Purpose-orientated stocking of procedure trolleys saves time in busy Emergency Centres

by

Phillip Pieter Furstenburg
MBChB, University of Cape Town
FRSPHI003

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Supervisor(s): Prof Lee Wallis and Dr Almero Oosthuizen

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Declaration

I, Phillip Pieter Furstenburg, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Abbreviations

EC	- Emergency Centre
ED	- Emergency Department
IV	- Intravenous Cannulation
LOS	- Length of Stay
SD	- Standard Deviation
US	- United States

Part A: Literature review

Objectives of literature review:

- To investigate the application of Lean in a healthcare setting.
- To investigate whether the application of lean principles to procedure trolleys increases efficiency in a medical work environment.

Literature search strategy:

A search was conducted using the following databases: 1) PubMed, and 2) Google scholar. The following keywords were used per objective:

- Lean management
- Lean principles
- Emergency Centres

After the above search was conducted, references that were deemed relevant to the objectives of this literature review were also explored.

Inclusion criteria:

- English Language articles

Exclusion criteria:

- Non-English Language articles

Quality criteria:

Titles and abstracts were reviewed to asses relevance to the review objectives and excluded when found not applicable.

Summary of literature:

Emergency Centres (ECs) worldwide are busy and stressful work environments. This is particularly true in under resourced settings such as public facilities in the Western Cape. Workflow is defined as the rate at which work progresses either by a person or within a department. Common tasks routinely performed in ECs that consume unnecessary time and resources, without improving service delivery, result in inefficient workflow and have been identified as an area of concern. There is growing interest in increasing workflow efficiency in healthcare through processes such as lean thinking.

"Lean" is a set of principles and techniques that drive organizations to continually add value to the product they deliver by enhancing process steps that are necessary, relevant, and valuable while eliminating those steps that fail to add value[1]. Lean has been used in manufacturing for decades and has been associated with an increase in product quality and overall corporate success[1]. Lean methodology is derived from principles of the Toyota Production System, developed in the 1950s by Ohno, who took inspiration from the work of Deming, Henry Ford's moving assembly lines, and United States (US) supermarkets[2,3]. Key principles of Lean methodology include the elimination of unnecessary waste, minimizing delays, just-in-time delivery of products and services, worker empowerment, and continuous improvement[4]. With regard to healthcare, thoughtfully changing the physical details of process design can be very effective in preventing errors or harm[5]. These details can be designed to speed up the process and make life easier for workers. Grout described how some hospitals have adapted the Toyota production system when it comes to workspace environment, which involves the following: thorough cleaning of the space in which processes occurs and discarding of items not being used, those items being used must be carefully placed in areas where they are being used increasing ease of work and reducing motion, once the item used in a process are in place, efforts must be made to ensure they stay where they belong, and finally these efforts should be maintained and institutionalized and must become habitual cultural parts of the establishment[5]. Preliminary evidence suggests that health care processes have a considerable amount of non-value adding tasks[5]. The Toyota Production Systems proponents view all of these activities as waste that should be reduced or removed. Although this paper's main focus was on reducing human error by making changes to the physical design of processes, it is still very relevant, as a reduction in error will consequently lead to an increase in efficiency.

Incidents and quality problems (i.e. poor service delivery) are one of the main reasons why health care leaders are promoting the redesign of health care delivery[4]. Lean thinking has the potential to improve health care delivery and Emergency Departments (ED – known in South Africa as Emergency Centres, EC) across the world are increasingly implementing this approach to address these and other issues. Rutman et al. noted that Lean could be successfully applied in the ever-changing world of emergency medicine and can help health care providers be more productive, engaged, and satisfied, while enabling patients to receive the value-added care they want and expect[4]. Holden critically reviewed 18 articles describing the implementation of Lean in 15 EDs in the United States, Australia and Canada[6]. The review revealed numerous ED process changes such as separate patient streams, structural changes, staffing changes, reorganization of physical space etc. and found that patient care usually improved after the implementation of Lean as decreases in waiting times, length of stay, and proportion of patients leaving the ED without being seen were reported. It also had a positive effect on employees and organizational culture. Mazzocato et al. reviewed 33 articles on Lean thinking applications in healthcare, and all articles reported positive results[7]. Benefits included improved quality, access, efficiency and reduced mortality[1,7,8]. Dickson et al. evaluated whether the adoption of Lean principles in EDs improved the quality of emergency care[1,8]. They implemented a variety of Lean techniques including process redesign and found a decrease in length of stay and increase in patient satisfaction despite an increase in patient visits during the post-Lean application period. Lean improved the value of the care they delivered to their patients. They found that generating and instituting ideas from their frontline providers has been the key to the success of their Lean program. They concluded that although Lean represents a fundamental change in the way we think of delivering care, the specific process changes made tended to be simple, small procedure modifications specific to their setting[7]. Arbune et al. realized that ED bottlenecks contribute to long waits and affects patient outcome in the ED[9]. They were able to reduce length of stay (LOS) for low-acuity patients by 30% using Lean management techniques. A quantitative, pre- and post-Lean design study by Chan et al. implemented a series of Lean management principles to improve the admission and blood result waiting time[10]. Waiting times in all categories were significantly reduced. They found that Lean management could be seen as another quality assurance tool to assure better patient outcome and improved patient flow in the ED[3,10].

