How to shorten anesthesia time through multidisciplinary team collaboration in operating room

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Abstract

Background: How to shorten the anesthesia time is an important problem to ERAS. The authors formulated a series of optimization measures and verified that these measures could shorten the anesthesia time and improve the operating room utilization efficiency by multidisciplinary diagnosis and treatment pattern. Methods: 90 patients were random selected to analyses the time of every preparing procedure and between 2 adjacent procedures, the multidisciplinary team established the optimization measures accordingly. Then 95 patients for gastrointestinal surgery received collaborative optimization measures that were established after discussion among anesthesiologists, surgeons and operating room nurses (optimization group), while 226 cases received the conventional approaches (control group). The data obtained from operating room monitoring recording of the two groups of patients were analyzed. Results: The preparation times from the initial of induction of anesthesia to start of surgery in optimization group were all significantly shorter than those in control group (all $P<0.0001$). In supine position surgery, the times from initial of induction of anesthesia to start of urinary catheterization, from urinary catheterization finish to start of disinfection, and from completion of draping to start of surgery in patients receiving optimization measures were all significantly superior to those receiving conventional approaches (all $P<0.0001$); in lithotomy position surgery, the times from the initial of induction of anesthesia to positioning, from positioning finish to start of disinfection, and from completion of draping to start of surgery in patients receiving optimization measures were all significantly superior to those receiving conventional approaches (all $P<0.0001$). Conclusions: The established optimization measures based on multidisciplinary team collaboration could significantly shorten the anesthesia time. The optimized measures in this study are feasible and effective to shorten the anesthesia time.

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Running Title:

Shorten anesthesia time

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Conclusions: The established optimization measures based on multidisciplinary team collaboration could significantly shorten the anesthesia time. The optimized measures in this study are feasible and effective to shorten the anesthesia time.

Key words: Operating room, Enhanced recovery after surgery, Optimization, Management, Anesthesia time.

Introduction:

Enhanced recovery after surgery (ERAS), also known as fast track surgery (FTS), refers to the integration of multidisciplinary perioperative treatment protocol aimed at acceleration of patient recovery. Various research about surgery, anesthesia, and nursing have proved that a series of evidence-based medicine optimization measures could bring significant benefit to the patients, such as reduce trauma stress, promote early recovery of body function, reduce the incidence of postoperative complications and shorten the length of hospital stay after surgery [1,2]. In recent years, the concept of ERAS has rapidly expanded to different surgical disciplines, such as orthopedics, thoracic surgery, general surgery, gynecology, and urology. At present, ERAS is widely carried out mainly in the areas of preoperative preparation, anesthesia management, analgesia, and nutrition

support. Among them, anesthesia runs through the entire surgical process and provides appropriate surgical conditions to ensure the safety of patients during the operation.

However, there are some serious risks during general anesthesia include blood pressure change, heart attack or stroke. Therefore, how to shorten the anesthesia time and then decrease those risk is an important problem to ERAS [3]. Nevertheless, the current anesthesia management focuses on the preoperative evaluation, induction models, anesthesia methods and drugs, depth of anesthesia and intraoperative heat preservation, etc. [4-9], but often ignored the operating room Multi-disciplinary collaboration between anesthesiologist, surgeon, and nurses and optimizing workflows to reduce anesthesia time. At present, how to reduce the anesthesia time through the management and optimization of the operating room workflow has rarely been reported. This study introduced how we formulated the optimization measures, and then examined that the team of anesthesiologists, surgeons, and nurses in the operating room collaborate to take a series of optimization measures could shorten the anesthesia time and improve the operating room utilization efficiency.

Methods:

Formulation of optimization measures

A random selection of 90 patients who underwent gastrointestinal surgery in supine position in November 2017 was selected for the study. The start time of anesthesia induction, the start time and end time of catheterization, the start time and end time of prepare and drape the operative site, and the start time of operation were obtained by the monitoring recording in operating room. We calculate and record the time of every procedure and between 2 adjacent procedures. After discussion by 3 anesthesiologists, 3 surgeons, and 3 operating room nurses, teamwork optimization measures will be established. (The researching flow as show in the Fig 1)

General information and data sources

After establishment of the optimization measures, 321 patients for gastrointestinal surgery were selected from 2017.12 to 2019 .02 to examine whether the measures were effective. The surgery preparation process for patients in the optimization group is led by the surgeon in our department and is performed in close cooperation with the surgeon, nurse, and anesthesiologist to implement the optimization measures established in the discussion. Patients in other departments composed the control group (the surgeons, anesthesiologists, and operating room nurses in control group were not informed about the content of this study. The data were obtained from operating room monitoring recording). The control group of anesthesiologists, surgeons, and operating room nurses performed the routine procedures.

