

## Human Resource Assignment and Role Representation Mechanism with the “Cascading Staff-Group Authoring” and “Relation/Situation” Model

Yasuyuki Hirose<sup>a</sup>, Yoshiyuki Sasaki<sup>b</sup>, Atsuhiro Kinoshita<sup>b</sup>

<sup>a</sup> Department of Medical Informatics, University of the Ryukyus Medical Hospital

<sup>b</sup> Section of Dental Informatics, Tokyo Medical and Dental University Dental Hospital

### Abstract

*We have previously reported the access control mechanism and audit strategy of the “patient-doctor relation and clinical situation at the point-of-care” model with multi-axial access control matrix (ACM). This mechanism overcomes the deficit of ACM in the aspect of data accessibility but does not resolve the representation of the staff’s affiliate and/or plural membership in the complex real world.*

*Care groups inside a department or inter-department clinical team plays significant clinical role but also spend great amount of time and money in the hospital. Therefore the impact of human resource assignment and cost of such stakeholders to the hospital management is huge, so that they should be accurately treated in the hospital information system. However multi-axial ACM has problems with the representation of staff groups due to static parameters such as department/license because staffs belong to a group rather temporarily and/or a medical staff may belong to plural groups.*

*As a solution, we have designed and implemented “cascading staff-group authoring” method with “relation and situation” model and multi-axial ACM. In this mechanism, (i) a system administrator certifies “group chief certifying person” according to the request and authorization by the department director, (ii) the “group chief certifying person” certifies “group chief(s)”, (iii) the “group chief” recruits its members from the medical staffs, and at the same time the “group chief” decides the profit distribution policy of this group. This will enable medical staff to access EMR according to the role he/she plays whether it is as a department staff or as a group member.*

*This solution has worked successfully over the past few years. It provides end-users with a flexible and time-to-time staff-group authoring environment using a simple human-interfaced tool without security breach and without system administration cost. In addition, profit and cost distribution is clarified among departments and inter-departments groups.*

### Keywords:

human resource management; hospital economics; costs and cost analysis; access control; medical record systems, computerized; hospital information systems; confidentiality; workflow control; system audit; software design.

### Introduction

In hospital information system (HIS), system account management and access control has ***three significant parts***: security and confidentiality, human resource management, and workflow control.

However the latter parts has been rather ignored until recently because in most HIS, the legacy rigid and tight access control method *could not even* provide healthcare practitioners with enough access right for flexibly pursuing treatment at the point-of-care while suppressing illegal access [1,2,3,5]. In addition, access control with ACM is too rigid to represent the staff’s role and affiliate/membership in the complex real world, so it may have been natural for a hospital to prioritize resolving of the former problem.

The former problem is caused by the security system representing neither the patient-doctor relation nor the clinical situation at the points of care in actual. To resolve this problem, the authors designed and implemented the innovative access control method based on the “relation and situation” model on a multi-axial ACM [7]. Simply said, our method holds user declaration of relation/situation as the access reason, then allows flexible data access as needed at the point-of-care. As the result, EMR system (EMRS) records 6W1H (who, when, where, why, whose, what, and how)[8] on each access, and has the ability of accurate audit without any maintenance cost.

Some parts of medical staff’s role are represented with the relation and situation model. And 6W1H information can also be utilized for the analysis of hospital management and economics. Therefore the preparation has been completed to proceed to the next step - representation of the staff’s affiliate and/or plural membership in the complex real world.

The solution should be as simple as possible, and be cost effective, without security breach. For this purpose, the authors have designed new human resource assignment and role representation mechanism: “cascading staff-group authoring” in addition to the “relation and situation” model and the multi-axial ACM.

## Methods

### Environment

In Tokyo Medical and Dental University Dental Hospital<sup>1</sup>, the EMRS has been installed and used for past decade, by the clinical staffs themselves directly operating the EMRS at the point-of-care. The EMRS is designed as the browsing platform for the whole data or information, and at the same time, as the operational platform for all order/entry procedures in the integrated HIS.

This HIS has some subsystems and the computer network of the HIS is air-gapped from the campus network or from the Internet. The authentication mechanism is fundamentally homogeneous, and access has been already controlled with “relation and situation” model on the multi-axial ACM. The PC terminal application has an automatic timeout-logout function.

Hardware specifications and numbers of hosts are as follows: Three servers consist of dual Ultra SPARC 167MHz, 128MB memory, 37.8GB HDD, and the platform is U-MUMPS ver.2.3.0. We use one of them as a mirror server for backup. About three hundreds PC terminals consist of Pentium 150-200MHz, 48-64MB memory, 1.2-4.8GB HDD, and the platform is WindowsNT4.0.