Applying Lean principles to procedure trolleys:

Most of the literature in regard to the stocking of procedure trolleys in a task-orientated manner involves cardiopulmonary resuscitation or resuscitation trolleys. Donchin used video analysis to gather information on cardiopulmonary resuscitation; with this information in mind they were able to design a resuscitation trolley based on the supermarket principle, that all merchandise should be seen and easily accessible to the customer[11]. Walker et.al identified issues with standard resuscitation trolleys and pioneered the new design of a resuscitation trolley, which were evaluated in simulated cardiac arrest scenarios[12]. In both these papers, problems with the contemporary resuscitation trolleys were identified e.g. drugs and the equipment necessary to administer them were usually opaque to the clinicians, hidden and, even after the items were located, access was not easy due to overcrowding and drawers not opening properly, they also found that labelling was not apparent which went against all rules of human factors design. In both cases they modified the design of their trolley by applying some design solutions to the problems encountered with the contemporary resuscitation trolley e.g. creating an open layout design meant all equipment could be seen at a glance making access easier, the use of transparent containers, eliminating the use of drawers, labels on each individual item pocket helped staff identify the correct equipment etc. It is evident in both papers that, by applying simple human factors principles can lead to a significant improvement in reducing errors and improving efficiency in a medical work environment.

Rutman et al. redesigned an existing resuscitation room by applying Lean management principles through the use of in situ simulation[13]. The goal of the redesign process included the elimination of waste and reducing the time it took to search for materials while administrating resuscitative care to a patient. They were able to identify several areas of waste; one example was that the nurse had to open several drawers to gather the necessary materials to place an intravenous cannula (IV) on the patient. By identifying these areas of waste, they were then able to implement several immediate changes including reducing clutter in the room, establishing standard IV setup trolleys allowing efficient access to needed IV supplies during procedure preparation etc. Additional changes were implemented over the next 6-8 weeks that included the standardization of room set up as well as the standardization of procedure trolleys. In addition to other improvements they were able to reduce the time it took to obtain IV access from over 3 min to less than 90 seconds and gathered that the provision of resuscitative care was overall more efficient.

Furthermore, van der Merwe et al. did a pilot study which was aimed at improving efficiency of procedure preparation focusing on commonly performed procedures in an EC i.e. blood culture sampling and combined intravenous blood sampling and intravenous cannulation[14]. They found procedure trolleys to be disorganized and in no way orientated to a particular task. It meant having to seek out the necessary items to perform the procedure, which increased the burden on human resources. By altering workspace layout i.e. stocking procedure trolleys in a purpose-orientated manner they were able to document significant improvements in especially time saved during procedure preparation post intervention. Another example as described by Rutman et al. in regards to purpose-orientated stocking of procedure trolleys involved keeping tongue blades, ear speculums and otoscopes in the same place[13]. It's a simplistic but illustrative example of Lean in action, if a healthcare provider sees twenty patients on a shift and does not need to look for these items, or cross the room to gather supplies each time he can save a couple of minutes with each encounter. Multiply that by twenty patients and you can potentially save an additional thirty minutes or more of time each day that adds value to patients and increases ED capacity.

Not all studies investigating the application of Lean principles in healthcare report 100% positive conclusions[15]. Moraros et al. conducted a review, which included 22 articles[16]. The purpose of this review was to independently assess the effect of Lean thinking or Lean interventions on worker and patient satisfaction, health and process outcomes, and financial costs[17-21]. They found that Lean interventions only showed potential benefits in regards to process outcomes, and concluded that the evidence up to date with regards to Lean interventions and quality improvements in healthcare was inconsistent[15,16,22]. Common challenges facing Lean can be divided into three parts: physical layout issues, process flow, and the employees' collaboration. Changing the physical layout and persuading employees to change their thinking towards customer value and waste identification can be costly, time-consuming, and challenging for any organization[2]. One can't however deny the fact that Lean has already achieved tremendous success in both the manufacturing and service sector industries and although Health Care systems have only introduced and implemented Lean principles quite recently they have been showing high levels of success with regards to: patient length-of-stay, EC waiting times, costs, safety and quality of care, and physical work environments for healthcare professionals[24-26]. Lean offers significant advantages with regards to increasing efficiency and reducing waste while simultaneously improving quality of patient care. With its focus on increasing value, Lean has the potential to reduce cost, increase job satisfaction of healthcare providers, and improve the health of our communities. Although Lean represents a fundamental change in the way we think of delivering care it does not however require an influx of resources, and the specific resource changes made can be simple, small procedure modifications specific to your clinical setting[1].

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Part B: Manuscript in article format

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Purpose-orientated stocking of procedure trolleys saves time in busy Emergency Centres

P Furstenburg, MB ChB, DipPEC; **A Oosthuizen**, MB ChB, DipPEC, FCEM, MMed; **L Wallis**, MB ChB, MD, FRCEM, FCEM(SA)

Division of Emergency Medicine, University of Cape Town, Cape Town, South Africa

Corresponding authors:

P Furstenburg (furstenburgphillip@gmail.com)
A Oosthuizen (almeroos@yahoo.co.uk)
L Wallis (lee.wallis@uct.ac.za)

Abstract

Background and aim

Inefficient storage and sourcing of routinely required consumables located on procedure trolleys results in time wasted when preparing for common procedures in Emergency Centres, contributing to poor efficiency and quality of care. We designed a novel purpose-orientated procedure trolley, and evaluated its impact on time spent on procedure preparation and efficiency.

Methods

In an urban emergency centre, eight participants were measured each day over 24 days, once using the contemporary setup and once using the modified procedure setup. During each simulation, efficiency markers were assessed (time spent on procedure preparation, steps taken, stops made, and amount of time participants had to open a drawer to locate required items).