Inclusion criteria: 1, 18 to 75 years old; 2, Gastrointestinal surgery; 3, General anesthesia for tracheal intubation; 4. Urinary catheterization in the operating room. **Exclusion criteria:** An unexpected situation that caused the operation procedure to be delayed(one 74-year-old man's false teeth fall into epiglottis during orotracheal intubation, another 65-year-old man has difficult to insert catheter and then had cystostomy, the data of the above two patients were excluded from analysis because they are outlier). Firstly, we recorded the start time of anesthesia induction, start time and end time of urinary catheterization, start time and end time of disinfection, start time of operation of the patients in the supine position (catheterizing on the operating table before disinfection). Then calculated the time from start of anesthesia to beginning of urinary catheter, catheterization time, time from catheterization to start of disinfection, disinfection time, draping time, time from end of draping to start of surgery. we also recorded the start of anesthesia induction, position start time and end time, disinfection start time and end time of disinfection and draping, urinary catheterization start time and end time, draping end time, operation start time of the surgical patients in lithotomy position (catheterizing on the operating table after disinfection), and calculated the time from the start of anesthesia to adjusting posture, the time of adjusting posture, the time from the end of the posture to the start of the disinfection, the time of the disinfection, catheterization, and draping, the time from the end of draping to the start of surgery.

Statistics:

SPSS 19.0 software was used for statistical analysis, the t-test was used for the data between groups, and the $\chi 2$ test was used for the count data.

Results:

90 patients who underwent gastrointestinal surgery in November 2017 were randomly selected. The total operation preparation time in the operating room was 24.46 ± 1.16 minutes, and the time spent in each procedure is shown in Table 1.

Discuss to establish the optimization measures

According to the time spent in each procedure shown in Table 1, the establishment of optimization measures was determined after discussing by a team including 3 anesthesiologists, 3 surgeons, and 3 operating room nurses.

The optimization measures:

1) The scrub nurse should wash the hand before anesthesia, prepare the items on the table and check the equipment, and prepare the disinfectant. Circulating nurse place various equipment (including laparoscope, trash can, electric knife, ultrasonic knife, etc.) according to the type of operation. The circulating nurse prepares the leg hanging device well first.

2) The surgeon start the procedure (the scrub nurse prepared well in advance).

3) Anesthesiologist induces anesthesia; tow surgeon stand by, after the patient loses consciousness, the circulating nurse undresses and poses the patient; one surgeon catheterizes the urine, and the other one surgeon prepare to disinfection. The disinfection of the surgical site as soon as possible begins after catheterization and the circulating nurse exposed the surgical site; the surgeon cooperate with the scrub nurse or other doctors to drape the patient.

4) The surgeon and the scrub nurse cooperate to connect equipments (electric knife, aspirator, ultrasonic knife, laparoscopic equipments, etc.).

5) Check the patient and start the operation (start with the incision of skin).

From December 2017 to February 2019, 96 patients in the optimized surgical procedure group, 23 to 78 years old, 61 males and 35 females (one 74-year-old male patient who lost dentures during tracheal intubation and fell into the epiglottis, and the operation began after the denture was took out, so this patient was withdrawed from the study); 227 patients in the conventional control group, aged 202 to 76 years, 144 males and 83 females (one 65-year-old patient was difficult to intubate the catheter. The suprapubic bladder puncture fistula resulted in a delayed start of operation and was not included in this study). There were no statistically significant differences between the two groups in terms of factors such as gender, age, operative position, and rate of intraday first operation. The two groups were comparable. (Table 2).

