

## OPERATING ROOM MANAGEMENT IN KLAIPĖDA UNIVERSITY HOSPITAL: PROSPECTIVE ANALYSIS IN 2009

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**Key words:** operating room (OR) management, regularly scheduled OR time, allocated OR time, case duration, actual surgical procedure time, surgeon estimated surgical procedure time, OR utilization, OR workload, turnover time, actually utilized OR time, OR efficiency.

ently (OR utilization was 82,76%, case cancellation rate was 3,8%, mean turnover time was 28 min, prolonged turnovers were less than 10%) in 2009 (four month period).

### Summary

Background: Klaipėda University Hospital performs about 30000 surgical procedures every year. The operating room (OR) is a major production unit in hospital. The OR is very expensive to construct and to operate. The goal might be thought to be full utilization of all operating rooms during all hours that they are staffed and available for scheduling. Management is the ability to apply a diverse body of knowledge to accomplish planning, organizing, staffing, leading, and controlling a work group.

Methods: We decided accidentally to choose and to analyze OR utilization. We had analyzed central operating department consisting of 9 ORs with regularly scheduled time 8:00 AM to 4:00 PM (8 h), full staffed in 2009 four months period (78 workdays). Four months (78 workdays) of data were collected from the 9 operating rooms surveys. Holidays and weekends were excluded. The data was analyzed using “Statistica” version 7. Results: There were performed 1982 surgical procedures (elective – 1807 (91,2%), urgent – 99 (5%), cancelled – 76 (3,8%)) during investigated period regularly scheduled time (8 h). Actually utilized OR time of all 9 ORs was 4648 h (82,76%), it was planned to work 5616 h. Our OR utilization was 82,76% during investigated period. Total under – utilized time was 968 h (17,36%). Surgeon estimated surgical procedure time was longer than actual surgical procedure time, variability of case duration between surgical teams was high. Turnover time mean duration was 28 min. Conclusions: Our study demonstrates that our central operating department have been worked effi-

### Introduction

The operating room (OR) is a major production unit in every hospital [1]. The OR is very expensive to construct and to operate. The goal might be thought to be full utilization of all operating rooms (ORs) during all hours that they are staffed and available for scheduling [2]. OR management decision – making is not based on maximizing OR efficiency; rather, it is based on tradition and surgeon convenience [3]. Progress has been made in the science of OR management for planning anesthesiologist staffing [4].

OR management is a challenging, dynamic activity that requires the application of management principles to achieve high – quality, cost – effective patient care. Management is the ability to apply a diverse body of knowledge to accomplish planning, organizing, staffing, leading, and controlling a work group. The purpose of these activities is to provide an environment in which surgical procedures can be safely performed – ultimately resulting in a healthy community [2]. Klaipėda University Hospital is one of the biggest hospitals in Lithuania. There are performed about 30000 surgical procedures every year. We decided accidentally to choose and to analyze OR utilization. We had analyzed central operating department consisting of 9 ORs with regularly scheduled time 8:00 AM to 4:00 PM (8 h), full staffed in 2009 four months period (from January till April) (78 workdays). Why did we need to apply OR management principles to our OR? There were four reasons:

1. Limited quantity of operating rooms.
2. Limited operating room staff.
3. Stable regularly scheduled operating room time (8:00 AM – 4:00 PM) for elective surgical procedures.
4. Add – on, urgent procedures at the same regularly scheduled time (8 h).

**The aim of our study** was to analyze scheduled and

actual OR utilization and to evaluate OR efficiency using prospective analysis.

### Methods

Data were collected from the 9 ORs surveys of four months (78 workdays) in 2009. The data used for each case were the OR used, date and time that the patient entered OR, date and time that the patient exited the OR, surgical performing the case, what kind of surgical procedure was performed, and whether the case was urgent. Holidays and weekends were excluded.