Results

The mean time required to collect the required items for IV cannulation and blood sampling from the purpose-orientated trolley was 22.7 seconds(s) (SD = 3.66) compared to 49.2 s (SD = 15.45) using the contemporary trolley. There was a significant difference in mean collection time between the two trolleys ($p < 0.0005$). There was a significant difference (p-value < 0.0005) in all the other categories: steps taken, stops made, and drawer opening.

Conclusion

In our setting, stocking procedure trolleys in a purpose-orientated manner has the potential to improve efficiency by reducing time spent on procedure preparation.

Introduction

Emergency Centres (ECs) worldwide are busy and stressful work environments.[1] In today's rapidly changing healthcare environment, ECs are expected to continuously improve the quality of care delivered to an expanding population of patients.[2] This is also true in under-resourced settings such as public facilities in South Africa, where high patient volumes and acuity combine with overworked staff to lead to multiple quality challenges.[1] One of the most visible challenges relates to long waiting times, a common cause of patient dissatisfaction. In addressing waiting times, numerous strategies are required, including more efficient use of existing resources. Common tasks routinely performed in ECs that consume unnecessary time and resources without improving service delivery result in inefficient workflow and have been identified as an area of concern.[3] Making small changes in workspace layout and workflow could produce significant efficiencies and reduce waiting times .[4]

There is growing interest in increasing workflow efficiency in healthcare through processes such as Lean thinking.[5] Lean is a set of principles and techniques that drive organizations to continually add value to the product they deliver by enhancing process steps that are necessary, relevant, and valuable while eliminating those that fail to add value.[6-8] Lean has been used in manufacturing for decades, and has been associated with enhanced product quality and overall corporate success.[6] Lean thinking begins with driving out waste so that all work adds value and serves the client's needs.[2,6] Identifying value-added and non-value-added steps in every process is the beginning of the journey toward Lean operations.[6] Substantial improvements in waiting times and patient outcomes have been achieved and sustained following Lean-thinking inspired changes to employee roles, staffing and scheduling, communication, workspace layout, and problem solving.[5]

Lean practices can be successfully achieved in emergency care, and can help health care providers be more productive, engaged, and satisfied while enabling patients to receive the quality of care they want and expect.[2] Numerous EC processes can be improved through Lean thinking, such as separate patient streams, structural changes, staffing changes, and reorganisation of physical space; a recent review found that patient care improved after the implementation of Lean, with decreases in waiting times, length of stay, and proportion of patients leaving the EC without being seen.[5]

A high proportion of EC patients need medical procedures, from IV line placement to lumbar puncture: inefficient storage and sourcing of routinely required consumables located on procedure trolleys results in time wasted when preparing for procedures, and this effect is magnified for those performed multiple times each day.[3] Procedure trolleys are clinical resource trolleys equipped with the essential equipment necessary to perform specific procedures within the EC. Following the principles of Lean thinking, a simple intervention that changes the way these trolleys are stocked may improve efficiency and reduce time wastage, thereby freeing staff to spend that time on activities that add more value. Reorganisation of procedure trolleys can reduce errors and improve efficiency.[9-11]

This study investigated the effect of stocking a procedure trolley in a purpose-orientated manner on procedure preparation time. Secondary objectives included the number of steps taken, stops made, and number of times participants had to open a drawer during item collection.

Methodology

Study design:
This was a quasi-experimental design testing the contemporary procedure trolley setup against a purpose-orientated setup.

Study setting and population:
The study took place at Karl Bremer Hospital, an urban district hospital in Cape Town. Data were collected during a simulated procedure within the EC. Participants were eight permanent full time EC doctors, calculated with 80% power, an assumed effect size of 1.5, and an approximate standard deviation of 15 seconds in each group. All participants signed informed consent.

Data collection:
Data were collected over a period of 24 days, including weekends, with measurements taken once a day. The lead investigator measured time taken to search for and collect the items required for IV cannulation and blood sampling (Table 1) and take them to a specified area in

the EC. The route taken, starting point and end point remained the same for both, whether using the conventional trolley or procedure trolley. The procedure-orientated & conventional trolleys were also situated at the same location in the EC as illustrated by figure 1. Time to perform the task was recorded with the same stopwatch for all measurements. One doctor was measured each day, once using the contemporary setup and once using the modified procedure setup and each doctor was measured six times in total.

The purpose-orientated trolley was stocked by the lead investigator and positioned at the same place where the contemporary procedure trolley is situated in everyday usage. The order of setup was randomised to reduce the risk of bias from a repeated measures effect. We collected 24 controls and 24 cases.

Table 1: List of items required for IV cannulation and blood sampling

1. Tourniquet
2. Alcohol swab
3. Intravenous catheter
4. Syringe
5. Saline lock
6. Ethylenediaminetetraacetic acid (EDTA) vacutainer
7. Transparent film dressing

Data analysis:

Descriptive statistics were presented for all variables. Categorical variables were reported as proportions with 95% confidence intervals. The data reflected the amount of time spent, actual steps walked, stops made, and drawer openings made while gathering necessary equipment during procedure preparation when using the contemporary emergency centre consumables setup vs. the purpose-orientated consumables setup. Figures were used to illustrate the important findings from the study. The statistical analysis tried to identify whether a difference between the mean in the two groups existed by using a t-test. A post-hoc power analysis was conducted to show whether adequate power existed for inferences to be acceptable. Where power lacked, preference was given for non-parametric analysis, such as the Wilcoxon rank-sum or Mann-Whitney tests.

