be roughly divided into five main categories; Strategic Planning, Patient Volume and Control, Resource Planning and Control, Patient Group Planning and Control and Patient Planning and Control (Vissers, et al., 2005).

Frequency of decision makings can be displayed by the area of triangle dedicated to the category and the impact on the total system by the height of the category in the hierarchy.

Figure 1 Levels of planning

For purposes of this study the focus is on areas of maximum impact to the situation at SBAH Emergency Department. These include the lower three levels of decision making.

Because of the hierarchy, administration and implementation difficulties the top two planning levels is not included the scope of this study. There are nevertheless plentiful opportunities for further study in these fields of healthcare public as well as private. (Carey, 2003).

2.1.2   Resource Planning and Control

A series of operations are performed to give care to any patient. These operations consist of any activity that is performed before, during and after the patient receives care at a specific institution. Operations utilise resources and services to be performed (Vissers, et al., 2005 p. 40). Without the necessary resources the operations cannot be performed and consequently the process of care giving cannot continue. All operations are resource dependent. By ensuring the necessary resources are available to be used during the operations process times and effort can be reduced.

Resources are "things resorted to for support" (Collins, 2004). This includes all products, personnel and services used to provide care to patients (Collins, 2004).

Only the main resources will be considered during this study. These are doctor time, nurse time and beds. These resources were chosen because they are usually the limiting factors in the system; the bottleneck resources.

Resources can be divided into two main groups: Leading and Following. This difference in resources can be described in the relationship they have towards each other. When a surgeon books an patient for a operation in the operating theatre (OT) a bed is reserved for that patient even before he/she goes for the operation. The process requires the ward to

have a bed available. The leading resource is the OT and the following resource is the beds in the ward (Vissers, et al., 2005).

The distinction between the two categories is important because of the impact different resources have on each other. Departments need to be aware of the impact their decisions will have on other departments and whether those departments can accommodate the change in, for example, patient arrival characteristics.

Hospital capacity planning should consider the impact resource utilization has on each other (Vissers, et al., 2005 p. 44). In the planning stages of a healthcare facility these resource utilization should be balanced in such a way that the different departments complement each other (Vissers, et al., 2005). Capacity planning falls under Volume Planning and Control and is not part of the scope of this project. It is, however, more relevant in the scheduled admissions done in a hospital. Capacity planning for the ER in the stochastic environment will be discussed later.

To develop a solution for the best use of resources two aspects need to be considered and defined. These are: what is the *best* use and of which *resources*?

It is known that the resources that will be analysed are doctor time, nurse time and beds. The question now is what is depleting these resources and how much thereof is being used?

Diagnosis Related Groups (DRG) (Diagnosis Related Groups: Production Line Management within Hospitals, 1986) was developed for this very reason. Fetter and Freeman needed a way to model the usage of resources in their implementation and adaption of MRP-II method to the healthcare environment. DRG puts the patient in a specific group according to his/her diagnosis. This group has predetermined resource usage defined. The amount of a specific resource consumed by a specific patient can now be established. This makes an accurate analysis possible of the resources needed to perform operations (not only in the OT but with respect to all operations concerned with the treatment of the patient).

The resources, and the resource usage have been defined. The following step is to define the process employed in the use of the resources.

Process mapping is used to give a visual representation of the process the patient is required to follow when treated at the SBAH emergency room.

Figure 2 Basic flow of patient

This flow diagram gives an aggregated view of the process a patient goes through when treated in the emergency room. Each of the process phases consumes different amounts of the defined resources. By combining a detailed map of the process it is possible to get a good idea of the usage of the resources for a specific DRG (Vissers, et al., 2005 p. 74).

To establish the total demand of resources within a specific scenario the amount and frequency of treating a specific DRG needs to be determined.
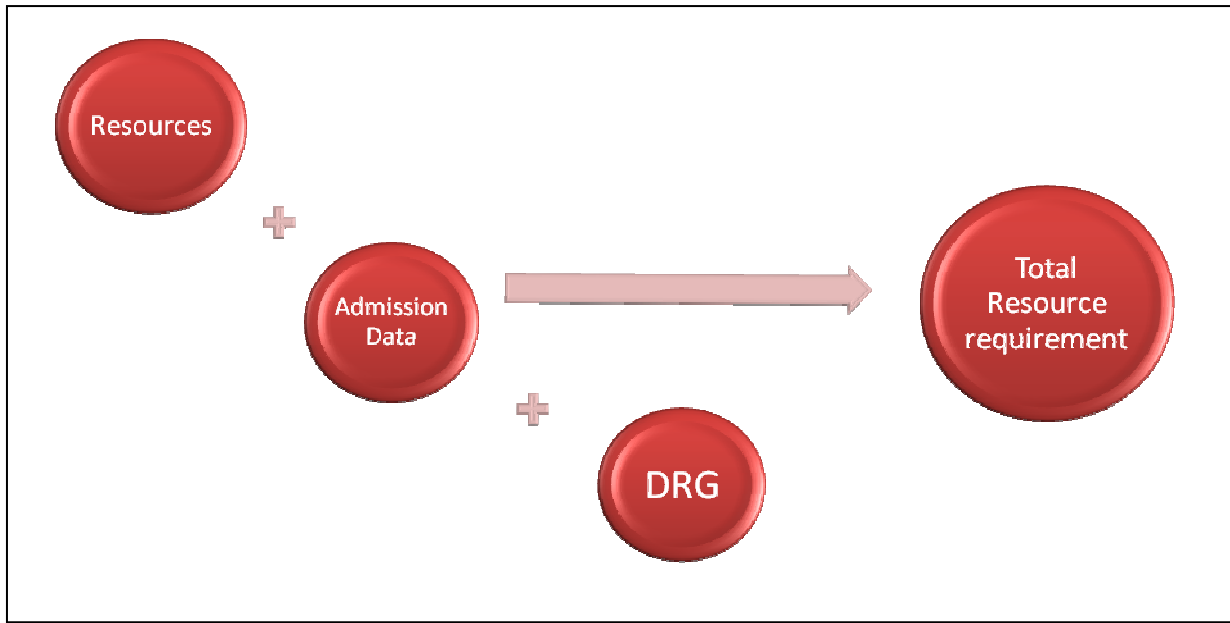
Figure 3 Total resource requirement

Admission data include statistics on the patient category mix and the time between arrivals of each DRG. The data need to be of a stochastic nature to represent the reality when analysis is done.

The total demand on the ER resources can now be modelled in such a way that reality is represented. Different approaches to increase throughput can also be compared within the limitations of the current resources.

2.1.3 Theoretical use of tools and techniques

Competition, limited resources and possible revenue increases have driven the manufacturing industry to develop the operations management field to find new solutions to their problems. These problems include lack of quality, efficiency, flexibility, increased throughput and long delivery times.

Healthcare is faced with similar challenges such as increased patient numbers, limited resources and pressure to improve patients view of service given.

Hospitals are not manufacturing organisations and some of the differences of these unique service providers compared to manufacturing are:

- Production is mainly concerned with the flow of material whereas healthcare is concerned with the flow of patients;
- Cost to patient is not predominant priority in healthcare;
- Production pursues rigidly defined outcomes, healthcare outcome requirements are more subjective;
- Line of command in healthcare is a balance of power between management, doctors and nursing staff;
- Care cannot be stored;
- Key operators are highly trained professionals who require and deliver services in the process of care giving

(Vissers, et al., 2005 p. 27)

A definition of production control in a health care setting was defined by J. Vissers as;

> "...*the design, planning ,implementation and control of coordination mechanisms between patient flows and diagnostic and therapeutic activities in health service organisations to maximise output/throughput with available resources, taking into account different requirements for delivery flexibility (elective, appointment, urgent and semi-urgent) and acceptable standards for delivery reliability (waiting list, waiting times) and acceptable medical outcomes."*

(Patient Flow based Allocation of Hospital Resources, 1994)

*T*he relationship between some of the aspects of healthcare and production can be summarised in the following table; (Vissers, et al., 2005 p. 27)

Characteristic	Manufacturing	Health care
Object	Material flow	Patient flow
End product specifications	Up-front specified	Subjective
Means of production	Equipment and Staff	Equipment and Staff
Buffers	Stock or lead times	Waiting times in queues
Financial goal	Profit	Cost Control

Table 1 Table of similarities and differences

Different methods and techniques have been developed in the industrial engineering profession, operations management and operations research fields to solve manufacturing challenges. Because of the above mentioned similarities these tools can now be used to solve health care challenges.

Some possible methods and techniques will be discussed to find the appropriate ones to use in the study.

2.1.3.1 Different industrial approaches to improve process:

The following approach is concerned with tools used to reduce waiting times. This tool has proven to be effective at solving waiting time problems.

Bottleneck analysis: This method of analysing a process focuses on the limiting factor of the process, the bottleneck. The logic is that if one can improve the limiting factor, the whole process will be improved.

By increasing the processing capacity of the doctor (bottleneck) the process of treating a patient will be completed sooner. The increase in doctor process capacity can be achieved in two ways. The one is to increase the utilization of the current capacity of doctor time. The other is to increase the amount of patients a doctor can process in the time available by reducing consultation times. (Vissers, et al., 2005 p. 236)

Theory Of Constraints (TOC): TOC follows the same logic as Bottleneck analysis. "A chain is only as strong as the weakest link" (Using industrial process to improve patient care, 2004). Anything that is done that improves the capacity of the constraining resource and that is safe enhances the process. The economic impact of these changes should be measured against the gain in throughput to determine if the change is worth the investment (Theory of Constraints: A review of the philosophy and its applications, 1998).