We used the following definitions for the analysis:

Surgical service or surgical team refers to a group of surgeons who share allocated OR time. Surgical team was multiple: general surgeons, maxillofacial surgeons, orthopedic surgeons, neurosurgeons, thoracic surgeons, vascular surgeons, urologists. Regularly scheduled OR time of 9 ORs were allocated for all surgical teams every workday. 9 ORs were allocated for surgical teams: I – septic procedures for all surgical services, II – thoracic (KRUT)/general surgery (PECH, II CH, I CH), III – orthopedic (TR), IV – urology (UR), V – orthopedic (SIC), VI – general surgery (PECH, II CH, I CH), VII – general surgery (PECH, II CH, I CH) /maxillofacial (VZCH), VIII – neurosurgery (NCH), IX – vascular surgery (KRJG) / neurosurgery (NCH)(spinal).

Regularly scheduled OR time is the hours that individual OR team members plan on working (8 AM to 4 PM) (8 h). Allocated OR time is an interval of OR time with a start and end time on a workdays of the week that is assigned by the surgical suite to a service for scheduling its cases.

Case duration is defined as the time from when a patient enters an OR until he or she leaves the OR.

Actual surgical procedure time – skin-to-skin time.

OR utilization or OR workload is a sum of all case durations and turnover times in the same OR.

Surgeon estimated surgical procedure time.

Turnover time is the time from when one patient exits an OR until the next patient on that day's OR schedule enters the same OR on the same day.

Actually utilized OR time is time when the first patient enters OR and the last patient exits the same OR.

Under – utilized OR time is the positive difference between allocated OR time and the OR workload. For example, if the service was allocated an OR for 8 h from 8 am to 4 pm but finished cases at 3 pm, the under – utilized OR time would be 1 h.

Over – utilized OR time is the positive difference between OR workload and allocated OR time. When allocated OR time and the regularly scheduled OR hours are the same (allocated an OR for 8 h from 8 am to 4 pm) and

allocated OR time has not released, then over-utilized OR time is the hours that ORs run past the regularly scheduled OR hours. OR efficiency is the value that is maximized when the inefficiency of use of OR time has been minimized.

The number of elective, urgent surgical procedures which were performed on regularly scheduled OR time (8 h) on workdays from Monday till Friday.

The number of cancelled surgical procedures which were scheduled but weren't performed on regularly scheduled OR time (8 h) on workdays from Monday till Friday.

Prolonged turnovers (delays) – a length of time between cases that is longer than a defined interval (e.g., 1 h) should be considered a delay, not a turnover.

These ordered priorities were sufficient to specify how OR time was allocated, cases were scheduled, OR time was released, elective and urgent cases were sequenced, cases were moved on the day of surgery, and staff were assigned on the day of surgery. Cases cannot start earlier than scheduled.

**Statistics.** We analyzed the data using “Statistica” version 7. The results are presented for differences between the average of two independent groups were compared using the Student's unpaired t – test. A p value of  $\leq 0.05$  was considered statistically significant.

### Results

There were performed 1982 surgical procedures (elective – 1807 (91,2%), urgent – 99 (5%)), 76 (3,8%) surgical procedures were cancelled during investigated period on regularly scheduled time (8 h) (Figure 1). The number of elective surgical procedures had been different and variable on weekdays (e. g., greater number of elective surgical procedures had been performed on Tuesdays and Wednesdays) (Figure 2).

It was planned to work 702 ORs per 78 workdays, actually worked – 677 (96,44%) ORs, 25 (3,56%) ORs were free, unoccupied, but full staffed without scheduled cases. Actually utilized OR time of all 9 ORs was 4648 h (82,76%), it was planned to work 5616 h. Our OR utilization was 82,76% during investigated period. Total under – utilized time was 968 h (17,36%). Actual under – utilized time was 585,6 h (10,42%), unanticipated periods of surgical inactivity increase the hours of under – utilized OR time: 182,4 h (3,24%) were allocated for cancelled cases, 200 h (3,56%) – unoccupied OR time. Actually utilized OR time of 9 ORs were different (Figure 3). The VIIIth OR was allocated to neurosurgeons. The VIIIth OR utilization was 109,94% during investigated period.

