June 20, 2011 (Monday) Pre-Congress Seminars

KEMPINSKI HOTEL CORVINUS **Erzsébet tér 7-8, Budapest V.**
REGINA BALLROOM I. **Monday 10:00 – 18:15**

2.1. QUALITY IN HEALTHCARE

Seminar Chair: ***Sister Mary Jean Ryan,*** *SSM Health Care, St. Louis, MO, USA*

10.50 A Model for Personnel Allocation at Hospitals
Ryoko Shimono, Shogo Kato, Satoko Tsuru and Yoshinori Iizuka, University of Tokyo, Japan

Shimono, Ryoko (Japan)

He earned an M.D. (Doctor of Medicine) degree at the University of Tokyo where he attends now a Ph.D Course. He studied chemical engineering at undergraduate school and quality management at graduate school. He is interested in modelling quality management systems in healthcare and has developed a model to describe operation processes and a model for personnel allocation taking into account the healthcare-specific characteristics.

He has delivered several presentations in the Congresses of the Asian Network for Quality. In 2010 he was granted the Best Paper Award at the 8th Asian Network for Quality Congress.

A Model for Personnel Allocation at Hospitals

Ryoko SHIMONO, Shogo KATO, Satoko TSURU, Yoshinori IIZUKA

Department of Chemical System Engineering, School of Engineering, University of Tokyo
7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, JAPAN

1. INTRODUCTION

For hospitals, personnel allocation is a critical issue because the quality of healthcare depends on the competence of the personnel [1][2]. Personnel allocation at hospitals must take into account the diversity of patients' needs, the complexity of the services delivered, and the variation in specialized skills proficiency among personnel. A methodology taking these factors into account has however not been developed yet.

The purpose of this study is to develop a model method for personnel allocation that reflects the specific features of healthcare. The model is an effective method composed of several functions in order to derive personnel allocation patterns for quality assurance and efficient utilization of human resources.

In this paper, we defined functions composing the model, designed procedures to achieve functions step by step, and verified the developed model through application to actual cases.

2. STRATEGY AND METHOD USED TO DEVELOP THE MODEL

2.1. The Concept and Strategy Used to Develop the Model

Based on the concept that 'the personnel to carry out the work is the personnel competent to meet quality requirements in doing so', we identified three core aspects of personnel allocation: determining necessary competence, determining possessed competence, and deriving allocation patterns.

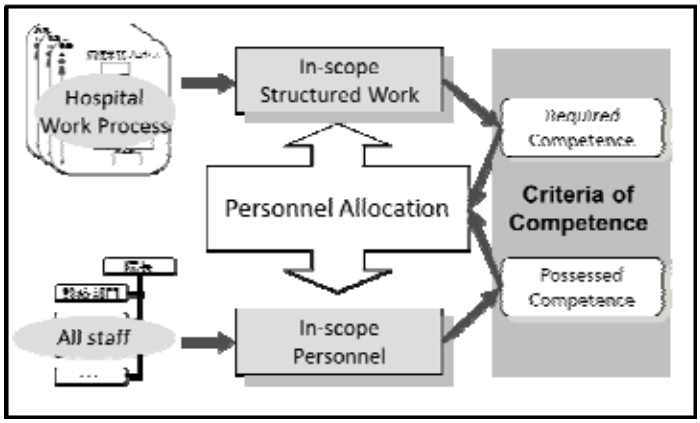


Figure 1. Fundamental Concept

We incorporated hospital-specific considerations to each of these aspects: Determining required competence involves identifying items to be evaluated and estimating the number of required personnel, based on a job description including hospital-specific features. Deriving personnel allocation patterns involves ensuring quality in situations where possessed competence does not satisfy the necessary competence.

2.2. Definition of Model Functions

We defined several functions in each phase. Phase 1 and phase 2 aim at defining in-scope processes and personnel, and determining required and possessed competence. Phase 3 aims at determining whether personnel competence are sufficient ("sufficiency of personnel") for the defined scope, and at deriving personnel allocation patterns logically. The relations among model functions are defined in Figure 2. These functions constitute the steps necessary to complete personnel allocation.