Steps to improve a process with TOC:

1. Identify the single most limiting factor in the process.
2. Get maximum usage of that specific constrain.
3. Support the constraint by making it only do the work that cannot be done by anyone else.
4. Prioritise the constraining operation/resource so that all other resources contribute to maximizing it.

(Using industrial process to improve patient care, 2004)

Optimised Production Technology (OPT): OPT is a decision support tool developed to coordinate decisions in an environment where various products (different DRG) should satisfy a specific demand. OPT calculates a production plan that maximises the throughput under specific conditions(resource constraints) (Vissers, et al., 2005 p. 35). This seems to be the ideal tool to implement at the ER.

There are, however, critical problems. The following assumptions are made in OPT:

a) There is a stable bottleneck;
b) OPT mechanism is based on deterministic planning concepts.

The bottleneck in the ER is highly unstable because of the nature of the work that can be done by the staff. The ER staff is highly adaptable to different situations in which they may find themselves. OPT results are very sensitive to changes in bottleneck capacity.

Planning in the ER is of a stochastic nature that is dependent on various unpredictable factors. The fact that OPT uses deterministic planning concepts does not represent the reality of the ER.

Due to these assumptions in OPT it cannot be used in the ER environment.

Enterprise Resource Planning (ERP): ERP is the successor of Manufacture Resource Planning. The ERP systems plan demand and capacity on a aggregated estimates.

Some of the drawbacks of ERP are:

- Process requirements need to be described precisely;
- Assumption that lead times are known;
- Require fixed process or routings;
- Assumption of deterministic processes.

(Enterprise resource planning for hospitals, 2004)

The use of a ERP system in a hospital has specific circumstances under which it should be used. The ERP is very useful for planning and controlling deterministic processes (Enterprise resource planning for hospitals, 2004).

Hospital Resource Planning (HRP): The system is based on the concepts of DRG and manufacturing resource planning (MRP-II). Advances are made on four main fronts 1) consideration of DRG as products with Bill of Resources; 2) implementation of hospital-wide planning and control systems; 3) the linkage of detailed on the various modules and gross to net requirements logic with treatment staging; and 4) new information systems support for process reengineering and redesign in hospitals (Hospital Resource Planning; Concepts Feasibility and Framework, 1995).

"HRP system will depend very much on the environment and the planning and control process." (Hospital Resource Planning; Concepts Feasibility and Framework, 1995) Implementation of HRP should happen on a hospital wide basis. The implementation requires large amounts of data about each of the different DRG's resource requirements to be effective. Also the treatment of a specific DRG by different doctors has to be assumed to be homogeneous to be useful in HRP.

Lean thinking: Lean thinking seeks to promote the processes that generate the most customer (patient) satisfaction. Quick, efficient and waste-free products (treatment) is the ultimate goal. Applications in health care include minimising delays, errors and incorrect procedures.

Concepts of lean thinking:

- Value – Treatment should be given that fits the patient's requirements to increase patient satisfaction;
- Value stream – Each step in the process of treating a patient should add value (treatment/care) to the patient;
- Flow – The process should flow efficiently without any intermediate storage (queues);
- Pull – Flexibility must be maintained in the process so that it can respond to changes in demand;
- Perfection – The aim of lean thinking is to develop a process that creates no defects.

(Using industrial process to improve patient care, 2004)

2.1.3.2   Unit and chain perspective

The unit perspective is represented by a single unit in the caring process such as X-ray or labs. The purpose of the unit manager is to run the specific service as beneficially as possible. The unit manager has total responsibility over his/her unit. The primary objective of the unit manager is to deliver the service required by others from the unit, while maintaining a balanced load on the available resource to maintain satisfactory working conditions.

The focus of unit logistic perspective is to maximise the flow of patients/service with the available resources.

Chain perspective can be represented by a patient group, i.e. trauma patients. The focus of this perspective is on the whole process to which the patient is submitted when being treated, from admission to discharge. Different units form part of the treatment process and are involved in the total chain of care the patient receives. The aims of a chain perspective are to reduce the waiting times in the process, reduced throughput time and quick access time to the needed care. The chain perspective does not take into account the condition under which the units has to work to achieve optimal chain output.

A network perspective approach combines units and chain into the process that a specific DRG goes through in the treatment it receives. For the chain of care to be as effective as possible a balance between the units need to be established for maximum chain throughput. The ideal throughput for the one unit is seldom in line with the ideal conditions of the following or preceding unit in the care chain. A solution for all the units that is involved in the specific process is needed to optimise the resources used and the waiting times in the process.

Items	Unit perspective	Chain perspective	Network perspective
Focus points	Resource utilisation; workload management	Service level	Trade off between resource usage and service
Strong points	Capacity management	Process management	Combination
Weak points	Not process oriented	Not related to use of resources	More effort
Suitable for	Efficiency analysis	Process design	Efficient process design

Table 2 Comparison of Unit and Chain perspective

2.1.3.3 Analysis Methods of changes

Queuing Models: By representing the reality by relatively simple equations a deep insight into the process can readily be found. Queuing Models take the arrival and service characteristics into account to produce theoretical answers to questions such as: how long does a patient wait and how long is a patient in the process? The implications of changes can be analysed by using this tool to establish if the specific change has a worthwhile impact on the process.

Computer simulation is a modelling tool used to model the behaviour of systems and processes of a stochastic nature. (Kelton, et al., 2007 p.8) This model can represent the process in infinite detail. Simulation modelling is used to analyse changes in the process and the effect those changes has on the whole process simulated.

Chapter 3

3.1 Tools and Techniques used for problem solving

Problem solving will continue on two fronts; resource related and service related.

3.1.1 Resources:

Doctor time, nurse time and beds are the main limiting resources in the ER. These resources are the main factors that influence the through put of patients. An analysis of each of these resources follows:

Doctor Time: Doctor time is the time a doctor spends on a patient in the process of treating the patient.

This is a resource that is different from most other resources. Firstly, the resource is a key operator in the process of treatment. Secondly, the resource can use other resources such as nursing time and services such as the labs.

Doctor time is a highly flexible resource and 100% utilization can be scheduled (Vissers, et al., 2005 p. 62).

Nurse Time: The time spent processing (caring) for a patient.

The traditional method of measuring nursing workload is done on a two dimensional care basis: direct and indirect. These measures do not represent the reality of the true working load on nurses (Measuring Nursing Workload: Understanding the Variability, 1997). The recommendation was made that a Meta-Paradigm should be used to study the workload on a nurse. The factors that should be included are Nursing Complexity, Medical Complexity, Medical Severity and Nurse and environmental factors.

60% of the variance in the workload can be explained. 9% by age , 19% by DRG, 5% by length of stay, 21% by nursing diagnosis pattern, 3% by environmental factors and 3% by nursing unit factors.

(Measuring Nursing Workload: Understanding the Variability, 1997).

The most significant factors contributing to variance in nursing time requirements are: DRG and nursing diagnosis patterns.

In the ER environment it could be argued that the time the majority of patients spends in the ER renders the need to take the length of stay into account pointless.

The conclusion is that the DRG is the main factor to consider when the patients nurses time requirement are to be calculated.

When calculating the resource requirement of a patient the priority(P1, P2,...) will be used to group the patients. Each group will have specific resource requirements linked to it.

The amount of nurses time available is a highly flexible resource. A target of 100% utilization can be set. Because of the flexibility of the resource up to 115% utilization is acceptable and operating utilization is usually from 85% utilization (Vissers, et al., 2005 p. 136).

Beds: The floor space, bed and other immediate equipment associated with the current non-expendable resource requirements of the patient.

The capacity of the ER is dependent on the type of bed in question. The beds in the ER can be divided into three groups: Trauma1, Medical1 & 2 and Other. Each of the types/priority of patient has a minimum requirement for a type of bed he/she needs. If this minimum requirement cannot be met the patient needs to be sent to another hospital. If the Trauma1 beds are full no P1 patients can be admitted until a Trauma1 bed opens up.

The Trauma2 and Other beds are rarely fully occupied. The Trauma2 beds have a fixed capacity whereas the Other beds capacity can be expanded.

3.1.1.1 Bottleneck analysis of specified resources

Each of these resources manifests specific characteristics. These characteristics are a function of the process in which they are used. The different processes can be described by the path of care different DRG / patient priorities follow.

Resource analysis will be done according to the main care process.

P1: P1 patents has the highest priority of need for treatment. P1 patients usually arrive with an ambulance so there is some notion of warning of the arrival. The patient gets ultimate priority above all other patients for resources. Concerning Doctor time and Nurse time these "resources" can leave (usually, because of the warning) whatever they were engaged in doing and attend to the P1 patient. The limiting resource in processing P1 patients is the amount of beds that can give the minimum required amount of support.

There are currently only 10 beds that can accommodate P1 patients. To reduce the probability of a patient arriving and being sent to another hospital there are two options. From a queuing theory point of view the traffic density has to be reduced.

$$\rho = \lambda / \mu\, n$$

Reduction of the traffic density can be accomplished by either reducing the treatment/stabilisation (service) (μ) time or increasing the amount of beds (servers)(n)

Reduction in service time is possible if the time a patient spends in the ER can be reduced. This is, however, not a function of the ER personnel. The time a P1 patient spends is divided into two components: stabilisation and waiting for a bed to open in a ward. The stabilisation

of a patient is done as speedily as possible because of the life threatening state the patient is in. The waiting of a bed to open in a ward is the responsibility of the personnel in charge of that specific ward.

