Development of process model for quality assurance of surgical operation planning

Rika Takao*1, Ryoko Shimono1, Satoko Tsuru1, Toru Kuroda2, Kazuhiko Yoshida2, Koji Asano2, Shogo Kato1

1. The University of Tokyo: 7-3-1 Eng. Bld. 3 5A13, Hongo, Bunkyo-ku, Tokyo, Japan 113-8656, 2. Jikei University School of Medicine: 3-25-8 Nishishinbash, Minato-ku, Tokyo, Japan 105-0003
*contact author’s e-mail address: takao@tqm.t.u-tokyo.ac.jp

Abstract:
To operate successfully, surgeons must plan surgical operations appropriately. However, it is difficult to plan operations adequately because they are often complicated and involve substantial amounts of medical knowledge and information concerning patients. Therefore, it is necessary to develop a process model for surgical operation planning.

In the present study, we divided surgical operation planning into three processes, “Process for understanding the patient’s condition,” “Process for designing the surgical operation plan,” and “Process for reviewing the plan.” We identified that an ideal surgery is one that can lead to a radical cure, and can minimize the adverse effect on the QOL of the patient. Based on this, we designed the basic concept of the best surgical operation plan, and developed a process model to facilitate its use. We first identified the components of surgical operation plan and information necessary to the processes for understanding and designing. We then identified functions of the processes and visualized information and functions with a data flow diagram. Finally, we developed a tool for quality assurance in planning, and tested the model by applying it to 9 cases. Subsequently, we proved that the model marshaled the complex process and facilitated the retrospective detection of problems.

Keywords
Quality of health care, Target setting, Quality of life, Operative method, Patient's condition

1. Introduction

1.1 Background
To ensure quality assurance in medicine, medical professionals plan medical interventions, which have a significant effect on the result of the intervention. Specifically, Iida S et al. (2005) contend that medical intervention planning involves setting a target that considers problems identified through the understanding of the patient’s condition, and designing appropriate medical intervention; therefore, it strongly depends on medical professionals’ ability to consider various perspectives in strategic planning. However, advances in medical care lead to a constant increase in their access to medical information. Thus, recent results (Institute of medicine, 2011; Institute of medicine, 1999) shows that the process of planning medical interventions, and their quality, is affected by individual differences in the ability to consider this information. This highlights the need recent research (Tsuru S et al., 2011; Tsuru S et al., 2010a, b) argues to visualize the planning process and develop a standard methodology for planning optimal medical interventions to ensure quality improvement, especially in operations.

1.2 Preceding studies
Some studies have examined the use of simulations to assist operation planning. However, these studies focused only on a particular operation, for example recent results (Tada Y et al., 2013; Lasser MS et al., 2012) focused on total hip arthroplasty and laparoscopic operations. Additionally, recent results (Haga Y et al., 1999; Haga Y et al., 2001; Copeland GP et al., 1991) have developed methods, like the E-PASS (Estimation of Physiologic Ability and Surgical Stress) scoring system and POSSUM (Physiological and Operative Severity
Score for the enumeration of Mortality and morbidity) scoring system to evaluate operation plans. These scores help predict the occurrence of post-operative coexisting diseases, and facilitate decisions, such as the selection of an appropriate operative method and the range of lymph node dissection.

However, none of these studies suggests a methodology logically to improve the quality of the complicated whole process for operation planning from identifying disease to designing the operation plan.

1.3 Purpose of the present study

Recent results (Iizuka Y, 2009; Iizuka Y and Tsuru S, 2010) argues that total quality management is based on the PDCA cycle (plan-do-check-act), which is strongly dependent on planning. Therefore, to address quality improvement of surgical operations, we focused on operation planning. Efficient planning assures quality of performance, and enables detection of possible problems and implementation of appropriate preventive measures.

Operations involve professionals from different medical fields (such as surgeons, anesthesiologists, and nurses), each of which requires a specific plan. It is difficult to develop a model that includes all of them. Therefore, we divided the process of operation planning according to the medical field involved, specifically, the surgical operation plan, conducted by surgeons; anesthesia plan, conducted by anesthesiologists; and nursing care plan for nurses in operation rooms (shown in Figure 1). Further, we identified that the anesthesia and nursing care plans for operations are based on the surgical operation plan. Therefore, we focused on the surgical operation plan, which highly affects the quality of operations.