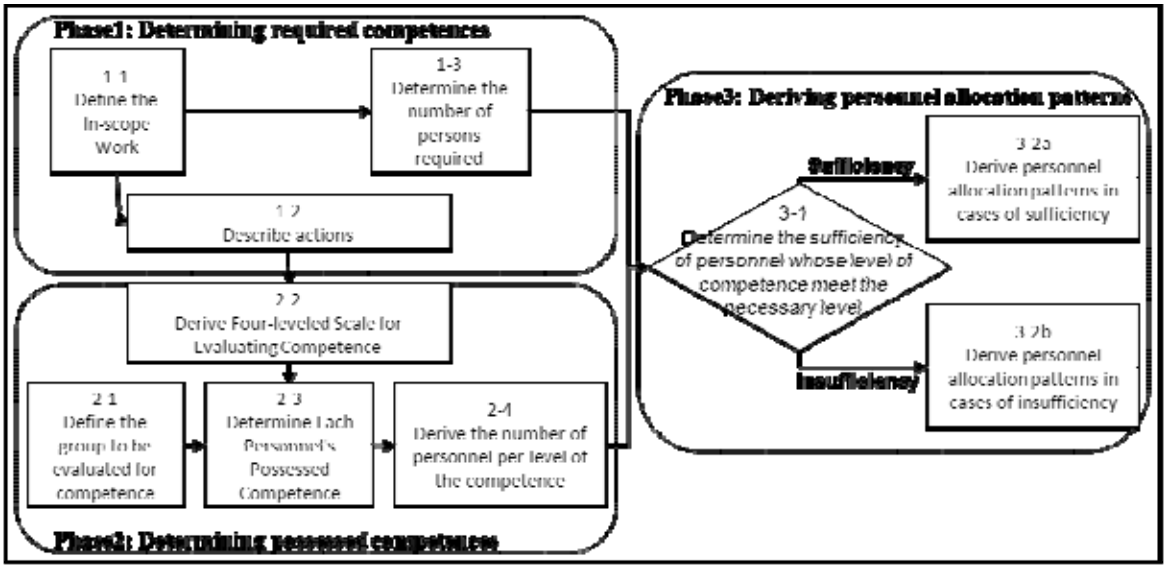


Figure 2. Diagram of the Model Steps

2.3. Design of Procedures to Achieve each Model Steps

We designed the procedures to achieve each model step by defining the inputs and outputs, and the function transforming the former into the latter, as shown in Table1 and Figure3.

Table1. Inputs and Outputs of Each Step of the Model

Phase		Steps Composing Each Phase		Input(s) of each Step	Output(s) of each Step	Considerations for Designing Functions Transforming Inputs to Outputs
1	Determining Required Competences	1-1	Define the In-scope Work	–	The in-scope work	A concept of "Unit Process" for definition of the in-scope work
		1-2	Describe Actions as Evaluation Items for Required Competence	Work process within the scope	Actions (Evaluation items for required Competence)	A concept of "Actions" for description of evaluation items of required competence
		1-3	Determine the Number of Persons Required	Work process within the scope	The number of personnel required	Situations to be considered for determination of the number of persons required
2	Determining Possessed Competences	2-1	Define the Group to be Evaluated for Possessed Competence	The attribution of personnel	The in-scope personnel (The group to be evaluated)	Means to define the group, License requirement for implementation of particular work
		2-2	Derive Four-leveled Scale for Evaluating Competence	Actions	Four-leveled scale	Means to derive four-leveled scale for evaluating competence
		2-3	Determine Each Personnel's Possessed Competence	The group to be evaluated, Four-leveled criteria	Each personnel's competence	Means to determine each personnel's possessed competence
		2-4	Derive the Number of Personnel per Competence Level	Each personnel's competence	The number of personnel possessed per level	Means to derive the number of personnel competence level
3	Deriving Personnel Allocation Patterns	3-1	Determine the Sufficiency of Personnel Whose Level of Competence Meet the Required Level	The number of personnel required, The number of personnel possessed per level	Sufficiency or insufficiency	Means to determine the sufficiency of personnel
		3-2a	Derive Personnel Allocation Patterns in Cases of Sufficiency	The number of personnel required, The number of personnel possessed per level in case of sufficiency	Personnel allocation patterns in cases of sufficiency	Logic flow for derivations of personnel allocation patterns in sufficiency
		3-2b	Derive Personnel Allocation Patterns in Cases of Insufficiency	The number of personnel required, The number of personnel possessed per level in case of insufficiency	Personnel allocation patterns in cases of insufficiency	Logic flow for derivations of personnel allocation patterns in insufficiency