The implication of adding a number of Trauma1 beds to the ER can be calculated by using optimization of queues (Windston, 2004 p. 336). An objective method for contrasting of the cost of sending a patient away and the financial cost of a Trauma1 bed will be needed.

The conclusion is that the options for increasing the throughput of P1 patients can either be done by increasing the beds or by improving the admissions of P1 patients to the wards.

P2: The number of P2 patients seen at the ER exceeds the number of P1 patients by a considerable margin. To improve the service to the majority of patients P2 process should be improved. The limiting resources in the P2 process is Doctor and Nurse time. The process can be described as follows:

Figure 4 P2 Process

The main waiting times (buffers) are before the Triage and Treatment operations. These operations are resource dependent operations. The doctors are primarily responsible for the triage and treatment operations with the nurses assisting them.

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A balance between the improvement of throughput between the two main bottlenecks in the system should be found. There is no total gain in speeding up the triage operation with all the resources if patients have to wait in the ER with no Doctor to attend to them.

A possible challenge and a blessing is the fact that the two processes use the same main resource. This means that the balancing of the process can be very complex because of the stochastic nature of the system. On the other hand the process has the ability to regulate itself through the movement of resources to the operation where it is needed most, the largest queue. The process can be simulated to get an idea of how it will perform under different conditions.

Assuming the process is self-balancing, improvements can be made at any of the operations to improve the total throughput of the process.

A critical analysis of the operations should be done. Time wasting activities can be identified and through brainstorming and fish bone diagrams the core problems will be identified. These problems can then be solved to have a beneficial effect on the total system.

3.1.2 Services
The three main services to the ER are: a) Administration; b) laboratories; and c) blood bank.

3.1.2.1 Administration
The administration is not one of the bottleneck areas in the process for patients. Problems do, however, exist because of the administration. For a patient to be identified with a patient number the patient needs to be registered on the hospital wide database. The patient number is needed for the Doctors to request blood from the blood bank and laboratory results for the patient. In the case of a P1 patient there is normally no time to wait for the allocation of a patient number.

There is a large variance in the time it takes to open a file for a patient. The average time a patient waits is also longer than the average time spent to open a file. This is in a stable process with two servers.

Motivations for this behaviour will be investigated by means of interviews with administration staff.

3.1.2.2 Laboratories
Laboratories receive a call from the nurse desk to collect a blood sample from the ER. Someone has to walk to collect the blood from the ER and then walk back to the laboratory with the sample for analysis. A high variance is experienced in the time spent to collect the samples. The blood analysis is also a possible critical part of the process of treatment, especially when the patient needs blood and the blood type has to be identified .

There is a tube system installed in the ER that can be used to send samples to the laboratory but is not in working order.

By changing the schedule of porters collecting the samples from the ER the pre-processing times can be reduced. Analysis of current state of the performance of the collection method could put pressure on management to make funds available for re-commissioning of the tube system.

3.1.2.3 Blood bank

The blood bank provides the hospital with blood. The blood bank also uses someone to collect and deliver the blood to the ER. Unfortunately the blood bank is situated in Tshwane District hospital next to SBAH. The supply of blood to the ER is thus an unreliable source. The current methodology used for the management is a no stock JIT approach. Because of the variability of the delivery and the short lead times needed for emergency blood, a buffer should be considered.

By looking at the most popular types of blood needed and the frequency of the blood needed a stochastic EOQ model can be used to analyse the possibility of keeping blood in the ER. The cost will be included into the holding cost of the blood (product). A method of measuring the cost of shortage will need to be developed.

If the analysis reveals positive results the proposal can be taken to top management for consideration.

Chapter 4

4.1 Data analysis

Analysis of various collected sets of data was necessary. Different methods was used to analyse the data according to the information that was sought from the analysis. General data analysis is described in this chapter. Problem specific analysis is described at relevant discussions.

4.1.1 DRG Analysis

Knowledge about the DRG admitted to the ER is fundamental to the understanding of the operations and processes in the ER. The different DRGs each has specific resource utilisations. Treatments and time spent in the system varies greatly between the groups.

Collection of the daily statistics over a 18 month period between January 2008 and July 2009 was used to attain the data. Processing of the data was done by using Microsoft Excel. The collected data was sorted according to DRG and admitted date for each month. Averages were calculated for each DRG.

Analysis of the DRG over 18 months prior to analysis revealed the following results:

Monthly average over last 18 months	
Burns combined	9.49
Chest pains combined	88.28
Children 6-12 combined	136.57
Organo poisoning	4.14
Overdose combined	13.27
P1 Medical combined	59.39
P1 Trauma combined	58.39
P2 Medical combined	976.61
P2 Trauma combined	514.98
P3 Medical combined	272.00
P3 Trauma combined	231.71
Peads 0-5 combined	85.00
Private Patients	295.85

Table 3 Monthly DRG's

The prime reason for collecting the average amounts of patients for each DRG was to assess the percentage of the total patients each DRG accumulates to. By doing a Pareto analysis of the DRG it can be seen from what DRG the majority of patients are admitted. By knowing which DRGs represent the majority of patients these DRGs will be the priority for improvement.

A calculation of the average monthly amount of patients per DRG was assumed to be sufficient for the purpose of this analysis. Calculation of the standard deviation and mean of patients per month per DRG was unnecessary.
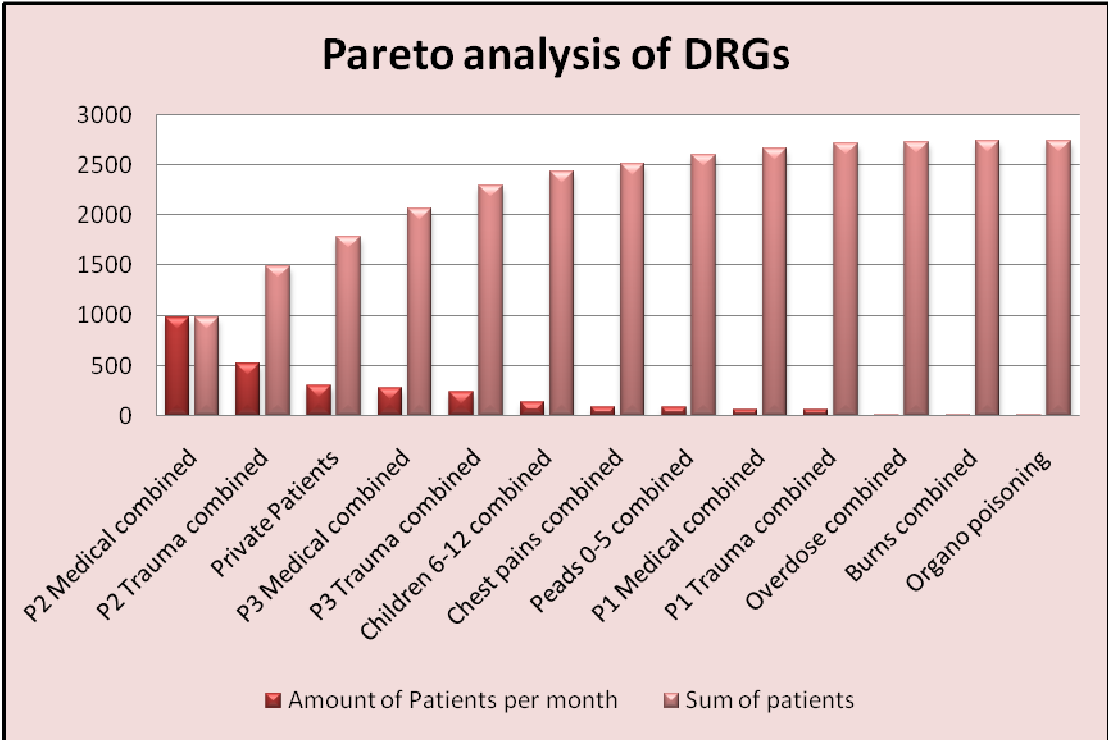
Graph 1 Pareto of DRG

It can be seen that the first five DRGs represents 83% of the total monthly patients. If the private patients are excluded the summation of P2 and P3 patients represent 72.6%

DRGs representing the majority of patients are in descending order: P2 Medical, P2 Trauma, Private patients, P3 Medical and P3 Trauma.

4.1.2 Admission analysis

Analysis of the admission characteristics of the ER will give a good insight into the process behaviour. By doing a statistic stability analysis of the time between each admission to the ER it can be established if the admissions to the ER is stable. If the admissions is not stable the analysis can help in identifying some possible problem areas or practices in the ER. If admissions appears to be stable the chaotic nature of the system can be assumed to have less of an impact on the process and stochastic characteristics can be fitted to the process in question.

Chart selection

After initial analysis of process it was noted that the time between admissions had a very large variance compared to the median time between arrivals.

It is assumed that the best representation of the process will be received by using an *Individual* and *Moving Range* chart. The *Individual* and *Moving Range* chart is the preferred chart to use when stability of a process with large numbers of measurements with high variances are tested.

Subgroup size

According to chapter 8 of *Quality Management* by Gitlow and Oppenheim it is recommended that a subgroup size of at least a 100 measures should be used when Individual and Moving Range charts are used. (HS, et al., 2005 p. 253)

Data collection and processing

Collection of 113 data points was done by using the log book of patient admissions that is used by the ER staff. Each admission to the ER is entered into the log book as soon as a patient is admitted to the ER. This data is used by the ER staff to verify the status of the different beds in the wards of the ER.