The actual mean duration of the surgical procedure was 80 min, surgeons estimated surgical procedure mean

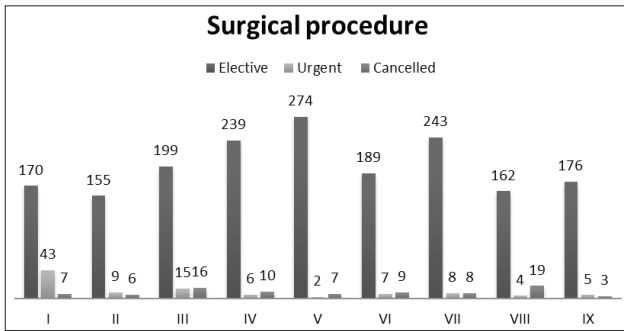


Figure 1. The number of elective, urgent and cancelled surgical procedures per OR during investigated period

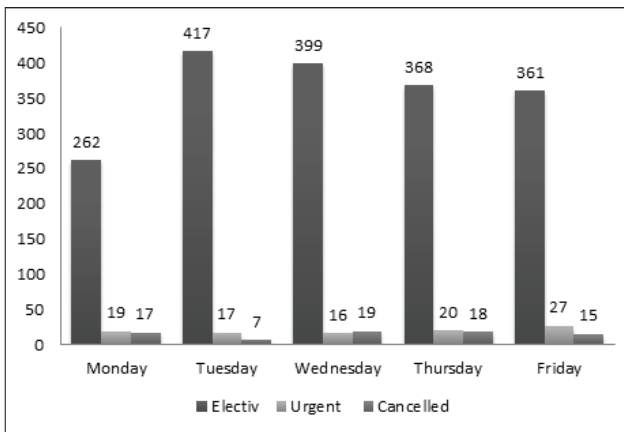


Figure 2. Distribution of the number of elective, urgent and cancelled surgical procedures on weekdays

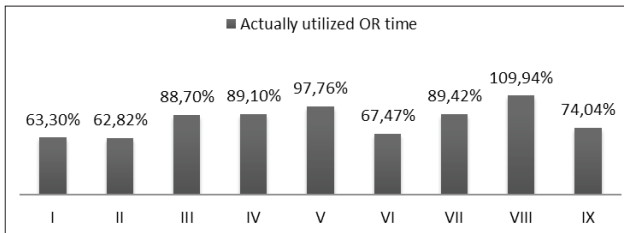


Figure 3. Actually utilized OR time per operating room, %.

duration – 90 min. Surgeon estimated surgical procedure time was longer than actual surgical procedure time (Figure 4). Variability of case duration was high between surgical teams (Figure 5). Case cancellation rate was 3,8% during investigated period.

The average of turnover time was: the shortest – 19.7 min, the longest – 41.7 min, mean duration – 28 min. (Figure 6). There were no prolonged turnovers (delays) in central operating department in 2009 (four month period).

Examples: The fifth OR one workday OR time analysis: regularly scheduled time was 8 h (100%), overall case

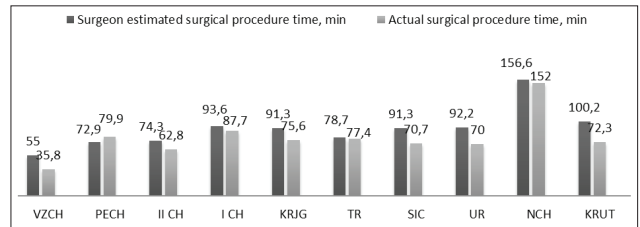


Figure 4. Distribution of surgeon estimated and actual surgical procedure time between surgical services, min.

KRUT – thoracic, PECH, II CH, I CH – general surgery, TR – orthopedic, UR – urology, SIC – orthopedic, VZCH – maxillofacial, NCH – neurosurgery, KRJG – vascular surgery.