Results

Overall, the purpose-oriented trolley resulted in significant efficiency savings (Table 2 and figures 1-3).

	Mean (Standard Deviation (SD)) Range		**p-value**
	Contemporary trolley	**Purpose-orientated trolley**	
Time (seconds)	49.2 (15.45) 29.5 – 95.8	22.7 (3.66) 17.6 – 30.5	< 0.0005
Steps	28 (13) 18 – 62	17 (1) 15 – 19	< 0.0005
Stops	4 (1) 3 – 7	1 (0) 1 – 1	< 0.0005
Opening a drawer	4 (1) 4 – 8	0 (0) 0 – 0	< 0.0005

Table 2: Efficiency indicators for Contemporary Trolley and Purpose-orientated trolley

The mean time to collect the required items for IV cannulation and blood sampling from the purpose-orientated trolley was 22.7 s (SD = 3.66) compared to 49.2 s (SD = 15.45) using the contemporary trolley ($p < 0.0005$). The mean number of steps was significantly reduced (17 (SD = 1) compared to 28 (SD = 13) ($p < 0.0005$)), as were both the mean number of stops made (1 (SD = 0) compared to 4 (SD = 1) ($p < 0.0005$)) and number of drawer openings to find equipment (4: there were no drawers on the procedure-orientated trolley).

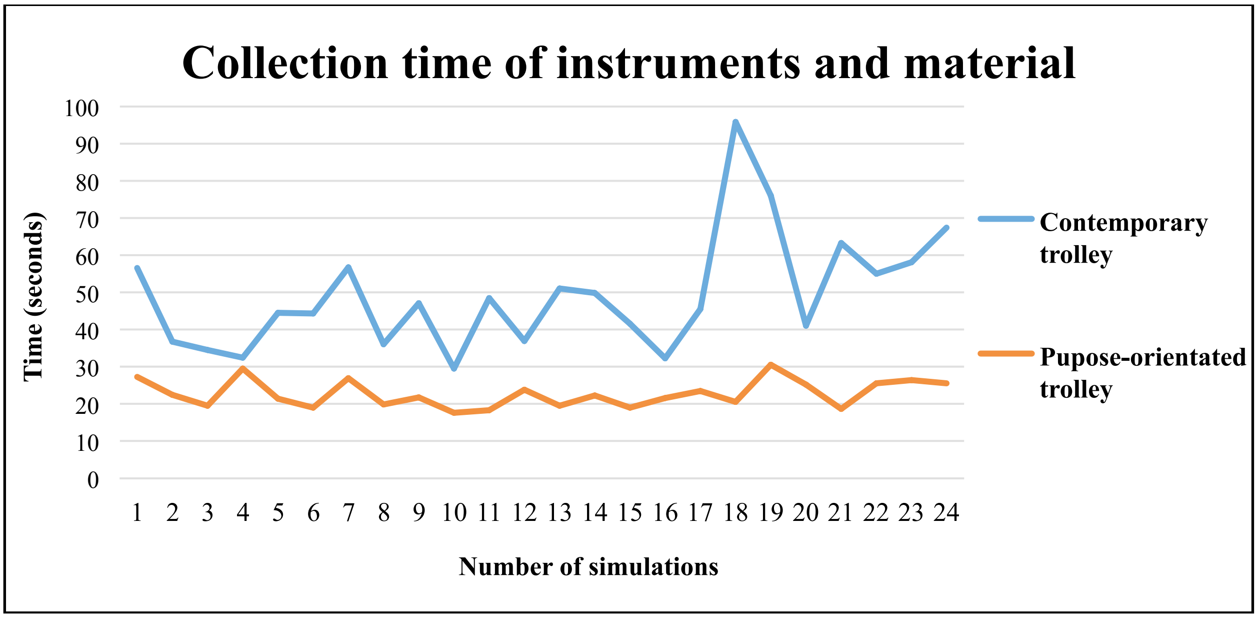

Figure 1: Collection time of emergency instruments and material using contemporary trolley vs purpose-orientated trolley