Under these conditions, the new mechanism has been applied to the inner access of the hospital, targeting medical staffs at the point-of-care.

### Strategy

The followings are decided:

- Represent medical staff's role in the combination of plural methods and each method should be simple and cost effective.
- Utilize multi-axial ACM for basic information on human resource and access limitation.
- Satisfy time-to-time needs at the point-of-care.
- Avoid direct utilization of multi-axial ACM because of system administration cost.
- Avoid breaking down of axis that causes complexity and combination explosion with inter-department group representation.

- Utilize the “relation and situation” model and ensure adequate and cost-minimum access control for security and confidentiality.
- Clarify the distribution policy of the profit from medical services among the members in a group. This includes the distribution of the cost of drugs/materials.

Consequently we have developed a new human resource assignment and access control mechanism to complement the previous developed methods.

### Design

#### Cascading Authoring Model

Application module and data structure is designed based on “three tier cascading staff-group authoring” model as shown in Figure 1. A system administrator certifies a “group chief certifying person” in the department according to the request and authorization by department directors or hospital director. Then the “group chief certifying person” certifies “group chief(s)”. Finally a “group chief” recruits its members from medical staffs inside the department or from other departments. The “group chief” also decides the profit distribution policy of the group at the same time.

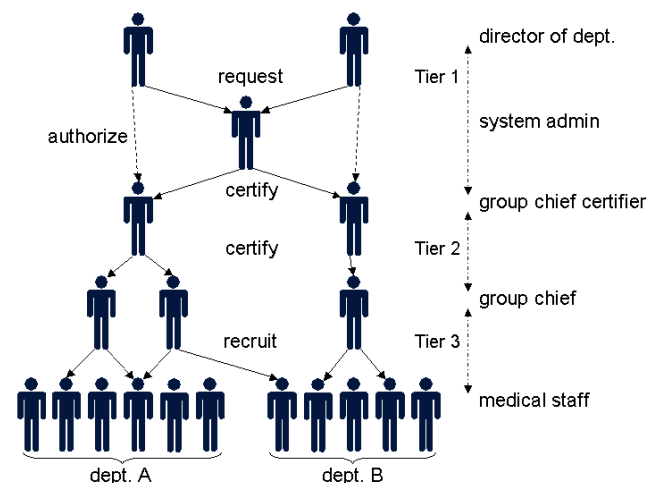


Figure 1 – Cascading authoring model

#### Module Behavior during Login Sequence

Many system modules interact or invoke/invoked and many access parameters are recorded in log/journals during the login sequence into the EMR platform as shown in Figure 2.

After logging on to HIS, medical staff should clarify his/her position of this access, i.e., his/her own position as a staff of his/her department, or member position of a certain group of a different department. In this step, the system module utilizes the information retrieved from multi-axial ACM and staff group database.

<sup>1</sup> average of outpatients : 1600-1750 a day, beds in a ward : 60, clinical department/service : 24, total hospital staffs : 1200. This hospital was the previous work place of the first author.

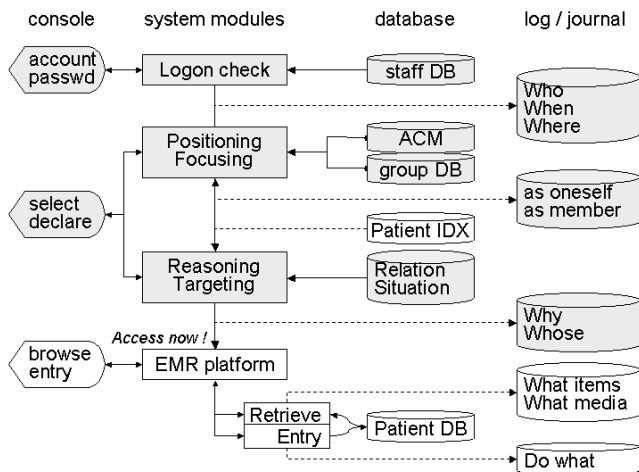


Figure 2 – Module behavior during login sequence

According to the selected position, the system module focuses on concerned patients. Next, the medical staff should declare the access reason based on the “relation and situation” model, for example, in charge of pre-examination, in charge, on night coverage, in an emergency, etc. [7]. This operation may reflect the list of concerned patients. Finally he/she can open a certain patient’s EMR.

Those login modules will pass necessary parameters to the EMR platform module for controlling accessibility to some functions or tools inside the EMR platform. The modules also record some of 6W1H into access log files for audit. Other 6W1H are recorded by EMR platform module partly into access log file, and partly into medical history file (MHF) that contains whole order entry history.