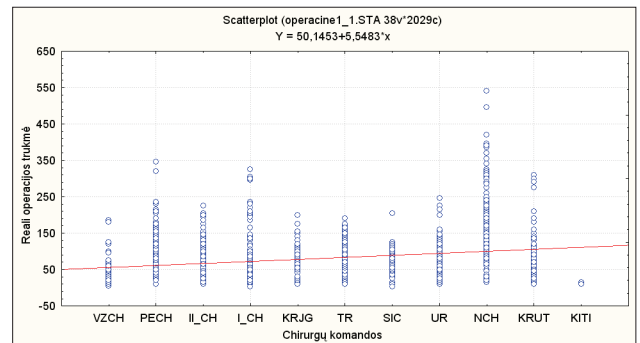


Figure 5. Variability of case duration between surgical teams, min.

KRUT – thoracic, PECH, II CH, I CH – general surgery, TR – orthopedic, UR – urology, SIC – orthopedic, VZCH – maxillofacial, NCH – neurosurgery, KRJG – vascular surgery.

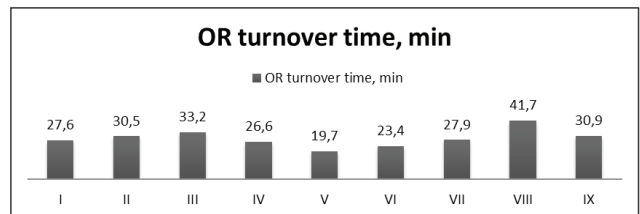


Figure 6. Distribution of turnover time between ORs, min.

duration time (lean operating time) – 6 h 31min (81,5%), actually utilized OR time – 7 h 29 min (93,5%), actual surgical procedure time – 4 h 20 min (54,25%), surgeon estimated surgical procedure time was 4 h 30 min. There were 3 elective hip replacement surgery performed during allocated OR time (Figure 7). The eighth OR one workday time analysis: regularly scheduled time was 8 h (100%), overall case duration time (lean operating time) – 7 h 26 min (93%), actually utilized OR time – 8 h 15 min (103,1%), actual surgical procedure time – 5 h 21 min (66,87%), surgeon estimated surgical procedure time was 5h. There was 1 elective removal of intracranial neoplastic lesion performed (Figure 8). The following OR was allocated for neurosurgery, where the average of lean operating

time was longer than in general surgery or orthopedic ORs. We didn't analyze – prediction bias in case duration estimates per 8 hours of OR time, tardiness from scheduled start times (start – time tardiness).

### Discussion

Did our central operating department (9 ORs) work efficiently during investigated period?

OR department work efficiently if: 1) start – time tardiness (mean sum of tardiness of start times for elective cases per OR per day) is less than 45 min; case cancellation rate is less than 5%; 2) turnover times are less than 25 min (no more than 40 min); 3) prediction bias (bias in case-duration estimates per 8 hr of OR time) is less than 5 min; 4) prolonged turnovers (% of turnovers lasting more than 60 min) are less than 10% [5].

Efficient OR management should aim for maximal use of available OR time while preventing frequent overtime work [1]. The classic definition of OR utilization is the sum of the time it takes to perform each surgical procedure (including preparation of the patient in the OR, anesthesia induction) plus the total turnover time, divided by the time available. The standard definition produces the actual utilization – the time that is actually used. Because it is necessary to know the actual case times to perform the calculation, utilization can never be known in advance [6]. Our OR utilization was 82,7% during investigated period. OR utilization rates in range of 65% to 70% are achievable given a reasonable commitment by all participants to timely performance of their duties. These rates are calculated counting all the time the OR is regularly staffed and in use for a productive purpose (operating, cleanup, setup, anesthesia induction, prep, and drape time all count). Utilization below 60% suggests that the facility is underused, and should prompt a review of the workload to determine if one or more ORs should be closed. Utilization rates above 75% can be obtained only at a cost of increased stress to all personnel and are often accompanied by negative impact on the quality of care. Utilization rates above 70% are a solid basis for extending the hours of regular staffing in order to add additional schedulable time available and to