The average preparation time in the optimized group from the start of anesthesia induction to the start of operation was 11.72±0.30 minutes, compared with 31.96±0.51 minutes in the control group, which has a significant difference (Fig 2A). Clinically, there are some differences in the pre-operative preparation between supine and lithotomy position. The time of each procedure in the preparation process is also different. Therefore, we further analyzed the time of preparation process of supine and lithotomy group separately. The preparation time in the supine position in the control group was 22.71± 0.49 minutes, while the time in the optimized group was significantly lower than that in the control group, which was 9.91 ± 0.13 minutes ($p < 0.0001$, Fig 2B). Then, we compared the time spent in each procedure between the optimized supine surgery group and the corresponding control group. We found that there was no significant difference in the time required for catheterization, disinfection, and draping. The time from the end of anesthesia induction to the start of catheterization, from the end of catheterization to the start of disinfection, from the end of the draping to the start of operation, totaling 3 period of time were significantly less than the control group (Fig 3).

The preparation time of surgery in the optimized lithotomy group was 15.83 ± 0.31 minutes, which was significantly less than the 32.49 ± 0.57 minutes of the control group ($p < 0.0001$, Fig 2C). In the optimized and control group of lithotomy position surgery, there was no significant difference in time of adjusting posture, disinfection, urethral catheterization and draping. Whereas the time from end of anesthesia to adjusting posture, the end of adjusting posture to start of disinfection, end of disinfection to start of urethral catheterization, and the end of draping to the start of operation were significant different between 2 groups, and the optimized group was significantly shorter than the control group (Fig 4).

Discussion:

Since the Danish surgeon, Kehlet first proposed and explored the concept of rapid rehabilitation surgery in 1997, the concept of rapid rehabilitation has been expanded to a certain extent and successfully applied in many surgical diseases, including rapid rehabilitation surgical treatment for colorectal resection, one of the most successful models [1,10-11]. At present, there is a lot of evidence-based medical evidence affirming the effect of rapid rehabilitation surgery. Through a series of perioperative or surgical treatments and the advancement of ideas, it has shortened the recovery time of patients' physiological functions, reduced the length of hospital stay and medical costs, decrease complications and readmission rates and increased utilization of medical resources without affecting safety [12-13]. not only that, the optimizing OR utilization is vital for delivering efficient and cost-effective care [14-15]. However, most of the current studies mainly focused on strategy of surgical treatment or scheduling, but the feasibility and efficiency of the processes are often overlooked. The patients remain in an unphysiological condition at general anesthesia, and the risk of blood pressure change, heart attack or stroke was hard to be eliminated. Therefore, the noneffective wait time should be as few as possible to decrease those risk to a certain extent. Silber et al. confirmed in their research that prolonged operation time and anesthesia time can affect the quality of surgery and the efficiency of treatment [16]. At present, the progress of surgical methods and concepts has been recognized, and the operation time itself is difficult to control. Therefore, the researchers have reduced the non-effective time and enhanced the operating room utilization by management methods, such as optimizing the surgery schedules.[17-18] And further shortening the anesthesia time can also help reduce the number of anesthetic drugs used by patients, reduce systemic stress reactions and drug side effects, and speed up patients Recovery, to achieve the goal of rapid recovery [19-20].

The anesthesia not only throughout the entire operation period, and also exceeds the operation time. Anesthesia time could separate into 3 parts: before the operation, during the operation, and post-operative anabiosis. The length of the operation time is related to factors such as the surgical method, the patient's condition, the medication and experience of the surgeon. There are so many uncontrollable factors during the operation, so it is difficult to shorten the operation time [21-22]. After operation, the surgeon has few works to do when patient is resuscitating in the anesthesia resuscitation room. And notably, it has been validated that the effective capacity of the PACU could increase through an improved schedule strategy [23]. In this research, we have only interfered the process before the operation. If we could optimize more process in whole period at anesthesia and cooperate better, there was much more noneffective wait time could be utilized.

Clinically, the surgical preparation requires cooperation of surgeons, anesthesiologists, and operating room nurses. There are many links between the steps of surgical preparation, such as anesthesia, urinary catheterization, disinfection, and draping. The smoothness of cooperation directly determines the length of anesthesia time before the operation. Actually, the cooperation is due in large apart to the surgeon's leadership of the team, and the optimization measure might be another aspect to foster leadership which could improve both safety and efficiency in the OR[24].