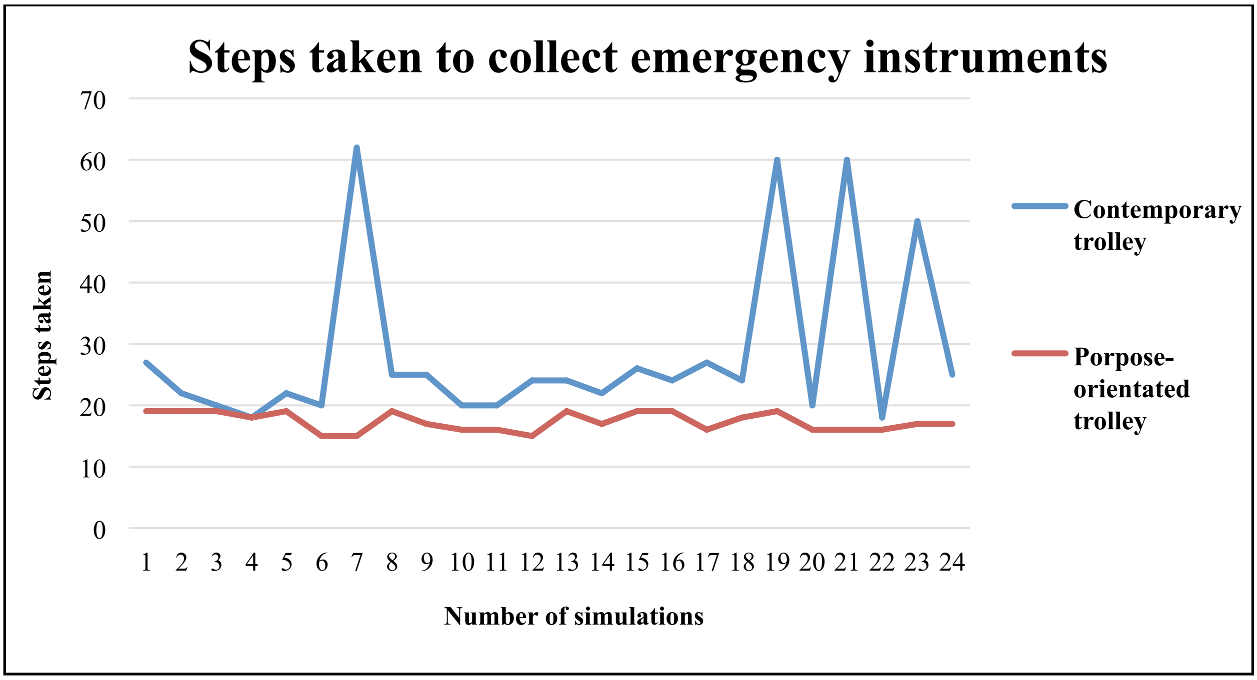

Figure 2: Steps taken to collect emergency instruments and material from contemporary trolley vs purpose-orientated trolley

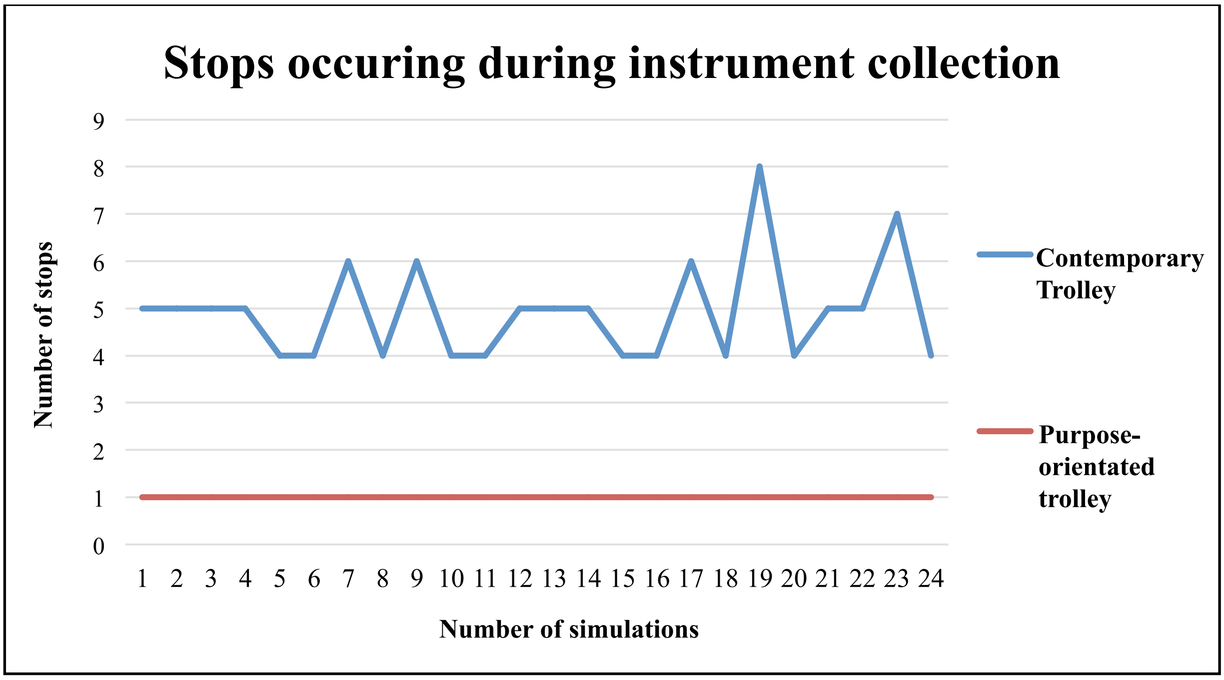

Figure 3: Stops occurring during collecting emergency instruments and material from contemporary trolley vs purpose-orientated trolley

Discussion

We have demonstrated significant reduction in time spent on procedure preparation when using a purpose-orientated trolley, as well as several other efficiencies. While a 26.5 second reduction may not sound important, there are several considerations. Firstly, Karl Bremer is a busy EC with a high acuity patient load. It sees over 90 patients a day, and admits about 50% of cases. Assuming that only the admitted patients get IV lines or blood work done (which we know is an under-estimate of the actual volume), that is 45 patients per day. A saving of 26.5 seconds per patient frees up 20 minutes of doctor time over the day. If similar small changes in workflow and efficiency can be made in other areas of the EC, significant cost savings can be made, allowing doctors to work on more value-added areas of direct patient care, and reducing waiting times.

Other authors have had similar success after modifying their resuscitation trolleys: drugs and equipment were accessed significantly faster[9,10], and IV preparation time was cut from 180 to 90 seconds.[11] Time is not the only important factor though: by reducing the number of steps taken, we presume that staff will be less tired during their shifts. Eliminating drawer opening not only increases efficiency, but reduces overall staff frustration. Other authors have shown similar results, keeping tongue blades, ear speculums and otoscopes in the same place.[11] This is a simplistic but illustrative example of Lean in action: if a healthcare provider sees twenty patients on a shift and does not need to repeatedly search for these items, or cross the room to gather supplies each time they are needed, she can save a couple of minutes with each encounter adding value to patients and increasing EC capacity.