Further, we considered factors that are common to all operations to ensure that we included all complicated procedures that vary according to the disease and patients. That is because a model for general surgical operation plan is applicable in developing a detailed model.

Thus, the purpose of the present study was to develop a methodology for surgical operation planning that can be used for operation planning in general surgeries. In addition, after developing this model, we tested its effectiveness by implementing it on surgical cases.

Figure 1: The operation process and components of the operation plan

1.4 Study system

Approved by the ethics committee of Clinic A, we conducted this joint research by consulting a surgeon who was a part of the working group for the standardization of the operation process. This working group included a surgeon, a nurse, an anesthesiologist, a pharmacist, a medical equipment technician, and a manager responsible for the procurement of medical supplies. In addition, the study procedure involved attending a pre-operative conference as an observer, and referring to the records of the pre-operative conference and implementation of operations.

2. Developing the process model

2.1 Basic concept of surgical operation planning

We examined the nature of surgical operation planning in the field by consulting a surgeon and attending a pre-operative conference as an observer. Based on this, we identified features of an ideal surgical operation plan, and developed the basic concept of the best surgical operation plan, thus minimizing the gap between the ideal plan and real plan.

Thus, we revealed that an ideal surgical operation plan cures the primary disease to the greatest extent.
possible, with minimum deterioration in the quality of life (QOL) of the patient. In other words, the goal of an ideal plan is to cure the primary disease radically, and to maintain the QOL of the pre-operative patient.

Nagase K et al. (2014) argues that surgical operation planning is a complex process that involves considering several factors because of the differences in patients’ conditions, difficulty in predicting the course and results of surgical interventions that lower the QOL of the patient, and different intra-operative and post-operative risks attached. In addition, surgical operation plans have to balance the two ideal targets.

To simplify this process, we broke down the planning into two steps. On the basis of the conception that planning is composed of setting a target and deciding measures for the target, in the first step, by focusing on one ideal target (i.e., to cure the primary disease radically), tentative measures are decided. Subsequently, in the second step, these measures are modified by reflecting upon the intra-operative and post-operative risks. That is to say, with reference to the other ideal target, which is operating safely and minimizing the deterioration in the QOL of the patient, the measures from the first step are reconsidered by accounting for intra-operative troubles and factors that may affect the QOL of the patient.

Accordingly, the basic concept of the best surgical operation plan that was developed was as follows. In the first step, the surgeon sets a tentative target. Thus, he/she considers the patient’s condition, only in relation to the disease to be targeted in the operation, sets the tentative intra-operative target as “taking measures to cure the disease radically.” Subsequently, he/she identifies the operative measures to be used to cure the disease radically. In the second step, he/she modifies them by forecasting the risks and considering the risk countermeasures. Thus, the surgeon forecasts the intra-operative risks by considering factors related to the patient’s total condition, which is the condition for the operation and factors preventing the accomplishment of the target, and available resources, and the post-operative risks that include the factors that could lower the QOL of the patient. Risk countermeasures are identified by lowering the target, or by altering the measures (shown in Figure 2).

Figure 2: Basic concept of surgical operation planning

2.2 Structure of the process of surgical operation planning

We designed components of the process for surgical operation planning in order to practice the basic concept efficiently (shown in Figure 3).

We divided considering process for surgical operation planning into three sub-processes that involve consideration of different factors: “Process for understanding the patient’s condition,” “Process for designing the surgical operation plan,” and “Process for reviewing.” In the process for designing the surgical operation plan,
the surgeon practice the basic concept, that is, he/she identifies the operative measures to achieve the targets by forecasting the risks and reflecting on the results of the risk forecast. This process inputs “information for designing” and outputs a “potential surgical operation plan.” In the process for understanding the patient’s condition, the surgeon considers the “information concerning the patient and resources,” which provides the “information for designing.” With respect to the process for reviewing, we referred to a pre-operative conference in which professions from various medical fields review the potential surgical operation plan in order to assure the quality of surgical operation plan, and Ichida T (1981) argues the importance of design review for quality assurance and improvement. Accordingly, we included the third sub-process (i.e. the “Process for reviewing a potential surgical operation plan”). This process inputs the “potential surgical operation plan” and outputs the actual “surgical operation plan.”

