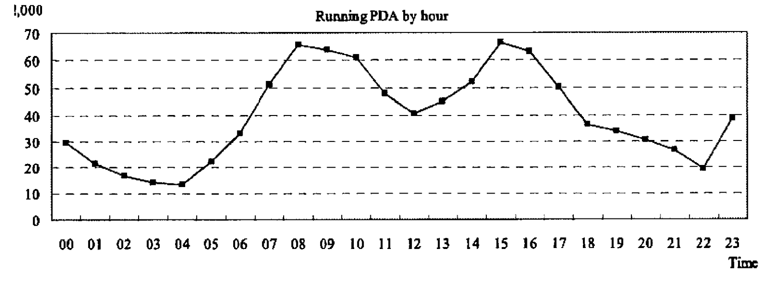
Figure 3 shows number of running PDA by hour. In Japanese Red Cross Hospital, Patients to nurse ratio during day time twice as high as during night time. The data implys actual working people at the time.

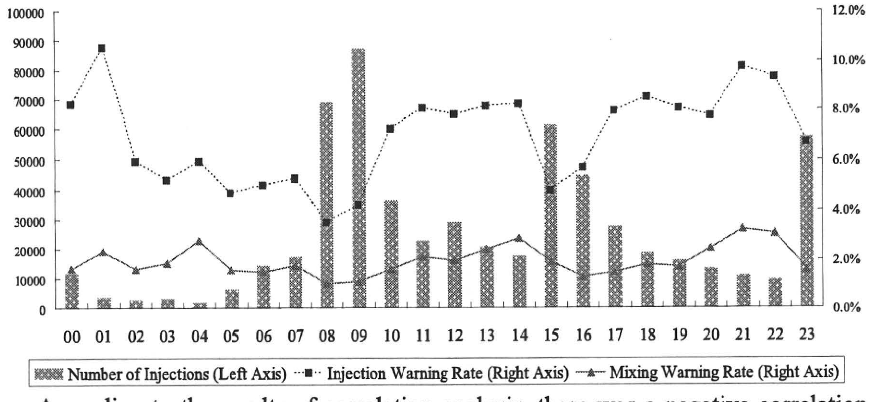
Figure 3. Number of running PDA by hour



3-2. Data Analysis

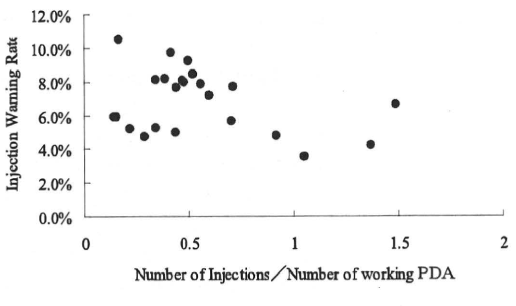
Figure 4 shows trend of warning rate and activities by hour. Bar graph shows number of injection by hour. There was variability in number of injections by hour. There are three points that nurses administrate injections in volume. Those were 9AM, 3PM and 11PM. Two line graphs show injection warning rates and mixing warning rates by hour. Mixing warning means drugs for injection are not mixed correctly. Minimum and maximum of the injection warning rates were 4.2% and 10.5%. Minimum and maximum of mixing warning rates were 1.0% and 3.2%. This graph shows the warning rate was relatively lower when nurses administrated many injections. In this hospital, there are three working shifts for nurses. These are Day shift (8:00-16:40), Evening Shift (16:00-0:40) and Night shift (0:00-8:40). The warning rates for each shift were 5.5% (Day shift), 7.3% (Evening shift) and 6.0% (Night shift). The tendency of injection warnings and mixing warnings have somewhere same tendency. Especially during day shift, this tendency was demonstrated quite clearly.

Figure 4. Number of Injections and Warning rate by hour



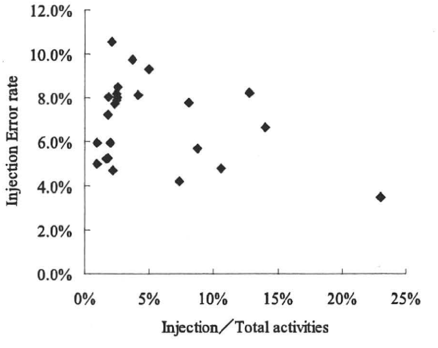
According to the results of correlation analysis, there was a negative correlation between number of injections and injection warning rates. The correlation coefficients between number of injections and injection warning rates was -0.48 ($p<0.05$) and between number of injections per PDA and injection warning rates was -0.34 ($p<0.05$) (Figure. 5). Both results are significant and implied negative relationships between error rate and business.