In this study, we firstly investigated the time of each step and the connection time between steps. We found that the links between two adjacent steps were not close enough, and the procedures could be overlapped at the same time were performed separately, resulting in a longer time for the operation preparation. After discussions by multiple surgeons, anesthesiologists, and operating room nurses, they agreed that there are many optimizable process and then established some optimization measures. In the subsequent controlled

study, the optimization measures were taken in the optimization group of patients by multi-disciplinary cooperation, compared with the same period of routine preparation procedures of the same operation. After the patients of optimization group entering the operating room, It took 11.72 ± 0.30 minutes from the start of anesthesia induction to the start of operation, which is significantly shorter than 31.96±0.51 minutes of the control group, which confirms that the optimization measures we have established are feasible and effective. We further analyzed the time spent in each procedure during the surgical preparation of the supine and lithotomy positions and found that the time of proficient procedures was similar (such as catheterization, disinfection, draping, etc.), but the time between two adjacent procedures has significant differences (such as from the end of anesthesia induction to the start of catheterization, from the end of catheterization to the start of disinfection, from the end of the draping to the start of operation in the supine position operations; from anesthesia start to adjacent posture, the end of adjacent posture to start disinfection, and the end of draping to the start of operation of lithotomy position).

ERAS is not limited to surgery at present, and it is not entirely up to the surgeon. With the outreach of the concept of ERAS, it is necessary to pay more attention the perioperative period. Cooperation of the entire medical team such as surgeons, nurses, anesthesiologists, could help us exploring a more complete, safe, and feasible operating procedure and operating system management mode. The preoperative preparation process could be optimized through good communication and close cooperation of members in the team. The optimized measures could make the connection process between operations smoother, and could further reduce the anesthesia time on the premise of ensuring the safety, not only promote the rapid recovery of patients, and improve the operating room turnover efficiency, saving more medical resources at the same time.

Conclusion:

Multi-disciplinary team collaboration and cooperation can significantly shorten the anesthesia time by optimizing the surgical preparation process. The optimization measures established in this study are feasible and effective to shorten the anesthesia time.

Table Legends:

Table 1 Time of each procedure and between procedures before Optimization

Table 2 Comparison of Optimized group and Control group

Figure Legends:

Fig 1 The researching flow chart.

Fig2. Comparison of Optimized group and Control group(A), Optimized supine group and the corresponding control group(B), Optimized lithotomy group and the corresponding control group (C).(*** P<0.0001)

Fig3. Comparison of each procedure in optimized supine group and the corresponding control group. (*** P <0.0001)

Fig4. Comparison of each procedure in optimized lithotomy group and the corresponding control group. (*** P <0.0001)

References:

1. Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth.* 1997; 78(5):606-617.

2. Rubinkiewicz M, Witowski J, Su M, et al. Enhanced recovery after surgery (ERAS) programs for esophagectomy. *J Thorac Dis* . 2019;11(Suppl 5):S685-S691.

3. Chen W K, Ren L, Wei Y, et al. General anesthesia combined with epidural anesthesia ameliorates the effect of fast-track surgery by mitigating immunosuppression and facilitating intestinal functional recovery in colon cancer patients. *Int J Colorectal Dis.* 2015; 30(4):475-481.

4. Spanjersberg W R, Reurings J, Keus F, et al. Fast track surgery versus conventional recovery strategies for colorectal surgery.*Cochrane Database Syst Rev.* 2011; 66(2):CD007635.

5. Riitta A Marjamaa, Paulus M Torkki, Eero J Hirvensalo, et al. What is the best workflow for an operating room? A simulation study of five scenarios. *Health Care Manag Sci.* 2009,12(2):142-6

6. Ljungqvist O, ERAS–enhanced recovery after surgery: moving evidence-based perioperative care to practice. *J Parenter Enteral Nutr.* 2014;38(5):559-66.

7. Gustafsson UO, Scott MJ, Hubner M, et al. Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations: 2018. *World J Surg.* 2019;43(3):659-695.

8. Wilmore D W, Kehlet H. Management of patients in fast track surgery.*BMJ.* 2001; 322(7284):473.

9. Jan P Mulier, Liesje De Boeck, Michel Meulders, et al. Factors determining the smooth flow and the non-operative time in a one-induction room to one-operating room setting. *J Eval Clin Pract.* 2015;21(2):205-14.

10. Zargar-Shoshtari K, Connolly A B, Israel L H, et al. Fast-track surgery may reduce complications following major colonic surgery.*Dis Colon Rectum.* 2008; 51(11):1633-1640.