The time of each admission was used to calculate the time between admission.
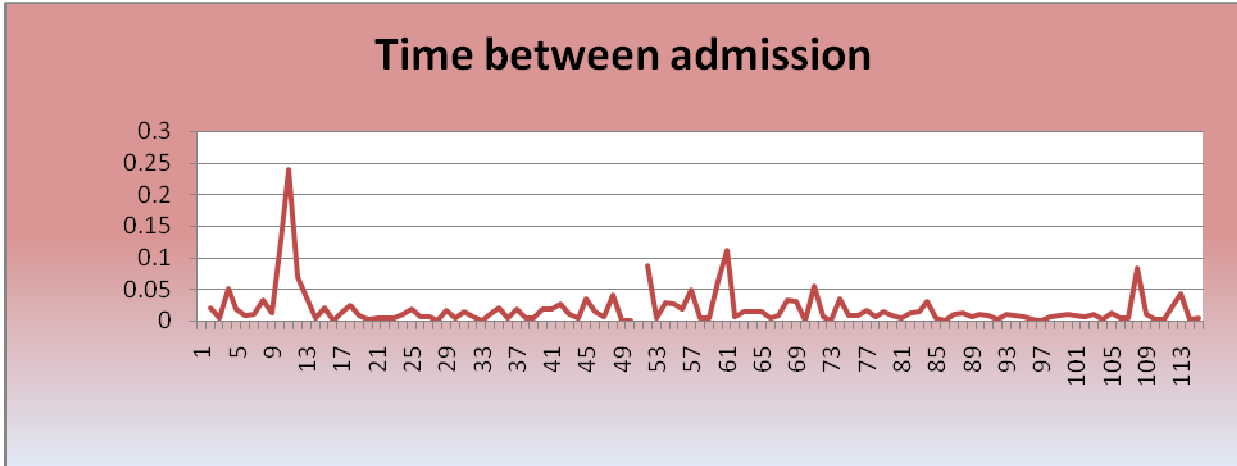
Graph 2 Time between admissions

Data analysis and processing was done using Microsoft Excel software and the processes and techniques described in Gitlow and Oppenheim.

The centreline of the data and control limits was calculated. Because Inflated control limits was expected the upper and lower control limits based on both the Median and Average was compared.

	Centreline	Upper Control	Lower Control
Average time	00:13:00	00:50:15	00:00:00
Median time	00:26:36	01:07:28	00:00:00

Table 4 Control Comparison

The method with the smallest bandwidth should be used (HS, et al., 2005). The average based control limits will thus be used.

The range of times between each admission and control limits based on the average time is represented as follows:
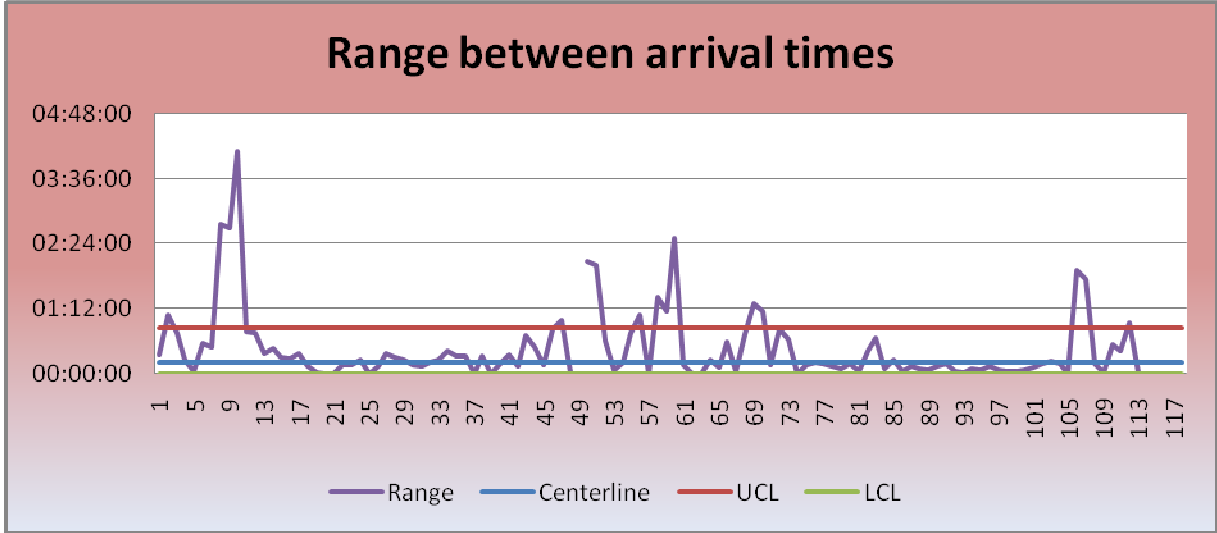
Graph 3 Arrival time ranges i

By investigating the out of bound points it was established that the majority of these points was admissions made during the early morning hours i.e. between 2am and 5am.

By removing the above mentioned points the chart change to the following:
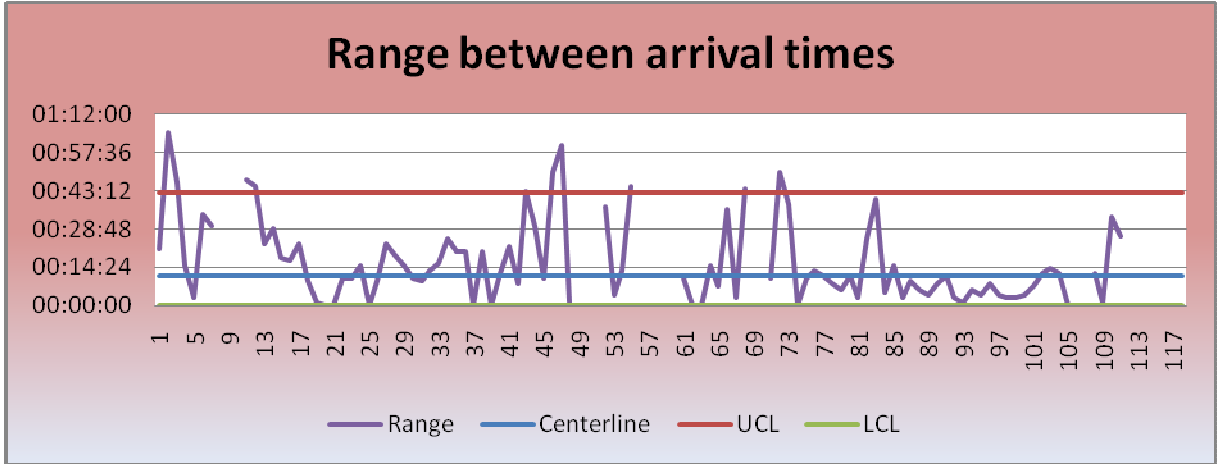
Graph 4 Arrival time ranges ii

The range between the admission times is still out of control because of the data points that are outside the upper control limits. This concludes that the admission characteristic of the ER is not statistically stable.

Distribution of data.
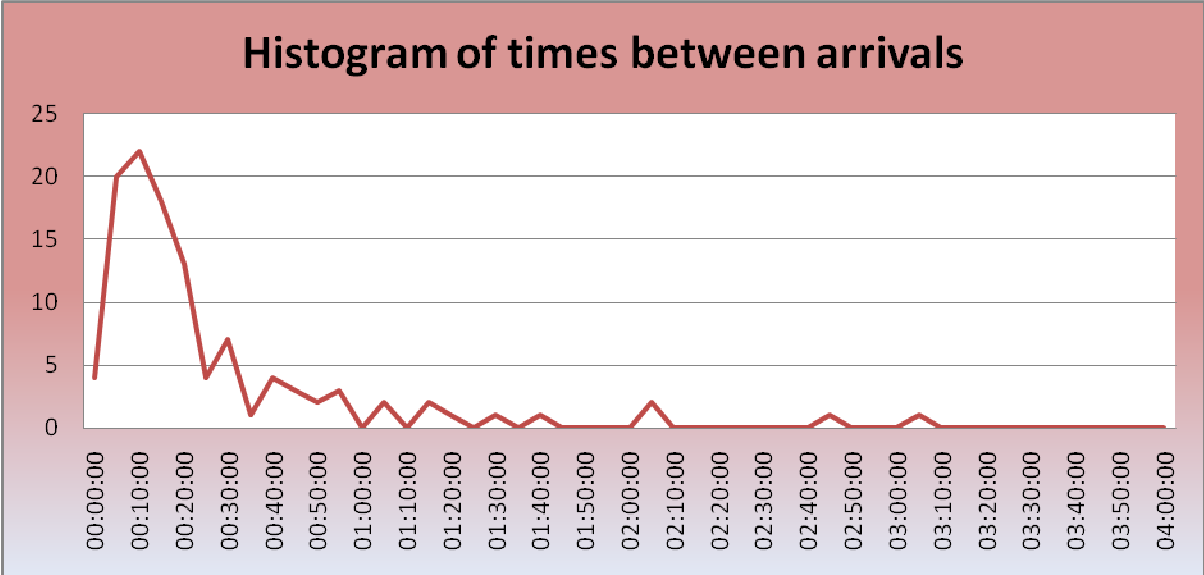
If the time between arrivals is plotted according to frequency over the 113 analysis a histogram of the admission can be drawn. The histogram plots the frequency of a data point within a 2.5min timeframe and to a maximum of 4 hours between admissions.