Figure 5. Scatter plot on Number of Injections and Warning rate by hour



Variation of activities had negative effects to warning rate. Figure 6 is scatter plot to show relationship between fraction of injections among total activities and injection warning rates. We chose proportion of injections among total number of activates at the time as an indicator for variation activities. In our assumption, nurse concentrating on administering injections tend to operate more safely. This figure implies negative correlation between the two indicators. The correlation coefficient between fraction of treatments among total activities and injection warning rates was 0.35 ($p<0.05$). High fraction of treatment means nurses should administrate injections with other kinds of treatments for patients and discourage nurses against concentrating on injections.

Figure 6. Scatter plot on proportion of injections among total number of activities adn Injection error rate



4 Discussion

In the literatures on patient safety, many studies had mentioned workloads and busyness are the principal cause of medical errors [7.8]. It was acceptable for workers that rushing and fatigue would cause lack of attentions to medications. However, this study demonstrated opposite tendency of medical errors. This study implied that people would make mistakes because of not doing too many things but too many kinds of things. Literatures on human factor engineering indicated same kinds of conclusions to ensure quality of activities [9.10].

Warning rates in this study was relatively high compare to other literatures on administration errors of injections [1-3, 7, 8]. This difference came from accuracy of data and detections of mixing errors. In this study, data was collected through routinely work by hospital information system. People tend to be careful when they are observed by other. Therefore, we indicate that the data captured by PDA is more bias free data compared to conservative data. And other study also could not detect wrong bottle errors caused by mixing error, because forgetting mixing drugs sometimes difficult to be found by human eyes. Single item management of drugs with serialized ID is essential for preventing and finding mixing errors [5]. Distinction of bottles and other drugs with single item level is an only method to distinguish mixed and unmixed bottle systematically.

It is possible to accumulate the data by wards and nurses to realize risky place and working style. In this study, we tried to investigate relationship between number of injections and injection warning rate by each ward. This analysis doesn't show clear relationship between two indicators, because each ward provides health care service to different patients. When we focus on the difference of error rate by ward, we need to consider some risk adjustment method to compare fairly. This policy can be applied in comparing results among multi hospitals. Accumulating by nurses submitted new issues on privacy of workers. The system anonymized data of each nurse and their attribution, but researchers could sometimes identify nurse through patterns of work and other aspects. Researcher should be cautious to publish results.

Beside, the other issue is weighting of each activity. We treated injections and other activities as same workload activities, though actually there are quantitative and qualitative differences among activities. It is necessary to decide weighs of each activity to analyze more deeply and accurately with time study or other research methods.

5 Conclusion

This study showed general tendency of possible medical errors in practice with data captured in real time and accurately. The result suggested that high variation of activities might have negative effects for patient safety, though busyness is not one of the main causes of errors. Our study also demonstrated the effectiveness of bar code administration system. According to the result, injection warning rate was about 6% and these warning had been prevented nurses against errors and accidents with the system. In conclusion, bar code administration system is quite effective way not only to prevent medical error at point of care but also improve patient safety with analyses of data captured by them.

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Capturing and Analyzing Injection Processes with Point of Act System for improving quality and productivity of health service administration

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Abstract. The objective of this paper is to show process data captured with barcode administration system and the results of data analyses and visualizations for improving quality of care and productivity. Hospital Information System named Point-of-Act System that was designed to capture every process of all medical acts was employed to capture data of medical processes. Data of injection process was analyzed based on operative timeliness. The result shows nursing workload didn't be allocated equally through the day and some parts of injections hadn't been administrated at the right time. Improving operative timeliness can contribute to improve quality of care and productivity. This kind of process information has a possibility to provide new research opportunity to analyze outcome with context information including process information.

