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Improving the efficiency of a chemotherapy day unit: Applying a business approach to oncology

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ABSTRACT

Aim: To improve the efficiency of a hospital-based chemotherapy day unit (CDU).
Methods: The CDU was benchmarked with two other CDUs to identify their attainable performance levels for efficiency, and causes for differences. Furthermore, an in-depth analysis using a business approach, called lean thinking, was performed. An integrated set of interventions was implemented, among them a new planning system. The results were evaluated using pre- and post-measurements.
Results: We observed 24% growth of treatments and bed utilisation, a 12% increase of staff member productivity and an 81% reduction of overtime.
Conclusions: The used method improved process design and led to increased efficiency and a more timely delivery of care. Thus, the business approaches, which were adapted for healthcare, were successfully applied. The method may serve as an example for other oncology settings with problems concerning waiting times, patient flow or lack of beds.

1. Introduction

With an estimated 2.9 million new cases and 1.7 million deaths each year in the European Union, cancer presents an important health problem.[1] These volumes make it understandable that the costs related to cancer care are substantial. In the Netherlands these are estimated to be 4.1% of total healthcare expenditure[2] and in the United States of America (USA) almost 5%.[3] In the near future, costs of cancer care are expected to increase at a faster rate than overall medical expenditures. As the population ages, the absolute number of cancer patients will grow relatively fast and the introduction of new cancer treatments will contribute considerably to total expenditure.[3] In combination with workforce availability problems, these trends increase the pressure on efficiency.

Traditionally, healthcare quality focused mainly on treatment issues and the patient-physician relationship[4] and so did improvement techniques.[5] A broader definition of quality, including efficiency and timeliness, has currently been accepted.[6] As a consequence, the acceptance for related improvement techniques is growing. In this paper we will show how business approaches can support efficiency improvements in a hospital-based chemotherapy day unit (CDU 1). Due to an increasing demand the unit was facing difficulties with waiting times and work pressure. The objective was to enable at least 20% patient growth without adding

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proportionally more staff while sustaining current quality and patient satisfaction levels.

2. Applying business approaches to improve efficiency in oncologic care

Because healthcare is labour-intensive, productivity is regarded as an important efficiency element. Working harder is unlikely to gain much effect; people have to work more effectively to obtain increased productivity.[7] Changing the organisation of processes may help to realise this as 'every system is perfectly designed to achieve the results it achieves'.[8]

During the last decade hospitals have sought the support of business approaches to improve their efficiency. Examples are:

- Business process reengineering (BPR) – this argues that radical change is the best way to improve. However, only an estimated 30 to 50% of all BPR projects achieve the intended results[9] and as a consequence organisations are looking for more comprehensive approaches.
- Benchmarking[10] – this is used to identify best-practices which can be used as input for improvements. This is done by comparing organisations, sometimes in other sectors.
- Total quality management – this focuses on the development of a culture and system for continuous quality improvements. The aim is avoiding mistakes.

These approaches do not describe in detail how processes should be organised and do not use process change as a means of achieving efficiency improvements. Pollitt[11] provides an overview of the successes of BPR and benchmarking in hospitals and concludes that although both methods sound promising, the results of the few studies – often based on single case studies – are not very convincing.

Another approach which focuses on process organisation and appears more promising is lean thinking, also known as lean production. It originated at Toyota and provides *'a way to specify value, line up value-creating actions in the best sequence, conduct those activities without interruption whenever someone requests them, and perform them more and more effectively'*.[12] It focuses on value for the customer (in healthcare the patient), the value stream (each activity must add value for the patient), flow (service delivery without stoppages or backflows), pull (deliver it when it is needed) and perfection.[12] Lean thinking is described as a philosophy to organise processes. It consists of many tools and those that we used are discussed in the methods section. Examples of lean thinking provided by national healthcare quality agencies, such as IHI, the NHS,[13] and the lean management institute,[14] all show promising results but most publications tend to have a descriptive character, lack pre- and post-measurements and do not use controlled studies.

Thus, although most business approaches claim to improve efficiency, the scientific evidence in (oncology) healthcare supporting this claim is limited. The complexity of cancer care and the continuous changes caused by scientific progress make oncology a difficult area to study improvement projects. Other reasons for the apparent lack of reported success from business approaches could be related to methodological issues caused by the implementation of multiple interventions and changing contingency factors.[15]

3. Methods and results per project phase

We applied lean thinking because it focuses on the organisation of processes and the results seem promising. Many lean principles correspond with oncology, and healthcare in general, where patients need to receive the right treatment at the right time in the most effective way. In order to obtain more insight into attainable performance levels we also decided to use benchmarking.

