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Mapping of pharmaceutical rooms in the Västra Götaland region

A pre-study for standardised work

Master's thesis in Production Engineering

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Abstract

The Västra Götaland region of western Sweden has invested in the new technology of automated pharmaceutical dispensers. Because of this, the work processes used in and potentially the layouts of pharmaceutical rooms in hospital wards will need to be reviewed in order to realise the intended outcomes of the investment; better working environment for employees, increased patient safety and increased process efficiency.

When committing to large development projects it is customary to start the process by ensuring complete understanding of the processes and facilities involved, in order to create optimal improvements.

This thesis aims to create the foundation for future standardisation of pharmaceutical rooms in the Västra Götaland region. To achieve this, a review of regulations, standards and routines concerning the processes in and layout of rooms was conducted, as was a mapping of nine rooms currently in use in the region. Theory regarding work design and standards is presented to give a context to the findings of the project.

Keywords: standardisation, work design, regulation, routine, process, layout.

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1. Introduction

In this first chapter, the topic and subject area of the thesis is laid down in order to set the scene for the work.

1.1. Background

Continuous improvement is a fundamental part of maintaining good quality (Bergman & Klefsjö, 2010). In time with technological developments, improvements are also needed for the surrounding infrastructure and the manual work conducted by employees. Popular manufacturing industry methods have seen a shift in focus from reduction of staff and assets to improving the current work processes. One such industry method, Toyota Production System (TPS), saw the introduction of the notion of waste in processes such as transport, waiting and producing defective parts, and much of the improvement work concerns the reduction of these wastes. (Womack, James, & Roos, 1990)

A study of activities in a hospital ward in the Västra Götaland(VG) –region showed that nurses spend around 12,7% of their time preparing pharmaceuticals for delivery to patients (Hermansson & Almström, 2016). This did not include the physical hand-over to patients in patient rooms, but merely concerned the preparation of the pharmaceuticals. In an effort to improve working conditions for nurses and to make the process more efficient, the VG-region made an investment in the technology of automated pharmaceutical dispensers for implementation at certain hospitals and for select wards.

Understanding a process before improvements are made is a pre-requisite in industry where investments are generally preceded by rigorous analysis. One tool often used is the mapping of existing infrastructure and sub-processes in order to understand the requirements of the process. (Bergman & Klefsjö, 2010)

1.1.1. Structure of the healthcare organisation in Västra Götaland

Healthcare in the VG- region is divided into five sub-regions; the north, south, east, and west and Gothenburg regions. These sub-regions have hospitals in multiple locations that are part of the same general organisation. The hospitals and their locations can be found below;

- Sahlgrenska University hospital, with three locations in Gothenburg.
- NU-sjukvården hospitals in the following cities: Trollhättan and Uddevalla.
- Skaraborg hospitals in the following cities: Skövde, Falköping, Lidköping and Mariestad.
- Kungälv hospital in the city of Kungälv
- Södra Älvsborg hospitals in the following cities: Skene and Borås.

(Lagersten, 2016)

Further division of responsibility within the region occurs in terms of the owner of the buildings, pharmaceutical services and so on.

In addition to their particular specialisations wards are sometimes characterised as belonging to one of two categories; surgical wards or medical wards.

1.1.2. Previous studies in the Västra Götaland Region

The VG-region has been involved in many research projects concerning productivity in healthcare in recent years. Studies to manage the planning of production at or flows through various departments of hospitals are especially popular, with many seeing significant improvements post-implementation. (Johansson & Plantin, 2012)

Since 2009, studies have been conducted to examine individual wards using a method called Unit Analysis (Sundström & Almström, 2016), an extension of an industry productivity measurement method, PPA, Productivity Potential Assessment. (Almström & Kinnander, The productivity potential assessment method: Assessing and benchmarking the improvement potential in manufacturing systems at shop-floor level., 2011) .By using the convention of productivity being the product of method, utilisation and performance, work is analysed to identify possible sources of so called productivity potential, areas that can be developed for improved productivity.

A previous thesis project has been conducted in an effort to map hospital facilities at Skaraborg hospital in order to document and facilitate development work (Broniewicz & Gutierrez, 2015). However, this study does not delve deeper into the layout inside rooms themselves but rather act as a large scale mapping of entire hospitals and their sub-units.

1.1.3. Details about the introduction of pharmaceutical dispensers

In an effort to decrease the amount of administrative work for nurses and thereby improve their working environment, the VG region decided to invest in a number of pharmaceutical dispensing machines. Using information from an internal information document, a description of the situation surrounding the pharmaceutical dispensers can be created. An investigation of pharmaceuticals showed that 80% of all pharmaceuticals are administered orally to patients and out of these, 75-80% would be suitable for dispensing from an automatic machine. As stock in medicine rooms have thus far been based on need, determined by use, it means that wards will have more or less of their pharmaceuticals delivered from the machine, and an individual plan for each ward will be set-up based on their current medicine room stocks. Only wards with an average care time of two days or longer will be covered by the machine. It is explicitly stated that this improvement is not intended to lead to a decrease in staff, but as a measure to relieve nurses of non-value-added work.

When the pharmaceutical dispensers are programmed the dosage and interaction effects of each pharmaceutical for each patient will be examined by a licensed pharmacist, in order to ensure the right dosage. Pharmaceuticals will be delivered to the wards in small plastic bags that showcase specific patient ID as well as information about the pharmaceutical. Each plastic bag will only contain one type of pharmaceutical and for only one delivery to patient, meaning that each patient may need multiple plastic bags per delivery. Deliveries of the bags to the wards will be conducted once per day. For those pharmaceuticals that are not covered by the dispensing machines there will still be pharmaceuticals stocked in the pharmaceutical rooms in wards and the general stock rooms (VNL) of the hospital.

1.2. Purpose and problem analysis

The implementation of pharmaceutical dispensers will impact how nurses and pharmacists conduct the process of preparing and delivering pharmaceuticals to patients. While not completely automating the process, the method currently used will need to change in order to realise the intended outcomes of the investment, such as the improving working environment for employees, safety for patients and overall productivity. The implementation therefore poses new demands on the pharmaceutical rooms and the work conducted in them. The long-term intent is to create a work standard for this process, but in order to do so the current circumstances of pharmaceutical rooms need to be defined and analysed.

The purpose of this thesis is to give an outline of the requirements that exist in relation to pharmaceutical dispensing and create the foundation for future improvement work. This includes an investigation of regulations and standards that exist in relation to the work conducted inside pharmaceutical rooms. In addition to this the current state of some pharmaceutical rooms in the VG-region will be mapped in relation to routines and room layouts in order to evaluate the possibilities and limitations for standardisation.

1.3. Research questions

In order to achieve the purpose two research questions were formulated to serve as the basis for this study:

RQ1: What regulations and standards exist for the work being conducted in pharmaceutical rooms?

RQ2: What is the current state of pharmaceutical rooms in the VG-region in terms of layout and organisation?

1.4. Scope and delimitations

This study will be conducted as a master's thesis by a mechanical engineering student at Chalmers University of Technology.

As the focus will be on the work conducted in the pharmaceutical rooms, rules and routines associated with the new technology are outside of the scope of this project. However, a brief introduction to the technology has been given in order to better understand the sort of change that is about to occur to the process.

As the implementation of pharmaceutical dispensers primarily concerns larger hospitals it has been determined that the study should only include select hospitals in the region rather than all hospitals. At the onset of this project it is accepted that the number of pharmaceutical rooms that exist in the region will greatly exceed the number of rooms being used as the basis for this study. A list of the exact hospitals studied will be provided in the method section.

For this project only nurses have been interviewed to gain information. Current processes include the activities of support-staff and pharmacists in selected hospitals but as nurses are involved in the process at all hospitals they were chosen as interview subjects.

The purpose of this project was to investigate pharmaceutical rooms in terms of regulations and standards, layout and organisation. As such it is beyond the scope to come up with suggestions for implementation in the rooms or evaluate the current designs.

2. Theory

This chapter aims to provide background information in order to put the research in a wider context.

2.1. Work Improvement Process

Most improvement processes are loosely based on the continuous improvement cycle (Liker, 2006) with an initial planning stage, an active stage, usually followed by an investigative and then a reactive stage. The process steps can be more or less defined or divided further, but overall a successful improvement project should be in one sense linear and in another cyclical, in order to achieve continuous improvement. Freivalds (2009) has defined a work improvement process which can be seen in figure 1. Each stage will be explained briefly below the diagram. Circled in red is the step is the focus of this thesis.

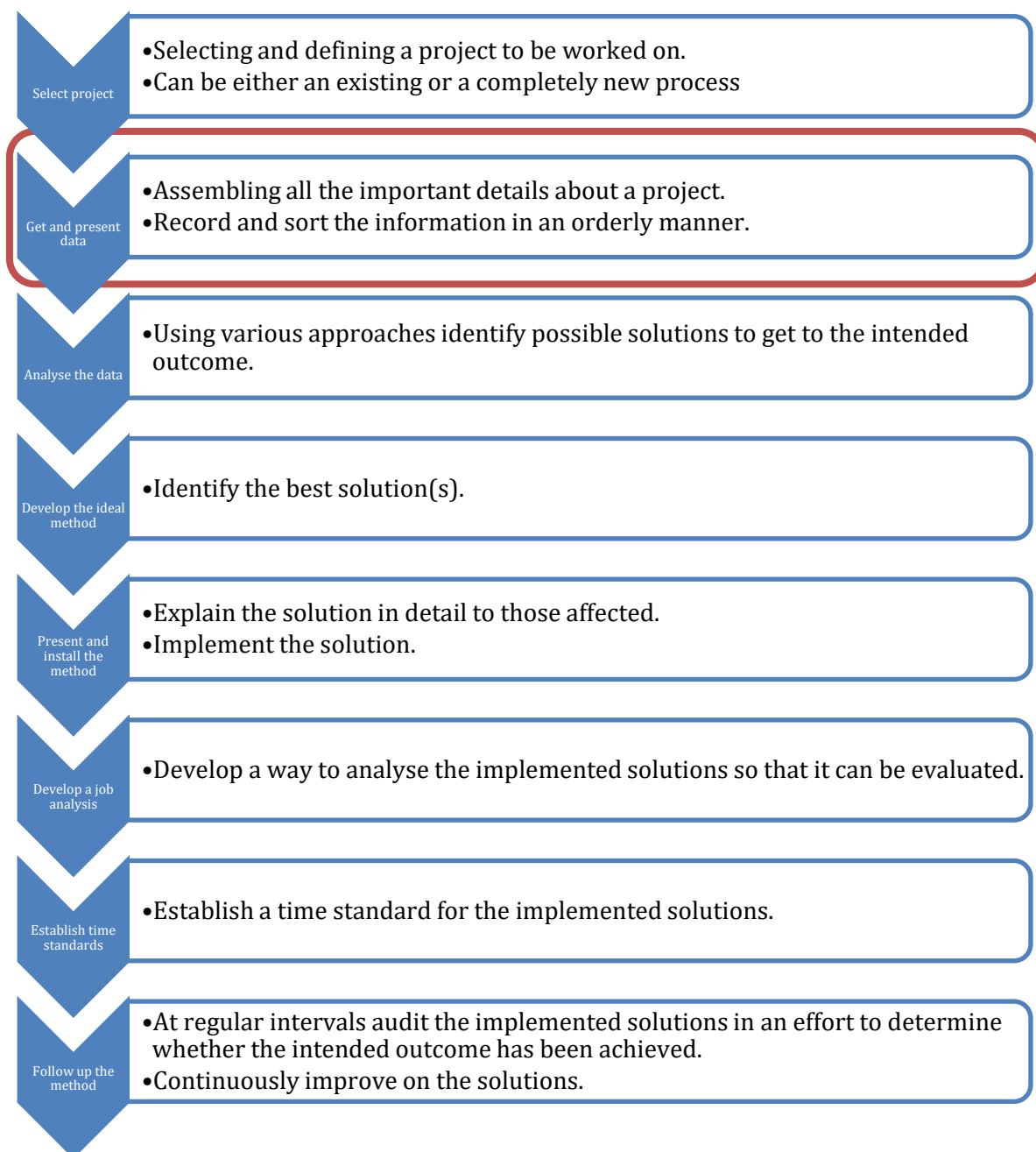


Figure 1 Diagram of the work improvement process presented by Freivalds (2009).