11. Scatizzi M, Kröning K C, Boddi V, et al. Fast-track surgery after laparoscopic colorectal surgery: is it feasible in a general surgery unit? *Surgery.* 2010; 147(2):219-226.

12. Gustafsson UO, Scott MJ, Schwenk W, et al. Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. *Clin Nutr.*2012;31(6):783-800.

13. Kennedy R H, Francis E A, Wharton R, et al. Multicenter randomized controlled trial of conventional versus laparoscopic surgery for colorectal cancer within an enhanced recovery programme: EnROL. *J Clin Oncol.* 2014; 32(17):1804-11.

14. Bartek MA, Saxena RC, Solomon S, et al. Improving Operating Room Efficiency: Machine Learning Approach to Predict Case-Time Duration.*J Am Coll Surg.* 2019;229(4):346-354.e3.

15. Stahl JE, Sandberg WS, Daily B, et al. Reorganizing patient care and workflow in the operating room: a cost-effectiveness study.*Surgery.* 2006;139(6):717-28.

16. Silber J H, Rosenbaum P R, Zhang X, et al. Influence of patient and hospital characteristics on anesthesia time in medicare patients undergoing general and orthopedic surgery. *Anesthesiology.* 2007; 106(2):356-364.

17. Fügener A, Schiffels S, Kolisch R. Overutilization and underutilization of operating rooms - insights from behavioral health care operations management. *Health Care Manag Sci.*2017;20(1):115-128.

18. Samudra M, Demeulemeester E, Cardoen B, et al. Due time driven surgery scheduling. *Health Care Manag Sci.* 2017;20(3):326-352.

19. Findlay J Y, Jankowski C J, Vasdev G M, et al. Fast track anesthesia for liver transplantation reduces postoperative ventilation time but not intensive care unit stay. *Liver Transplantation.* 2002; 8(8):670-675.

20. Veenhof A A, Vlug M S, Mh V D P, et al. Surgical stress response and postoperative immune function after laparoscopy or open surgery with fast track or standard perioperative care: a randomized trial.*Annals of Surgery,* 2012; 255(2):216.

21. Harrison O J, Smart N J, White P, et al. Operative Time and Outcome of Enhanced Recovery After Surgery After Laparoscopic Colorectal Surgery. *JSLS.* 2014; 18(2):265-272.

22. Bailey M B, Davenport D L, Vargas H D, et al. Longer operative time: deterioration of clinical outcomes of laparoscopic colectomy versus open colectomy. *Dis Colon Rectum.* 2014; 57(5):616-622.

23. Fairley M, Scheinker D, Brandeau M L, et al. Improving the efficiency of the operating room environment with an optimization and machine learning model. *Health Care Manag Sci.* 2019; 22(4): 756-767.

24. Hu YY, Parker SH, Lipsitz SR, et al. Surgeons' Leadership Styles and Team Behavior in the Operating Room. *J Am Coll Surg*.2016;222(1):41-51.

Table 1 Time of each procedure and between procedures before Optimization

Preparation procedures	Time(minutes)
Start of anesthesia to the beginning of urinary catheterization	7.73±4.52
Urinary catheterization	3.21±3.36
End of catheterization to start of disinfection	8.43±4.13
disinfection	2.05±2.91
Draping	3.47±3.87
End of draping to start of operation	7.85±4.94
Total preparing time	31.75±4.29

Table 2 Comparison of Optimized group and Control group

	Optimized group	Optimized group	Control group	P
Sum	Sum	95	226	
Gender	Gender			0.9842
Female	Female	35	83	
Male	Male	60	143	
Age	Age			0.8957?¿?
50	[?]50	39	91	
>50	>50	56	135	
Position	Position			0.7063
Supine position	Supine position	68	157	
Lithotomy position	Lithotomy position	27	69	
Order of the operation	Order of the operation			0.7112
The first operation of the day	The first operation of the day	16	42	
Not the first operation of the day	Not the first operation of the day	79	184	
Time(min)	Time(min)	11.72 ± 0.30	31.96±0.51	< 0.0001