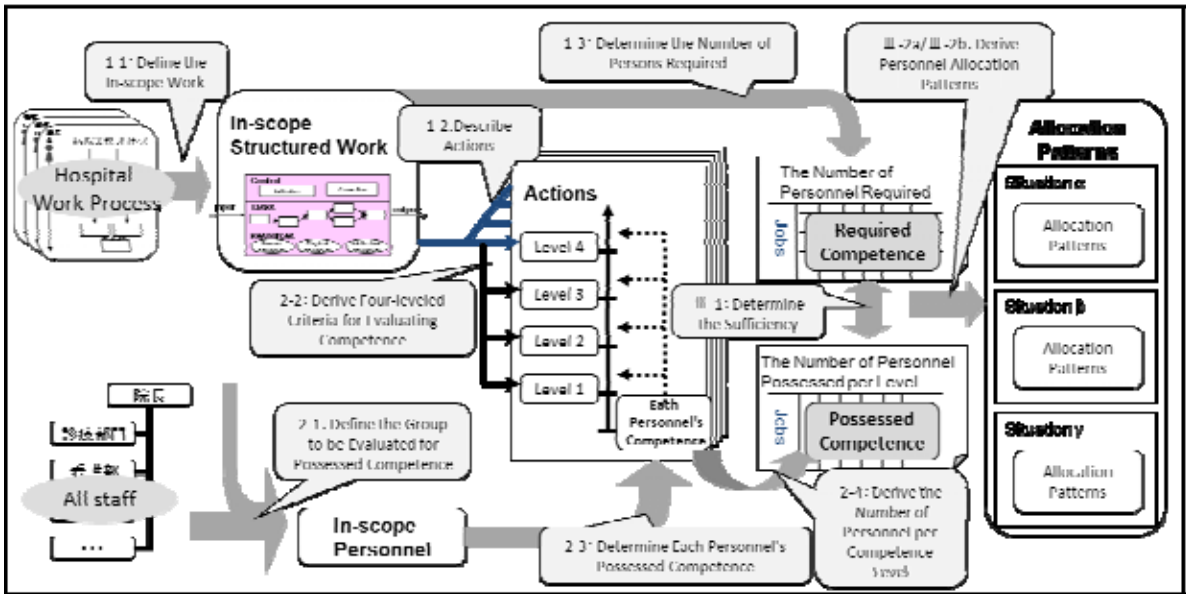


Figure 3. Whole Image of the Developed model

3. THE DEVELOPED MODEL

3.1. Phase1: Determining Required Competence

3.1.1. Define the In-Scope Work (Step1-1)

The in-scope work process (hereafter "Unit Process"), is a unit of work composed of continuous actions performed by one or more persons. Basic aspects of Unit Processes are included below. (Refer to *Hospital Operational Process Description Model* [3] (Shimono et al., 2010) for a detailed explanation).

3.1.2. Describe Actions as Evaluation Items for Required Competence (Step1-2)

In order to determine the competence required for a Unit Process, it is necessary to determine the actions impacting quality assurance. Understanding these actions clearly and exhaustively is difficult, however, because work in healthcare is complicated by healthcare-specific characteristics, such as the variety of patients and their condition, and the fact that some medical interventions involve human body invasion.

In order to determine actions impacting quality assurance for hospital work, we apply a model for describing hospital operational processes that derives component actions based on hospital-specific characteristics [3]. These actions are classified into "action types", according to their function in each Unit Process. The structure and concepts of the description model are shown in Figure 4.

The actions derived using the description model for the Unit Process constitute the aspects for which competence need to be evaluated, hereafter referred to as "evaluation items".