Keywords: Hospital Information System, Process Management, Electrical Data Capturing, Data Analysis, Visualization

1 Introduction

Utilizing data captured and stored by hospital information systems is quite important issue to make hospital IT systems more effective for improving health care quality and productivity. After the report of medication errors and health care quality by Institute of Medicine, these data have been regarded as significant sources for managing hospital environments [1-2]. The data can be constructed as indicators evaluating health care process and outcome. The movements such as "e-indicators" have been trying to analyze and publish these data for the purpose of health outcome management with bench marking and public disclosure [3-11]. Outcome information has a possibility to affect patient's decision and make health care system more patients centered. In addition to this outcome information, process information is also important to understand reality of health care service provision. Process indicators provide context of outcome indicators and show practices to improve quality and productivity [12-15].

Data captured through daily use of hospital information systems are containing data of medication processes. Utilizing process data for understanding daily medication process is an useful way to plan resource allocation in hospitals to improve operation and management of service delivery. Process information has an ability to provide why differences of outcome are coming from. And this activities capturing process information and managing medical process also have a possibility to make health care industry more transparent and accountable through publishing the information. Transparency is one of the prioritized areas to be solved to construct better health care systems [16-18].

The objective of this paper is to show process data captured with barcode administration system and the results of analyses and visualizations for achieving the targets described above. This study will emphasize benefits of hospital information system named Point of Act System based on process management and real time data capturing and capturing every activity in the hospitals. In this study, we focus injections and utilize injection process data to analyze medical activities and visualize process in the hospital.

2 Methods

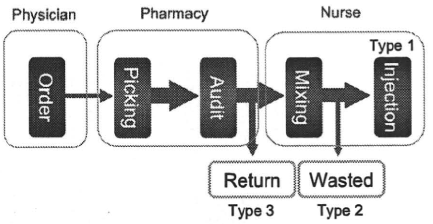
2-1. Things that need to be addressed

Point of Act System (POAS) is a real time bar-code capturing health information system in International Medical Center of Japan (IMCJ) in Tokyo, Japan [19-22]. POAS has a function to prevent medical errors by certifying correctness of medical activities with capturing bar cords on patients, worker and drugs. It ensure not only the correctness of patients, drug, dose but also route and time based on real time information. At the same time, POAS captures implementation records at each process of medical activities including 6W1H information (When, Where What, Why, for what, to whom and How) of the activities. The basic requirement for successful measurement and data capturing, they must be integrated with the routine provision of care and whenever possible should be done using IS and this system satisfied this requirement [6].

There are basic characteristics of POAS captured data. The data is including every activity in the hospital that means it concludes complete data of the administration. This implies the research based on not sampling data but all data of the medications. The second characteristic is process management of administration. The first target of process management is restraining skipping processes that would sometimes be causes of medication errors. The system record the data at each point of action of processes described by figure 1 showing injection process as an example.

By capturing the data routinely at each process of activities, the data provides information on returned and wasted injections as well as normal injections without entering additional information at end points.

Figure 1. Data capturing points of Injection processes



2-2. Data and Analysis Methods

Injection process was chose as a target of this study to analyze process data and visualize processes of medical activities. As a standard injection process physicians order for patients and pharmacists pick up and audit the order. These drugs deliver to nurse stations and nurses mix and inject them to patients. 6W1H information have been captured at each point of action; Order, Picking, Audit, Mixing and Injection. In addition to these data, data on order is including "scheduled order time" that shows the scheduled time to inject to patients. These data were liked by serialized ID on each drug and order. Data from July to September 2007 that is including 306768 drugs taken in all injections during the term at every ward in IMCJ was used to analyze. The data was merged from different partial information system such as physician order entry system, pharmacy system and risk management system. Data from other term was also referred if necessary. Basic descriptive analyses and some visualization techniques are applied for analyzing injection process. Especially we described frequency of injection processes minutes by minutes to analyze business of the hospital and time differences including scheduled time and actual administration time to assess time precision of the administration processes to scheduled plan.

3 Results

Figure 2 shows the distribution of scheduled injection order time by physicians. Enormous portion of orders were scheduled on 6AM, 10AM and 6PM. Figure 3 shows actual number of activities including mixing of drugs for injections and injections of drugs by minutes. As the peak of order by physicians was 6AM, the time of peak of actual injections is around 6AM. The orders scheduled 6AM were injected from around 4AM to 7AM, because the number of orders surpassed capacity of nurses at the time. Nurses adjusted to variation of number of orders by time by injecting earlier than scheduled time.