decide about opening or constructing additional ORs [2]. Utilization of 85% to 95% is the highest that can be achieved without delay or running late [6]. Other factors may also affect utilization. One is case duration. It is easy to see that shorter cases are easier to fit into a schedule than longer cases, because the remaining may not accommodate a longer case. Variability of case duration also makes it difficult to predict actual utilization. If case times could be predicted accurately, it would be relatively easy to schedule an OR, but the actual case duration is not known in advance. Decreasing the variability of case times allows increased utilization to be achieved. Cases of different duration, changes in the variability of case duration, emergencies, cancellations, and so on, will decrease the optimum utilization [6]. The evidence supports the idea that type of surgery is the most important single source of variability among surgeries [1].

OR schedules depend crucially on estimated case durations [1]. The duration of each individual case will always have a random component that can never be predicted with certainty [7]. Surgeons are chronic optimists and consistently underestimate the time it will take them to perform an operation. Collection of surgeon – specific data regarding actual operative durations will allow more precise scheduling [2]. There are cases that have a high probability of taking longer than scheduled. If too much time is allocated to a case, expensive OR capacity is likely to be wasted, leading to a decrease in OR utilization. With too little allocated capacity to a surgical case, the OR schedule must be modified, resulting in idle OR times and increased demand for anesthesiologists, nurses and support staff. Improving coupling between estimates of scheduled time reduces the prediction error of a scheduled surgical case [1]. Among the many factors that worsen the efficiency of use of OR time are case cancellations on the day of surgery and performing the case on a later date. Such unanticipated periods of surgical inactivity increase the hours of underutilized OR time, reduce surgeon productivity, reduce staff morale, and decrease patient satisfaction. Case cancellation also increase cost to physicians, hospitals, patients, and society. At facilities with many ORs and at least 8 hours of cases

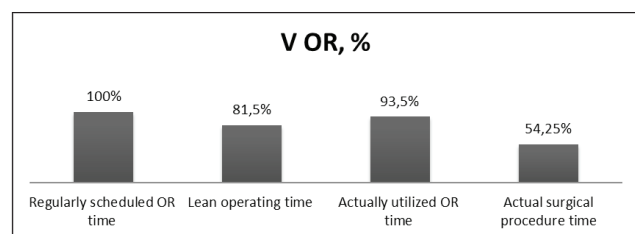


Figure 7. The V OR one workday OR time analysis, %.

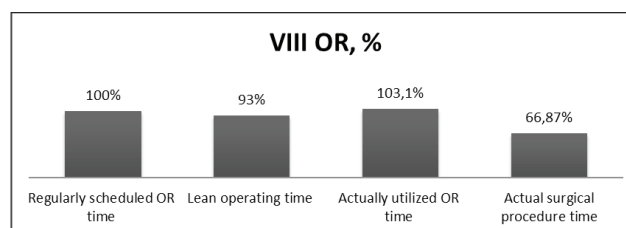


Figure 8. The VIII OR one workday OR time analysis, %.

per room (including turnovers), case cancellations can worsen OR efficiency [8]. If case cancellation rate is less than 5% and turnover time is less than 25 min OR works efficiently [5]. Case cancellations on the day of surgery reduce OR and anesthesia group productivity. The patients seen in a preoperative clinic were less likely to have cancelled appointments on the day of surgery than those who arrived on the day of surgery without having been seen in advance [8]. Prolonged turnover times peak in the middle of the workday because that is when most turnovers occur. Fewer than 10% of prolonged turnovers (delays) should last longer than 60 min in well – functioning OR suites [5]. Potential benefits to reducing turnover times are both quantitative (e. g., complete more cases and reduce staffing costs) and qualitative (e. g., improve professional satisfaction) [9]. Delays in the OR have effect on its efficiency and the working environment. Delays in the OR negatively affect both patients and health workers. Although not all delays directly affect patient health, they often increase anxiety for patients and their families and are a source of frustration for surgeon and other staff [11]. Opinion about turnover times can be nonlinearly related to their duration. Surgeons working in a short – turnover – dedicated OR had an increased feeling of personal competence and achievement [10].