Only one participant was measured per day, once using the contemporary setup and once using the modified procedure setup thus reducing the risk of bias from a repeated measures effect. This study however took place at a single unit, which may limit the external validity but we believe that this site is typical of most large district hospitals in the country.

Our trolley redesign proved to be successful and did indeed increase efficiency by reducing time spent on procedure preparation. It's a simple example of how the implementation of Lean principles can improve health care. Our study reiterated the fact that, although Lean represents a fundamental change in the way we think of delivering care, it does not however require an input of resources, and the specific resource changes made can be simple, small modifications specific to your clinical setting.[6] This study can serve as a pilot for future work on small changes with incremental efficiency gains in busy ECs across the country.

Conclusion

By applying Lean principles to the design of the procedure trolley, we produced significant reductions in time taken to prepare for IV cannulation and blood work in a busy urban emergency centre. Similar efficiency gains in other areas of EC work can compound this work, to lead to overall improved efficiency and reduced waiting times.

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Conflict of interest

None.

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Ethics approval

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Facility approval

National Health Research Database: *WC_201709_021*

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Part C: Addenda

a. Acceptance letter for publication

SAMJ <em@editorialmanager.com> Jun 12

to me

CC: almeroos@yahoo.co.uk, lee.wallis@uct.ac.za

Ref.: SAMJ13422
Purpose-orientated stocking of procedure trolleys saves time in busy Emergency Centres
South African Medical Journal

Dear Dr furstenburg,

We are pleased to tell you that your work has now been accepted for publication in South African Medical Journal.

Thank you for submitting your work to the journal.

Best wishes

Bridget Farham, PhD
Editor
South African Medical Journal

b. Journal instructions

A complete list of the SAMJ instructions to authors is available at http://www.samj.org.za/index.php/samj/about/submissions

c. Acknowledgements

I would herewith like to thank the supervisors of this thesis, Prof Lee Wallis and Dr Almero Oosthuizen for their tremendous support. Without their guidance it would not have been possible. I would further like to acknowledge the help of Dr Dirk Smith who assisted with data analysis of this study.

d. Research Protocol

Purpose-orientated stocking of procedure trolleys saves time in busy Emergency Centres

Student:

Dr. Phillip Furstenburg
Division of Emergency Medicine, University of Cape Town
Email address: furstenburgphillip@gmail.com

Supervisors:
Prof. Lee Wallis (principal investigator)
Head of Division of Emergency Medicine, University of Cape Town

Dr. Almero Oosthuizen
Division of Emergency Medicine, University of Cape Town

Introduction

Emergency Centres (ECs) worldwide are busy and stressful work environments.[1] This is particularly true in under resourced settings such as public facilities in the Western Cape.[1] Workflow is defined as the rate at which work progresses either by a person or within a department. Common tasks routinely performed in ECs that consume unnecessary time and resources, without improving service delivery, result in inefficient workflow and have been identified as an area of concern.[2] There is growing interest in increasing workflow efficiency in healthcare through processes such as lean thinking.[3] When providing health care for a patient, workers must rely on multiple, complex processes to accomplish their tasks and provide value to the patient. Waste – of money, time, and supplies – increases absolute cost and decreases value return on resources spent. Lean thinking begins with driving out waste so that all work adds value and serves the patient's needs. Identifying value-added and non-value-added steps in every process is the beginning of the journey toward lean operations. Lean thinking focuses on redesigning processes to improve workflow and reduce waste.[6] Substantial improvements in waiting times and patient outcomes have been achieved and sustained following lean- thinking inspired changes to employee roles, staffing and scheduling, communication, workspace layout, and problem solving.[3] Holden critically reviewed eighteen articles describing the implementation of lean thinking in fifteen Emergency Departments (ED – known in South Africa as Emergency Centres, EC) in the United States, Australia and Canada.[3] The review revealed numerous EC process changes including the reorganization of physical space, which lead to an increase in efficiency i.e. decreases in the length of stay, waiting times, and proportions of patients leaving the emergency centre without being seen.

Public hospitals in South Africa are understaffed[1]. Making small changes in EC workspace layout and workflow could reduce patient waiting times. For example, it is hypothesized that inefficient storage and sourcing of routinely required consumables results in time wasted when preparing for common procedures. Procedure trolleys are clinical resource trolleys equipped with the essential equipment necessary to perform specific procedures within the EC. Following the principles of lean thinking, a simple intervention that changes the way these trolleys are stocked may improve efficiency and reduce time wastage, thereby freeing staff to spend that time on activities that add more value. Literature describing the stocking of procedure trolleys in a purpose-orientated manner is limited. Most of the literature regarding this subject matter involves resuscitation trolleys. Walker et.al identified issues with standard resuscitation trolleys and pioneered the new design of a resuscitation trolley, which were evaluated in simulated cardiac arrest scenarios.[5] By making simple changes to the standard resuscitation trolley such as creating an open layout design, which meant that all equipment could be seen at a glance making access easier, the use of transparent containers, and eliminating the use of drawers, they were able to show a significant improvement in reducing errors and improving efficiency in a medical work environment. This study aims to measure time spent on the preparation for common tasks before and after a simple intervention (stocking a procedure trolley in a purpose-orientated manner), in order to discover if such an intervention results in a meaningful difference in efficiency.