Graph 5 Histogram

By glancing at the histogram of the inter arrival times it seems that an exponential distribution can be fitted to the data.

Times between arrivals of P1,P2 andP3 was grouped into 10 categories. The number of counts in each category is as follows:

Category	Time between (minutes)	Amount
1	0 – 2.7	10
2	2.8 – 5.8	22
3	5.9 – 9.3	9
4	9.4 – 13.3	18
5	13.4 – 18.1	14
6	18.2 – 23.9	10
7	24.0 – 31.6	11
8	31.7 – 41.9	4
9	42.0 – 59.9	9
10	60.0 +	0

Table 5 Histogram categories

By doing a Chi-square test a value of 20.85 was calculated. A cut-off value calculated by using the parameters of the test gave a value of 15.5. Since the test value of 20.85 is more than the cut-off value of 15.5 the time between all arrivals cannot be modelled by using a exponential distribution.

Chapter 5

5.1 Idea generation and verification

The idea generation process was done in various ways. From an informal discussion with a nurse or clerk to a meeting of doctors in a conference room.

Theoretical solutions was suggested to some of the problems. A conversation was then started on how these solutions would impact various other areas of the ER and other departments. Challenges in the theoretical improvements were identified and discussed. Insights from other parties revealed numerous practical solutions and new problems.

The discussions led to two categories of thought;

1) Proposals able to implement and improve the process
2) Defining of other challenges where implementation is currently not a option or the change is more a change of mindset.

5.2 Changes and implementation.

Implementation of proposed plans and changes requires that theoretical solution are to be adapted for practical use.

By using the theoretical background gained from the literature study practical improvements can be sought that should (theoretically) improve the process. Practical implications have the potential to overrule the theoretical answers to a problem and require an innovative solution to be sought.

Problems identified during the brainstorming sessions and in conversations held were discussed with various staff members. By cross checking these problems those with the highest impact on most of the ER staff were identified.

The identified problems are:

- Laboratories;
- Administration;
- Limited number of beds.

These are some of the problems the ER staff experience as factors limiting their capabilities and the quality of care they are able to given to patients. The problem is seldom apparent at first glance. Further investigation in all of these problems resulted in finding root causes of the problems in the ER.

5.2.1 Laboratories

Laboratory services the ER uses can be divided into two by looking at the service providers. NHLS Laboratories provide the core analysis of samples and the Blood bank provides the ER with blood.

5.2.1.1 NHLS Laboratory background

The service the NHLS laboratory gives to the ER was identified as being critical to the time a patient spends in the ER. It is thus a crucial part in overall improvement of the ER.

The flow of a sample to the NHLS laboratory starts by waiting for a porter to collect it from the ward of department or ward where it was drawn. The porter takes the sample to the Laboratory and removes it from its bag and displays it with the form that was filled in by the doctor. The sample is then sent to the preparation area where the data from the form is put on a database. When the sample is registered on the database it is sent to the analysis area where it is analysed for the required tests. After the tests are done the preliminary results are verified by a technologist or clinical assistant. After the tests are verified the results are uploaded onto the network and the results are available to the staff.

Factors affecting the time from drawing of blood to the availability of results on the network are described in a hierarchy format:
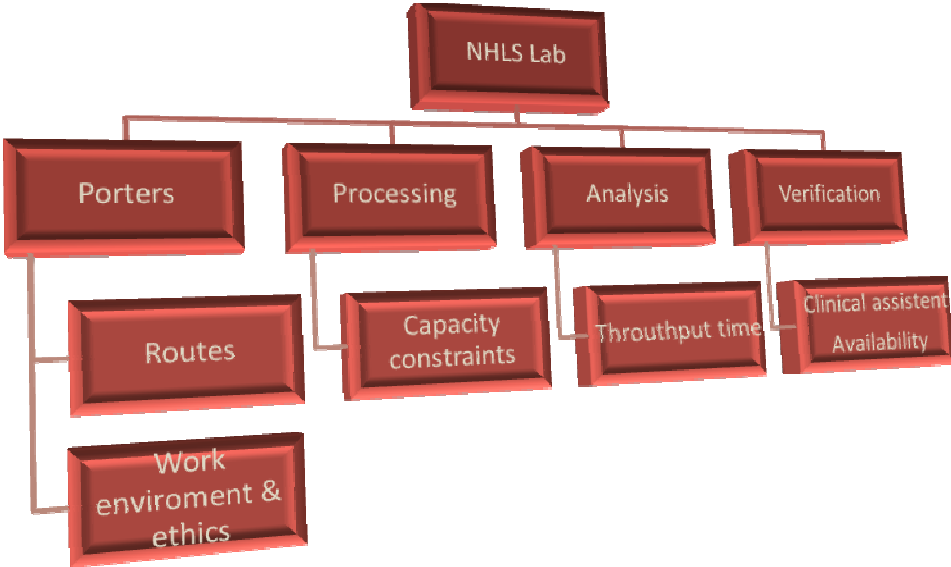

Figure 5 NHLS Lab processes

Routes
Currently the porters travel a circular route on their designated floors once an hour. They leave every half past the hour. There are seven routes covering the nine flours the route is roughly described by management but not really enforced. The important thing for

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management is that the porters collect all the samples on the specific route not how they do it. As a result each person travels in a slight different manner and thus the times it takes to complete the rounds vary. For the route on the 3rd and 4th floor the porter takes the lift from the 5th floor to the 3rd floor, he the collects all the samples on the 3rd floor and moves up the stairs to the ER on the 4th floor and then collects the rest of the 4th floor samples on his way back to the 5th floor where the lab is situated. The median travelling time is 25 minutes. The time spent to take the samples out of the bags and staple the paper onto the bag normally occupies 5 minutes. This gives a utilisation of .5 of the porter working on the 3rd and 4th floor.

Because of the low utilisation of the time spent optimisation of the route travelled is not a priority. The objective is to increase the utilisation of porter time and level the arrival of samples to the processing part of the system. Utilisation should increased in such a manner that the porters would not feel that their work increased significantly. Levelling of arrival of samples is needed to reduce the mean waiting time. The current method of collecting the samples only on an hourly basis produces a large spike in the queue each time when the porters arrive from their rounds.

Work environment
The porters are not employed by the hospital but by the NHLS laboratory group. Thus the hospital does not have direct authority over them. Porters have been working for a long time and does not feel compelled to provide an improved service. They only want to do the least of what is required from them. The porters employment is dependent on a pneumatic tube system not working. This creates tension between the porters and those persons trying to improve the global system. Careful consideration must be taken not to upset the porters while at the same time every effort is being made to improve the service they provide to the ER and the hospital as a whole.

If the porters are upset and do not understand the importance of changing their customs, the implementation of the improved routes could be impeded.

Capacity constraints
When the samples are received they go to a sorting area. Sorting takes place according to the type of tests that is required and the urgency of the results. From sorting the samples are taken to the typing area where all the information is digitised and a lab-number is given to the sample. The lab-number is put on the sample and taken to be processed.

There are currently eight typist working in the typing area. The arrival of the samples on a periodic basis puts a lot of strain on the typing staff. A levelled distribution would relieve the pressure from the typing staff and reduce waiting times.

Sample analysis throughput
Analysis of the samples is done automatically on various machines according to the type of test needed. The throughput of the automatic machines is practically fixed and there is very little variation in the analysis time. A variable time in the analysis process is the "setup" or

calibration time. The machine has to be calibrated each morning to make sure of the quality of tests done. Since the operators working on and calibrating the machines are very well trained the setup times are also stable.

There is limited room for improvement in the analysis part of the processing of the samples.

Verification

Verification of samples has to be done before the results can be posted on the hospital wide network. Verification can only be done by a clinical assistant or qualified technologist. This creates another potential bottleneck and increased waiting times.

5.2.1.2 Analysis of NHLS lab

A process wide analysis was done to establish where effort spent will have the largest positive impact on the quality of service provided by the NHLS to their clients in the hospital.

The following areas were identified after initial analysis of the laboratory and consultation with NHLS employees. By implementing changes in these areas a meaningful impact could be made. Opportunities to change the current operating procedures presented themselves.

a) Porter travelling routes
b) Availability of test results

a) Porter travelling routes

Data collection

Collection of data from the laboratory was done using various methods to attain the correct information from the system.

To establish how the porters spend their time three techniques were used: Analysing data from laboratory logbooks, interviews with employers and time studies.

Firstly the breakdown of their time had to be done to establish what they were doing during their working day.

At the outset information was obtained by interviewing employees of the laboratory. By interviewing the manager of the laboratory in SBAH good insight was gained about the internal workings and limitations of the laboratory. It was established that there is a shortage of staff in the typing and analysing areas. Poor performance of the porters was a known fact. Improving the collection process was identified to be an area where implementation of a new method could be considered. Access to the porter logbooks was

gained and permission was granted from NHLS management to analyse the porters performance.