![Figure 3: Components of the process for surgical operation planning](image)

2.3 Developing a process model for surgical operation planning

Based on the components of the process for surgical operation planning, we developed a process model for surgical operation planning. We first identified the sources of information, the “Information concerning the patient and resources,” “Information for designing,” and “Surgical operation plan”. Next, we identified the process for considering this information and visualized the relation between information and processes with a data flow diagram. For this, we divided the process for understanding the information and the process for designing the plan into several functions. Since the process for surgical operation planning are complex, the quality of process for considering need to assure the quality of the outputs of process for considering. Besides, since review process has to be performed effectively and efficiently within a limited time, reviewers have to pay attention to the quality of process for considering. Therefore, we identified specific “points of attention in performing of functions and review” for each function. Finally, we developed a tool for putting the methodology of surgical operation planning into practice in a clinical field.

Thus, we developed a process model for surgical operation planning, which is composed of “Components of the process for surgical operation planning”, “the DFD showing the relationship between information and functions”, “points of attention in performing and review”, and the tool for putting the methodology of surgical operation planning into practice”.

3. The developed model

3.1 Information items

On the basis of the basic concept, we reached the structure of information items concerning surgical operation plan and information for designing. They include information concerning target, measures for the target and practical target, and information necessary to decide tentative and practical targets. Furthermore, practical target is derived by subtracting factors preventing the accomplishment of the target from ideal target. We first identified the components of the surgical operation plan (shown in Table 1). Measures for the target are “Operative method”, “Resources”, and “Countermeasures for risk”. “Operative method”, which is used in clinical field, includes measures to start the intervention, the target organ for the intervention, and the main intervention procedure. “Predicted operative time” and “Predicted amount of bleeding” mean the degree of
intervention. “Results of forecasting risks” and them represent the practical target. Information concerning the risks was divided into intra-operative and post-operative risks, and necessary to account for the risks during and after the operation.

Table 1: Surgical operation plan

| Category                        | Sub-category                        | Surgical operation plan |
|---------------------------------|-------------------------------------|-------------------------|
| Operative method and invasive degree | Operative method                   | Predicted operative time |
| Resources                       | Professionals                       | Predicted amount of bleeding |
| Results of forecasting risks    | Level of safety during the operation | QOL of the patients after the operation |
| Countermeasures for risk        | For pre-operative risk              | For intra-operative risk |
|                                 | For post-operative risk             |                         |

Table 2: Information for designing the surgical operation plan

| Category                        | Sub-category                        | Sub-sub-category |
|---------------------------------|-------------------------------------|------------------|
| Organ                           | Location                            | Dimension        |
|                                 |                                     | Depth            |
|                                 |                                     | Property         |
| Lymph node                      | Location                            | Dimension        |
|                                 |                                     | Depth            |
|                                 |                                     | Property         |
| Blood vessel                    | Location                            | Dimension        |
|                                 |                                     | Depth            |
|                                 |                                     | Property         |
| Nerve                           | Location                            | Dimension        |
|                                 |                                     | Depth            |
|                                 |                                     | Property         |
| Classification                  | Location                            | Dimension        |
| (select from the sub-sub category) |                                     | Depth            |
|                                 |                                     | Property         |
| Measure                        | Measure to cure the disease radically |                   |
| pre-operative risk              | For pre-operative risk              | For intra-operative risk |
|                                 | For post-operative risk             |                         |

We also identified the information necessary for designing the operation plan by referring to some medical literature (Japanese society for cancer of the colon and rectum, 2009a, b; Japan pancreas society, 2009a, b; Konishi F and Ando H, 2006) (shown in Table 2).

An ideal surgical operation plan must strike a balance between the two ideal targets: the intra-operative target of curing the disease radically, and the post-operative target of maintaining the pre-operative QOL of the patient.
To decide a tentative target, the surgeon must have a clear understanding of current status that is the disease to be cured. Based on medical literature and consultations with surgeons, we identified its components. To decide a practical target, the surgeon must forecast risks. Factors that prevent the accomplishment of the target include intra-operative and post-operative factors, lead risks, such as factors that make the operation difficult, and factors that lower the QOL of the patient, respectively. “Factors that make the operation difficult” were broken down to those related to the patient, and those related to available resources as this determined if they make operation procedure difficult, or enable patient to tolerate operation difficult. Factors related to the patient—such as surroundings of the disease for the operation, patient’s congenital history, and presence of disease other that the one being targeted through the operation—are some factors that make operation procedure difficult. On the other hand, factors such as general conditions of the patient and patient wishes can enable patient to tolerate operation difficult. With reference to resources, factors such as the quality of resources and the difficulty level of the operative method need to be addressed. Finally, to identify the factors that lower the QOL of the patient, we divided them into factors related to the patient and resources, which are general conditions and the effects of the operation derived from risk forecasting.