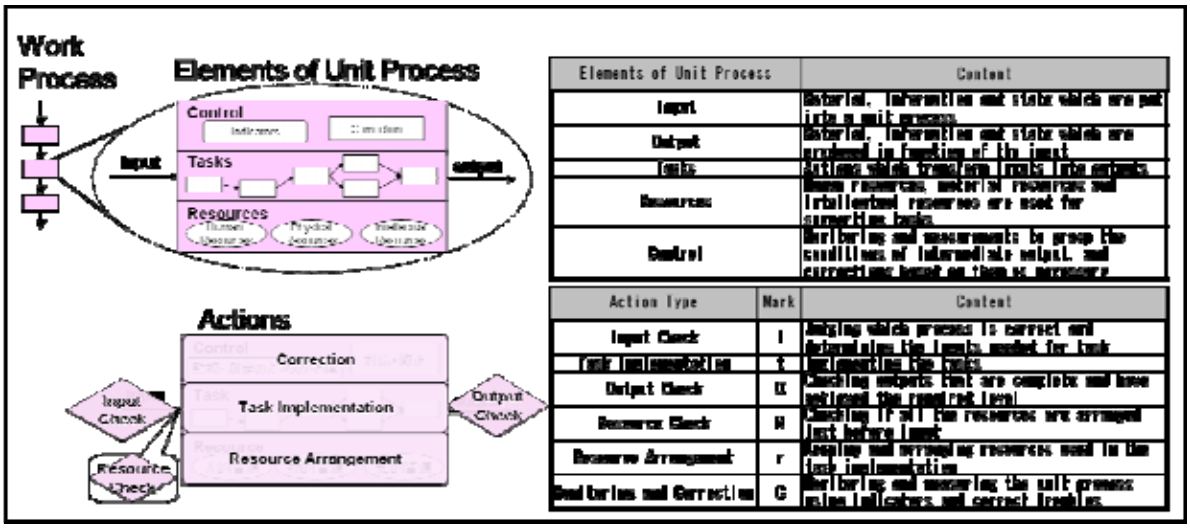


Figure 4. Outline of the Description Model

3.1.3. Determine the Number of Persons Required (Step 1-3)

In this step, we determine the number of persons required in the Unit Process for a

specific situation (i.e., a specific shift or level of busyness). There may be several situations where the number of persons required varies for a single Unit Process, such as work process requiring multiple people during a day shift, but handled by one person during a night shift.

3.2. Phase 2: Determining Possessed Competence

3.2.1. Define the Group to be Evaluated for Possessed Competence (Step 2-1)

In this step, we determine the group of persons whose competence have to be evaluated for the Unit Process defined in step 1-1. The purpose is to select a preliminary group of personnel for which there is a possibility of allocation, based on readily available information. Selecting the group based on possessed licenses is effective because licenses personnel possess are known in healthcare organizations. For example, the group to be evaluated for the work of blood sample taking is personnel having license of medical doctor, nurse, or medical technologist because blood sample taking is invasive to human body.

3.2.2. Derive a Four-Level Scale for Evaluating Competence (Step 2-2)

In this step, we derive leveled criteria for each action derived in step 1-2, by applying the generic table of required competence per level and action type (Table 2) to the target action. Possessed competence is evaluated on a four level scale. The definition of a level is based on whether a member of personnel has the ability to implement an action by themself, and on the degree of difficulty of the case to handle, i.e., whether the case is "typical", "standard" , or "complex".

A standard case does not mean a typical case or simple case, but rather a case which can be implemented following a standard procedure. A standard procedure includes procedures for typical cases and if-cases. Therefore, as shown in Table 2 below, a person in level 3 has the ability to implement almost all cases by themself.

Table 2. Generic Contents of Actions and Required Competence par Level

Generic Content of Actions per type / Generic Content of Required Competence per Level		Level1	Level2	Level3	Level4
Action Type	Generic Content	Ability to implement with on-site help	Ability to implement in typical cases by oneself and to ask the highly-leveled personnel for help in standard or complex cases	Ability to implement in standard cases by oneself and to ask the highly-leveled personnel for help in complex cases	Ability to implement in complex cases by oneself
Resource Arrangement	Prepare and maintain resources based on a specific input	Knowledge of the resources to be arranged	Ability to prepare the required resources, basing judgment in typical cases	Ability to prepare the required resources, basing judgment in the standard cases	Ability to modify and revise resources on a case-by-case basis, basing judgment in all cases
Resource Check	Evaluate the adequacy of resources for given unit processes	Knowledge of the criteria for evaluation of resources	Ability to assess the adequacy of the resources in typical cases	Ability to evaluate the adequacy of resources for the inputs	Ability to propose/decide on resources modification
Input Check	Evaluate whether the input is appropriate or not for a given unit process	Knowledge of the criteria for evaluation of inputs	Ability to assess the adequacy of the inputs in typical cases	Ability to assess the adequacy of the input (with regards to the task to be performed).	Ability to evaluate the adequacy of the input, including assessment of complex cases
Task Implementation	Implement based on standards	Knowledge of the standard procedures	Ability to implement by following the steps of standard procedures in typical cases	Ability to implement following standard procedures	Ability to exceed standard procedures when a situation requires it
Output Check	Evaluate the (implementation) output	Knowledge of the criteria for evaluation of outputs	Ability to evaluate the output for typical patterns	Ability to evaluate the output. (Understands whether good or bad)	Ability to evaluate the output, even for complex tasks
Monitoring and Correction	Monitor the state of implementation and take appropriate follow-up actions	Knowledge of the criteria for monitoring and of how to correct	Basic understanding of items to be monitored and appropriate values, and ability to ask help for follow-up actions	Understanding which items have to be monitored along which lines, is able to take the first necessary steps and to ask help for follow-up actions	Ability to monitor and make appropriate judgments in unexpected situations