Figure 1

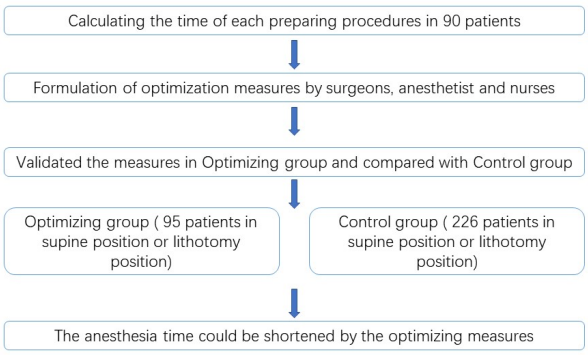


Figure 2

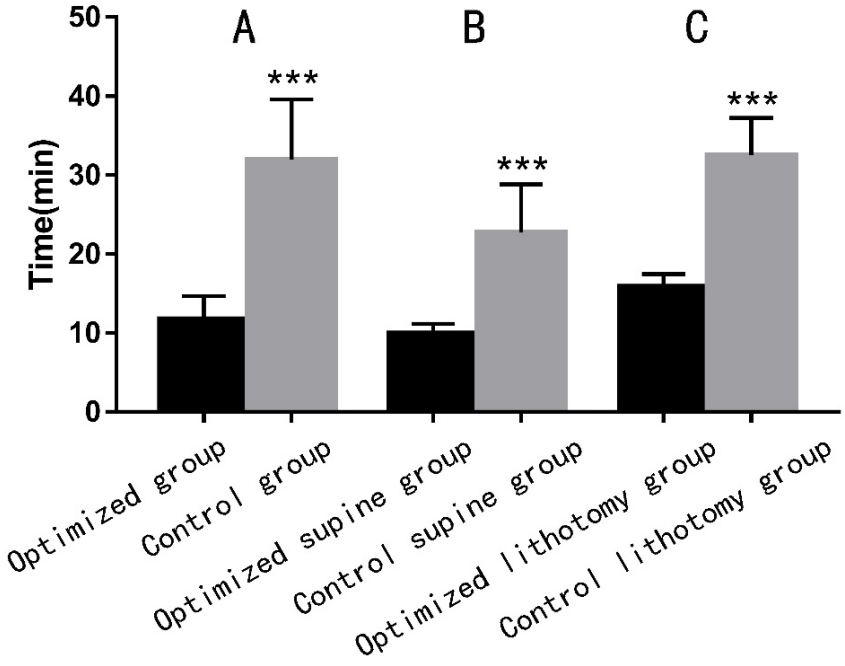


Figure 3

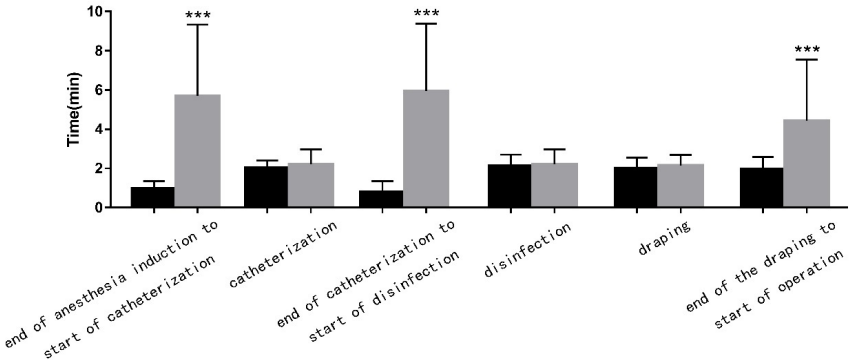
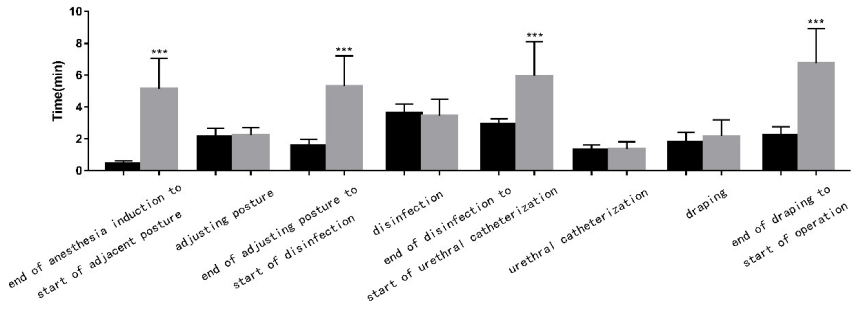


Figure 4



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