The first step of this process is to choose the project to work on. The choice of project can be largely determined by three types of factors; economic, technical or human. Economic factors can be the need for lowered costs or improved productivity, technical can be the purchase or implementation of new technologies that require a change in method and human factors can be intensified occurrence of employee injuries or high staff turnover.

Once the choice has been narrowed down it is time to get detailed. In order to get a view of factors that influence specific situations a job or worksite analysis can be performed. Here, work tasks, work environment or administrative tasks are identified through a walk-through or on-site observations. This means that while the previous step can be considered more objective, this is a subjective investigation performed by the analyst.

When moving on to the third step of the process - getting and presenting data - it is time to chart processes which will bring to light sequencing inter-relationships between tasks. It is in this part of the process that additional performance data for the entire work process should be collected in order to establish the potential constraints that a process is under.

Operation analysis can be performed to identify value-adding and non-value-adding parts in a given method. It can also help define a new method based on the data obtained in the previous step. This step can be performed in different depth. Very detailed analysis can be performed with tools using predetermined time systems which study operations and tasks at movement level (Sakamoto, 2010). These tools can also be used further along in the process when designing methods. General operation analysis can be conducted by answering the questions what, who, why, when, where and how. Why is generally characterised as the most important question and should be applied to all angles of an operation; why is this necessary?, Why is it performed in this manner? Why is this operator doing this operation? And so on. These questions directly lead to the other lines of questions such as how can this operation be performed in a better way? Who can perform it best? Where should it be performed? and when should it be performed?

When investigating the purpose of operations the guideline should be to simplify as far as possible, which can be achieved through elimination and combination of operations or simplification of tasks or sequences. It is important to investigate and analyse the purpose of an operation before improvement begins, otherwise there is a risk that future improvements will be sub-optimised. An example of this can be an analyst investigating the material used as input, and questioning the choice, this can potentially result in new ways of going about the process that can lead to further improvements.

The fifth step in the process involves the implementation of the chosen method in the workplace. Assuming that a method has already been decided upon and depending slightly on how the previous steps have been conducted in terms of informing employees, the main activity for this step is to sell the solution to the people that will be affected by it.

The sixth step involves the design of evaluation tools for the method. In order to be able to maintain a standardised method, there must be some way of evaluating whether or not the process was implemented correctly and if it is functioning as it should. In order to be able to apply evaluation tools it is important that an accurate definition of the process exists. An example of this can be a job description where a certain job is described in a detailed and impartial way. Each time the job is updated this description also needs to be, so that the performance of employees can be evaluated against it during appraisals.

The last part in the process is the follow-up of the method. A follow-up, or audit, is performed, using the evaluation tools designed in the previous step. New ideas for further improvements can also be gained from reviewing the current state of a process at regular intervals, and comparing the standards and the data with newer methods that have since been conceived. Without proper follow-up it can also be difficult for new methods to stick, and operations will then revert back to their previous stage. It is therefore advised to audit regularly and at shorter intervals close to the completion of the seventh stage. The intervals can then become slightly longer as time wears on. This audit can then be used in the consideration of new improvement projects, where problems are identified and then chosen to go through the improvement process once again.

2.2. Work studies

Since the 19th century various labour movements have used the phrase “a fair day’s wage for a fair day’s work” in order to drive policy-making in regards to employment (Engels, 1881). We can clearly see that there needs to be some method of analysing and evaluating work.

There are a number of methods that currently exist and they can take many different forms depending on what is being studied. Two of the mostly commonly used methods are ergonomic and time studies.

2.2.1. Ergonomic studies

Ergonomic studies and evaluations investigate work based on the human in the system (Chartered Institute of Ergonomics and Human Factors, n.d). These types of studies are interested in how the method and work environment affect the person, and how knowledge of the human body can be used to make improvements. At a relatively abstract level, ergonomic evaluations analyse whether the work and the environment is suited to the inherent constraints and capabilities of the human body (Berlin & Adams, 2017). They concern both physical and cognitive aspects of work. It ought also to be borne in mind that while an objective measurement may not suggest a significant risk in the method, a subjective assessment of the worker can mean that the work needs to be redesigned. (Freivalds, 2009)

Ergonomic studies can focus on the manual labour, the workplace and tools that are used, the general working environment or, as previously mentioned, the cognitive aspects of work (Freivalds, 2009). Ideally, all four components should be evaluated and considered simultaneously in order to gain the most accurate results.

When evaluating manual labour, the risks that are investigated concern what is referred to as physical loading, which is the product of force, posture and time. (Berlin & Adams, 2017)

$$\text{Physical loading} = \text{Posture} \times \text{force} \times \text{time}$$

Posture refers to the positioning of joints and muscles in the body, either during rest or during work, and it can be influenced by the circumstances of work in various ways. Space and vision, for instance, mean that the employee may have to adapt their posture in order to be able to complete a task. Stress is another factor, and this can affect the worker in different ways, either in the sense that rushing means not being able to perform movements in the intended way, or that it leads to muscle tensions that affect the way the body functions. Particular tools or equipment may also alter the posture.

It becomes slightly more complicated where force is concerned. The body's ability to handle forces can be attributed to inherent mechanical capabilities of bone or tissue, but can also be influenced by training and the general health of a person, including genetic preconditions. Forces are generally divided into six different categories; internal, external, repetitive, dynamic, static and mass related forces.

The final contributor to physical loading is time. Factors that affect the time variable include repetitiveness of tasks (or the opposite, variation), frequency and duration of tasks, cumulative loads and the recovery times between work cycles.

Two out of the three factors are to a great extent dictated by the work-place and its design, together with the design of necessary tools and equipment. Their design can influence how the body needs to be kept in order to complete tasks; it can also affect the amount of force required to be exerted in order to complete a given task.

When evaluating the working environment it is primarily the so-called hygiene factors that are considered, such as lighting, noise, vibration, temperature, radiation and ventilation. (Berlin & Adams, 2017). These factors can have direct impact on the employee, both subjectively as experienced by the individual and objectively. Most of these factors have approved ranges, set by individual industry sectors or by nationally applicable standards, but even within these ranges performance can differ between employees. Adjustability, again, proves the key that can allow employees to tailor their environment to themselves, and this can be achieved through appropriate use of suitable equipment (clothing, tools and glasses, for example).

Cognitive ergonomics concerns how the brain acquires and processes information. The information can be received through any of the five senses; smell, scent, touch, hearing and vision (Berlin & Adams, 2017). Most commonly evaluated for workplace design purposes are the latter three; touch, hearing and vision. Processing of information is affected by the way in which the information was delivered, as well as the overall amount and complexity of the information that needs to be processed. Determining the load of these factors on the individual can be difficult, as people perceive them differently, but measures nevertheless exist and these are based on biological reactions of the body such as an increase in pulse, blood pressure or temperature. (Berlin & Adams, 2017)

2.2.1.1. Ergonomic design principles

Using the knowledge above there are a few design principles to keep in mind when designing work and the work place, and these can be used as guidelines when investigating current states as well:

- Design tasks so that the effects of physical loading can be minimised, by limiting the risk factors associated with the three components – posture, force and time. This includes limiting elements of heavy lifting, situations which encourage bad posture and prolonged and or repetitive movements.
- When designing the workplace, including available tools and equipment, it is again important to consider the operator. As many workplaces have multiple employees, it might be beneficial to design the workplace with built-in adjustability such as tables that can be raised or lowered, or providing step-stools. Ideal working positions according to the Swedish authority *Arbetsmiljöverket* (Arbetsmiljöverket, 2015), can be seen in the figures below.

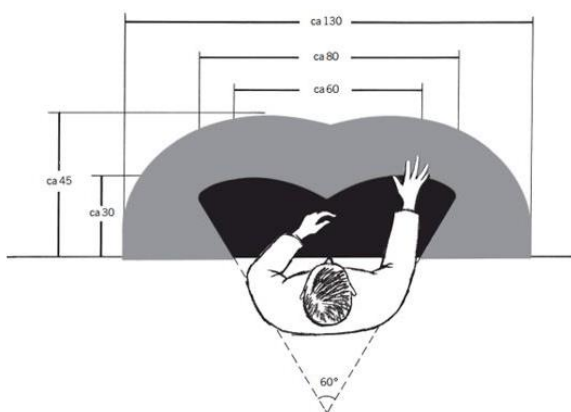


Figure 2 Work surface design. Retrieved from (Arbetsmiljöverket, 2015)

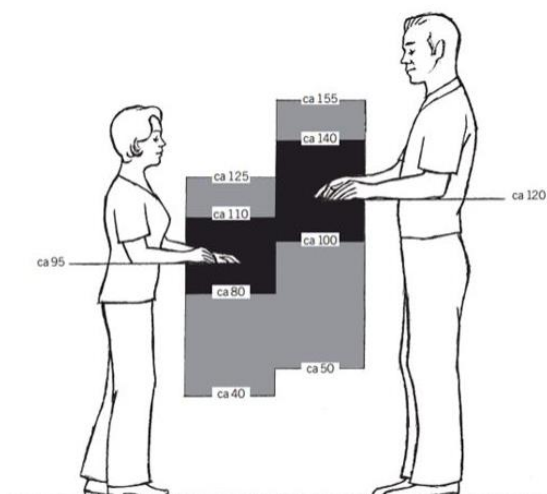


Figure 3 Optimal working height. Figure retrieved from: (Arbetsmiljöverket, 2015)

- Equipment design should take into consideration the three factors of physical loading. This includes the design of the grip, and an evaluation of the forces (such as vibration) that can be exerted from the tool into the body.
- Hygiene factors should be kept at adequate levels for the tasks; this includes reducing background noise, keeping a comfortable temperature for the level of exertion and adequate air quality. In order to cater to the individual employee equipment can be supplied, such as hearing protection and protective clothing, so that employees can customise the environment to themselves.
- Information attainment should be facilitated through the design of the work place. Delivery through multiple senses simultaneously or consecutively, such as both vision and hearing, make it more likely for the information to be delivered successfully. Conscious design choices, such as what is called design for assembly, mean that thought has been placed into how a product is to be assembled when it is being designed, in order to make the assembly process easier. Furthermore, the amount of information and how it is presented to employees affect the way that it is processed, so careful analysis of information in order to create appropriate circumstances is important.

2.2.2. Time studies

Time studies investigate how time is spent performing the work. They can be performed in three different ways; pure estimations of time, which hold the lowest accuracy, direct method observations which can depict the division of time between different activities, or using standard times (Zandin, 2001).

Pre-determined standard times exist based on extensive research and studies of motion. Methods such as MTM, method time measurement, use standard values for movements of various detail, coupled with factors relating to the circumstances of the movements. MTM-SAM, sequential activity method, a slightly simplified version of MTM, uses combinations of so called basic, supplementary and repetitive activities together with additional factors relating to circumstances to reach a total time. (UK Methods-Time Measurement Association 2000 Limited, n.d)

Table 1 Description of tasks and activities in MTM-SAM. Reproduced from (Sakamoto, 2010)

Task	Activity
<i>Basic</i>	Get, Put
<i>Supplementary</i>	Apply force, step, bend
<i>Repetitive</i>	Screw, crank, to and from, hammer, read, note, press button.

The factors that affect basic activities are distance travelled, need for precision in the execution and whether there is significant weight being transported. The factors each have categories, distance having been divided into three categories; up to 10, 45 or 80 cm, and precision and weight being divided into two categories, with precision or not with precision and up to 5kg or in excess of 5kg respectively. (Sakamoto, 2010)

The use of time standards requires a method to be standardised in order to give any valuable result. Without a standardised method, the accuracy will only ever be equivalent to estimation, and as such the effort put into studying time will be wasted (Zandin, 2001).

2.3. Production and operations management

Production and operations management sciences contain many valuable tools and theories that could, and to a large extent have been, applied in healthcare. As previously mentioned, TPS argues for a limit to motion or general transport, both of the product but also of the employees working on them. In healthcare this applies to the design of the facilities and the aids used by healthcare professionals in their delivery of care. Additionally, limiting the

inventory levels and the number of defects produced is sought in order to increase resource efficiency.

Standardisation, it is argued, can be an effective tool in limiting variation in output. Variation is inferred to be the cause of some of the defects, or at least the unpredictability of a system. (Liker, 2006)

2.4. Standardised work and work standards

Zandin (2001) defines three criteria for work to be considered standardised:

- All elements of the work and necessary resources need to be defined.
- The sequence of use of the above needs to be defined
- Ideally the pace for the combination of the above should be set.