Day – to day operational decisions can be made based on four ordered priorities: (a) safety, (b) providing surgeons with access to OR time on the workday that they and their patients choose, (c) maximizing OR efficiency, and (d) reducing patient delays. These ordered priorities are sufficient to specify how OR time is allocated, cases are scheduled, OR time is released, elective and urgent cases are sequenced, cases are moved on the day of surgery, and staff are assigned on the day of surgery [9]. Perioperative delays occur on the day of the scheduled operation and include delays during the operation. There is no consensus about how best to monitor delays or classify their causes [11].

Only basic historical data are required to supplement the daily schedule: scheduled and actual start times, scheduled and actual case durations, and surgical service [7].

Hospitals can determine the efficiency of their OR suite using a OR efficiency scoring system for evaluating baseline performance and identifying areas that need improvement [5].

Prediction bias is the bias in case – duration estimates per 8 hours of OR time. Prediction bias indicates whether the estimate of case times is consistently too high or too low. Efficient OR suites should aim for bias in case – duration estimates of less than 15 minutes per 8 h of OR time [5]. Some surgeons consistently shorten their case – duration estimates because they have too little OR time allocated and need to „fit“ their list of cases into

the OR time that they do have. In contrast, other surgeons purposely overestimate case durations to maintain control and access of their allocated OR time, so that if a new case appears, their OR time is not given away [5].

Getting the right case into the right room at the right time is the goal for every OR director. For anesthesiologists, goals of increasing anesthesia group productivity are the same as increasing the efficiency of use of OR time [5].

Tardiness for each case are quantified as the difference between the time the patient actually entered the OR and the scheduled start time of the case. Many surgical suites have undertaken initiatives to reduce tardiness from scheduled start times. Changing human behavior can successfully reduce late starts for first cases of the day and decrease turnover times [7].

**Recommendations:** 1) to maximize OR efficiency we need to minimize case cancellation rate in our central operating department (e.g., if all scheduled surgical cases had been performed our OR efficiency would have been 89,58%), 2) to optimize our OR workload we must maintain equivalent and stable surgical procedures scheduling in all ORs on all weekdays, 3) computerized data collection of all ORs and sustained every day analysis is needed for actual OR management, 4) surgeon services and OR team must understand a structure of OR time which is allocated for surgical procedure performing, 5) ORs must be allocated between surgical services depends on their patient queues and the number of elective surgical procedures performed per weekdays, 6) to increase OR efficiency is needed to identify areas of inefficiency which are institution specific and depends on the local culture, leadership, 7) supranormal human efforts to increase OR efficiency on the day of surgery can be dangerous and stressful, on the day of surgery the best way to proceed is by simply taking care of each patient in a relaxed and supportive manner.

Finally, OR management introduction into daily operating department work, for patients would improve satisfaction with their experience at the hospital and for OR team would create unstressful working atmosphere.

## Conclusion

Our study demonstrates that our central operating department have been worked efficiently (OR utilization was 82,76%, case cancellation rate was 3,8%, mean turnover time was 28 min, prolonged turnovers were less than 10%) in 2009 (four month period).

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**OPERACINĖS VADYBA KLAIPĖDOS  
 UNIVERSITETINĖJE LIGONINĖJE:  
 2009 M. PROSPEKTYVINĖ ANALIZĖ  
 R. Paškevičiūtė, G. Klimavičiūtė**

Raktažodžiai: operacinės vadyba, reguliariai suplanuotas operacinės darbo laikas, reali operacijos trukmė, chirurgo numatyta

operacijos trukmė, operacinės darbo efektyvumas, operacinės apyvarta, operacinės paruošimo laikas, operacinės panaudotas laikas.  
 Santrauka