The data of 94 random, recent rotation was drawn from the logbook , 48 of which were during normal office hours. This rotational log represented the times the porter left the laboratory and each time he logged in at one of the collection stations and when he returned to the laboratory again**.** The average, median and standard deviation of the route times were analysed by transferring the printed data to an excel worksheet and doing calculations using the software.
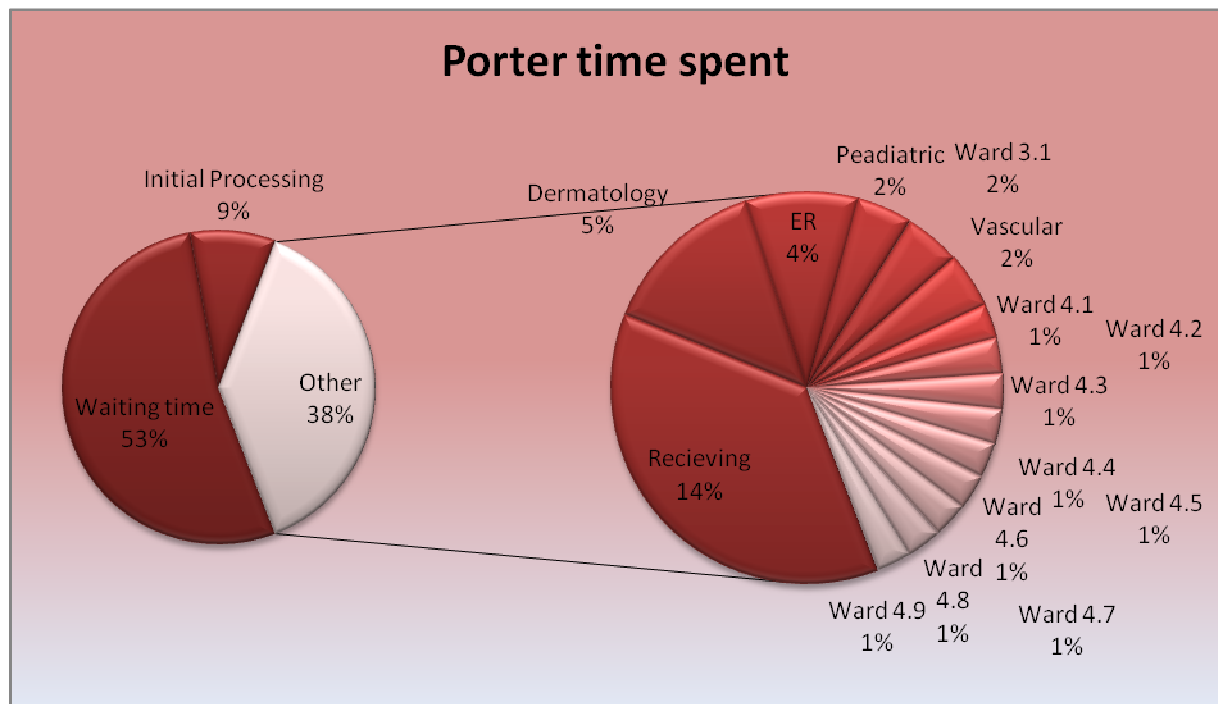
Porter travel times	
Median	00:22:30
STD deviation	00:05:58
Average	00:24:23

Table 6 Porter travel times

The travelling time spent between the different collection points was also calculated. Because of the fact that each porter travels in a different sequence to the collection points the analysis had to be done by looking at all the different routes and finding the same groups of two specific collection points (e.g. Casualty and Vascular ward). All of the travelling times between these two specific destinations were analysed and an average travelling time between the two destinations could be calculated. The sum of these times corresponded to the total travelling time.

For verification of the analysis the porters were timed without their being aware of it. The travelling times of the porters on their routes were taken at random. These results were compared to the time from the logbook and they corresponded closely.

By using all of the information gained from the above mentioned processes a utilisation breakdown of the time the porter spends was drawn:

Figure 6 Porter time spent

The low utilisation of the porters verified the opportunity to increase the performance of the collection methodology.

Possible Alternatives for porter travelling routes

Eight different route-schedule alternatives were analysed to establish which would have the best impact on the processing time of a sample. The impact of the different route-schedules was analysed through simulating the pre-processing of the samples.

Periodical arrivals of the samples suggested a possible problem in the original method of collection. The fact that porters arrive within a small time window (+-7min) creates a large queue at the receiving of the samples. This sudden increase in the number of samples that have to be processed puts the staff under strain to process it as quick as possible.

A schedule was sought that would be acceptable from the point of view of both the porters and clients and that could decrease the time a sample spends before it is being analysed.

The ideal situation would be that the samples would arrive as soon as they are collected from the patient. By striving towards the ideal but with the known constraints, alternatives were devised. The first methodology for creating an alternative was to divide the arrivals of the porters at the collection. Levelling of the strain put on the laboratory staff is done this way.

The second was to decrease the time a porter spends between walking his route thereby reducing the time a sample waits to be collected. A combination of the two methodologies was used to create six alternatives.

Alternative number	1	2	3	4	5	6
Cycle Time (min)	60	45	60	45	60	45
Time between departures (min)	0	0	10	5	15	11.25

Table 7 Alternative duration

The seventh alternative was created by combining two of the four routes. This creates two route-groups, each with two porters available. The combination of the routes is possible because of the low utilization of the porters. Each of the two available porters to each route-group walks his rounds every 60minutes but with 30minutes between the two. The eight alternative is similar to the seventh but there is a 15minute gap between the arrivals of route-group A and route-group B.
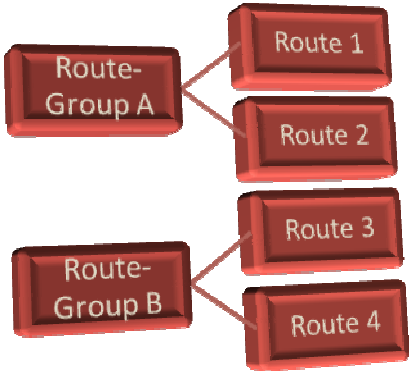

Figure 7 Route groups

Alternative number	7	8
Cycle Time (min)	60	60
Time between departures (min)	0	15

Table 8 Alternative duration

Simulation of possible schedules

A model of the pre-analysis process was created using Arena software. The model included all the main steps followed during the process in question and the applicable resources. The different alternatives were tested using the same model. The model was a simulation of a normal working day. Data was used that was gathered from the NHLS database and time studies done in and around the laboratory. These times was processed in Microsoft Excel.

It was assumed that the processes where people are involved and the times they are busy are distributed normally. No warm up or cooling down period was used because a) only one day at a time was simulated and b) the lab starts with an almost empty process each day (Only emergency tests are done during the night).

The basic logic (processes, resources and flow) of the simulation model can be described by the following flow diagram:
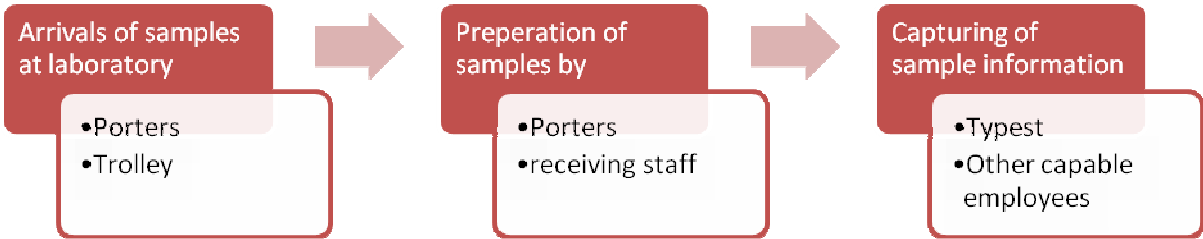
Figure 8 Basic simulation logic

Ten working days were simulated with each different alternative. No changes in resources were simulated since it was assumed that all staff would be present. This assumption was made because there is some redundancy in the staff and it is possible for some staff members to fill a critical position if it is necessary to do so.

By combining the time a sample waits for collection by the porter at the ward with the pre-testing time a total time to testing can be compared.

Alternative number	1	2	3	4	5	6	7	8
Ward waiting time (min)	30	22.5	30	22.5	30	22.5	15	15
Average Pre-processing time (min)	32.7	27.61	22.9	24.7	18.5	18.1	20.4	15.6
Total time to testing (min)	62.7	50.11	52.9	47.2	48.5	40.6	35.9	30.6

Table 9 Alternative duration

The alternative with the shortest total time to testing is alternative 8. Alternative 7 has the second quickest time. The increased utilization of the porters combined with the levelled arrival of the samples and increased frequency of collection has the possibility of reducing the total time to testing by with about 30 minutes.

Implementation

Implementation of the proposed alternative was done successfully after some initial complaints from the porters.

By assessing the results of the implementation by comparing 17 random samples times with measurements taken from before the implementation the following was found:

	Before	After	Difference
Average	01:58	01:19	**00:38**
Mean	01:59	01:18	**00:41**
Std dev	17:23	03:38	**13:45**

Table 10 Alternative result

The positive results in the pre-processing time is confirmed in the analysis of the results of the implementation of the new schedule.

The true time for analysis to go through the pre-processing was longer than the simulated times. This could be due to the ineffectiveness of the porters in the collection of the samples and most likely to the limited amount of staff working during the time the above mentioned measures were taken.

The longer pre-processing times can thus be explained by the changing conditions in the system during the time between the simulation and the analysis.

Repercussions

Due to the time studies in the laboratory and the results of those studies there was a spark of change in the NHLS laboratory and the hospital. Partially due to the above mentioned efforts the tube system has been repaired and re commissioned.