The researcher Nakamura (1993) gives a slightly simplified description of a standard arguing that standards “are clear, simple descriptions of the best methods for making things”. This can be expanded to apply to sectors beyond manufacturing, by changing the definition from making to doing things. The International Organization for Standardization, ISO, has developed in excess of 20000 management standards used in various industries (International Organization for Standardization, n.d). Standards can also be developed by other authorities, in order to enable continuous improvements; they also create transparency of the method and can reduce variation (Liker, 2006)

Standardised work has gotten a bad reputation in recent years through its connotation to mundane and repetitive work. What may not be obvious is that although it promotes repeatability in a method, it by no means requires it to be mundane. It should be used as an aid to employers and employees, allowing both to define expectations and rewards for work. (Marksberry, Rammohan, & Vu, 2011).

The implementation of standardised work can occur in slightly different ways, but three guiding principles exist in order to facilitate it; engage employees in the design of standards, keep information about the current standardised work documented and readily available, and audit regularly (Jakubik & Kagan, 2015). By engaging employees in the development of standards it is more likely that they will be followed, so a good rule of thumb is to engage as many individuals as possible in the development. This also increases the likelihood of obtaining tacit knowledge from employees with experience of the work, thus better input into the design process. Continuously auditing work against standards gives the foundation for a continuous improvement cycle (Jakubik & Kagan, 2015). Once changes are made to the standard, it is important that the existing documentation is changed to reflect this change; otherwise the basis of the standard hangs loose. Documentation proves useful in other areas as well, as it can be used, in the form of work instructions, to train new employees (Marksberry, Rammohan, & Vu, 2011).

2.5. Quality and design in healthcare

The healthcare organisation in the VG-region is tasked with providing the inhabitants of the region with good quality healthcare. Ali Mosadeghrad refers to good quality healthcare as something that is “consistently delighting the patient by providing efficacious, effective and efficient healthcare services according to the latest clinical guidelines and standards, which meet the patient’s need and satisfies providers” (Mosadeghrad, 2013) . In order to achieve this, the healthcare sector has increasingly looked towards industry methods and research. As previously mentioned many studies concern work and processes, but in recent years the design of hospital facilities has also received attention. (Reiling, 2005)

Within the healthcare sector, studies of physical environment try to establish connections between the physical environment and improved quality of care, improved effectiveness of

care, improved patient safety and improved working conditions for staff (Ulrich, Quan, Zimring, Joseph, & Choudhary, 2004). This can be looked at from various points of view, from purely aesthetic characteristics to how facilities can be designed in order to limit errors.

Many regional guidelines containing requirements for pharmaceutical rooms were discovered during the course of this thesis, but only one source related the design of the room to the execution of the work in terms of flow of processes (NHS National patient safety agency, 2007). This report from the UK national healthcare services was based on theories of ergonomics, workflow and the UK regulations and standards in relation to pharmaceuticals. While the general theory can be applied to Swedish pharmaceutical rooms, a more thorough investigation of the underlying regional regulations and standards would be necessary to fully evaluate the applicability in Swedish healthcare.

3. Method

This chapter details the method used to conduct this project, with special emphasis on the data collection.

3.1. Approach

The method for this study commenced with a planning stage. This stage involved the selection of wards and nurses, as well as the assembly of an interview guide and routine for visits to hospitals. The search for related information in terms of laws, regulations and routines commenced in the planning stage, but was continuous through the process as new information became available through the visits and interviews. Following the planning, visits were conducted at the selected hospitals.

3.2. Selection of wards and nurses

The hospital organisation in the region can be described as consisting of several sub –regions that can contain one or more hospitals (Lagersten, 2016). As this project concerns the region as a whole it was intended to spread the visits out over the region. To select the wards the department manager of hospital pharmacies for the region was asked for contact details to the department managers of hospital pharmacies at the hospitals. In some instances this contact resulted in direct contact with nurses and in others contact went through the department managers. The selected wards should fulfil the requirements below;

- One or two wards per hospital depending on size of the hospital.
- Different enough to give an overview of the range of medicine rooms that exist.
- Will use the services of the pharmaceutical dispenser after its implementation in the region.

A summarised table of the distribution of hospital wards between can be found below.

City	Hospital
Göteborg	Sahlgrenska University Hospital
Göteborg	Sahlgrenska University Hospital
Uddevalla	Uddevalla Hospital
Trollhättan	Norra Älvsborg Hospital
Borås	Södra Älvsborg Hospital Borås
Borås	Södra Älvsborg Hospital Borås
Kungälv	Kungälv Hospital
Kungälv	Kungälv Hospital
Skövde	Skaraborg Hospital Skövde ¹

3.3. Interviews and visits to wards

Prior to the interviews an interview guide was created using the author's previous knowledge about medicine rooms and the work conducted in them, as well as previous knowledge regarding standardisation and work design. The intent behind these interviews was not to evaluate specific wards or with specific working teams, but rather to get an understanding of the processes used in the current state, as a supplement to the drawings of the layout of the pharmaceutical rooms. Questions were asked in relation to procedures for the re-stocking of rooms, as this can explain some local routines, knowledge of current standards and routines in order to gain more input into the search of related laws and regulations, use of

¹ This ward had been recently redesigned and had not opened at the time of the visit.

pharmaceutical cart as an aid in the preparation process, as well as if specific issues relating to the room had been identified.

The interview guide can be found in its original Swedish version in the appendix.

Interviews were held in a semi-formal manner, meaning that while the interview guide was used additional questions could be asked in order to gain clarification or information about a subject that came up in the answer to another question. The intent behind using this method was to make the nurses more comfortable with the interview setting but also to treat the project as uncharted territory where the nurses hold more knowledge of the situation than the author and will therefore be able to supply information that the author may not have expected.

Visits to wards were scheduled between the author and the specific nurses in order to suit the nurse's schedule. They were generally set in-between traditional pharmaceutical distribution times in order not to interfere with the work taking place. Visits were most often divided into two parts, where one part concerned the interview and the other the investigation of the rooms. While in the rooms, photos were taken and additional usage questions were asked in order to clarify certain parts of the layout and design. Measurements were taken of the area and various heights in the room, and rough drawings were made in order to compare the rooms to each other. In one case, the entire interview took place inside the pharmaceutical room.

Written notes were taken throughout the visit and interviews were not recorded as there was a chance that sensitive patient information could be recorded inadvertently.

The resulting notes were used to create a narrative about each room in regards to processes and routines.

3.4. Search for regulations and standards

The search for regulations and standards related to the process of work in pharmaceutical rooms was conducted throughout the study both in an effort to keep up to date on designations and contents, but also due to input from nurses. At the outset of the study a few authorities were identified by the author as potential data sources and these were investigated for any information related to pharmaceuticals. These authorities include:

- Socialstyrelsen
- Arbetsmiljöverket
- Läkemedelsverket

Additional sources that were identified early on were:

- Vårdhandboken
- Västra Götalandsregionen.

Once those sources had been identified and investigated, a more detailed search for information surrounding pharmaceutical rooms was conducted.

Many sub-regions have their own standards and guidelines for how work should be performed based on the regional standards. These regional standards in turn, were based on the national standards and regulations. As the purpose of this thesis was to create the foundation for future *regional* standardisation efforts, sub-regional standards were deemed to be of lesser importance, unless they diverged from the regional standard or in cases where no regional standards existed. As the standards were presented in Swedish and the language of this report is English, the contents were summarised in the results section as a product of translation by the author of this thesis. Direct translation of all standard documents was

deemed too time consuming and as producing little value so for future research the references to standard documents can be used.

Regional standards from other parts of Sweden were found but not investigated in great detail for this report, as the aim was to create the foundation for a standard in the VG-region. In future research projects, these other standards could give input for solutions, but that endeavour is outside the scope of this project.

3.5. Limitations and ethical considerations

As with most methods, there exist limitations to this one. It is important to consider the limitations of the approach and to evaluate these in terms of ethical considerations that need to be taken into account when conducting research, and how these might potentially affect the results.

In their review of ethical considerations in management research (Bell & Bryman, 2007) identified several points that need to be considered when conducting research, these include; harm to participants, informed consent, anonymity, dignity, privacy, confidentiality, affiliation, honesty and transparency, deception, misrepresentation and reciprocity. These considerations will be kept in mind when reviewing the limitations of the proposed method.

Firstly, the number of hospital wards used as the basis for this thesis is much smaller than the actual number of wards that exist in the hospitals and that will make use of the pharmaceutical dispensers. This is true both in terms of division between hospitals and regionally. This means that the information collected from the visits may not paint an accurate picture of all wards. The choice of wards and nurses for this research lay with the chief pharmacist, hospital pharmacists and or the wards themselves. Thus, there is a risk of deception and misrepresentation as the researcher has no way of evaluating the truth or circumstances of the information received. However, this risk is mitigated by the fact that the chief pharmacist is directly in charge of the pharmaceutical dispenser project and it is in the best interest of the pharmacists and wards that accurate information be given, to get the most out of this project. As such, it is believed that these considerations have been taken and that the results gained from this study are valid. Future research could possibly include quantitative data collection, but due to the purpose and scope of this thesis this was not considered appropriate for this particular study.

Any change project should include the process of establishing buy-in from employees affected by the change (Kotter, 2007). This thesis takes only nurses into account when looking at the work being performed in the pharmaceutical rooms, but there are more employee groups that are potentially affected by the change such as pharmacists, doctors and additional support staff. For an ever more accurate depiction of the process, these employee groups could have been asked for input. It is also the case that most visits have contained interviews with one nurse and occasional input from additional nurses, and it could be beneficial to have the input of more nurses, as the methods and circumstances for dispensing pharmaceuticals seems to vary within and between wards. However, as the intent behind the interviews is to get a scope rather than a picture of all of the possible methods, this limitation does not pose a significant threat. Though the names of the nurses are attached to the interview notes and their superiors knew about the interview it is not believed to be any risk of harm to the participants. In the report, only narratives of the wards have been included and no information has been attached to a particular ward, other than potentially distinguishing features, which means that the anonymity of the participants is maintained.

All nurses that have been interviewed were asked for consent in terms of their names potentially appearing in the thesis and have been given opportunities to look through and

comment on both the interview notes and the thesis at various stages of completion. They were informed of the interviews in advance, their purpose and the intended result, and were able to look through the interview guidelines to prepare and potentially clarify the meaning of some of the questions. This has ensured that they have been able to comment on how the information has been presented, and seen the progress of the report which has given them opportunity to object to parts of content they considered a risk to them.

The final limitation that has been identified to the method is that of language. Most of the information gained specific to the healthcare sector in the VG-region has been in Swedish whereas the guidelines for master theses state that they should be presented in English. This means that much of the information has been translated by the author, with some assistance from healthcare professionals and online translation tools which leaves some reservation about proper vocabulary.

4. Results

This chapter provides a presentation of the data gathered in order to answer the research questions. The first two sections, 4.1 and 4.2 will be considered raw data and section 4.3 will hold a brief discussion of the results.

4.1. Standards and regulations

Regulations and standards relating to the handling and preparation of pharmaceuticals exist from many different instances and have been adapted for the different regions. There are industry standards and regulations that act on a national level; regional standards that concern all hospitals in the VG-region and that are, to a large extent, adaptations of the national standards and regulations. Furthermore, there exist sub-regional standards that act as adaptations of the regional standards. The sub-regional standards were not deemed to be of great interest of this thesis other than to serve as a context builder.

4.1.1. National standards and regulations

The Swedish medical product agency, *Läkemedelsverket*, has developed a standard document describing how pharmaceuticals should be stored, marked and containing specific information related to the defined life-time pharmaceuticals (*Läkemedelsverket*, 2017). Depending on the active contents of pharmaceuticals these can be different for various types of pharmaceuticals, but general regulations state that they should be clearly marked with what ever restrictions exist for the particular pharmaceutical and stored accordingly. These restrictions can be based on light-sensitivity, temperature-sensitivity and sensitivity to the air in the room. Shelf-life dates are also determined based on individual basis. An additional standard document relates to the hygiene routines surrounding utensils such as IV-stands and containers.