Tikslas: išanalizuoti planuotą ir realią operacinės apyvartą ir įvertinti operacinės darbo efektyvumą Klaipėdos universitetinės ligoninės centrinio operacinio bloko 9 operacinių 2009 m. 4 mėnesių laikotarpiu. Metodas: atlikome prospektyvią duomenų analizę, naudojant statistinės programos paketą „Statistica“, naudotas Stjudent'o kriterijus dviejų nepriklausomų imčių vidurkių statistiškai reikšmingiems skirtumams įvertinti. Analizavome operacinės darbą 2009 m. sausio – balandžio mėnesiais. Analizuotas 78 darbo dienų, 9 operacinių paskirto operacinės laiko panaudojimas reguliariai suplanuotu operaciniu laiku nuo 8:00 iki 16:00 (8 darbo valandos). Visose 9 operacinėse personalas buvo visiškai sukomplektuotas. Buvo vertinamas kiekvienos operacinės darbas – planinių skubių operacijų skaičius, kurios įvyko reguliariai suplanuotu laiku. Neanalizuotas operacinių darbas savaitgaliais ir švenčių dienomis. Analizuotos šios sąvokos: reguliariai suplanuotas operacinės darbo laikas, operacinio atvejo trukmė, operacinės paruošimo laikas, panaudotas operacinis laikas, grynas operacinis laikas, nepanaudotas operacinis laikas, reali operacijos trukmė, chirurgo numatyta operacijos trukmė, operacinės apyvarta, planinių, neįvykusių (atidėtų) planinių, skubių operacijų skaičius. Rezultatai: tiriamuoju laikotarpiu buvo atlikta 1982 operacijų, iš jų planinių – 1807 (91,2%), skubių – 99 (5%), neįvykusių planinių buvo 76 (3,8%) reguliariai suplanuotu laiku (8 darbo valandos). 2009 m. 4 mėnesių laikotarpiu, per 78 darbo dienas 9 operacinėse planuota dirbti 5616 valandų, realiai buvo panaudota planuoto dirbti operacinio laiko 4648 valandos (82,76%). Tiriamuoju periodu centrinio operacinio bloko 9 operacinių darbo apyvarta buvo 82,76%. Chirurgo numatyta operacijos trukmė buvo ilgesnė už realią operacijos trukmę. Operacijos trukmės variabilumas tarp chirurgų komandų buvo didelis. Operacinės paruošimo laiko vidurkis tiriamuoju laikotarpiu buvo 28 min. Išvados: centrinis operacinių blokas, susidedantis iš 9 operacinių, 2009 metų 4 mėnesių laikotarpiu dirbo efektyviai. Rekomendacijos: 1) norint padidinti operacinės darbo efektyvumą būtina sumažinti neįvykusių (atidėtų) planinių operacijų skaičių ir išnaudoti esamus operacinės pajėgumus (operacinės apyvarta padidėtų nuo 82,78% iki 89,58%), 2) norint optimizuoti operacinės darbą būtinas tolygus planinių operacijų paskirstymas savaitės dienomis, 3) realiai operacinės vadybai užtikrinti reiktų kompiuterizuotos duomenų bazės ir nuolatinės duomenų analizės, 4) chirurgas planuodamas operaciją privalo suprasti operacinio laiko, skirto operacijai atlikti, struktūrą, 5) norint tolygiai ir efektyviai panaudoti paskirtą operacinių darbo laiką būtina operacijų laiką paskirstyti chirurgų komandoms remiantis jų atliekamam planinių operacijų skaičiumi ir operacinės apyvarta, 6) norint padidinti operacinės darbo efektyvumą reikia identifikuoti neefektyvaus operacinės darbo priežastis, kurios priklauso nuo institucijos, vietinės darbo kultūros, vadovavimo, 7) nežmoniškos pašlangos padidinti operacinės darbo efektyvumą operacijos dieną gali būti pavojingos ir stresinės. Operacinės vadybos principų taikymas organizuojant kasdien operacinių darbą sąlygoja pacientų pasitenkinimą teikiama sveikatos priežiūra ligoninėje, o operacinės komandai sukuria neštresinę darbinę atmosferą.

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