Like many healthcare improvement projects, this project is structured according to the Plan-Do-Study-Act cycle.[16] This iterative method has much in common with clinical practice where *'therapies are initiated under close observation and adjustments are made as data and experience accumulate'*.[17] The project lasted from 2005 until 2008, but we did not work full-time on it. Table 1 provides the time required per phase. We discuss the application of lean management tools and benchmarking per phase.

3.1. *Plan phase*

During the plan phase the process was analysed. The pre-measurements delivered data about efficiency, patient satisfaction and staff satisfaction. We used the following techniques:

1. An in-depth process analysis of CDU 1 consisting of lean thinking techniques:
   - Direct observation of the entire process, including pharmacy and phlebotomy. Few publications have included the interrelatedness between departments.[18]
   - Mapping the process, with a technique called value stream mapping.[12] We also identified patient groups based on the track they completed before reporting at the CDU.
   - Identification of gaps between staff members' perceptions and the results from previous steps. Root-cause analysis techniques[12] revealed causes of the perceived bed shortage and high work pressure.
   - Collecting data. Measurements were needed for: time spent in the waiting room, time needed to order medication, medication preparation time, and the waiting time

Table 1 – Timespan of the various plan-do-check-act phases.

Phase	Period
Plan	March–November 2005. Arranging the benchmarking resulted in time delays
Do	January –October 2006. Minor adaptations have been made after this period
Check	March 2008
Act	March–April 2008

on a bed before medication is administered. We also had to minimise the administrative burden needed to execute the measurements. Therefore we collected 1 week data and evaluated the results with the staff.
- Doing a Rapid-Plant-Assessment[19] which was translated to Dutch and modified for use in hospitals. The assessment contains a framework to determine whether the department is lean and includes a questionnaire about the application of best-practices.
- Visualisation of the improvement potential when reducing the weak points. Although not a lean technique in a strict sense this was important for the rest of the project. We used data of two busy days, according to the department head, to discuss the current capacity use and the best capacity use.

2. Benchmarking with two other CDUs in the USA and Europe. Literature reviews, desk research and interviews were used to identify performance indicators. Interviews and site visits were used to retrieve the data needed for comparison.

The main findings of the analysis are:

1. In a CDU the pharmacy prepares most medication when there is certainty about the actual administration. The continuation of the treatment often depends on the phlebotomy results. The observations and value stream map showed the different tracks patients complete before reporting at the CDU. Fig. 1 shows a simplistic visualisation of those tracks. We identified the patient groups' volume during a 1 month sample. Depending on their treatment phase, patients switch between groups. Each group affects the process in a different way and therefore optimisation per group is required. For example, patients with previous appointments are more likely to arrive later than those without.
2. Root-cause analysis techniques revealed that the reported bed shortage and high work pressure were caused by unequally distributed daily demand with peaks around 11.00 AM and 1.30 PM. In turn, this peak was caused by the planning system because scheduling did not match with the nurses and beds available at a specific time.
3. The analysis showed different forms of waste. An example of wasted nursing time is the time spent on patients waiting on a bed for their medication. Stagnation was found in the medication order process. Pharmacy measurements revealed that on average 23 min are needed to prepare medication ($n = 92$) while CDU measurements showed that medication was delivered 53 min after the scheduled appointment time ($n = 126$). The measurements have been confirmed by the CDU and pharmacy. They concluded that medication was often ordered after the original appointment time. Causes were unavailable lab results and the work pressure of the single nurse practitioner responsible for the orders.
4. The Rapid-Plan-Assessment appointed information transparency and materials management as improvement areas. A reorganised inventory would ease inventory control while transparency contributes to an improvement culture.
5. The visualisation of possible improvements showed a planning system considering nurse and bed capacity, enabling the treatment of the same amount of patients with 30% less beds in an ideal situation. The project team confirmed plausibility of the results.