Risk forecasting is performed by considering the risk which can result from the combination of “factors that prevent the accomplishment of the ideal target” and “the ideal targets”, and represented with minus signs (shown in Figure 4 and Figure 5). To examine if the measures identified to cure the disease radically are safe, it is necessary to forecast the intra-operative risks involved. On the other hand, to restrict the extent to which the QOL of the patient is affected, it is necessary to forecast the post-operative risks.

Therefore, we identified the key points involved in developing risk countermeasures (shown in Table 3). The surgeon can select and use one or several of these points, as necessary. We derived these key points based on the countermeasures pointed in the 124 pre-operative conferences of Clinic A conducted in a period of three months. We translated the countermeasures into coarse granularity, and categorized them. We proved 3 points as follows about countermeasures: the higher or lower the risk is, the more the potential surgical operation plan changes, and they consider countermeasures for pre-operative, intra-operative, and post-operative. Besides, we identified minimum change of plan as alerting attention to risks, and maximum change of plan as reconsidering the implementation of the operation. Based on these points, we identified the key points.

Figure 4: Forecasting intra-operative risks

Figure 5: Forecasting post-operative risks

| Measures to cure the disease radically through the operation | QOL of the patient before the operation |
|-------------------------------------------------------------|----------------------------------------|
| - General conditions of the patient | - Inevitable effect of the operation |
| - Surroundings of the disease for the operation | - Possible effect of the operation |
| - Competence of the surgeon | - General conditions |
| - Functions of surgical equipment | QOL of the patient after the operation |

| Level of safety during the operation | Effect of the operation |
|-------------------------------------|-------------------------|
| - Patient’s wishes | - Patient’s wishes |

| For intra-operative risk | For post-operative risk |
|-------------------------|-------------------------|
| Cure diseases other than the one targeted in the operation | Conduct a follow-up examination |
| Alert attention to risks | Modify the pre-operative treatment |
| Conduct a follow-up examination | Modify the intra-operative treatment |
| Modify the pre-operative treatment | Modify the post-operative treatment |
| Modify the intra-operative treatment | Modify the resources |
| Modify the resources | Modify the operative method |
| Modify the operative method | Reconsider the implementation of the operation |
| Reconsider the implementation of the operation | |

With regard to the information concerning the patient and resources, we include the information concerning past and current patient’s condition, and resources, which enable to understand current status. We referred to the records of pre-operative conferences because the developed model was based on information that is common to all surgical operations (shown in Table 4).
3.2 The process of considering the information

We developed the functions of the process for understanding the patient’s conditions and the process for designing the surgical operation plan. The purpose of these functions was to produce the information which this two processes output. Therefore, we expressed these functions by their output information. As for the functions that involve complicated consideration, we added a function in which the surgeon identifies or decides the outline. For example, the surgeon identifies the location, dimension, depth, and property of the disease for the operation after identifying the outline of the organ in question, and classification of the disease for the operation. The surgeon decides the operative method after deciding the outline of the operation (i.e., determines which organ to intervene in) and the property for the operation.

In developing the functions in this way, we used a data flow diagram (DFD) and visualized the relationship between information and functions (shown in Figure 6).

