Behavioral Sensor-Based Organizational Design and Management in Japan: From the Perspectives of Communication Channel in Nursing Organization

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The goal of our study is to design organizational interventions aimed at enhancing individual and group performance by applying statistical analysis and simulation techniques to behavioral sensor data combined with other sources of information such as interview surveys and performance data. Therefore, to complete one of our researches, we have introduced a sensor-based approach developed by media laboratory, Massachusetts Institute of Technology, to study the relationship between social signaling behavior, interpersonal communication patterns and social network characteristics, with organizational performance metrics such as task efficiency, productivity and job satisfaction. We have deployed an experimental research platform under naturalistic settings and we are now validating our approach with university hospital especially in nursing organization.

Our approach of this study is based upon the following basic proposition from the view point of interpersonal influence: social signaling behavior and interpersonal interaction networks can be automatically captured using electronic sensors.

In this study, we will present the results from one case study where we have instrumented several participants with electronic badges capable of measuring social signals (i.e., verbal cues extracted from speech and body movement), interpersonal interaction and physical proximity. This case study is very significant in nature due to the difficulty in obtaining access to organizational performance data and digital communication records, as well as the complexity involved in deploying an experimental research platform under naturalistic settings in real organizations.

As the results, a total number of participants was 34 (male=16, female=18). Response rate was 100 percent. Since we accepted a withdrawal of consent from one nurse, this study analyzed 33 (male=16, female=17) valid data. A total number of administrative nurses was 6 (male=2, female=4). We have clarified the differences in the role of task and job in nursing. Particularly, administrative nurses have great influence to stakeholders including staff nurses. Above all, the importance of communication in and around top management and middle management nurses was suggested, at the same time as existence and the role of the senior nursing officers were important in nursing organization.

Keywords: social signaling behavior, electronic badges, interpersonal interaction networks, communication channel, nursing organization

1. Introductions

Along with the advancement of the medical technology, the nursing work in hospital has been complex and developed more and more recently. At the nursing station, several nurses are filling up patient record forms, talking on the telephone of an extension and the outside line, or discussing the coordination of dairy schedules. Definitely, great effort is expended by the hospital to ensure that the patient record forms adequate and accurate information. In this way, communication activity has been implemented in many
sciences in hospital and no individual, group, or organization can exist without communication (Robbins & Judge, 2012). This is similar in the world of sports team and the professional athlete (Mizuno et al., 2009; Mizuno et al. 2012).

However, we hardly argue about how structure can restrict communication flows, leading to problems of distortion and omission, and how solutions to these difficulties can in turn lead to information overload (Rogers & Rogers, 1976). In any exhaustive theory of organization, communication would occupy a central place (Barnard, 1938). From the point of view, it is significant to develop the communication study in the hospital especially in nursing organization.

In this study, electronic badges (wearable sensing devices) developed by MIT and applied by Hitachi High-Technologies Corporation in Japan were used for measuring the communication time at nursing organizations, including formal and informal scenes (e.g. nursing station, locker rooms and dining rooms) during working hours as the communication channels and social signalling behavior in university hospital.

2. Purpose
The purpose of this study is to clarify the communication channel and social signaling behavior in nursing organization of university hospital from the perspective of interpersonal influence, with electronic sensors.

3. Methods
3.1 Participants
This research was carried out in one unit of the psychiatric ward consisted of 33 nurses. In addition to these nurses, we recruited the senior nursing officer of the university hospital. Through the informed consent procedure, a total of 33 nurses (male = 16, female = 17) agreed and two nurses disagreed with this study (response rate = 94.1%, cover rate = 94.1%). Thirty-three participants consisted of five administrative nurses including one senior nursing officer, two nursing divisional managers and two nursing chief managers and twenty-eight staff nurses. Moreover, they were full time workers. The mean age was 35.6 (SD=±7.2) yrs. old and mean seniority in current hospital was 6.9 (SD=±5.0) yrs.

3.2 Measures (Procedure)
In this study, electronic badges (wearable sensing devices) developed by MIT and applied by Hitachi High-Technologies Corporation in Japan were used for measuring the communication channels and social signalling behavior of nursing organization in university hospital. In detail, electronic badges capable of detecting face to face interactions, conversations, body movement, physical proximity were introduced in order to measure the organizational communication. Participants put on electronic badges (wearable sensing devices) for measuring the communication time at nursing organizations, including formal and informal scenes (e.g. nursing station, locker rooms and dining rooms) during working hours as the communication channels and social signalling behavior in university hospital. In this study, we analyzed human relations and human networks among nurses from the frequency of communication by calculating total time (minutes) for communication.