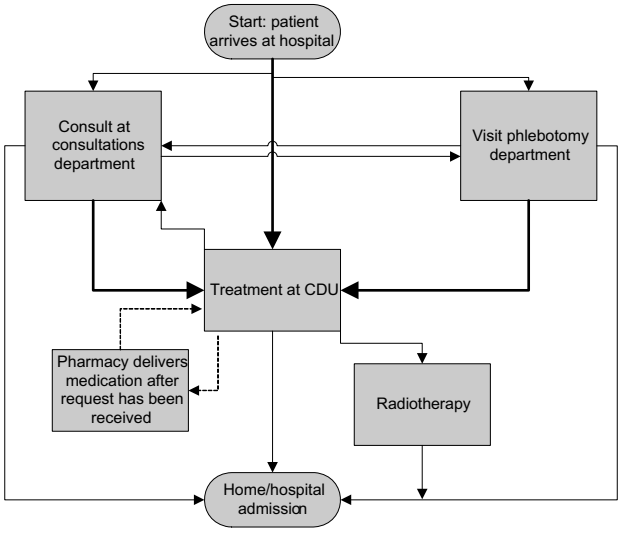

Fig. 1 – Relation of CDU and other departments.

Table 2 summarises the main performance indicators of the benchmarking. CDU 2 was by far the largest involved organisation. CDU 3 clearly outperforms the others on efficiency; we tried to understand how this was done. CDU 3 provided possible best-practices for the planning system, reduction of non-value added activities and use of nurses. Table 3 provides a list of data collected for this study.

Table 2 – Main performance indicators benchmarking.

Performance indicators	CDU 1	CDU 2	CDU 3
Total patient visits 2004	11,152	80,000	12,371
Estimated total patient visits 2005 in November	12,000	107,000	12,500
Indexed average number of patients treated per bed per month (not corrected for differences in opening hours)	44	77	100
Indexed average number of patient visits per month per total CDU staff	58	44	100
Indexed average number of patient visits per nurse per month	62	53	100

Indexed = the best performing CDU received a score of 100, the other CDU received a relative score compared to the best performing CDU.

Table 3 – Data collected.

Indicator		
Walk-in appointment system or planning system at phlebotomy department?	Phlebotomy department information system	Benchmark
Analysing waiting time phlebotomy department	Phlebotomy department information system	Benchmark
Time needed to determine phlebotomy results	Phlebotomy department information system	Benchmark
General description of CDU planning system	System includes: 1. Occupancy time of beds? 2. Available beds at a certain moment? 3. Available nurses at a certain moment? 4. Workload? 5. Planning is visualised? 6. Knowledge about CDU needed to plan appointments?	Benchmark
Number of patient visits		Benchmark
Number of beds/chairs		Benchmark
CDU opening hours		Benchmark
Number of staff employed at CDU (in full-time equivalents)	Relative importance of experience for the planning	Benchmark
Number of nurses	Head CDU	Benchmark
Number of other CDU staff	Head CDU	Benchmark
Time needed per treatment	Hospital information system/treatment protocols	In-depth analysis CDU1
Patient arrival time	Sample: measured by secretary	In-depth analysis CDU1
Planned appointment time	Hospital information system	In-depth analysis CDU1
Patient on bed/chair	Sample: measured by nurses	In-depth analysis CDU1
Prescription to pharmacy	Sample: measured by nurse practitioners	In-depth analysis CDU1
Medication ready	Sample: measured by pharmacy	In-depth analysis CDU1
Medication administered	Sample: measured by nurses	In-depth analysis CDU1
Bed utilisation per hour	Sample: measured by project leader	In-depth analysis CDU1
Volume of the patients groups	Sample: combination of HIS and treatment information	In-depth analysis CDU1
Workplace absenteeism	HRM system	In-depth analysis CDU1
Overtime	HRM system/CDU head (claims for expenses)	In-depth analysis CDU1
Patient satisfaction questionnaire	Sample: standard hospital questionnaire	In-depth analysis CDU1

3.2. *Do-phase*

In the Do-phase a multidisciplinary project team examined which recommendations seemed suitable for implementation. The team included among others: a medical oncologist, nurse, nurse practitioner, secretary and programmers. The following activities were conducted:

1. Waste reduction. Based on the value stream map, waste – activities without added value for the patient – was identified. Waste was eliminated whenever possible.
2. Developing the new planning method that delivers optimal value for patients and staff.
3. Techniques to align the capacity of related departments with the CDUs patient flow:
   a. We tried to level peak demand by reserving certain times for specific patient groups, a technique called heijunka (see [12]).
   b. We either tried to eliminate causes of variation or adapted the system to enable absorption of variation.
4. Measures to make the changes last.