3.2.3. Determine Each Personnel's Possessed Competence (Step 2-3)

In this step, we evaluate each personnel's possessed competence by using leveled criteria developed in step **2-3.**

3.2.4. Derive the Number of Personnel per Competence Level (Step 2-4)

In this step, of the result of the evaluation of possessed competence on a per-action level is converted to the unit-process level. The conversion is performed by retaining the lowest score of the per-action evaluation: if a member of personnel is determined to be at level 1, 2, 4 for three actions a, b, and c part of a Unit Process, his/her level for the entire Unit Process will be 1. After this conversion process, the level of in-scope personnel is added to obtain to obtain the Group result.

3.3. Phase 3: Deriving Personnel Allocation Patterns

3.3.1. Determine Sufficiency of Personnel (Step 3-1)

Sufficiency of personnel for a given Unit Process is determined by comparing the number of required personnel (determined in step 1-3) to the number of personnel with a competence level of 3 and above. If the number of the latter is greater than the former, personnel is deemed to be sufficient for this Unit Process. (Additionally, adjustments are made where necessary to the number of level 3 and above personnel to accommodate the fact that some actions are shared between multiple members of personnel.)

3.3.2. Derive Personnel Allocation Patterns in Cases of Sufficiency (Step 3-2a)

Sufficiency means that personnel possessing a competence level 3 or above is in sufficient number. Personnel allocation patterns are derived from the viewpoint of efficient utilization of human resources, because quality assurance is achieved in this case.

Additionally, two measures can be taken from a cost perspective if the Unit Process does not require licensed-personnel. Firstly, non-licensed personnel can be allocated in preference to licensed-personnel. Secondly, (non-licensed) personnel with a competence level 2 can be allocated, if allocated in combination with highly-leveled personnel.

3.3.3. Derive Personnel Allocation Patterns in Cases of Insufficiency (Step 3-2b)

Insufficiency means that personnel possessing a competence level 3 or above is not in sufficient number. In this case, level 2 personnel can be allocated on certain conditions, so quality is ensured in spite of insufficiency.

Level 2 personnel can be allocated with the following conditions because they have "the ability to implement typical cases by themself and to ask highly-experience personnel for help in standard or complex cases". The first condition is the allocation in combination with highly-leveled personnel. The second condition is that for difficult cases, allocated level 2 personnel should not perform actions but only take temporary measures and wait for highly-leveled personnel instruction.

Figure 5 shows the developed logic flow for deriving personnel allocation patterns based on the results personnel sufficiency assessment (step 3-1)