## Results

### Easy Access

End users can easily identify his/her position for each access out from the selection shown in the combo boxes and declare access reason from the list box on upper left area in the “login and patient selecting window” as shown in Figure 3.

This window also has focusing buttons on the top of the window which lists up proposed patients, *i.e.*, proposed index of EMR, according to the given information about group/department and the access reason. For example, today’s appointment list can be shown by sorting out only the patients of the user, whole patients of his/her department, or of a certain group selected.

### Plasticity of Assignment

Usually the vice director or the assistant manager of a department is appointed to “group chief certifying person” because he/she is knowledgeable of the department human resource status and can directly manage them (Tier 2 in the cascade; See Figure 1). “Group chief(s)” recruit necessary staffs following the department directions. With this

workflow, the staff-group authoring becomes available at the point-of-care without any latency.

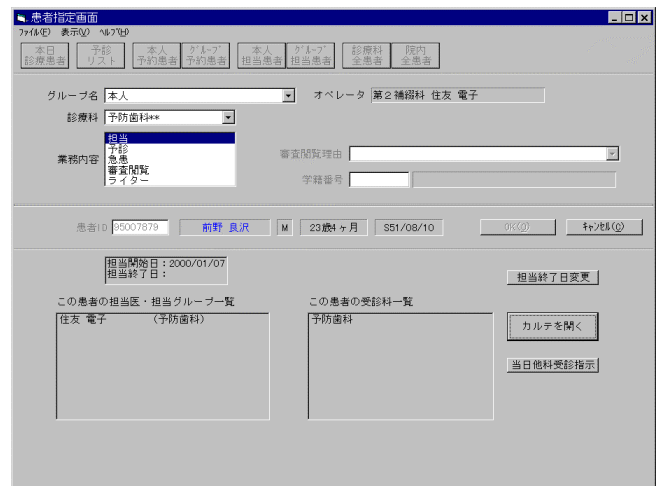


Figure 3 – Login and patient selecting window

### No Security Breach

Before the implementation of the “cascading staff-group authoring” mechanism, improper use of account has rather prevailed. Typical case is the substitute entry for the director/professor of a department performed by residents; needless to say, all of them know account and password of their boss. Such a scene has extremely diminished today because a ‘professor group’ can now be created inside a department and the residents can login by their own account/password. In this case, profit distribution policy may be set full to the professor and none to residents.

And more, the declaration of the access reason is recorded in the EMRS. For example, access log described as “Dr X accessed the ‘infection information window’ of Patient Foo for the Role of ‘night coverage’ as Position ‘respiratory infection disease care team’ during 23:30-23:45 at Terminal 99”. Therefore both the mutual watch function and the audit ability are maintained [7].

## Discussion

### Three Tier Cascading Model

The cascading authoring model premises that system administrator entrust some of end-users with a part of account and access control management. Therefore, the authorization and its confirmation by directors of departments are essential, but this kind of procedure is usually time consuming. It is preferable that such a procedure is single or very rare if possible.

On the other hand, medical staffs are too busy and situation changes are too fast to wait for ‘oracle’ certification at the point-of-care. Both “group chief certifying person” and “group chief(s)” claim immediate restructuring of group(s).

The two tier cascading model does not have enough capability to deal with these realities because it does not

have ‘buffer zone’, this means that ‘time consuming procedure’ directly influences on ‘group restructuring operations’. Therefore only the three tier cascading model can fulfill the requirements from both sides. (See Figure 1)

### Group Representation

Staff-group representation inside the HIS is not independent on department axis of ACM *in nominal*. The reason is because staff-group has the same department attribute as “group chief” for convenience of search operation. *In actual*, group representation space is independent of ACM space, therefore plural membership and profit/cost distribution can be processed inter-departmentally.

This implementation tactics may seem not to be normative or beautiful in design, and you may think that the representation in multi-axial ACM is better. However, such an approach falls into a pitfall. When new parameter axis is added on an axis of ACM, huge system administration works immediately occurs because ACM essentially has data item axis and the number of data item is over thousands. If ACM has multi-axis, parameter combination would easily explode [1,5]. Therefore Group representation on multi-axis ACM is not feasible.

### Hospital Management

#### Profit/Cost Distribution and Clinical Outcome

Chief executive officer of a hospital has responsibility to maintain sound profit/cost balance. For this purpose, profit/cost analysis of whole hospital as well as department/group should be performed based on precise cost/profit distribution among departments/groups. At the same time, hospital director and directors of departments should analyze medical service performance as clinical outcome in order to maintain the quality of services. Our method provides enough information for these analyses.