During this phase a set of interventions were implemented, examples of the most important interventions are:

1. Waste reduction:
   a. Nurses welcome patients when available instead of being called in the middle of an activity.
   b. A single code for a set of lab tests is used instead of ticking each test separately.
   c. Patients requiring no staff attention no longer wait on a bed but in the waiting room which has been converted into a lounge like environment.
   d. Medication orders for non phlebotomy dependent treatments for the next day are signed around 14.00 PM to enable preparation in the afternoon.
   e. The pharmacy prepares all biphosphonate medication and about 75% of the trastuzumab needed for that day in advance instead of preparing per single patient. This reduces pharmacy time for almost 20% of the patients.
   f. Oral medication is handed out by nurse practitioners at the consultations department instead of the CDU where medication delivery often involved a 1 h waiting time.
   g. Nurses do the paperwork in the patient's presence while discussing the patient's situation.
2. The development of a new planning system:
   a. Planning is based on expected treatment duration.
   b. Planning is based on the availability of a bed and nurse. Each nurse has three beds.
   c. The CDU attempts to assign patients to their primary nurse.
   d. Inserting a venous cannula is the most labour-intensive part of the treatment, thus this is avoided during the lunch break of the two shifts. However, the goal is to occupy all beds before lunch because this increases bed utilisation while dealing with the limited staffing levels.

3. Aligning the planning method with the capacity of related departments to improve patient flow:
   a. The pharmacy's early morning demand was high because it had to prepare medication for the wards and the CDU. Treatments that are administered independent of phlebotomy results are scheduled before 10.00 AM or after 3.00 PM. The medication is prepared in advance, during quiet hours of the pharmacy. This corresponds with the recommendations of a simulation study in a CDU.[18]
   b. Service level agreements with other departments determined the compulsory time between appointments to reduce chances on delayed patients. Phlebotomy for patients with long treatments now takes place the day before the treatment. In this way the treatment can start in time.
4. Measures to maintain the effects of the interventions:
   a. Development of standard working procedures for patient planning, emergencies and cancellations.
   b. Logistic information was added to the patient leaflet so patients knew what to expect.[20] This was done in the form of boxes which were ticked by the nurses. Examples are: time needed for blood analysis, compulsory time between consultations department and CDU appointments.

Initially, staff members reacted sceptically to the proposed changes, which required a cultural change, but management succeeded in gaining the essential project support. The project support did reduce, however, after 9 months had expired and no changes had been noticed, but this time was needed to develop an IT-system that supported the new planning method.

3.3. *Study phase*

In this phase the results were evaluated with a post-measurement. Table 4 shows a 24% growth in the number of patient visits, a 12–14% increase in staff productivity, and an 81% reduction of overtime while the average expected treatment duration remained stable.

Part of the objectives was to increase efficiency without harming the other quality aspects. The number of complaints was already low before the interventions and we have found indications that this decreased slightly. Medical oncologists participated in the project to safeguard quality and ensure that internal medical guidelines had not been changed due to this project. Patient satisfaction remained stable. Part of the questionnaire is the perceived waiting time; this received only a 52% satisfaction score. However, additional measurements showed that patients wait on average almost 10 min between the scheduled appointment time and actual treatment start ($n = 144$). This suggests a discrepancy between the perceived and realised waiting time. Almost 45% of the patients report at the CDU 30 min before their appointment; this is the starting signal for preparation of the medication. Comparison of waiting times with 2005 is difficult because patients used to wait on a bed while they now wait in the waiting room. The questionnaire also showed that some interventions, like the scheduling of non phlebotomy dependent treatments on specific times, had not enhanced satisfaction. However, this was implemented to enable more patients to be treated in a timely manner.

Staff satisfaction was evaluated by workplace absenteeism, overtime and observations. We found a 36% decrease in workplace absenteeism and an 81% reduction in overtime. Finally, observations revealed a decrease in perceived work pressure and a more relaxed working environment.

3.4. *Act phase: results*

In this phase the project team discussed the results, with the objective of identifying disadvantages of the interventions that had to be changed to ensure a more effective use in daily practice. Two types were identified: implemented interventions with disappointing results and possibilities for further improvements. We will give examples of each group.