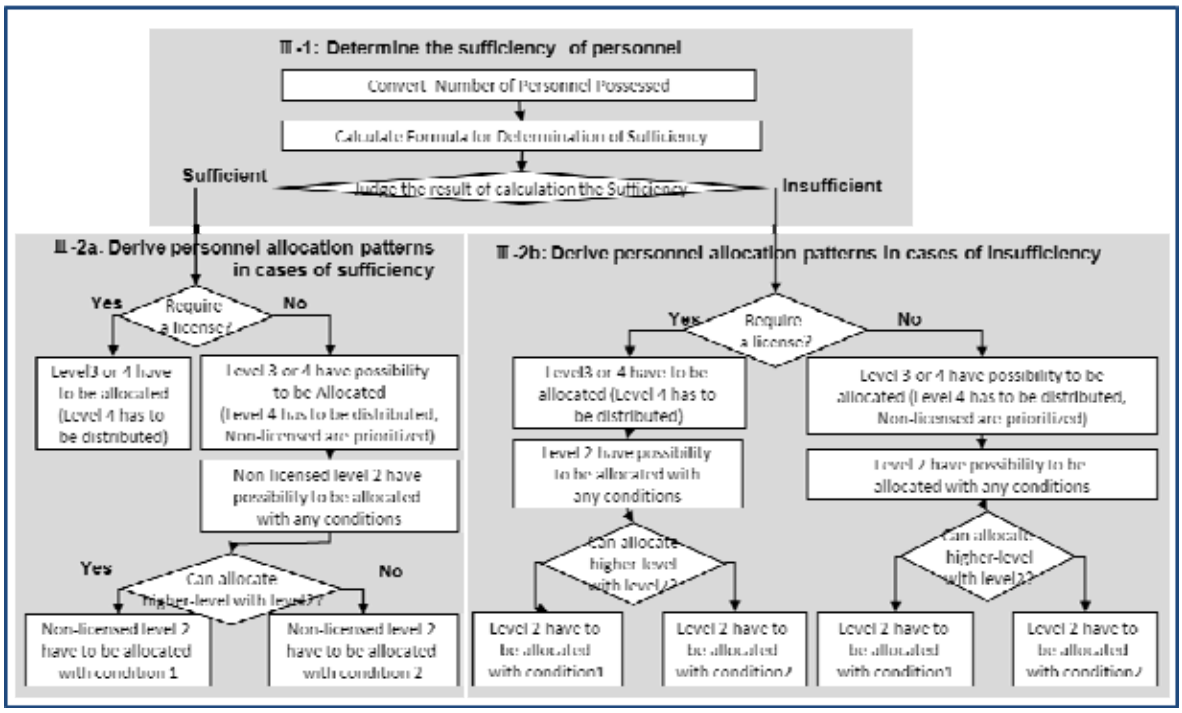


Figure 5. A Logic Flow for Deriving Personnel Allocation Patterns

4. VERIFICATION OF THE MODEL

4.1. Outline

We verified the developed model by evaluating which allocation pattern is more effective between by the model and current methods in terms of quality assurance and efficient utilization of human resource.

We organized a workshop in an actual hospital selected for a case study of a clinical testing process. In this workshop, two managers tried deriving personnel allocation patters in different ways in order to compare the results. The first manager (Manager M) derived allocation by applying the developed model, while the other manager (Manager N) derived allocation without using the model.

In this case study, target Unit Processes are “blood sample taking”, “pre-measurement treatment” and “measurement of specimens”. The Group to be evaluated is composed nine medical technologists and two assistants without a license of medical technologist.

The case study is suitable for verification of the model because the Unit-Process possesses hospital-specific characteristics [3].

4.2. Allocation Results

The allocation patterns derived by applying the developed model, (“Application Results”), are derived by completing each step of the model. Table 3 and Table 4 show the intermediate outputs of each step. Table 3 shows the actions of the Unit Process, together with the four-level evaluation criteria per action, and each personnel’s competence per

action and for the entire Unit Process. Table 4 shows the number of personnel required, the number of personnel possessing competence per level, and the result of the sufficiency assessment.

Manager M derived personnel allocation patterns as shown in the upper part of Table 5. In Table 5, the possibility of allocation and condition for allocation of personnel A to K are shown per Unit Process situation (i.e., day shift, night shift, etc.).

Table 3. Intermediate Outputs of the Model -1

Step 1-1	Step 1-2		Step 2-2				Step 2-3										Step 2-4										
Unit Process (In-scope work)	Actions		Four-leveled Scale				Each Personnel's Competence per Action										Each Personnel's Competence per Unit Process										
	Action Type	Content	Level1	Level2	Level3	Level4	A	B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	I	J	K
Blood Sample Taking	Input Check	Check the patient identifications: name and birth date			Ability to check the patient identifications		3	3	3	3	3	3	3	3	–	–		3	2	2	2	2	2	2	3	3	–	–
	Resource Arrangement	Prepare instruments for blood sample taking: sample tube, needle, holder and so on			Ability to prepare instruments for blood sample taking		3	3	3	3	3	3	3	3	–	–												
	Resource Check	Check a label on a sample tube			Ability to check a label on sample tube		3	3	3	3	3	3	3	3	–	–												
	Task Implementation	Find puncture site and choose a suitable needle			Ability to find puncture site and choose a suitable needle		3	3	3	3	3	3	3	3	–	–												
	Task Implementation	Take blood sample	Knowledge to find suitable blood vessel	Ability to take blood sample from a viewable vessel sample which is typical case	Ability to take blood sample not only from a viewable but also from touchable blood vessel, and ability handle a butterfly needle	Ability to take blood sample from difficult patient case to be taken blood sample	3	3	3	3	3	3	3	3	–	–												
	Control	Monitor patients' condition and adapt it	Ability to monitor patient's condition by patient's complaint	Ability to find abnormality of patient's condition through observation	Ability to monitor patient's condition and to make initial response	Ability to monitor patient's condition and adapt it in difficult cases	4	2	2	2	2	2	2	4	4	–	–											
	Output Check	Check blood sample's amount and condition			Ability to check blood sample's amount and condition		3	3	3	3	3	3	3	3	–	–												