Purpose of study

Much time is lost gathering necessary items during procedure preparation, due to inefficient stocking of procedure trolleys. We hypothesize that a simple intervention such as the stocking of procedure trolleys in a purpose-orientated manner can significantly reduce time loss during preparation for commonly performed tasks.

Aim and objectives

The aim of this study is to determine whether a purpose-orientated consumables setup of a procedure trolley results in time saved during the preparation for a common procedure when compared to a contemporary EC consumables setup.

In order to achieve this aim, the following objectives will be addressed:

- To describe the difference in time taken to collect a set of intravenous(IV) cannulation and blood sampling resources, from a purpose-orientated procedure trolley to a set destination when compared to collection from the currently designated source to a set destination
- Secondary objectives will include the number of steps taken, stops made, and number of times participants have to open a drawer during item collection.

Methodology

Study design:

This study follows a quasi-experimental design testing the contemporary consumables setup against a purpose-orientated procedure trolley setup.

Study setting and population:

The study will take place at Karl Bremer Hospital, an urban district level hospital in Cape Town. Data will be collected during a simulated procedure within the real EC environment. The participants will consist of eight doctors, of whom all are currently working in the EC at Karl Bremer Hospital. Only EC doctors will be participating in the study. As this is a novel study, it is challenging to estimate the standard deviation likely to be observed. However, assuming an effect size of 1.5 and an approximate standard deviation of fifteen seconds in each group, this study is sufficiently power at 80%.

Recruitment and enrolment:

Emergency centre doctors participating in the study will be recruited via an informed consent process. The research, including its potential risks and benefits, will be explained to each participant individually to ensure all participants have sufficient information to make an informed decision in regard to whether they want to participate in the study. Participants taking part in the study will sign a consent form. Participation will be completely voluntary and participant names or personal details will not be collected or reported on.

Research procedures and data collection:

Data will be collected over a period of 24 days, including weekends (non-consecutive), with measurements taken once a day. The lead investigator will measure the time it takes an emergency centre doctor to search for and collect the items required for IV cannulation and blood sampling (Table 1) and take them to a specified area in the EC. Time to perform the task will be measured with the same stopwatch for all measurements. One of the eight doctors participating in the study will be measured each day, once using the contemporary setup and once using the modified procedure setup. Each doctor will be measured six times in total, thrice using the contemporary setup, and thrice using the modified procedure setup. The purpose-orientated trolley will be stocked by the lead investigator, and positioned at the same place where the contemporary procedure trolley is situated. A crossover design will be used in which the order in regard to which setup is used will be randomized to reduce the risk of bias from a repeated measures effect. There will be twenty-four controls and twenty-four cases collected in total.

Table 1: List of items required for intravenous cannulation and blood sampling

1. Tourniquet
2. Alcohol swab
3. Intravenous catheter
4. Syringe
5. Saline lock
6. Ethylenediaminetetraacetic acid (EDTA) vacutainer
7. Transparent film dressing

Measurements will be taken over a controlled route. The EC doctor will start at the doctors' workstation (A) and end at a specific bed (C) in the EC at Karl Bremer Hospital (Figure 4).

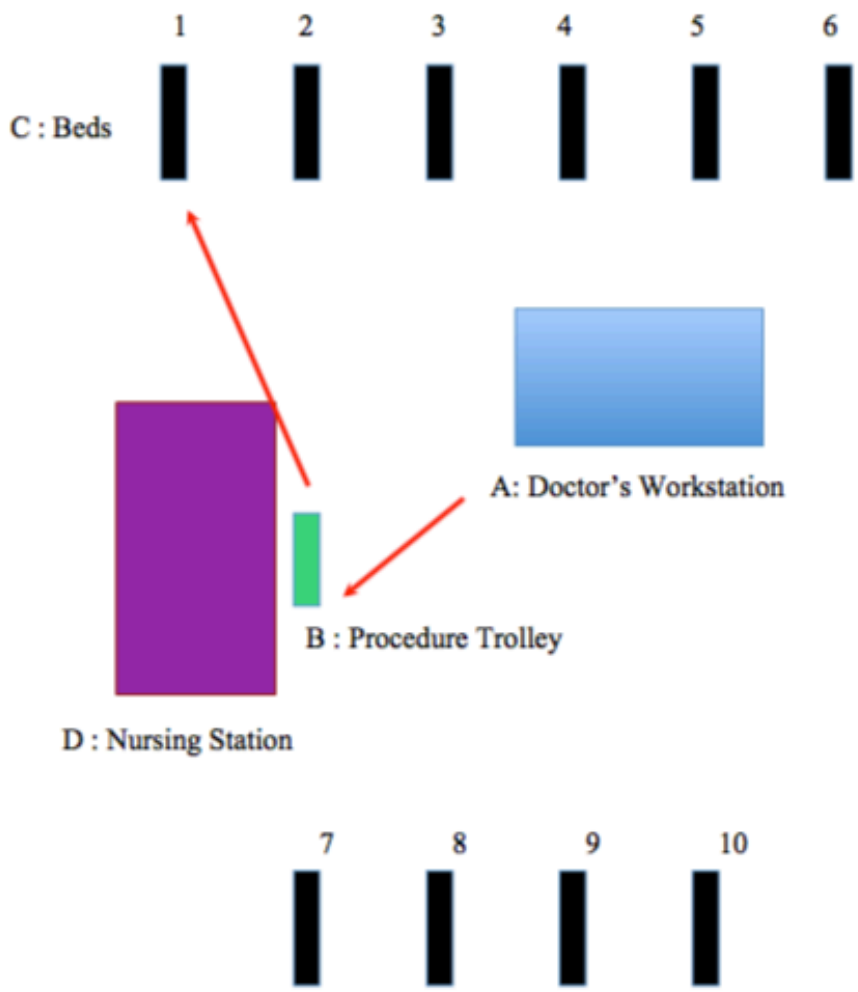

Figure 4: Karl Bremer Hospital Emergency Centre floor plan

A: Doctor's workstation (starting point); B: Procedure trolley; C: First bed; D: Nursing station

Data management:

All data will be entered into a password protected Microsoft Excel spread sheet, on a password protected work computer.