A document containing guidelines and regulations for the construction of pharmaceutical rooms has been created by *SVHF, Svensk Förening för Vårdhygien* (Dahlberg, o.a., 2010). In this document it is stated that many demands placed on the room come from the routines related to the work such as the delivery system for pharmaceuticals, the specific pharmaceutical needs and regulations for working environment as set by the Swedish work environment authority. The document makes specific reference to the national laws for working environment, healthcare, safety and the environment. In addition to this there has been a tool developed for the process of steering hygiene control at hospitals has been developed by the same committee.

A comprehensive description of national standards in terms of care procedures exist in the online portal, *Vårdhandboken*. The procedures stated in *Vårdhandboken* are not regulations, but are best-practice examples used as guidelines for a high quality healthcare (Ahrnstedt, Andersson, & Byström, Om *Vårdhandboken*). The portal sorts guidelines into subject areas, each with a descriptive overview and with references to the specific regulations that are related to the procedures. Information can be found on how pharmaceuticals should be prepared (as close as possible to the delivery to patients), how control and documentation should occur in relation to the administration of pharmaceuticals, how pharmaceuticals should be stored and marked when delivered to patients, as well as who is responsible for the process.

Specific guidelines for the use of pharmaceuticals in various treatments, their quantities and effects, can be found *Läkemedelsboken* online (Örtkvist, 2017). Additional information aimed at particular pharmaceuticals can be found in the book *FASS*, created by *Läkemedelsindustriföreningens Service AB* (*Läkemedelsindustriföreningens Service AB*). Although not strictly related to the work process, this general information about treatments

and pharmaceuticals is considered as an important standard as it can affect the inventory of materials, pharmaceutical or not, in the pharmaceutical room.

Standards for different aspects of the working environment can be found in the collection of regulations and guidelines from the website of Arbetsmiljöverket. (Arbetsmiljöverket, 2015)

Regulations of particular interest can be seen in the table 2 below:

Table 2 Regulations

Name	Content
AFS 2005:5	Concerns the use of pharmaceuticals used for chemotherapy. The regulation brings up risk evaluation, handling of the pharmaceuticals and safety equipment needed.
LVFS 2012:8	Concerns how hospitals should be supplied with pharmaceuticals
LVFS 2012:14	Concerns measures for the safe-keeping of pharmaceuticals.
SFS 2014:821	The so called “patient law” concerns regulations in relation to patients, their integrity and wellbeing.
SOFS 1997:14	Concerns delegation of responsibility for administering pharmaceuticals to patients.
SOFS 2001:1	A comprehensive list of laws and guidelines active through the entire pharmaceutical handling process. Chapters 4 and 6 are of specific interest for this thesis as they concern the preparation and administration of pharmaceuticals.
SOFS 2001:16	Specific regulations for the competence of a nurse administering pharmaceuticals.
SLS 2017.1	Standards for pharmaceuticals
SOFS 2011:9	Concerns processes related to systematic quality improvement wards.

4.1.2. Regional regulations and standards

Four out of five sub-regions have their own organisation of healthcare hygiene, with guidelines and standards accessible online. Guidelines primarily concern how employees should work with hygiene matters such as cleaning of working areas, appropriate clothing and personal hygiene. Individual guidelines for how to work with the national tool for steering hygiene work exist in these portals, but they are mostly applications of the national method. These sub-regional guidelines are based on the overall regional standards, so the content of the regional standards will be presented below;

- Chapter four concerns the pharmaceutical room, what items should and should not be stored there and how it should be cleaned.
- Chapter five of the standard concerns the preparation of pharmaceuticals.
- Chapter six relates to the delivery to patients including who has the authority to perform the preparation and the hand-over, how it should be ascertained that the right pharmaceuticals reach the right patient, how documentation should occur, times and amounts of pharmaceuticals and how information should be stored.
- Chapter eight focuses on working environment, and how systematic efforts should be put on improving it.

Standards have been established for pharmaceutical rooms on a sub-regional basis in relation to their layouts and inventory. Skaraborg Hospitals have one such standard, and the following

information was gained from an unpublished work-document. The demands placed on the room have been identified using regulations and standards, similarly to the work of this thesis.

Demands on pharmaceutical rooms as presented by Skaraborg Hospital;

1. A room should not be smaller than 12 sq.m; the specific size is determined by the specialisation of the ward.
2. It should be possible to lock doors and windows in the room. Windows in pharmaceutical rooms should be avoided but if they exist they should be fitted with sun blocking technology, limit the view into the room from outside and have metal bars if applicable.
3. The room should contain a sink and accompanying equipment so that staff can uphold good hand hygiene. The sink should preferably not be placed directly next to a work surface. A screen dividing a clean zone from an unclean zone is a good solution. Waste disposal bins should be placed in the unclean zone.
4. The room should not be a walk-through room and should not be used to store aids used by patients and staff.
5. The inventory in the room should be designed in such a way as is appropriate for the storing of pharmaceuticals (boxes and shelves). They should be designed so that nurses can reach pharmaceuticals easily.
6. Good lighting is important. >600 lux above work-surfaces and >200 lux for the rest of the space.
7. In order to avoid high levels of contrasts, dark floor and wall colours should be avoided.
8. The room should be designed so that it is easy to tidy and keep clean.
9. The room should be well ventilated according to the guidelines in *Boverkets byggregler BBR* and have a temperature range of 15-25 degrees centigrade. A thermometer should be stored in the room.
10. See additional guidelines in the *Västfastigheters program för tekniska standard för (PTS) Läkemedelsrum*
11. There should be storage for additional non-pharmaceutical material needed for the preparation of pharmaceuticals
12. There should be work surfaces available for work to be conducted standing.
 - There should be space for a computer with all the necessary equipment.
 - There should be space for documentation and necessary medical literature.
13. There should be space for recycling
14. There should be space for pharmaceutical carts and, if appropriate, fluid carts.
15. The room should be design to promote an effective way of working
16. The room can be designed with a delivery hatch for pharmaceuticals. If this is added, the delivery hatch needs to be fitted with locks on both sides.
17. See additional guidelines from *PTS Riktlinjer för vårdhygieniska aspekter vid renovering, om- och tillbyggnader samt nybyggnad av vårdlokaler*.

Additional guidelines mentioned in regards to rooms where preparation occurs include:

1. A work surface for use during the preparation of pharmaceuticals should be included, with a height that allows work to be carried out standing up.
2. Safety equipment and non-pharmaceutical material for the preparations of pharmaceutical according to guidelines found in *Fokus – Läkemedel – Läkemedelshantering*
3. If a pharmaceutical cart is used, this should be placed next to the work-surface.
4. See additional guidelines from *Svensk Läkemedelsstandard*.
5. A hook for the preparation of infusions should be located close to the preparation area.
6. An examination screen for injections should be placed close to the preparation area.

Specific equipment required in the room was also detailed in this standard:

1. A refrigerator, specific model based on current tender contract
2. Shelves required for larger materials such as fluids and larger boxes; lowest height for a shelf specified as 20cm above ground and highest shelf as 140 cm above ground, with an additional shelf on top to protect from dust. An appropriate amount of shelving is determined by the specialisation of the ward
3. A computer and keyboard, or a laptop on a rolling cart
4. A section of work surface, length determined by the intended number of staff working in the room simultaneously, height 93 cm.
5. Power sockets
6. Network ports or wireless network connection

Safety equipment:

5. Safety lock on doors, opened with key-card and code
6. Specific equipment to automatically close doors should be considered
7. Peep-hole in the door. If the door has a window it should be possible to look out of the room but not in, and the glass should be unbreakable

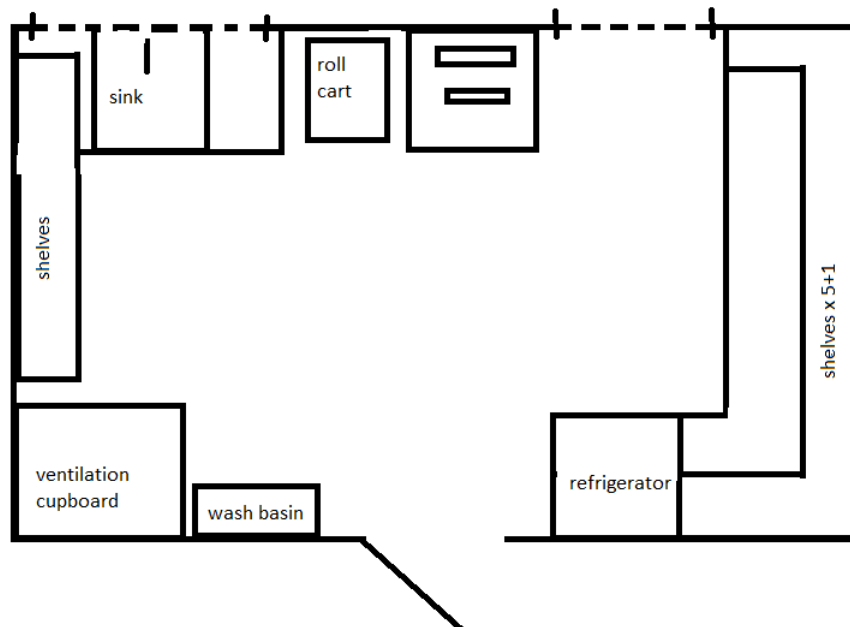
Additional features include edge covers for shelving and, if appropriate, a white board

4.2. Mapping of wards

The wards have been made anonymous through the use of a letter reference. Below is a table aiming to give a brief overview of the pharmaceutical rooms studied. Each room is then individually described in more detail.

Information	Size of room (sq.m)	Number of computers in the room	Pharmaceutical cart in room (yes/no)	Pre- sorting of pharmaceuticals in the pharmaceutical cart (yes/no)	Ventilation cupboard present in the room (yes/no)
Ward A	22,59	1 stationary computer, potentially additional laptops	Yes	Yes	Yes
Ward B	6,48	2 laptops	No, ward does not yet have pharmaceutical carts.	No, ward does not yet have pharmaceutical carts.	No
Ward C	12,45	2 stationary computers	No	No	No
Ward D	12,33	1 stationary computer	Yes, as often as possible	Carts are stocked but not in exact kits, each cart will have some buffer material	No
Ward E	11,61	1 stationary computer	Yes	Somewhat, the cart is sorted based on type of pharmaceutical, rather than per patient.	No
Ward F	13,14	2 stationary computers	Only if a lot of pharmaceuticals are to be prepared	Yes	No
Ward G	14,58	1 stationary computer, 2 laptops	Yes	Yes	No
Ward H	13,88	1 stationary computer	Yes	Yes	Of sorts, a separate space divided by a glass wall.
Ward I	Measurement not taken.	Room not in use at time of visit.	N/a	N/a	No

4.2.1. Ward A



Layout

The pharmaceutical room in ward A is rectangular in shape measuring 538 cm by 420 cm, with two windows opposite the door.

Directly in front of the entrance is a desk at a height of 110 cm with a stationary computer. Above this desk are two shelves for storage of documentation. To the left of the desk is a rolling cart for fluids and to the left of the cart is a small working area with a sink. Below the working area are a cupboard and a set of three drawers. On the wall adjacent to this working area is a section of three to five shelves, three above the work area and five for the remainder of the section. In the bottom left corner of the room there is a ventilation cupboard and between this cupboard and the door is a small wash basin for the employees to wash their hands.

On the right side of the room directly next to the door is a full-sized refrigerator, and next to this a section of workspace stretching from the bottom right corner all the way to the top right corner. This workspace is 61 cm in depth and 92cm in height. Underneath the workspace is a series of drawers, three drawers per set with three sets in total. Below the workspace in the top right corner is an empty space for waste disposal units. Above the workspace is a series of five shelves used for pharmaceuticals that stretches the same section as the workspace. Above these five shelves is a larger and higher shelf used for storage. At the time of the visits there were tentative plans to reconfigure the five pharmaceutical shelves.

Organisation

This ward delivers pharmaceuticals to patients at many different times, 8 AM, noon, 2 PM, 4 PM, 8 PM, 10 PM, and midnight depending on patients' needs. The largest deliveries occur at 8 AM, 4 PM and midnight, but patients that arrive having already been given antibiotics have to be accommodated as they should receive antibiotics every 8 hours. Pharmaceuticals related to Parkinson's disease may also alter delivery times, based on patients' needs. The nurse interviewed (from here on referred to as Nurse A) estimates that each patient requires on average 13 different pharmaceuticals and although the design of the ward is optimised for 8 patients per nurse, it is generally so that each nurse has about 10-11 patients on any given day. The organisation of nurses and assistant nurses used to be more pair-based than it is today, but during the day there is still a team organisation, with one nurse and two assistant nurses per team. The decision to move away slightly from pair-based care was taken together, after having tried various kinds of organisation. Nurse A prefers it the way it is now.