#### Human Resource Assignment

Human resource cost occupies large portion in hospital budget, therefore human resources should be assigned effectively and efficiently. To achieve this goal, precise information of human resource ‘recruitment’ and staff’s time consumption information is essential as well as profit/cost balance and clinical outcome. Our method can also provide some information for this type of analysis.

### Role Representation

The role of a certain person in a certain circumstance is determined by various factors in the real world.

When implementation of those factors within a system, they should be classified by scale of *firmness*: Firmness of a factor is determined by lifecycle and dominance of authority. (N.B. lifecycle is judged from system administration view)

1. Lifecycle is long and Authorities endorse its validity. However the effectiveness may be modified according to the occasion: *exp.* license, department

2. Lifecycle is intermediate and its duration is given. Rather dominating party gives certification: *exp.* group chief certifier, group chief
3. Lifecycle is short such as access. Declaration of the reason is required to compensate for no explicit certification: *exp.* in charge, night coverage

According to this classification, our role representation method consists of three portions. Each corresponds to multi-axial ACM, a group representation space, and the “relation and situation” model respectively. In other words, the combination of those three portions is able to cover almost factors for precise role representation of a certain person in a certain situation in the hospital.

This kind of approach avoids complexity and combination explosion, and gives both implementation realistic and maintenance realistic.

### Workflow Control

This system environment has been prepared to provide enough role information to control workflow. But we cannot yet broadly utilize role information for workflow control in EMRS because the lack of clinical knowledge inside the system. Therefore our next step is to resolve this.

### Conclusion

In hospital information system, system account management and access control has three significant parts: security and confidentiality, human resource management, and workflow control. The authors have designed new human resource assignment and role representation mechanism; “cascading staff-group authoring” in addition to the “relation and situation” model and the multi-axial access control matrix.

It provides end-users with a flexible accessibility with adequate role and human resource assignment using a simple human-interfaced tool without security breach and without account maintenance cost increase. In addition, profit and cost distribution is clarified among departments, inter-departments groups, and staff. This system environment contributes to hospital management in the aspects of human resource assignment, cost/profit balance analysis, and risk management of confidentiality.

### Acknowledgments

The authors are grateful for the comments and suggestion provided by Dr.Atsushi Takeda, and Dr.Shunsuke Minakuchi (Tokyo Medical and Dental University). We thank Mr.Akira A Fujie, Mr.Hideo P Togashi (Sumitomo Electronic Systems Co., Limited) and Mr.Shigeru Bito (Seafic Software Corp.) for sincere efforts in system coding and implementation. Finally, the primary author thanks Ms.Ruby Tanaka for the thoughtful supports in bringing the manuscript to publication.

## References

- [1] Bakker AR. Security in Medical Information Systems. In: van Bommel JH, McCary AT eds. *IMIA Yearbook of Medical Informatics*. Stuttgart: Schattauer, 1993: 52 - 60.
- [2] Henkind SJ, Orlowski JM, Skarulis PC. Application of a Multilevel Access Model in the Development of a Security Infrastructure for a Clinical Information System. *Proc 17<sup>th</sup> Sym Comp App Med Care* 1993: 64 - 68.
- [3] Brannigan JD. A Framework for "need to know" Authorizations in Medical Computer Systems. *Proc 18<sup>th</sup> Sym Comp App Med Care* 1994: 392 - 396.
- [4] Safran C, Rind D, Citroen M, Bakker AR, Slack WV, Bleich HL. Protection of confidentiality in the computer-based patient record. *MD Comput* 1995: 12 (3): 187 - 192.
- [5] Barrows R Jr., Clayton PD. Privacy, confidentiality, and electronic medical records. *J Am Med Inform Assoc* 1996: 3 (2) : 139 - 148.
- [6] Cushman R. Serious Technology Assessment for Health Care Information Technology. *J Am Med Inform Assoc* 1997: 4 (4) : 259 - 265.
- [7] Hirose Y. Access Control and System Audit Based on "Patient-Doctor Relation and Clinical Situation" Model. *MEDINFO '98* 1998: 2: 1151-1155.
- [8] CEN/TC251. *prENV 13606-3. N99-042*. 1999-05-28.

### Address for correspondence

Uehara 207, Nishihara, Nakagami, Okinawa 903-0215, JAPAN

Email: [hirose@hosp.u-ryukyu.ac.jp](mailto:hirose@hosp.u-ryukyu.ac.jp)

URL: <http://www.hosp.u-ryukyu.ac.jp/medi/>