We also derived the points of attention for performing of functions and review of the surgical operation plan (shown in Table 5). It is based on the problems identified from the records of the 124 pre-operative conferences conducted in Clinic A over a period of three months. We translated these problems into coarse granularity, regard them as the points of attention, applied them to appropriate functions in which it was possible to occur these problem.

| Table 4: Information concerning the patient and resources |
|---------------------------------------------------------|
| **Category** | **Sub-category** |
|----------------|-----------------|
| Patient | Age |
| | Sex |
| | Chief complaint |
| | Onset and course of the present illness |
| | Anamnesis |
| | Physical findings |
| | Examination image findings |
| | Blood biochemistry findings |
| | Spirometer results |
| | Electrocardiogram findings |
| Resources | Professionals |
| | Instruments |

Table 5: Functions and points of attention in the execution and review of the surgical operation plan

| Function of the process | Points of attention in performing of functions and review |
|-------------------------|--------------------------------------------------------|
| Identify the outline of the organ in question, and classification and properties of the disease for the operation | Track back the course of the disease |
| Ask essential wishes |
| Select the appropriate spot and method of inspection |
| Track back the course of the disease |
| Identify the location, dimension, depth, and property of the disease for the operation | Select the appropriate spot and method of inspection |
| Understanding the patient's wishes | Track back the course of the disease |
| Select the appropriate spot and method of inspection |
| Identify the classification of the disease for the operation | Track back the course of the disease |
| Understanding the general conditions of the patient | Select the appropriate spot and method of inspection |
| Track back the course of the disease |
| Check whether to attend to the surroundings of the disease | Select the appropriate spot and method of inspection |
| Track back the course of the disease |
| Check for the presence of any congenital features that may affect the outcome | Select the appropriate spot and method of inspection |
| Track back the course of the disease |
| Check for the presence of comorbidities | Understand the patient's daily life |
| Understand the quality of the resources | Understand physical functions and living environments |
| Evaluate the quality of the resources of professionals and instruments | Understand the patient's daily life |
| Check whether to attend to the surroundings of the disease | Understand physical functions and living environments |
| Check for the presence of comorbidities | Forecast the intra-operative risks and consider countermeasures |
| Decide the outline of the operative method (which organ to intervene in and examine its properties) | Reflect on the patient's wishes |
| Decide the operative method | Decide the extent of intervention |
| Decide the optimal operative method | Select the safest method |
| Forecast the intra-operative risks and consider countermeasures | Decide the extent of intervention |
| Evaluate the level of difficulty of each factor | Reflect on the patient's wishes |
| Forecast the post-operative risks and consider countermeasures | Decide the extent of intervention |
| Evaluate the level of difficulty of each factor | Reflect on the patient's wishes |
| Consult other doctors when the case is difficult to forecast | Decide the extent of intervention |
| Overestimate risks when the case is difficult to forecast | Decide the extent of intervention |
| Select the safest method | Select the safest method |

[DOI : 10.17929/tqs.1.65] Copyright © 2015 Journal of the Japanese Society for Quality Control. All rights reserved.
3.3 Tool for quality assurance in surgical operation planning and review

We had visualized information and process for considering surgical operation plan. Then, we developed a tool for putting them into practice in a clinical field. (shown in Figure 7) This tool is used by surgeons in charge and reviewers. They fill in the output of each executed functions into the deep color cell. The details of this tool has been described below.

![DFD Diagram](image)

Figure 6: DFD showing the relation between information and functions

Figure 7: Tool for quality assurance in surgical operation planning

We arranged each function of the process for designing because functions sometimes return to the previous one. To highlight the necessary information and functions, and the points of attention for each function, we
colored the essential fields. We arranged all of the information and functions maintaining the information structure to enable the surgeon and reviewers to recognize why this information is needed.

4. Examining the effectiveness of the model

4.1 Applicability

We examined whether the visualized information and process for considering is applicable to surgical operation planning in practice. In examining, we used the tool, which enable clinical cases apply to the model. The information and functions of the model are applicable if a potential surgical operation plan identified by a surgeon and the modifications suggested by the reviewers can be completed in the tool. The flow of the model’s functions is applicable if the modifications suggested by the reviewers are derived according to the function flow in the designing process.

We applied the tool to 7 cases that we observed during their pre-operative conference. These 7 cases include 3 breast and endocrine surgery, 2 hepato-biliary-pancreatic surgery, and 2 digestive surgery, and they represent general surgeries. We completed the surgical operation plan as developed by the surgeon in charge, marked the contents questioned by the reviewers, and completed the modifications next to an arrow (shown in Figure 8).

Thus, we examined if the contents of the potential surgical operation plan identified by the surgeons, and the modifications by the reviewers in the actual situation, were applicable to the designated fields in the model, and whether the modifications were completed according to the relevant information and functions.

We also confirmed the appropriateness of the information and model functions.