Ward A practices continuous improvement using monthly improvement meetings between nurses. Once an idea has come up and approved by the meeting attendants, it is brought forward to the nurse in charge of pharmaceuticals. One recent development is that of person-centred care and daily meetings at a control board, where the current situation has been mapped out. Nurse A reports that this has vastly improved the hand-over process between shifts.

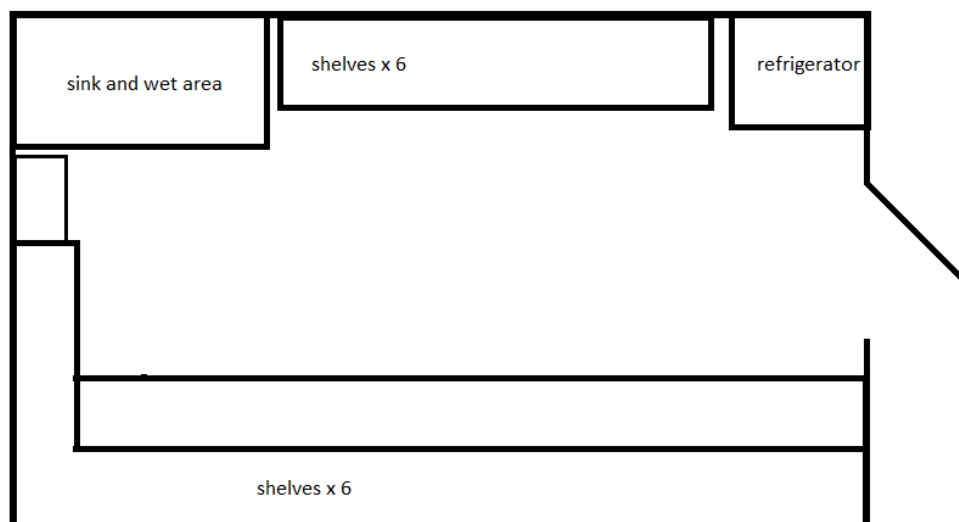
Nurse A reports that there are many written routines at the ward, such as for the method of security of the room, hygiene related matters, the handling of narcotic pharmaceuticals. Additional routines can be found online through a portal, and some are established based on habit. Doors are locked at all times, and can be accessed using a key-card and code. Only nurses and pharmacists are allowed into the room, and nurses apply to receive access. Hygiene routines are determined at a sub-regional level and can be accessed online. New employees receive a so called “hygiene letter” with the most important routines, and can view all routines online. They receive training at university (as hygiene routines tend to be fairly standard) and additional information when they shadow colleagues during the first 4-5 weeks on the job. Ward A has as a routine that the night-staff cleans all surfaces in the pharmaceutical room during their shift, in preparation of the next day. Guidelines for the preparation of antibiotics are posted on the side of the ventilation cupboard as this is where the preparation should take place. Nurse A reports that some preparation takes place in the ventilation cupboard, but that more and more antibiotic pharmaceuticals arrive on the ward already prepared, meaning they can be administered right away. Routines for the handling of narcotics are “somewhere” in the room, but can easily be accessed online. Ward A uses pharmaceutical carts in their ward. The carts are stored in the pharmaceutical rooms, where they are filled up by night staff, one cart each night and each cart every three nights. They are filled through a process where one nurse reads the pharmaceutical list and another nurse picks the mentioned pharmaceutical and places it in the cart.

Pharmaceutical carts are occasionally taken into patient rooms, if there is adequate space in the room, otherwise stored in the hallway and the nurse dispenses pharmaceuticals from there. IV-solutions are stored in a separate cart, brought to the ward by support staff every other week. The layout of the IV-cart is not standardised, so solutions may end up in different places from time to time, and as it has shelves from top to bottom this can create more or less lifting from below knee-level. There is additional storage on a high shelf, but those items are seldom accessed and a step-stool has been provided in order to assist in reaching it. In general, Nurse A reports that the layout works well, the only problem reported being that the ventilation cupboard does not work as intended in terms of adjustable working height – this is due to the ceiling being too low to accommodate a height increase. A potential problem is that the cupboard can only be used by one person at a time, but as more and more antibiotics arrive pre-prepared, this is not deemed critical.

The pharmaceutical unit takes care of the ordering and dating of pharmaceutical. They visit the wards and scan barcodes on the shelves once a week. They are also in charge of the re-stocking of the pharmaceuticals, and these are stored based on an industry wide ATC-code. For this ward, Nurse A notes that it is a happy coincidence that has allowed the most often used pharmaceuticals in the most easily reached places.

If a specific pharmaceutical is needed in between visits from the pharmaceutical unit, a visit to the pharmaceutical stock room can be done. When this occurs, a nurse will ask all other nurses if they need anything from the stock room, and then one person goes to retrieve all of it in one go in order to minimise the number of trips

4.2.2. Ward B



Layout

This room is the smallest room in the study. It was originally designed to be a toilet, as the architect forgot to add a medicine room. It is rectangular in shape measuring 240 by 270 cm, with no windows other than the window in the door.

Immediately on the right is a full-sized refrigerator, next to which there is a section of six shelves used for storing bags of fluids. Next to this section and reaching to the corner is a sink and wet area with a height of 90 cm.

Covering half the far wall and the rest of the left side of the room is a section of 6 shelves used to store pharmaceuticals. The lowest shelf on the far wall reaches all the way from the end of the workspace until the start of the wet area, and this space is used to store frequently used materials such as labels. Below the shelves on the left side is a section of workspace with a height of 90 cm and a depth of 60 cm. Underneath the workspace in the far corner are two sets of six drawers. Following this is an empty space for waste disposal, a section of three shelves and in the corner closest to the door is another set of six drawers. Above the workspace in the corner is a cupboard with a key-lock.

Organisation

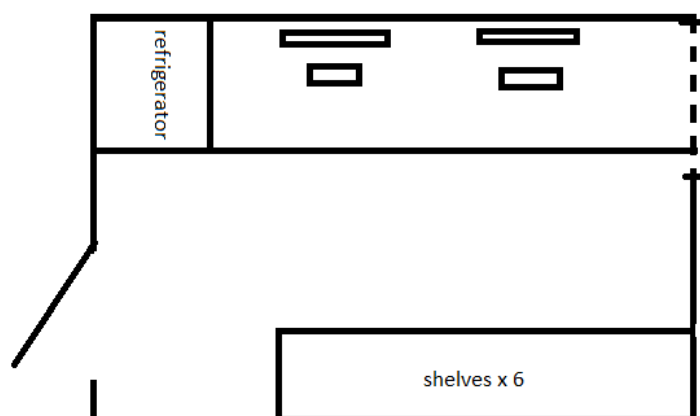
According to the nurse interviewed, from here on referred to as Nurse B, the room can be considered fit for purpose, but only because the employees are so flexible in their work. The room doesn't have a ventilation cupboard, but it does have a designated bench for pharmaceutical pills, one preparation surface, and a wash basin, which makes it "ok" according to staff.

At ward B, nurses are divided into three patient groups with each group consisting of a team made up of nurses and assistant nurses. When it becomes time to dispense pharmaceuticals, it is a local routine that the nurse that did the rounds with the doctor first gets to prepare pharmaceuticals first. Some nurses like to prepare the pharmaceuticals all at once for the entire day whilst other nurses do it bit by bit during the day. They are delivered to patients throughout the day and Nurse B notes that the first delivery takes place sometime around 7:30-8:30 PM and additional deliveries are made based on need from patients. Another common delivery time is 2PM. There are no fixed routines for how many people can be in the pharmaceutical room at once, but as it is quite small it becomes crowded easily. Only nurses are allowed in the pharmaceutical room, and the door is kept locked to be opened by an access card, no code necessary.

It is the responsibility of the pharmaceutical group, consisting of 4 nurses at the ward, to handle ordering, re-stocking and organising of pharmaceuticals. One large order is made on Sunday evenings, as it needs to be made by Monday morning, and one smaller order just before the weekend. As the room is small there isn't a lot of storage space, this means that Ward B visits the VNL frequently, sometimes up to six times a day but mostly around three times. Nurses try to coordinate the visits as best they can by using a list. Pharmaceutical orders are delivered to the expedition in the middle of the ward in grey boxes and deliveries of IV-carts also arrive there. It is the responsibility of the pharmaceutical group to date and stack pharmaceuticals, and this is done by ATC-code, which means, Nurse B remarks, that things end up where they do. The highest top shelves are used for storage, difficult to assess how often they are used. Although it is the responsibility of the pharmaceutical group to handle the storage of pharmaceuticals, all nurses are expected to assist where they can. There are lists for temperature control, narcotics and the dilution of certain pharmaceuticals. One nurse has been recruited on a 25% time basis to cross-check the lists, she does this three times a week or more if necessary. Nurse B does annual checks of the "date-binder" and other binder updates are conducted on a need basis by the pharmaceutical group, usually annually. Specific routines exist for how signing of the narcotics binder occurs, where each use requires a cross-check of the list, personal ID number of the patient, a signature from the nurse, date and time.

Routines are generally stored "in the minds of employees", but lists and information can be gathered online or in binders. New nurses shadow another nurse for 4 weeks at the beginning of their employment. All employees are expected to look for improvements in their work. If one is found and applied, the person that came up with it writes a note and places it in the binder in the corridor. This binder is used at the beginning of each shift, which means that the information about the improvement reaches the other employees. There is currently one pharmaceutical cart on trial at the ward, but it doesn't fit into the pharmaceutical room. One nurse wanted to try using pharmaceutical carts, so a decision was made to trial the use of the carts.

4.2.3. Ward C



Layout

The pharmaceutical room at this ward is rectangular in shape measuring 530 cm by 235 cm with the door on one end and a window on the other end. The window sill is currently used as storage for documentation.

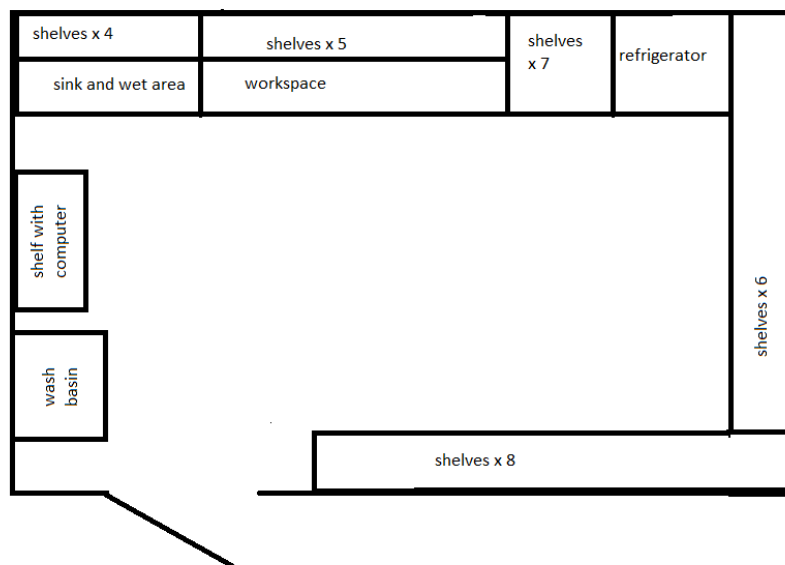
Immediately upon entry there is a full-sized refrigerator to the left, followed by a stretch of workspace with a height of 90 cm and depth of 60 cm that reaches all the way to the window. On top of the workspace are two supports that hold up keyboards for computers, with screens attached to the wall and the PC unit suspended below the work surface. Below the surface there are three sets of drawer units, each with three drawers, separated by empty space currently containing waste disposal units. Between the computer screens and just above the work surface is a smaller shelf, used for the storage of often used non-pharmaceutical materials.

Along the other wall is a section of seven shelves, stretching from the far wall almost all the way to the door opening. The shelves are of different heights in order to accommodate different pharmaceutical packaging.