Not all implemented interventions lead to the desired results. Although the patient leaflet was renewed, patients still arrived too late because the leaflet proved too complex. This is currently being adapted. Furthermore, only a part of the team does the paperwork in the patient's presence while dis-

Table 4 – Pre- and post-measurement CDU.

Indicator	2005	2007	Difference in (%)
Number of beds	30	30	0
Total number of patient visits	12,634	15,662	+24
Average number of visits per bed	421	522	+24
Average number of employees	19.65	21.75	+11
Average number of nurses	11.2	12.21	+9
Average number of visits per employee[a]	643	720	+12
Average number of visits per nurse[a]	1128	1283	+14
Average treatment time per visit in hours	2.2	2.2	No change
Workplace absenteeism excluding maternity leave (%)	9.2	5.9	−36
Overtime in hours	581	113	−81
Patient satisfaction (1–10) 2005: $n = 109$ 2007: $n = 146$	8.1	8.2	+1

a Based on the average number of full-time employees (FTE).

cussing the patient's situation. Management decided to implement this in 2009 together with a project to improve the quality of the administration.

Although the results are successful further efficiency improvements seem possible. Firstly because capacity is not completely used, a further 10% growth seems possible but there was no more demand. Secondly, the introduction of the new hospital information system required 0.66 FTE staff which could not be directly used for the CDU. Besides that, the implementation of several interventions has been postponed. The optimisation of the administrative procedure to order chemotherapy was postponed due to its' complexity and interference with patient safety. Also, transparency and materials management were postponed because they were not essential to enable the desired patient growth.

4. Discussion

This project resulted in considerable efficiency improvements in CDU 1: 24% growth of treatments and bed utilisation, 12–14% increase of staff productivity and 81% overtime reduction. The objectives have been reached and additional patient growth seems possible.

A disadvantage of this research type is that socio-dynamic processes might change during the project and affect the results.[15] However, we have not found indications that the results are influenced by other contingency factors, thus it is most likely that the interventions have caused the results. Another disadvantage is the dilemma caused by using staff members to execute measurements for the analysis. Although this increases staff involvement, the disadvantage is the administrative burden that comes with it. To minimise this we chose small sample sizes, whereas from a research perspective larger sample sizes ($n > 1000$) might have been better. However, the outcomes have been accepted by the staff and thus it is unlikely that this would have led to different findings.

The combination of benchmarking and lean thinking was experienced as logical and seemed to enhance the results. Therefore, best-practices from the benchmarking were used in discussions about the planning system. Furthermore, the PDSA-cycle offered a good project structure.

In the Do-phase it was decided not to implement all proposed changes due to their perceived negative effects towards other quality aspects or staff satisfaction. One example is doing the medication check before administering medication (not to be confused with the check on medication prescription) with two nurses instead of one because this might harm patient safety. For patient satisfaction we did not reduce the duration of patient education and the system of assigning patients to a primary nurse. For staff satisfaction we left opening hours and staffing levels at the end of the day unchanged.

Further research in comparable settings is needed to prove the method's success. The current performance levels and decisions made concerning the different quality aspects determine the success rate. The use of a control group would be ideal but almost impossible due to organisation specific characteristics and socio-dynamic processes.

Based on our experience we recommend considering the following items when applying business approaches to (oncology) healthcare:

1. Ensure that increasing added value for the patient is the main project objective. Ultimately, this guarantees commitment of all stakeholders.
2. Objectify choices concerning the trade-off between efficiency and the other quality aspects as defined by the IoM.[6]
3. Avoid using business jargon since it reduces project support by alienating medical professionals.[13] However, 'translated' lean principles seem to appeal to most professionals.
4. Optimise process flow as this diminishes suboptimal cooperation of departments.
5. Choose a sample size that is workable. For short process improvement projects, limited sample sizes are preferred.
6. Benchmarking should not only be used for comparison of performance, but especially to gain insight into underlying organisational principles.
7. Include someone with expertise on process improvement techniques from outside the organisation (department) in the project. The required expertise seems related to the organisations development stage and capability.[21]
8. Make sure that there is noticeable change within a short period of time after the project's start.[11]

All organisations delivering (oncology) care should strive for operational excellence. However, efforts to provide compassionate high quality care should also be taken into consideration. This contributes to the quality of care, as more patients receive their treatment in time while accessibility increases as more patients are treated with the same resources.

Conflict of interest statement

None declared.

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