Table 4. Intermediate Outputs of the Model -2

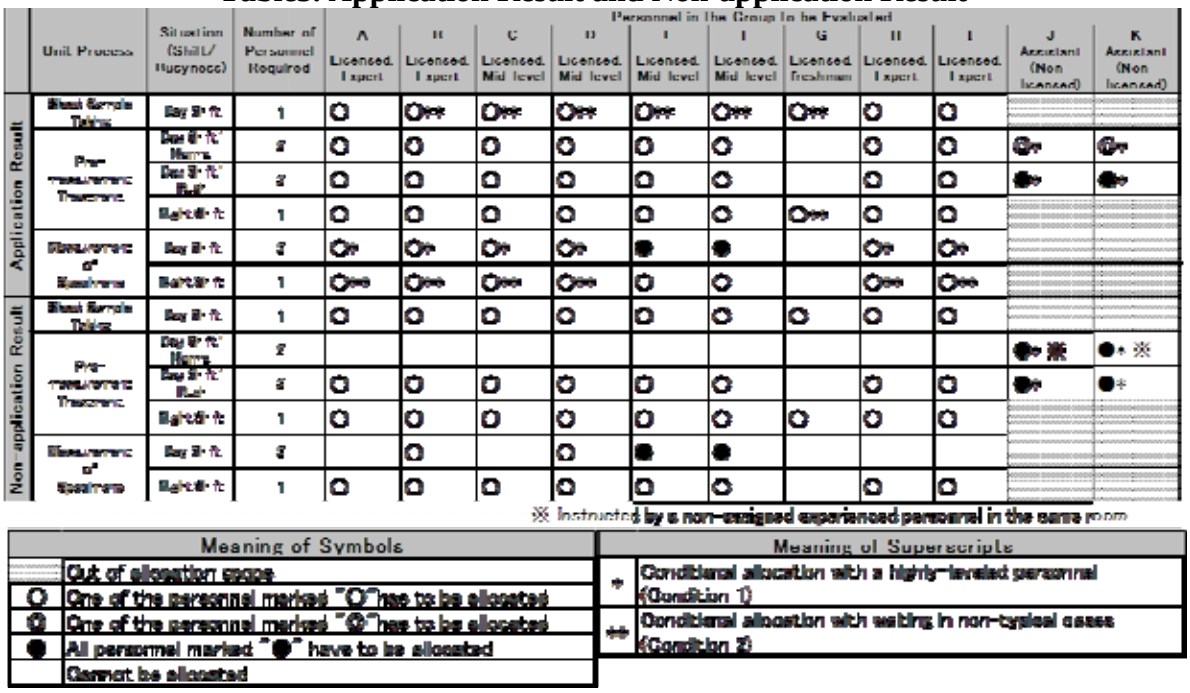
Model Step / Output / Unit Process / Situation		Step 1-3	Step 2-4			Step 3-1	
		The Number of Personnel Required	The Number of Personnel Possessed per Level			Sufficiency or Insufficiency	
			Level4	Level3	Level2	Calculation Result★1	Determination Result★2
Blood Sample Taking	Day Shift/ Normal	1	0	3	6	-0.7★3	Insufficient
	Day Shift/ Rush	1				-0.7★3	Insufficient
	Night Shift	0				–	–
Pre-measurement Treatment	Day Shift/ Normal	2	0	8	3	6	Sufficient
	Day Shift/ Rush	3				5	Sufficient
	Night Shift	1				-0.2★3	Insufficient
Measurement of Specimens	Day Shift/ Normal	3	0	2	6	-1	Insufficient
	Day Shift/ Rush	3				-1	Insufficient
	Night Shift	1				-0.8★3	Insufficient

★1 Culculation Formula for Determination of Sufficiency:
"The **Converted** Number of Personnel Possessed" − "The Number of Personnel Required"

★2 Determination Criterion The Result of calculation ≧0: Sufficient, <0: Insufficient

★3 The Converted Number = The Number of Personnel Possessed / Frequency, 10 in these situations

Table5. Application Result and Non-application Result



※ Instructed by a non-assigned experienced personnel in the same room

Meaning of Symbols	
	Out of allocation scope
○	One of the personnel marked "○" has to be allocated
◎	One of the personnel marked "◎" has to be allocated
●	All personnel marked "●" have to be allocated
	Cannot be allocated

Meaning of Superscripts	
*	Conditional allocation with a highly-leveled personnel (Condition 1)
**	Conditional allocation with waiting in non-typical cases (Condition 2)