4.2 Usefulness

The model is useful if a potential surgical operation plan is improved by implementing information and process for considering of the model. We also applied the model to 2 cases in which reoperation was performed because of some problems to the tool.

We completed the pre-operative conference record of the first operation, marked the cause of the problem by referring to the post-operative review of the first operation, and completed details of the second operation as ideal modifications based on its pre-operative review (shown in Figure 9).

---

**Figure 8: Examining the effectiveness of the model**

**Table: Input, process, output/process for designing the surgical operation plan**

| Category | Sub-category | Sub-sub-category |
|----------|--------------|-----------------|
| Patient  | Age          | Sex             |
|          | Chief complaint | Onset and course of the present illness |
|          | Anamnesis    | Physical findings |
|          | Examination image findings | Spirometer results |
|          | Electrocardiogram findings | Professionals |
|          | Instruments | Identify the outline of the organ in question, and classification and properties of the disease for the operation |
|          | Identify the patient’s wishes | Select the appropriate spot and method of inspection |
|          | Track back the course of the disease | Difficulty level of the operative method |
|          | Predicted operative time | Professionals |
|          | Level of safety during operation | Instruments |
|          | Effect of the operation | Result of forecasting risks |
|          | QOL of the patients after operation | Key points for risk countermeasures |

---

**Figure 9: Usefulness of the model**
The model identified the cause of the problems, which were overlooked in the actual situation. These results were verified as appropriate by a surgeon who is an operation director. Thus, the model was confirmed as useful.

However, as the model’s usefulness was reviewed retrospectively, it is not clear if the model can detect all problems of the surgical operation plans by prospective review. We could not confirm if reviewers can question every problem of a potential surgical operation plan.

### 5. Discussion

#### 5.1 Results of evaluation of the model

The model helped organize complicated information and processes, and identified the flow of surgical operation planning. However, the model could not be implemented in cases from all surgical departments of Clinic A. To achieve the present study’s purpose regarding the development of a model that can be applied to every operation, it needs to be examined by implementing it to more cases within the other surgical departments.

The model was also found to be useful for preventing the omission of necessary information, and for analyzing problems that may arise during an operation.

We had comments that this discussion is appropriate from a surgeon, professionals assisting the implementation of operations in terms of resources, an anesthesiologist, and a nurse.

#### 5.2 Expectation

We focused on 7 cases for avoiding too many cases from view point of research ethics, because pre-operative conference is essential and immediately preceding review. The surgeon and the anesthesiologist, who are cooperated with our research, have agreed that this process model has no problems as a planning process model for general surgical operations. This model enables surgeons to plan surgical operations effectively and efficiently. In addition, as the surgical operation planning process can be recorded with this tool, we can use the PDCA cycle. We can analyze the causes of problems during surgery, and improve surgical operation planning. This model is useful for quality assurance and quality improvement of operations.

#### 5.3 Future challenges

We need to improve the model by applying it in practice.

Focusing on the evaluation of the model, it needs to be useful for reviewing more efficiently and effectively than planning. As a solution, we established an order for review or refine a review functions.

Focusing on the future granularity of the model, we aimed to minimize the individual differences between model users in the model outputs. To address this, we improved the quality of the function implementation, for...
example, developing functions in detail or enriching the points of attention in performing functions and review.

In any case, we need to use the model for analyzing several cases and examine if it is relevant to different cases, and review functions and related information and functions.

6. Conclusion

Surgeons must plan surgical operations appropriately to operate successfully. However, it is difficult to plan operations because they are complicated, and they deal with a substantial amount of medical knowledge and information concerning patients. It is therefore necessary to develop a process model for surgical operation planning to improve medical service quality.

In this study, we divided surgical operation planning into three processes: “Process for understanding the patient’s conditions,” “Process for designing the surgical operation plan,” and “Process for reviewing the surgical operation plan.” We revealed an ideal surgical operation that can cure the disease to the best possible extent and minimize the compromising of the patient’s QOL. We designed the basic concept of the best surgical operation plan, and developed the process model based on this concept. Subsequently, we identified components of the surgical operation plan and information necessary for the designing processes. Next, we broke down the process of understanding the information and designing the operation plan into functions, and visually represented them with a data flow diagram. Then, we developed a tool for quality assurance in planning, and tested the model by applying it to 9 surgical cases. Thus, we proved that the model helped simplify and organize the complex process of operation planning, and could detect problems retrospectively.