Final testing of the tube system between the ER and the laboratory was done two days before the project deadline. The system was confirmed to be working by both the heads of the ER and the NHLS labs. As a result the travelling time for a sample between the two units is reduced to only a few minutes.

b) Availability of test results

Verification of the results needs to be done before the tests are made available. Currently the most unstable waiting time in the whole process of requesting test results is the time a test result waits to be verified. This time ranges from 30 minutes to up to 16 hours.

By ensuring that the preliminary results for some of the tests are available the time a doctor has to wait for the test results will be reduced. The majority of the tests that take an exceptionally long time to be verified are tests done at night. These have to wait to the next day for verification.

Treatment of patients varies greatly depending on the results of the ordered tests. What is envisaged would causes the tests to be made available only after verification thereby reducing the chance that patients will be incorrectly treated.

A possible solution could be to reduce the amount of porters working due to the tube system that is re commissioned. The newly available funds could then be used to employ a clinical assistant during the night shift to verify the results after hours. This will reduce the

initial waiting time for results to be verified and lighten the morning working load of the day time staff.

5.2.1.3 Blood bank

The blood bank was not earmarked as being one of the services that has a large negative effect on the performance of the ER. Thus no further analysis of the blood bank was done. Time and resources was used otherwise.

5.2.2 Bed relations and limitations

5.2.2.1 P2 trauma medical bed relationship

The limited amount of space and resources affects and constraints the amount of beds available in the ER. Space for a total of number of 33 bed are available. The relationship of the number of beds available for each type (Medical or Trauma) of DRGs has a large impact on the operating characteristics of the ER. The amount of beds available to each type of DRG dictates the expected time a patient will wait for a bed, the probability of a patient being admitted upon arrival, the expected number of patients in the system and much more.

The minimisation of the expected waiting time was the main objective to increase the quality of care to patients. Reduction in treatment times was conceived by increasing the performance of the services used to treat the patients.

Objective function measured the perceived waiting time for each type of patient. The perceived waiting time for a medical patient is less than the perceived waiting time for a trauma patient. One minute waiting as a trauma patient can be seen as having the same negative effect as two minutes of waiting as a medical patient.

Modelling the impact of a changing number of beds available to each type Queuing Theory will be used. The optimisation of the model will be done on a basis of industrial analysis using Microsoft Excel.

For using Queuing Theory the assumption of Exponential arrivals has to be made.

Times between arrivals P2 was grouped into 5 categories. Only P2 arrivals was modelled because P1 has separate beds and P3 patients do not require a bed. The number of counts in each category is as follows:

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Category	Time between (minutes)	Amount
1	0 – 12	16
2	13 – 27	10
3	28 – 49	9
4	50 – 86	7
5	87 +	10

Table 11 Category amounts

By doing a Chi-square test a value of 4.34 was calculated. A cut-off value calculated by using the parameters of the test gave a value of 7.814. Since the test value of 4.34 is less than the cut-off value of 7.814 the time between arrivals can be modelled by using a exponential distribution.

By assessing the daily statistics over 18 months it was established that trauma and medical patients arrives at 1.01 patients/hour and 1.70 patients/hour respectfully.

Due to difficulties in tracking patients in the ER the best information on the time needed to service the patient was gathered from discussions with nursing and doctor staff. It was concluded that 0.1428 medical and 0.2857 trauma patients could be seen in an hour.

The layout, equipment and current practice dictates that 6 of the beds are used for both medical and trauma patients. These beds can be classified as general beds. A total number of 27 beds are available to allocate to specific types of patients.

The objective function consists of the sum of the expected waiting time for each specific type of patient multiplied with their relative weight.

$$Objective\ Function = \sum_{1}^{2} Rwi \times Wi$$

Were $i \in 1,2$

      Rwi = Relative weight

      Wi = Expected waiting time

      i = 1 : Trauma

      i = 2 : Medical

Constraints to the problem:

The sum of the number of the allocated beds <= to 27

There should be at least 1 bed of each type

Queuing Theory

Queuing Theory calculation was done using Excel. Optimisation of the problem was done by assessing the different inputs (amount of beds for each type of patient) to the queuing theory model. The objective function was used as the driving formula and a 2-way data table was created. The first input being the number of beds allocated to medical patients and the second the number of beds allocated to trauma patients.

The minimum amount of perceived waiting time is found if 8 beds are allocated to trauma and 19 beds are allocated to medical patients respectfully.

The probability of being admitted into one of the allocated beds is 0.96 and 0.99 and a true expected waiting time of 2.4 and 1.5 minutes for medical and trauma patients respectfully.

5.2.2.2 P1 bed availability

A total of 8 beds has the equipment to support a P1 patient of an medical or trauma type. The time a patient spends in the ER is the main factor determining the probability of having to send a patient away because the beds are full. Assuming the arrival rate of P1 patients are stable, as they were over 18 previous months.

The time a patients spends in the ER has a non linear effect on the probability of sending a patients away. By demonstrating the effect the time a patient spends in the ER has on the probability of sending a patient away an understanding of the importance of this time can be found.

The arrival rate of P1 patients is 0.16 patients / hour and the amount of servers is 8 beds.
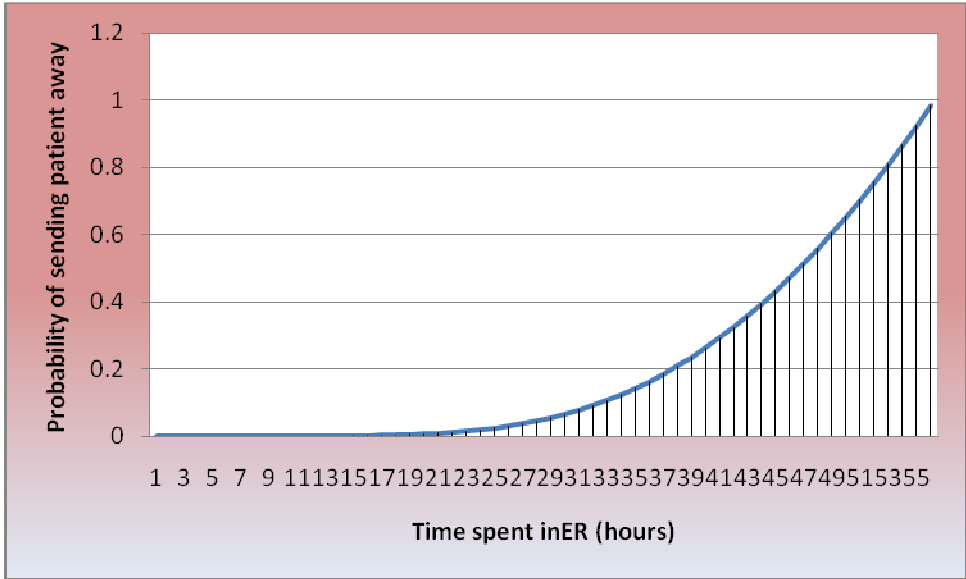
Graph 6 Probability

If patients spends 20 hours in the ER 0.5 of all P1 patients arriving will have to be send away.

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Reducing the time spent in the ER by transferring patients earlier to wards and trusting other personnel with patients will greatly increase the chance of admitting a P1 patient upon arrival.

5.2.3 Administration of patients

The time a patient spends waiting to open a file in order to receive a patient number is preserved by the patient as a non value adding step in the treatment process. Though administration of the patient's details is essential to the treatment process at SBAH, because an patient cannot be admitted or tests cannot be ordered without a patient number, it is a frustrating part of the treatment process.

To analyse the performance of the clerks the times to process a patient were calculated by taking 20 random samples times. These times were taken without the administration staff knowing that they were timed to ensure that the times revealed the true processing time. The average processing time was calculated to be 00:07:26.

By assessing the administration staff during the course of the study it was noted that they spend a lot of the time not serving the clients (patients). So, even though the time taken to do all the administration is not extensive there is still poor overall performance of the administration.

To increase motivation it was decided to develop a guideline to establish what is acceptable performance. This guideline will provide an acceptable time to spend waiting in line for the opening of a file as a function of the amount of clerks working at the specific time. Since there are very limited resources available in the ER it cannot fairly be expected from the ER staff that they should check the clerks conform to the guide. A possible solution is to make the guide available to the patient waiting in line. A simple graph could display the maximum expected waiting time. By increasing the transparency of performance of the clerks a possible increase in motivation will be nurtured and performance improved.

A maximum of four counters can be occupied by the clerks (servers). The arrival rate of the patients will be assumed to be the same arrival rate as the admissions of patients. This assumption is valid because only patients that are going to be admitted goes through the administration process. All the admitted patients have been to the administration and no patients go through the administration and are not admitted.

By using queuing theory the waiting time that a specific percentage of the patients(clients) should be served in can be calculated.

S: Servers = 1/2/3/4

λ: Arrival rate = 0.0714 clients / min (median of every 14 minutes a patient arrives)

μ: Service rate = 0.1411 clients/min (7:05 min per client)

$$\rho = \lambda/s\mu$$

$$\rho = 0.0714/s\ 0.1411$$

Modelling of the queuing theory analysis in Microsoft Excel created the ability to do a quick analysis of various states of the system.

For servers numbering from 1 to 4 an accepted waiting time was calculated by seeking a time that 85%, 90% and 95% of clients should be served in.

Amount of Servers	Acceptable waiting time for 95% (min)	Acceptable waiting time for 90% (min)	Acceptable waiting time for 85% (min)
1	42.9	33.0	27.2
2	22.3	17.3	14.3
3	21.3	16.4	13.5
4	21.2	16.3	13.4

Table 12 Acceptable times

These performance measures should be displayed for the clients to see and measure the performance of the servers accordingly. The amount of complaints will then be logged and assessed by the administration staff to enforce good and acceptable service.