Organisation

Ward C practices team-based care, where each team consists of one nurse and two assistant nurses. Most pharmaceuticals are delivered to patients at 8 AM, 2 PM and 8PM, occasionally also at noon, if a patient needs it. Pharmaceuticals are occasionally divided into plastic cups, with the patient's name, and then each cup is delivered to the patient, occasionally this is done individually where pharmaceuticals placed in a cup and delivered directly to the patient. The nurse interviewed at this ward, Nurse C, wouldn't like to say that there are any specific routines for the work written down, but there are routines for how to order pharmaceuticals. However, it is the pharmaceutical unit at the hospital that is in charge of the stock in the pharmaceutical room, they order, sort and unpack the pharmaceuticals. They are stored according to a modified alphabetical and ATC-code system, on the shelves in the room. Additional stock of pharmaceuticals, from a dispenser, is located relatively close to the ward, but it is seldom needed as the process with the pharmaceutical unit. Non-pharmaceutical materials are stored in the pharmaceutical room and a room designed for patient aids are used as additional buffer storage for frequently used non-pharmaceutical materials. There are routines for how narcotics should be handled, but Nurse C doesn't exactly know where they are stored. Most routines are stored within employees. New employees receive training of routines as part of their 4 weeks of shadowing, education about certain routines also occurs at university. Nurse C perceives the pharmaceutical room to be small, and mentions that it can get very crowded during busy times, but that they try to accommodate each other. The pharmaceutical cart cannot be taken into the room for this purpose. The type of cart used is relatively old; the model number no longer exists according to support staff. Continuous improvement work is brought up during nurses' meetings, and it is the responsibility of Nurse C to take these ideas further and implement them.

4.2.4. Ward D



Layout

The pharmaceutical room at ward D is of a rectangular shape measuring 411 cm by 300 cm, with the entrance in the bottom left corner and no windows to the outside.

Immediately by the entrance along the left wall there is first a small wash basin for the employees to wash their hands and next to this a small shelf containing a computer screen and keyboard, with the PC unit suspended below. Along the top wall there is a workspace with a sink and wet area in the left corner and attached to a set of shelves at the other corner. The workspace is 60 cm in depth and 90 cm in height. The wet area covers a distance of 222 cm of the workspace and above this is a section of four shelves which ties into a section of five shelves. These shelves are currently used as temporary storage and may move. Below the wet area is an empty space for waste disposal units, a set of five drawers and a small metal cart with five shelves.

Next to the work space is a set of seven shelves 60 cm in width next to which there is a full-sized refrigerator. Along the right wall there is a section of six shelves running the entire length of the wall. Along the bottom wall from the right corner up to the door is a section of eight shelves of varying heights

Organisation

Ward D uses team-based care with teams being based on three different disciplines (3 teams in total). Each team has roughly 10 patients at any given time and optimally each team should have two nurses and two assistant nurses, but due to staff-shortages this doesn't always happen. There is one doctor per group and if two nurses then one of them has the overall responsibility for the team. Difficult to give standard times for pharmaceutical delivery as it is largely based on the patient, the nurse interviewed (Nurse D) estimates that most deliveries occur at 8AM, noon, 2PM, 5PM, 8PM and 22PM. While the ward has pharmaceutical carts, they are not brought into the patient rooms as it would be too crowded, sometimes it is parked outside the room or further down the corridor but they are brought into the pharmaceutical room as often as possible. Carts are restocked twice a week, Tuesdays and Fridays around lunch-time. There is a slight buffer in the stock in the pharmaceutical carts as it is deemed easier to take pharmaceuticals out than it is to restock.

Pharmaceuticals are restocked by the pharmaceutical unit at the hospital, they order on Wednesdays and it arrives on Thursdays. Items are sorted by ATC-codes, antibiotics stored

close to where they are prepared and narcotics in the far corner as they are seldom used, coincidence that the pharmaceuticals that are used often happen to be at eye-level.

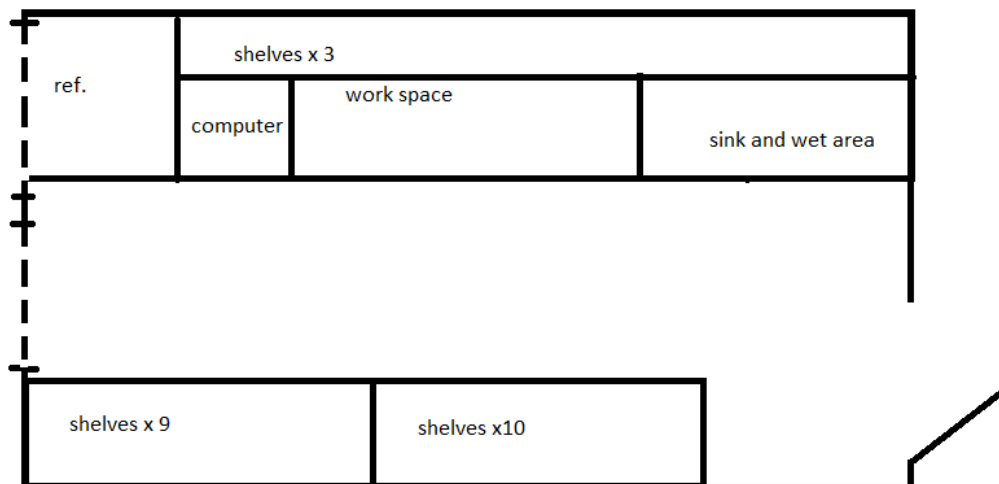
Nurse D notes that there are several written routines for the work; regional procedures and routines for narcotics from the book FASS, local directive and ward-specific routines written by the nurse in charge of pharmaceuticals (Nurse D) together with the pharmaceutical unit. These ward-specific routines are updated once a year, in the fall, and Nurse D meets with the pharmaceutical unit bi-annually. Routines and regulations are taught to new employees as a continuation of university, to find short-cuts and best-practices. They are stored online and in note-pads but primarily transferred orally due to time restrictions. If errors have occurred there are extra walkthroughs of whatever went wrong.

The ward has a large stock-room for non-pharmaceutical materials due to their need for IVs. It is the responsibility of Nurse D to audit to make sure that too much extra material doesn't end up in the pharmaceutical room. The ward is close to the VNL, but there was no mention of how often it is visited.

Almost only nurses are allowed into the room, pharmacists can enter to go through the restocking procedure; assistant nurses can deliver pharmaceuticals to patients if they've been sorted by nurses. The pharmaceutical room is locked and a key card with chip is required to enter. The room is cleaned every day (usually) by the employees themselves; there is a list on the door that is signed when the room has been cleaned.

When asked about the room layout a few issues were mentioned. There is no ventilation cupboard for antibiotics and the general ventilation isn't the best. The room is considered small and it can be crowded when more than two people need to be there at the same time. More work surface would be appreciated. Improvement suggestions are brought up with Nurse D, who then acts on it.

4.2.5. Ward E



Layout

The pharmaceutical room in ward E is rectangular in shape measuring 270 cm by 430 cm, with the entrance on one end and two windows at the other. During the visit the window on the right had been boarded up due to issues with the central heating and ventilation system.

On the left side of the room from the aspect of the entrance is a stretch of shelves from the window and measuring 320 cm in length. Half of the length contains nine shelves in total and the other half contains ten shelves. The shelves have different heights to accommodate different sizes in the packaging of pharmaceuticals.

On the right side of the room there is a section of work bench with height 92 cm and depth 59 cm, stretching from the window and all the way to the other side of the room. At the end closest to the entrance there is a sink with an extended wet area made of metal. On top of the work bench closest to the window is a refrigerator and next to the refrigerator is a stationary computer. Above the work area is a stretch of three shelves reaching from the refrigerator to the other side of the room. The heights of the shelves are 144 cm, 165 cm and 203 cm respectively. These shelves are used for non pharmaceutical materials such as syringes and labels. Below the working area is a set of shelves used for storage, with a gap underneath the computer for waste disposal units and a set of five drawers underneath the metallic wet area.

Organisation

The nurse interviewed at ward E, Nurse E, reports that there is no standardised way of working other than that which has been specified by the region, those routines are accessed online. The routines for the documentation of narcotics are mentioned as especially important.

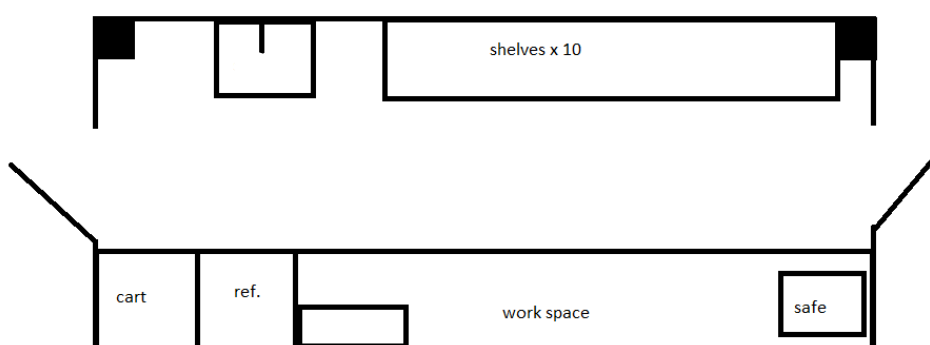
Pharmaceutical unit restocks and stores pharmaceuticals in the room, and they are sorted by ATC-code. The room is used for restocking the pharmaceutical cart, preparing infusions and injections, IVs, insulin and antibiotics. The room is perceived to be small, poorly ventilated and too hot, by Nurse E, who comments: "it is fit for purpose but nothing more". The work surface in the room is primarily used for the preparation of IV's. The room is accessed using a key card with specific access; Nurse E notes that they are very strict on who can come in.

Carts are restocked by the night shift, usually during the night until Monday and the night until Friday. The most often used pharmaceuticals are stocked near the top. If a patient arrives between restocks of the cart, then the nurse that signs him or her in is in charge of stocking the cart with the appropriate pharmaceuticals. Patients come to the expedition to get care from the team, where the pharmaceutical cart is placed. Occasionally nurses will bring the cart with them to the patients.

Most pharmaceuticals are delivered to patients at 7:30 AM and 7:30 PM, but also at 12PM and sometimes 2PM, occasionally there will also be deliveries of IVs and antibiotics throughout the night. There are two improvement groups at the ward, one for improvement to routines and one "right thing in the right place"-group.

New employees are trained through the shadowing of another nurse for the first four weeks. After that they can ask anyone if they feel unsure, and there is a binder in the room that they can look through for more information.

4.2.6. Ward F



Layout

The pharmaceutical room at ward F is a so called walk-through room with a door at each end of the room measuring 559 cm by 235 cm. The room had no windows other than those in the doors.

Along one side are a wash basin and a section of ten shelves. On the other side there was a section of workspace at a height of 90 cm and a depth of 60 cm, a fluid cart and a full-sized refrigerator. On top of the workspace were two stationary computers with their screens attached to the wall and the PC suspended below the workspace. Underneath the workspace are three sets of drawers separated by empty space currently containing waste disposal units. The drawer units each have three drawers. Attached to the wall was a safe in one corner and above the workspace a section of four shelves containing often used non-pharmaceutical materials.

Organisation

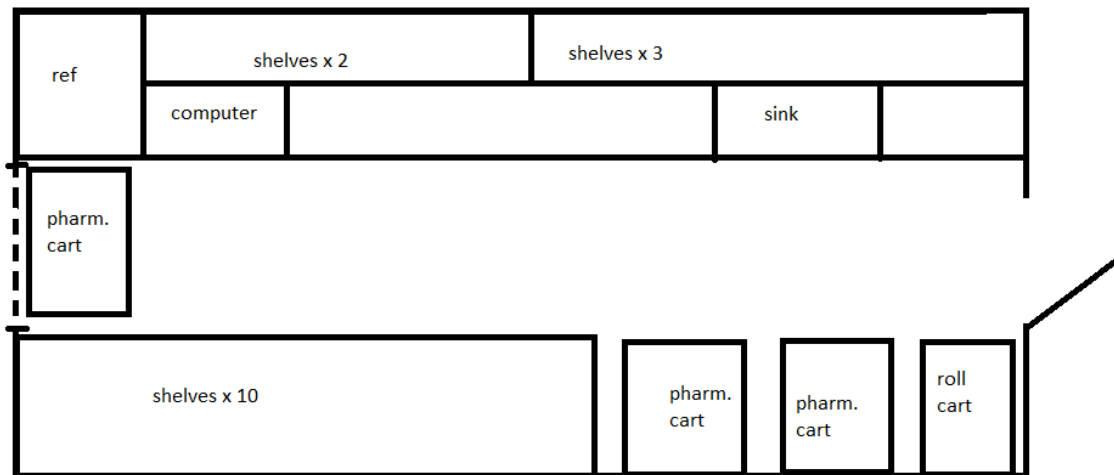
Ward F uses team-based care where the nurse has the main responsibility for pharmaceuticals. Sometimes this responsibility will be delegated to the assistant nurse, if the pharmaceutical has specific restrictions such as it needs to be ingested with food. Pharmaceuticals are most often delivered to the patient thrice a day, unless for a specific patient's needs. There are no standardised routines for the work in the room other than the maintenance; these are updated once a year by the pharmaceutical unit. Once a week a pharmacist from the pharmaceutical unit goes through the inventory and places orders as necessary, but if something is needed in between visits it is up to the ward to either retrieve it from the stock room VNL or to order it to the hospital. When the pharmaceutical unit designed order of pharmaceuticals it was intended to be in alphabetical order, but due to size changes in packages this is no longer the case (some shelves are too low to accommodate certain boxes). The cooperation with the pharmaceutical unit works well and Nurse F remarks that the room is definitely fit for purpose.