In future, we must improve the model by implementing it in practice. We also need to use the model for analyzing cases and examining if it is relevant to different cases, review functions, and related information and functions.

References:

Copeland GP, Jones D, Walters M. (1991). “POSSUM: a scoring system for surgical audit”, Br J Surg, Vol.78, pp.355-360
Haga, Y., Ikei, S., Ogawa, M. (1999). “Estimation of physiologic ability and surgical stress (E-PASS) as a new prediction scoring system for postoperative morbidity and mortality following elective gastrointestinal surgery”, Surgery Today, Vol.29, pp.219-225
Haga, Y., Ikei, S., Wada, Y., Takeuchi, H., Sameshima, H., Kimura, O., Furuya, T. (2001), “Evaluation of an estimation of a physiologic ability and surgical stress (E-PASS) scoring system to predict postoperative risk: A multicenter prospective study”, Surgery Today, Vol.31, pp.569-574
Ichida, T. (1981), “Design review (Japanese)”, Nikkagiren Publishing Co.
Iida, S., Iizuka, Y., Munechika, M. (2005), “A Term Encyclopedia for Quality of Healthcare (Japanese)”, Japanese Standards Association.
Iizuka, Y. (2009), “General outline of quality management today (Japanese)”, Asakura Publishing Co.
Iizuka, Y., Tsuru, S. (2010), “The quality of management for medicine: methodology and meanings of patient-centered medicine (Japanese)”, Japan medical planning.
Institute of medicine. (1999), “To err is human: A safer health system”, National Academies Press.
Institute of medicine. (2011), “Health IT and patient safety, Building safer systems for better care”, National Academies Press.
Japan pancreas society. (2009), “Medical guideline for pancreatic cancer (Japanese)”, Kanehara Publishing Co.
Japan pancreas society. (2009), “General rules for the study of pancreatic cancer April 2009 the 6th edition (Japanese)”, Kanehara Publishing Co.
Japanese society for cancer of the colon and rectum. (2009), “Japanese classification of colorectal carcinoma (Japanese)”, Kanehara Publishing Co.
Japanese society for cancer of the colon and rectum. (2009), “Medical guideline for cancer of the colon and rectum (Japanese)”, Kanehara Publishing Co.
Konishi, F., Ando, H. (2006), “Instructions for doctors-in-training (Japanese)”, Yodo Publishing Co.
Lasser MS, Doscher M, Kehn A, Chemyak V, Garfein E, Ghavamian R. (2012), “Virtual surgical planning: a novel aid to robot-assisted laparoscopic partial nephrectomy”, Journal of endourology, Vol.26, pp.1372-1379
Nagase, K., Murase, T., Goto, N. (2014), “Time and information and management for operation region (Japanese)”, Japanese association for operative medicine.
Acknowledgements

Special thanks to Shuzo Kono, Masatoshi Yumoto, Kazuhiro Shoji and the members of working group for Jikei University Hospital for Jikei Standardization Project.

Author’s biographical notes

Rika Takao is a graduate student at School of Engineering, the University of Tokyo. She is interested in quality management system for healthcare focusing on process of considering.

Dr. Ryoko Shimono is an assistant professor at School of Engineering, the University of Tokyo. She is interested in modeling of service delivery process in healthcare for a process design with taking into account the healthcare-specific characteristics.

Dr. Satoko Tsuru is a Professor at School of Engineering, the University of Tokyo. She is leader of research group for clinical knowledge structuring in healthcare. The project is developing integrated Patient Condition Adaptive Path system: PCAPS for clinical quality management. Her research interest is Healthcare Social System Engineering.

Dr. Toru Kuroda is a surgeon and a safety manager of an operative department at the Jikei University Katsushika Medical Center. He specializes in surgical oncology.

Dr. Kazuhiko Yoshida is a surgeon and an assistant director of the Jikei University Katsushika Medical Center. He specializes in surgical oncology.

Dr. Koji Asano is a surgeon and an assistant director of the Jikei University Hospital. He specializes in urology.

Dr. Shogo Kato is an assistant professor at School of Engineering, the University of Tokyo. His research interests are system analysis engineering in both healthcare and industrial fields, as represented by patient safety, trouble prevention, and so on.