Data analysis and interpretation:

Descriptive statistics will be presented for all variables. Categorical variables will be reported as proportions with 95% confidence intervals. The data will reflect the amount of time spent on gathering necessary equipment during procedure preparation using contemporary emergency centre consumables setup vs. a purpose-orientated consumables setup. Figures will be used to illustrate the important findings from the study. The statistical analysis will try to identify whether a difference between the mean in the two groups exists by using a t-test. Time tends to be parametric, but this will have to be considered post collection, given the sample size. A post-hoc power analysis will be conducted to show whether adequate power exists for inferences to be acceptable. Where power lacks, a preference will be given for non-parametric analysis, such as the Wilcoxon rank-sum or Mann-Whitney tests.

Ethical considerations

Ethical approval will be sought from the Human Research Ethics Committee of the faculty of Health Sciences, University of Cape Town. Facility approval will be sought from Karl Bremer Hospital via the National Health Research Database.

Potential risks:

A potential risk might involve the removal of items from the procedure trolley preventing other staff from using those items at that precise moment. This risk will be minimized by returning all items acquired from the procedure trolleys during data collection to their previous locations immediately once finished. In addition, the investigator will ensure the trolleys are properly stocked and alert the lead nurse if this is not the case, so it may be restocked. In the rare instance that an item in the possession of the investigator is required by any emergency staff members, it can be obtained from the investigator immediately as he will be residing in the EC during data collection. Additionally, all staff in the emergency centre will be made aware that the study is in process and can be interrupted in an emergency.

Potential benefits:

This study aims to test whether a simple intervention i.e. changing the way procedure trolleys are stocked in emergency centres can reduce time loss, thereby freeing staff to spend that time on more value-adding activities, and inevitably improve service delivery to our patients. There are no direct benefits for individual study participants, however participants will gain insight into improving their own workflow efficiency within the work environment. No additional staff members will be required to perform this activity (stocking the procedure trolleys in a purpose-orientated manner) nor will it have any financial implications as there are already staff members allocated to stock/re-stock procedure trolleys on a daily basis. Ultimately, if we can show that this simple intervention saves time, we hope that our trolley recipe might be more widely implemented in emergency centres throughout the Western Cape.

Informed consent:

Emergency centre doctors participating in the study will be recruited via an informed consent process.

Privacy and confidentiality:

All results will be kept strictly confidential as described. Permission will be granted from the necessary authorities prior to making any changes to current processes.

Reimbursement:

There will be no reimbursement for participation in this study.

Limitations

The study will take place at a single unit (the EC at Karl Bremer Hospital), which limits the findings to one setting: it would be interesting to perform the study at other units simultaneously and compare findings across different units. The study is only measuring four variables, adding more variables could create a much richer narrative of 'efficiency'. It would also need internal validation first as at present our study will be simulated in a real EC environment. One has to also consider the Hawthorne or observer effect which could possibly influence our study. Despite the above-mentioned limitations, this small study is aimed at assessing whether the methodology described in this study will work, and whether it could be translated to larger studies conducted in the near future surrounding this topic.

Reporting and implementation of results

The study will be written up as a MMed thesis, and will be submitted for publication in a scientific journal. Feedback will be provided to departmental managers in the EC at Karl Bremer Hospital. If our trolley recipe proves to be successful and indeed does increase efficiency in our unit we will implement our findings at Karl Bremer Hospital. This study could serve as a pilot study for future studies surrounding this topic, and if our findings are replicated elsewhere, we are hoping our trolley recipe might be more widely implemented in Emergency Centres throughout the Western Cape.

Personal work plan:

- EMDRC 2 months
- HREC 2 months
- NHRD 2 months
- Data collection 1 months
- Analysis 2 months
- Summary 2 months

Budget:

Table 2: Budget

Item	Description	Unit cost	No. Of units	Total cost
1. Internet and email services	Wi-Fi / Airtime cost	R200.00/month	3	R600.00

2. Specialized services	Bio statistical services	R185.00/hr.	9	R1665.00
3. Office supplies, printing & reproduction for data collection	Printing, Paper			R200.00
Total direct cost				R2465.00

The lead investigator will fund all expenses.§§

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e. **HREC Approval letter:**

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E53-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: sumayah.ariefdien@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

12 September 2017

HREC REF:656/2017

Prof L Wallis
Division of Emergency Medicine
C/o Aileen Maas
J-Floor-OMB

Dear Prof Wallis

PROJECT TITLE: THE EFFECT OF PURPOSE-ORIENTATED STOCKING OF PROCEDURE TROLLEYS ON TIME SPENT DURING PROCEDURE PREPARATION (MMeD-candidate-Dr P Furstenburg)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 September 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

We acknowledge that the student: Dr P Furstenburg will also be involved in this study.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

HREC 656/2017

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI),and Declaration of Helsinki (2013) guidelines.
The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC 656/2017