5.3 Further challenges

Further ideas and challenges were identified with a positive and helpful attitude. Ideas were not criticised when they were suggested, rather the suggestion of new ideas was encouraged. The discussion had the overtone of a brainstorming session. Ideas were gathered from a range of people with a sound understanding of the intricate processes involved in the ER.

Three main ideas were identified through the various discussions:

- General short stay ward;
- Patient visibility improvement;
- Fast track.

5.3.1 General short stay ward

The idea is to have a General ward where patients can spend time when they are waiting for a specialist to see them. It is important to note that patients having to wait should be sent to such a ward. The patient thus needs to be stable and non critical. This is in contradiction to the only P1 and P2 policy the ER has in place at present, but is in line with the reality of the situation.

If a short stay ward is available the majority of referral patients can spend their time in this ward and not in the ER. Referral patients make up more than 40% of the total patient count. This will decrease the bed utilisation in the ER and relive the ER staff from relative low intensity care needed for such patients. Staff will thus be able to concentrate on the higher priority patients requiring more doctor and nurse time.

The ward needs to be a general ward to accommodate patients of all DRG's. This will increase the utilisation of such a ward. Special equipment needed for different DRG's should not be needed since patients would be stable and only basic care would be required.

Resistance to the suggested implementation of new ideas is grounded on two fronts; physical and mental barriers.

Physical room for any such ward would have to be found close to the current ER in an already crowded environment. Funding will be needed for a department that is already operating over budget and under staffed. Doctors working in the SBAH believe that the ER staff is better qualified and equipped to care for patients than the staff in some of the other wards. By implication some of the doctors are reluctant to move their patients away from the ER and into the wards. Unless staff can be increased the current staff will have to work harder to run a short stay ward.

Implementation of this improvement will have to be backed by top management to secure funds and floor space. Support from the staff will ease the implementation and could reduce resistance from management.

5.3.2 Patient visibility

Because of the chaotic nature of the environment it is easy for a patient to go unnoticed. By unnoticed it is meant that the patient details are not readily visible to staff. Simple details could be better displayed where they are more visible to staff. Details should include the doctor responsible for the patient, the patient's health- status, DRG and the time patient was last checked by, either a nurse or a doctor.

Increased visibility of patients could have a positive effect on the service the patients will receive at the ER. By noting the status and time from last check up from staff at a glance doctors can move more quickly between patients who are in need of their attention. Responsibility for patients will be more visually represented and personal ownership of patients could be increased.

A culture of high intensity and adrenaline exists in the ER so that it can happen that a patient can get lost in the chaos after initial care was given to him or her. By increasing both personal responsibility for a patient and his or her visibility staff will better be able to give the required care to each patient as and when the patient may need it.

Physical implementation of this idea does not involve excessive resources. The Identification of the patient can be done on a clip or Perspex board and a white board marker.

The mental resistance may well be more difficult to overcome.   The successful implementation will largely depend on the manner of employment of the system by the doctors and nursing staff. Because of the relative short stay of patients in the ER a culture change will be needed for doctors to accept personal responsibility for the particular patients. This culture change could have a negative impact on the morale of the doctors because of high mortality rate (+/- 1person/day) in the ER. The nursing staff will play a critical role in the successful implementation of a visual identification system.

5.3.3 Fast track

FIFO single server method is used in the triage of the patients. At the triage area the patients are ranked according to the urgency of medical treatment they need and not according to a specific queuing methodology. This has a negative effect on overall waiting time of patients. Some of the patients with relative minor ailments have to wait for long time for a rather quick treatment.

A fast track could eliminate the long waiting times for those patients who needs only a short consultation. Sending patients from the triage area directly to administration and then to the Fast track area will change the flow of patients through the system.
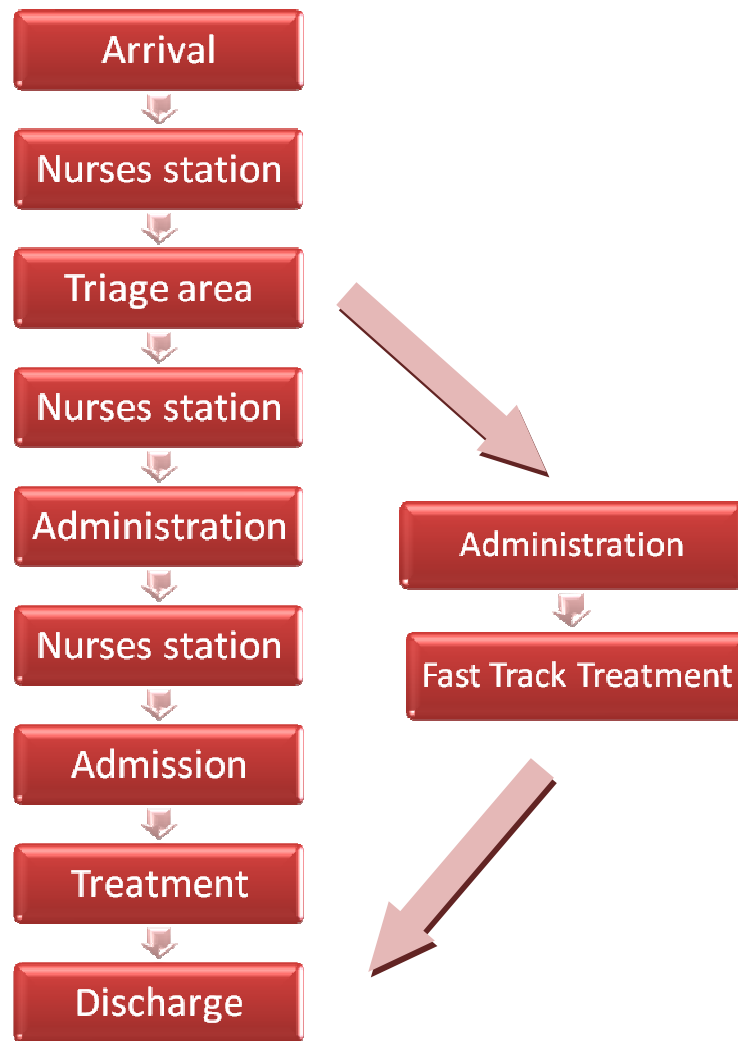
Figure 9 Flow of Fast track

Strict criteria would have to be adopted to keep the fast track from bogging down. The criteria can include prerequisites such as: patients who do not need a bed or any other services such as x-rays taken and a maximum time of consultation.

The location for a fast track does not need to occupy a large area. A small consulting room with basic resources should suffice. A junior doctor could be deputed to man such an operation when staff limitations would prevent more senior doctors from being available to work on the fast track. Funding for the transformation of a small office or room into a fast track will be needed from management.

To avoid patients from getting upset if they do not meet the requirements for the fast track the exit of the fast track should preferably lead away from the ER so that waiting patients will be unaware of other patients leaving ER after being treated.

If the fast track is implemented there is a chance that the public will view the SBAH ER in the same light as a clinic. They could then try to see a doctor faster for minor ailments at SBAH and not at a local clinic. This would overcrowd the whole ER and be counterproductive. By

allocating a doctor to the fast track more pressure is placed on the rest of the staff to keep the ER running.

Implementation of such a proposal would in the first instance depend on the willingness of the doctors to do the fast track work. Secondly a method should be implemented to prevent the majority of the public from trying to be seen at the SBAH. If it should become commonly known that quick basic care can be received at SBAH the ER could be turned into a clinic. Strategically a fast track option could thus be risky.

But with 25% of the total admissions over the last 6 month being P3 the idea of a fast track is a viable option to consider implementing in the future.

Conclusion

The world of healthcare service is a complicated and interesting world. Role players and stakeholders ranging from highly trained professionals to an dying homeless person. With such an range of inputs into an system of queues and servers, bottlenecks and delays, chaos and human predictability, a solution to a problem is bound to be needed.

Various problems was initially identified only to find, after careful analysis, the cause of the problem is rooted some were totally different. This fact included various, internal and external to the emergency department, processes into the project. The human factor in the system of healthcare showed itself to be present in all aspects of the project. Sometimes dominating the solutions, and problems.

As the root causes of the problems began to be understood in the environment an idea was developed to what changes would make a positive difference in the ER. Prioritisation of these challenges created the best opportunity for solutions to have a lasting effect on the emergency department.

The changing of the porter's schedule revealed some facts about the service that was not previously known or understood. By adapting to change these results not only an improvement in the service to the ER was made but to the whole hospital. Ultimately playing a role on the re-commissioning of the tube system reduced the time to wait for test results by a minimum of 90 minutes during the day and 150 minutes during the night. Results can now be received in less than an hour from the time a sample was taken.

The balancing of beds decreased the probability of a patient arriving and not having a bed ready for him. The global reduction in expected waiting time is also notable.

One of the best achievement of this project is not the reduction in the time a patient spends in the ER or the increased performance of the service to the ER. It is the education of the ER and service staff in the implications of their actions on the ER as a whole. This is applicable from the porters that linger while collecting samples to the doctors that is reluctant to move his/her patient to a ward.

By highlighting the effects of actions hopefully a culture of consideration, effectiveness and efficiency can be established in the emergency department of Steve Biko Academic Hospital.

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Appendix