The following is an explanation of Table 5 for the "pre-measurement treatment" Unit Process, in a day shift/Normal situation. In this situation, the number of personnel required is two, and the Application Results indicate possible personnel allocation patterns are a set of two persons, composed of one person from A-F or H-I, and one person from J-K. J and K are set apart because they are non-licensed assistants. There allocation involves conditions because their competence level is 2. A-F and H-I are therefore marked a white circle, and J and K are marked with a double circle with an asterisk. Personnel allocation patterns performed based on usual methods by Manager N are shown at the bottom part of Table 5. In this case, J and K are selected for allocation for the "pre-measurement treatment" in a day shift/Normal situation, and are therefore marked with a black circle with an asterisk. Additionally, J and K are with a bigger marked bigger asterisk, meaning that they will need to receive instructions from non-assigned experienced personnel in the same room, because they do not possess sufficient competence to implement the required actions by themselves.

4.3. Verification of the Model

In order to verify the model, we firstly extracted the differences between the Application Results and allocation patters derived from usual methods, as summarized in Table 6. There are five types of differences, explained in the "meaning of symbols" below Table 6. Secondly, we analyzed these differences using the criteria of quality assurance and efficient utilization of human resource. The criterion of quality assurance is "whether the possessed competence of personnel having probability to be allocated meets the required

competence (possessed competence ≧ required competence)". The criterion of efficient utilization of human resource is "whether all personnel whose possessed competence meet required competence is selected as allocable or not". Applying these criteria show that the personnel allocation patterns derived by applying the model were better than the one derived without.

Table 6. Comparison of Model Application Results and Usual Allocation Method

Unit Process	Situation (Shift/ Busyness)	Personnel in the Group to be Evaluated										
		A	B	C	D	F	F	G	H	I	J	K
Blood Sample Taking	Day Shift	=	△	△	△	△	△	△	=	=		
Pre-measurement Treatment	Day Shift/ Normal	■	■	■	■	■	■	=	■	■	■■	■■
	Day Shift/ Rush	=	=	=	=	=	=	=	=	=	=	=
	Night Shift	=	=	=	=	=	=	△	=	=		
Measurement of Specimens	Day Shift	△△△	△△	△△△	△△	-	-	-	△△△	△△△		
	Night Shift	△	△	△	△	-	-	-	△	△		

Meaning of Symbols	
=	Two results are same
△	Application Result: Allocation with condition ("Cond" in the Table5) Non-application Result: Allocation without conditions ("O" in the Table5)
△△	Application Result: Allocation with condition 2("Cn" in the Table5) Non-application Result: Allocation without conditions ("O" in the Table5)
△△△	Application Result: Allocation with condition ("Cond" in the Table5) Non-application Result: Non Allocation (No symbol in the Table5)
■	Application Result: Allocation without condition("O" in the Table5) Non-application Result: Non Allocation (No symbol in the Table5)
■■	Application Result: Having possibility of allocation ("◎" in the Table5) Non-application Result: Having success of allocation ("●" in the Table5)
	Out of allocation scope

5. DISCUSSION

5.1. Verification Results

Personnel for whom the patters of allocation differed had been evaluated as possessing level 2 competence in our model. This indicates that identifying and utilizing level 2 personnel via current methods is usually problematic, and that applying our model provides an effective solution to these problems in terms of quality assurance and efficient utilization of human resources.

5.2. Reproducibility of the Model

Our model was designed to produce identical results regardless of who is using it. For this reason, all phases 1 and 2 are provided as detailed step by step methods. Phase 3 in particular is based on a logic flow automatically deriving allocation patters from the inputs of Phase 1 and 2, ensuring the accurate of the allocation pattern. In other words, once the results of phases 1 and 2 are validated, valid personnel allocation patterns can be derived reproducibly.

5.3. Future Tasks

In order to obtain more precise and reproducible personnel allocation patterns, steps 1-2 (Describe Work Process) and 2-2 (Derive Four-Leveled Scale for Evaluating Competence) can be refined by developing a knowledge base of hospital work process and evaluation criteria. Such a knowledge base will contribute to assure the accuracy of the outputs of these key steps.

References

[1] Iida, S., Iizuka, Y., Munechika, M. (2005), A Term Encyclopedia for Quality of Healthcare (Japanese), Japanese Standards Association.

[2] Uehara, Kuroda, Iizuka, Munechika, Oyaizu, (2003), A Quality Management System for Healthcare; (Japanese), Japanese Standards Association.

[3] Ryoko Shimono, Shogo Kato, Satoko Tsuru, Yoshinori Iizuka: Proposal of Hospital Operational Process Description Model, *Proc.8th ANQ Congress, New Delhi*, CD-ROM, 2010.