The restocking of pharmaceutical carts is the responsibility of the night shift, who should look through it every night. However it is everyone's responsibility that there is enough in there, so if a mistake is found it needs to be corrected. The cart is easy to manage but takes a lot of room, so it is only brought into the room and or the patient room if a lot of pharmaceuticals need to be moved.

Continuous improvement work is conducted every morning at the nurses' meeting, and it is up to the nurse responsible for pharmaceuticals (Nurse F) to collect the ideas and if possible implement them.

New employees learn the routines during their shadowing of a colleague. If possible to schedule, new nurses will also get some dedicated time with Nurse F.

4.2.7. Ward G



Layout

The pharmaceutical room at ward G is rectangular in shape, measuring 270cm by 540 cm, with the entrance on one end and a large window at the other end. Right in front of the window there is a pharmaceutical cart and a radiator/ventilation unit. Immediately on the left from the entrance is a rolling cart, with shelves and boxes for IVs. Following the rolling cart there are two pharmaceutical carts against the wall. Above the carts there is a stretch of two shelves. On the side of the two carts there is a section of ten shelves stretching all the way to the window, from the floor to the ceiling. This section has been divided into two, with slightly different heights for the two sections and the different shelves to accommodate varying sizes of pharmaceutical packaging. The lowest shelf, dedicated to large boxes, is raised off the ground and is the shelf with the largest individual height.

On the right immediately following the entrance there is a small stretch of work space followed by a sink. Next to the sink is a section of work space stretching all the way to the window. This entire section has a height of 90 cm and a depth of 61cm. Below the work space is a series of shelves and one set of five drawers (underneath the sink), there is also space for waste disposal units below the computer. On top of the work space closest to the window there is a refrigerator, and next to this a stationary computer. Above the workspace and stretching from the entrance area to the refrigerator is a length of two shelves for non pharmaceutical-supplies and binders with documentation. There is also a smaller shelf located next to the computer, for smaller often used materials such as labels. Hanging down from the ceiling next to the sink is an IV-hanger, to assist with the preparation of IV-fluids.

Additional computers are stored on top of the pharmaceutical carts.

Organisation

Ward G makes use of slightly different organisation of staff depending on what shift it is. The day shift has three nurse groups and two assistant nurse groups; in the evening the organisation holds three nurse groups and three assistant nurse groups, with one additional nurse that helps all the groups during both day and evening. Pharmaceutical tablets are delivered to patients at 8AM, 2PM and 8PM; antibiotics are delivered in 8 hour intervals, 8AM, 4PM and midnight. IV's and pharmaceuticals related to Parkinson's disease can be administered between these times, occasionally also pharmaceuticals that need to be ingested with meals or similar.

Pharmaceutical carts are restocked by the additional day-time nurse on Mondays and Thursdays to coincide with the main rounds process that takes place then, so that they can coordinate. Sometimes there can be three carts at once in the room, and a lot of people, which

makes it difficult to concentrate. The carts are used for dispensing pharmaceuticals that are then delivered to patients; they are not brought to the room. Otherwise, the room is perceived to be fit for purpose. Some items end up on high shelves but these are seldom used.

The pharmaceutical unit orders pharmaceuticals every Wednesday for delivery on Friday. If something particular is needed, nurses can request it from the pharmacists. The pharmaceutical unit also checks all the best-before dates once a month. Pharmaceuticals are sorted by ATC-code which means that things end up where they do, but this works well because the same types of items will be stocked together. Narcotics are stored close to syringes and preparation materials. The preparation of narcotics requires a cross-check of the list and a signature, the list is then double checked by a nurse once a month. If a mistake is caught, then it is usually followed up right away. Two nurses need to sign off if a narcotic is borrowed from another ward or if some type of narcotic pharmaceutical is disposed of.

In general the routines that are followed come from the VG-region. There are some local routines for ordering, cleaning, administration and control of narcotics. The local routines are created by a team of nurses from the surgical wards at the hospital, and are the same for all three wards. It has been roughly ten years since completely new routines were introduced, the current ones are usually, but not always, updated yearly and as mentioned it is the same for all three surgical wards. A current project is investigating a hospital wide standard routine based on these routines.

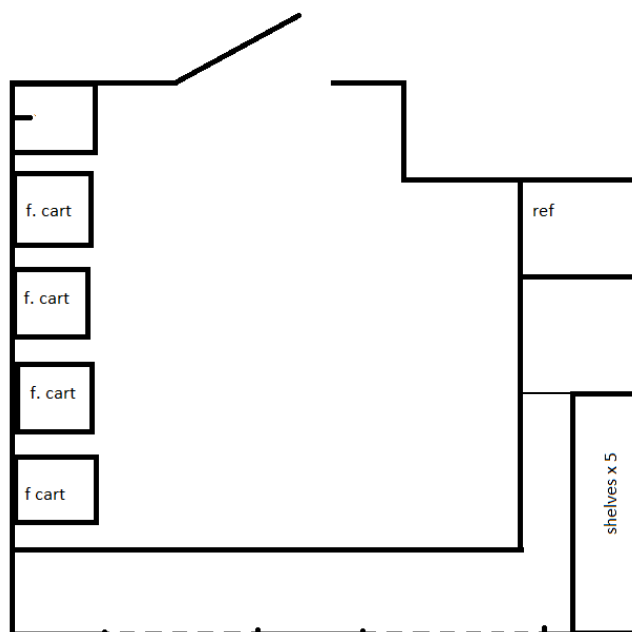
Only nurses and pharmacists are allowed into the room, but sometimes the cleaners are let in unsupervised. A card with a chip and code is required to gain access to the room.

The practical parts of routines are taught to new nurses through the shadowing period of 4-5 weeks. There is a binder in the room containing the routine that can be looked through, but due to time constraints very few people look through it.

Improvements are brought forward to the nurse responsible for pharmaceuticals (Nurse G). Updates are made continuously and iteratively.

The stock room is relatively close but there is no mention of how often it is visited.

4.2.8. Ward H



Layout

The pharmaceutical room in ward H is slightly L shaped and as such slightly more difficult to determine the size of. The longest sides are 460 cm by 320 cm, with an indentation measuring 70 cm by 120 cm. The room has two windows located opposite the door.

Upon entry there is a wash basin to the right followed by four fluid carts. Above the fluid carts runs a shelf currently used for storage of non-pharmaceutical supplies. In the corner of the workspace next to the fluid carts is a stationary computer.

Along the far side of the room is a section of workspace that wraps around the wall all the way to the full-sized refrigerator. This surface has a height of 89 cm and is 60 cm deep. The area next to the refrigerator is separated from the rest of the workspace by a glass divider, and is used for the preparation of antibiotics, below which there is empty space, currently used for waste disposal. The rest of the workspace on this wall has a series of drawers beneath it, three sets of three drawers each. Under the rest of the workspace, along the other wall, is empty space with a few additional storage shelves suspended from the work surface. Above the workspace on the left wall is a section of five shelves used for storing pharmaceuticals. Additional pharmaceuticals are stored on the work surface, flush against the wall. The shelves on the wall are of different heights in order to accommodate different pharmaceutical packages.

Organisation

Ward H practices team based care with 1-2 nurses per team. The pharmaceutical room has no limit on the number of people that are allowed in, for example one person can prepare injections and two can prepare tablets, but then it can be slightly crowded. Most pharmaceuticals are delivered to patients at 8 AM, 2PM and 8PM. Antibiotics can sometimes be administered at midnight and the occasional pharmaceutical is delivered outside these times based on patient need such as sleeping aids and pharmaceuticals related to Parkinson's disease .

The pharmaceutical carts are restocked every two to three days but are checked every day by the day shift, if they don't have time then the evening shift does it and if an emergency case comes in the night shift loads up the cart. Carts are taken into the pharmaceutical room but not into the patient rooms, this is an issue of space, so when not taken it to patients it is left right outside the door.

Standard regional routines such as temperature checks and best before procedures are used at the wards, but there are also certain local routines such as the ones for ordering pharmaceuticals. Work description, division or responsibility and so on have been developed by the nurse responsible for pharmaceuticals (Nurse H) and two other managers. These can be found in binders in the room or accessed online. Routines are followed up annually or bi-annually. Local routines for the handling of narcotics have been developed, including double-signing and weekly journal checks by the nurse in charge of narcotics.

The ward practices very extensive quality improvement work with multiple quality groups and nurse's meetings every month (if possible). One nurse has the assignment manager of quality and is in charge of the improvement work. Ward meetings every other week for one hour, and APTs on opposite weeks for one hour means that there is almost a weekly hour where improvement suggestions can be brought up.

Orders of pharmaceuticals are placed on one specific day a week and they are then delivered to the ward in large, grey plastic boxes. It is up to all nurses to help unpack and sort the pharmaceuticals, using ATC-code, but no thought is given to the placement of pharmaceuticals

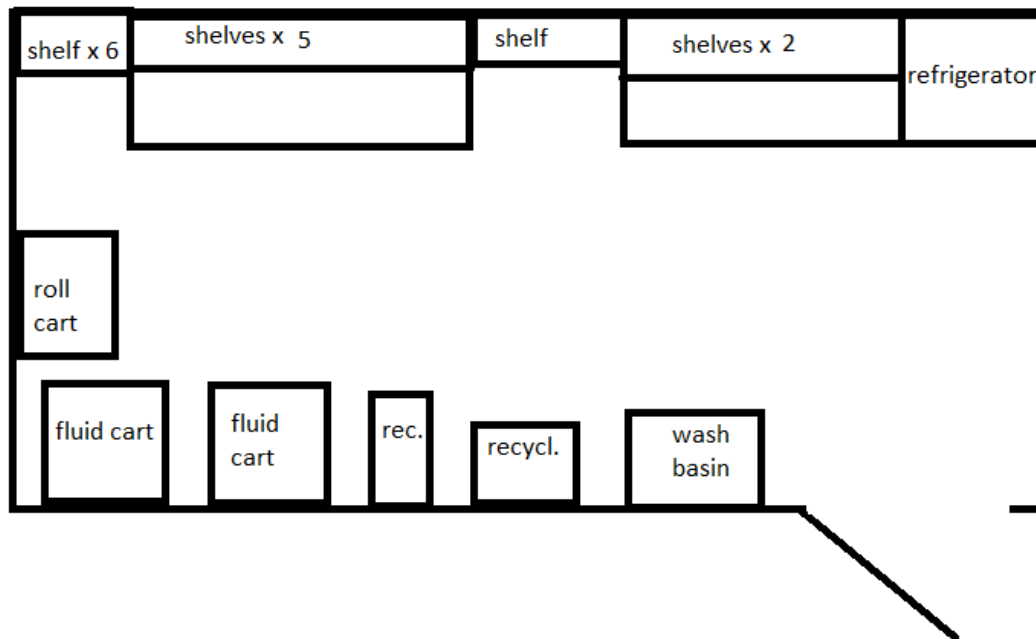
in terms of height. Materials for injections are kept close to where they are prepared. Fluid carts are delivered to wards by support staff and the placement in the cart can differ from time to time. When this happens, it isn't changed, so some heavy lifting can occur. Visits to the hospital stock room, VNL, occurs every to every-other day, and when a visit is needed it is coordinated using a list on the door, A nurse with a specific assignation then goes and retrieves what is needed.

Paper cartons and assorted rubbish, left over from pharmaceutical deliveries are sent to the recycling centre daily, as it would not fit in the room.