4 Results
As the results, a total number of participants was 33 (male=16, female=17). Response rate was 94.1% (cover rate = 94.1%). Since we accepted a withdrawal of consent from one nurse, this study analyzed 33 (male=16, female=17) valid data. A total number of administrative nurses was 6 (male=2, female=4). We have clarified the differences the role of task and job in nursing. Particularly, administrative nurses have great influence to stakeholders including staff nurses. Above all, the importance of communication in and around top management and middle management nurses was suggested, at the same time as existence and the role of the senior nursing officer were important in nursing organization. Moreover, in the psychiatry, it became clear that male nurses had strong influence toward both administrative and staff nurses.
4.1 Results (1): Network channel by communication time per day

The total amount time (minutes) at which the nurses of university hospital spent as face to face communication was calculated at 30 minutes, 90 minutes and 180 minutes interval units per day (Figure 1.2.3.). Communication networks have been getting tight more and more individually, according to time axes from 30 minutes, 90 minutes to 180 minutes. In addition, with progress of the time, interpersonal connection became clearer. As time goes by, a communication network became clarified. Besides, the key person in nursing organization became clear at the time unit at of 180 minutes the most. Especially, it became clear that four people of 17-year male nursing divisional manager (MM(17)), 7-year female nursing chief manager (FC(7)), 12-year male nurse(M(12)), and 10-year male nurse (M(10)) were the key persons of this nursing organization (Figure 3). By the way, the nurses who excluded from these communication networks were due to the lack of the considerable time.

4.2 Results (2): Network channel by the amount time of communication for 2 weeks

Similarly, the total amount time (minutes) at which the nurses spent as face to face communication was calculated at 180 minutes, 480 minutes and 1000 minutes interval units for 2 weeks (Figure 4.5.6.). However, the key persons of communication network were slightly different from the upper figures. In other words, with progress of the time, it was similar that communication becomes tight, but there was communication activity a certain degree among administrative nurses, and on the other hand, communication with the staff increases. Furthermore, the isolating networks, in whole communication channels, exist a few.

![Communication network graph](image-url)

Figure 1. Communication time > 30 min/1day
Figure 2. Communication time > 90 min/1day

Figure 3. Communication time > 180 min/1day
Figure 4. Communication time > 180 min/2weeks

Figure 5. Communication time > 480 min/2weeks
5. Discussions

From the results above, we have predicted and clarified the differences of role and job in nursing by an experiment to measure communication time both per a day and 2 weeks. Particularly, it is confirmed that administrative nurses have great influence to stakeholders including staff nurses in both aspects. Above all, the importance of communication in and around top management and middle management nurses was demonstrated to some extent at the same time as existence. And the role of the senior nursing officer plays an important role in nursing organization.

In addition, one of the remarkable suggestions is that the mentioned-above is effective for administrative nurses in personnel evaluation and job rotation. However, the problem may happen when performance rating reflect a performance evaluation directly. Therefore, it is thought that it must be reflected as basic materials and information for education training of staff nurses. In any case, our approach of this study is only based upon the view point of interpersonal influence with electronic sensors. Therefore, although not still being proved certainly by the evidence of this study, it is expected that administrative nurses (including nursing divisional managers and nursing chief managers) would be valuable and important existence for the vitalization of organization, especially in the perspective of communication channels and networks.
6. Conclusions (The limitation and further assignments)

As the combined results, this study provided at least the following two conclusions: 1) Communication networks have been getting tight more and more individually, according to time axes from 30 minutes, 90 minutes to 180 minutes. In addition, with progress of the time, interpersonal connection became clearer. 2) It was clarified that male nurses had strong influence toward both administrative and staff nurses in the psychiatry.

The limitation and further assignments of this study are as follows: Firstly, it is necessary to consider whether social signaling behavior is correlated with a variety of organizationally relevant outcomes such as performance and job satisfaction by applying statistical analysis and simulation techniques to behavioral sensor data combined with other sources of information such as interview surveys and performance data. Secondly, it is significant to clarify that the interpersonal interaction network characteristics are predictive of individual and group performance. In this viewpoint, it is necessary to push forward this study in consideration of the data obtained from acceleration sensor and gravimeter. Finally, the research of this study was carried out in one unit of the psychiatric ward. In the future, it will be necessary to investigate more wards as control group.

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