Training of new employees occurs using the shadowing of colleagues for 2-4 (usually 4) weeks, an on-site, half day training session as well as an online tutorial.

Only nurses have access to the pharmaceutical room through the use of a card with a chip

4.2.9. Ward I



Layout

The room at ward I was rectangular in shape with no windows and the door located at the bottom right corner of the room. Right in front of the door was a section of workspace with two shelves above and 4 shelves below. In the top right corner there was a full-sized refrigerator and the workspace is flush against the side of this refrigerator. After the section of workspace there was a gap containing two waste disposal units, in addition to one shelf in line with the top shelf above the work space. Immediately following this gap was another section of workspace with four levels of shelving below and five shelves above. In the corner was a section of only shelving, with six shelves in total.

On the side of the door is a small wash basin for employees followed by two recycling units. Next to the two recycling units were two fluid carts and next to these a rolling cart for supplies.

Organisation

The layout of ward I was not measured but was been drawn schematically to create an understanding of the design.

Ward I had been recently re-designed using a sub-regional standard. Pharmaceutical rooms at this hospital are designed by a team of two, with previous experience of nursing. During the visit to the ward an interview was conducted with one half of this team. As the questionnaire

posed questions around the process of the work conducted, these were deemed less important and a discussion was held in regards to the process of designing rooms.

When a pharmaceutical room is renovated or re-designed, wards can contact the design team who will visit and measure the room and use their previous knowledge and current sector standards in order to design the room. After they have created a design, it is supplied to the ward and a decision is made on whether to implement the design or to make changes. The team can then assist in the implementation process by ordering the specified inventory, or an itemised list is left to the ward manager.

4.3. Discussion of results

In the search for regulations and standards it became obvious that there are many standards surrounding the work in pharmaceutical rooms. Many sub-regions have their own standards and guidelines for how work should be performed based on the regional standards. These regional standards in turn, were based on the national standards. As the purpose of this thesis was to create the foundation for future regional standardisation efforts, sub-regional standards were deemed to be of lesser importance, unless they diverged from the regional standard.

The sample size used for the investigation of the current state is rather small to be order to draw direct conclusions about the entire region, as the choice of wards may have influenced the outcome to quite a large extent. Even though evaluation of the layout is outside of the scope of this project, a note has to be made in regards to the interaction between processes and physical space. As the process for designing rooms differed between wards it is possible that processes have developed as a consequence of the physical space, or in instances where nurses have been able to influence the design process, the physical space may have evolved as a result of the processes. What has been noted, however, is that much of the shelving used in the wards has been designed so that they can change in height and layout. This gives a good starting point for improvements, as the designs are not fully set but can be changed if the need should arise.

5. Discussion

This chapter supplies a discussion of the contents in this thesis with three separate sections; results in relation to theory, a critical examination of the method used and finally the connection between sustainability and the topic and result of this thesis.

5.1. Results in relation to theory

The descriptions of what constituted a standard acted as a guideline for the data collection. Using the more detailed description of standardised work by Zandin (2001) would have yielded far fewer results in terms of work standards, as few documents with exact descriptions and sequences exist in relation to work in pharmaceutical rooms. Standards that do fulfil these criteria relate mostly to the exact dosages of pharmaceuticals. The slightly more vague description of standards from Nakamura (1997) gives a bigger range of standards. Using this definition meant that collections of written best-practices could constitute a standard, and as such *Vårdhandboken* could be considered a standard for healthcare. Additionally, guidelines from *Arbetsmiljöverket*, mentioned in the theory section of ergonomics which are not necessary but recommended to follow can affect potential standardisation efforts.

Though guidelines and regional standards in terms of content existed for pharmaceutical rooms, no literature was found on the topic of their exact configuration. Standards found from other regions were not included as this would have necessitated an analysis of the purpose behind requirements which was outside of the scope of this thesis.

The theory supplied on work studies aimed to show how the design of workspaces affects the wellbeing of employees and productivity, which is relevant to the overall design of pharmaceutical rooms and could be used in the creation of a standard. It also shows relationships between design for productivity and design for ergonomics, which can be an important point to make when discussing work improvement projects.

The diagram depicted in chapter 2.1 showed a work improvement process, with the second step circled as that was to be the basis for this thesis. It is intended that the theory section of this report, in part, acts as the foundation for future work and that it thus constitutes necessary information in order to move the process along. As such, even though the data collected in this report may not relate strictly to this theory, it is believed to be an important addition for general context-building.

5.2. Method

The method for this project included an investigation into laws and regulations surrounding the handling of pharmaceuticals in hospital wards, visits to eight pharmaceutical rooms in wards at hospitals in the Västra Götaland region including one room which had been redesigned and yet to be used. At the same time as the visits, interviews with nurses at the wards were conducted to gather information about the current processes.

The purpose of this thesis was to gain an understanding of the regulations and standards tied to the process of delivering pharmaceuticals to patients. Additionally, a mapping of the current state of the pharmaceutical rooms was to be performed, in order to get an impression of the current possibilities and limitations that exist in preparation for standardisation efforts.

The study of Swedish laws and regulation can be performed again yielding the same results provided that the same approach is followed and the designations of laws don't change. Each update to an official regulation generally results in a change of designation and the designations of laws in this thesis are accurate as of April 12th 2017. As such, it becomes a

continuous effort to keep up with laws and regulations, and this means that the outcome of this project has a limited shelf-life. As many wards reported continuous improvement efforts to their work, it is also possible that the processes and layouts outlined through interviews and visits to wards will have changed slightly by the time this thesis is printed. Though a new study wouldn't result in exactly the same results, the overall purpose of creating the basis for a standardised pharmaceutical room can still be met by using the same method.

A study of regulations and standards followed by mapping of the current state can be used to investigate any physical space in any industry, which means that the approach has general applicability. The results gained from this study are more difficult to apply in a general setting, as the regulations specifically target pharmaceutical rooms in hospital wards. The limited sample size in comparison to the overall number of pharmaceutical wards prohibits conclusion of a general nature, as they cannot be statistically valid.

5.3. Context in terms of sustainability

Evaluating the topic and information gained from this project in terms of sustainability it is important to firstly define sustainability. In this instance, sustainability is defined as consisting of three parts, economical, ecological and social sustainability.

In terms of economical sustainability, this thesis aims to prepare for the development of a work standard for pharmaceutical rooms in the VG-region. This will hopefully allow for a more efficient and effective use of the hospitals' resources and as such contributes to improved economical sustainability in healthcare operations in the region.

In terms of ecological sustainability, the work conducted in pharmaceutical rooms concern direct or indirect contact with many kinds of pharmaceuticals. As such it is of vital importance that the design of such a space caters to safe interactions with these compounds. By presenting the regulations that exist in the relation to the work, particular attention can be given to ensuring that any future standard meets the criteria for the safe and sustainable handling of pharmaceuticals. As pharmaceuticals can lead to environmental problems if disposed of in an unsatisfactory way taking waste disposal into account when creating a work standard becomes important. Additionally, one ward reported that the recycling of non-pharmaceutical material took up a lot of time and perhaps further investigation of this could lead to improvements.

Finally, in terms of social sustainability, the work conducted during this thesis has aimed at bridging the gap between engineering and healthcare. Doing so has hopefully improving the perception of engineers in healthcare among the nurses, which will lead to future bi-disciplinary improvement projects. By including information about ergonomics in the theory section and pointing to this as an important consideration in determining a standard, the author hopes that the working environment for nurses will improve with future design projects. While the data collected has primarily concerned the current state as it is now in hospitals, the theory section provides a theoretical basis on which to create the standard.

6 Conclusions

This chapter provides conclusions in regards to the overall purpose of the thesis, as well as summarised answers to the two research questions.

6.1 Research question 1

What regulations and standards exist for the work being conducted in pharmaceutical rooms?

There are many regulations and standards that affect the work conducted. These are issued from various organisational levels and are of varying level of detail. Many of the standards issued of the sub-regional basis are based on the regional standards, which in turn are based on national standards. The level of detail given in the standards and regulation varies; in some standards specific item numbers are given for inventory in the rooms, in others it is the function of the item that is important. Generally, the level of detail increases the more localised the origin of the standard is, but this statement is only based on the nine rooms studied. The evaluations of standards in terms of effectiveness and suitability was outside of the scope of this thesis, so in order to apply the information in future such an evaluation would need to be conducted.

Three national Swedish authorities constituted the main source of regulations, *Arbetsmiljöverket*, *Läkemedelsverket* and *Socialstyrelsen*. These have been considered mandatory to follow as they are mandated by law; however, these are generally more vague in their formulation and thus leave room for different kinds of applications.

6.2 Research question 2

What is the current state of pharmaceutical rooms in the VG-region in terms of layout and organisation?

The physical space in rooms differed slightly between wards, in terms of doors, windows and overall size. What is clear from the investigation is that many items in the layout appear to be the same, or very similar, such as a sink, shelving and work surfaces at a height of 90cm. What differs is the exact configuration, such as the amount of shelving space or the amount of work surface. Additionally, some rooms were fitted with ventilation cupboards. This can to large extent be attributed to the different specialisations of the rooms as well as their organisation, as there are differing needs and limitations for pharmaceuticals or space. As this investigation has only taken nine rooms into consideration, and not evaluated them in relation to their specialisation, it is difficult to make a firm conclusion for all rooms in the region. The shelving systems used were to a large extent transferable, meaning that they could be changed in order to accommodate changing needs such as a new type of packaging. This is good in terms of possibilities for standardisation, as a change in layout would be easy to facilitate.

6.3 Concluding remarks in relation to the purpose

The purpose of this thesis was to evaluate the possibilities and limitations for standardisation of the process of pharmaceutical delivery to patients in the VG-region, in terms of layout and organisation. Due to time constraints, only nine out of many more pharmaceutical rooms were investigated and as such it becomes difficult to make any clear conclusions regarding the entire region. What can be determined is that there are possibilities to standardise to a certain extent without any alteration to the physical environment, as certain inventory remains the same between the wards studied. If alterations to the configuration of rooms can be performed, even greater standardisation can be achieved as the rooms studied are of roughly the same shape and area. Thus, it becomes a question of whether the intended standard should adhere to the definition of (Zandin, 2001) , or that of (Nakamura, 1993), as they describe vastly different levels of detail and control.

7 Areas for future research

As this project comes to an end there remains a few avenues for future research:

- Large scale mapping of layouts would need to be conducted in order to create a future standard. The nine wards studied in this project give an outline, but by no means a comprehensive overview of rooms. This mapping should include a mapping of rooms within the same specialisation, as many current standards specified that allowances were made in order to accommodate specialisation, something that wasn't taken into account in this project. A definition on a regional level of what current standards presented in this thesis are necessary to follow is also required, as part of the ambiguity of the results from presented above is determined by the fact that there are different definitions of what constitutes a standard.
- The subjective opinion of the author is that vocabulary and delivery of information has been important in determining the success of the project. It would be interesting to further explore this avenue and whether this holds true for all other disciplines that engineering might like to branch into. Such an investigation could then aid in the preparation of future cross-disciplinary projects.

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9. Appendix

9.1 Appendix I – Interview guide in Swedish

Frågeställningar

Rumsnummer:

Avdelning och Sjukhus:

Kontaktperson

Datum

- Finns det (standardiserade) rutiner för arbetet i läkemedelsrummet?
 - Utvecklade av vem?
 - När?
 - Var finns de att tillgå?
 - Hur utbildas man?
- Om ja: Hur ser rutinerna ut?
 - Vem får utföra arbetet?
 - Hur många samtidigt?
 - När?
 - Uppföljning?
- Om nej : Hur fungerar arbetet;
 - Struktur?
 - Tidpunkt?
 - Träning för nyanställda?
- Har man parvård (usk+ssk)
- (Hur) genomförs förbättringsarbete?
- Problematik i dagens utformning:
 - Finns det några uppenbara problem i nuvarande utförande:
 - Är rummet ändamålsenligt?
- Preparat;
 - Antal (sorts) preparat?
 - Vem "fyller på"?
 - Placering av vanligast förekommande preparat?
 - Narkotika?
 - Separata rutiner?
 - Vårdnära lager?
 - Säkerhet? (kodlås, nyckel etc.)
- Lokalbegränsningar;
 - Utförande (tas vagnen in i rummet, går man fram och tillbaka)
 - Modell på vagn.