Figure 2. Distribution of scheduled time

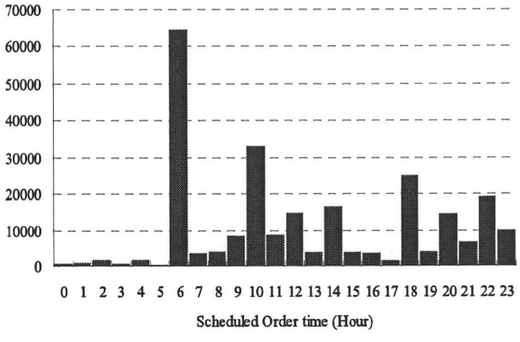


Figure 3. Distribution of scheduled time of injections

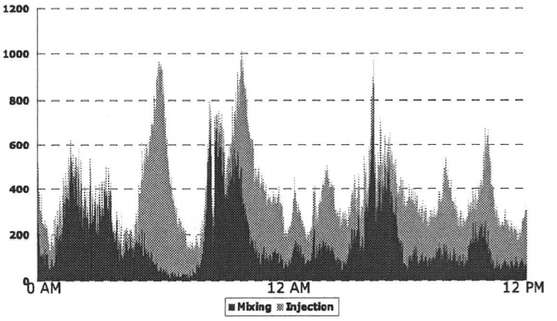
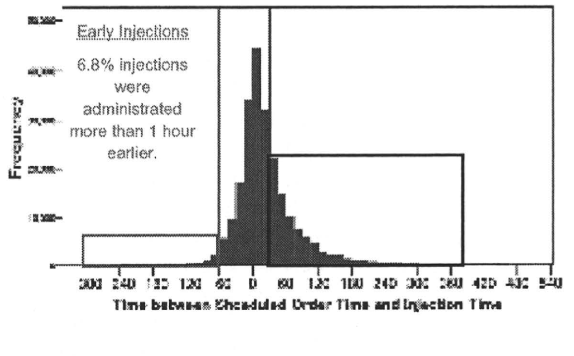


Figure 4. Distribution of difference between scheduled time and actual time of injections



As described above, nurses adjusted to high frequency of scheduled order by injecting earlier or later. Figure 4 shows Distribution of time difference between scheduled order time and injection time. Time between scheduled order time and injection were calculated by the formula and a minute unit.

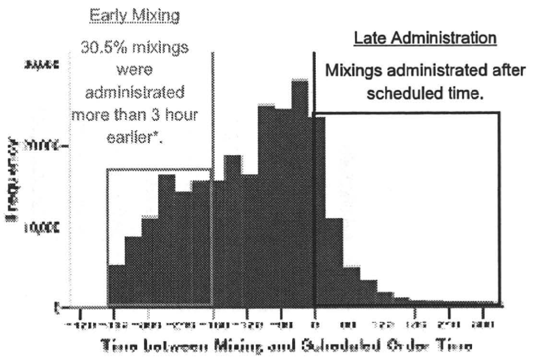
(Time between scheduled order time and injection) = (Scheduled Order Time) – (Injection Time)

Positive numbers shows early administration of injections, negative number shows lately administration of injections and 0 means right on time. It might be regarded as positive to close to 0 from the point of view of right time administration. Mean of the time is 10.63 minutes. The most frequent category is from 0 to -15 and the second most frequent category is from 15 to 0. Most of injections are around 0. 6.8 % of injections were regarded as early administration that was defined by one hour early administration[33].

Figure 5 shows time between mixing and scheduled order time. Time between mixing and scheduled order time was calculated by the formula and a minute unit.

(Time between mixing and scheduled order time)= (Mixing time) – (Scheduled Order time)

Figure 5. Distribution of difference between drug mixings and injections



For example, 180 minutes means mixing before 3 hour. Mean of the time is 108.5 minutes. The highest frequency is from 0 to 30 minutes. According the guideline for safe medication in the hospital, drug mixing shouldn't be implemented 3 hours before injection. However, 30.5 % of injections were regarded as early mixing and this information hadn't informed by the nurses.

4 Discussion

We captured data by POAS that was designed by the concept of process analysis and management. This concept provided the system a structure to capture the data. According to the survey of system use, the system covered more than 99.9% mixing drugs and injections. Process management prohibits workers from skipping each activity on the process and that contribute to ensure the correctness of medical activities through the process.

Secondly these process data suggests the importance of process indicator related to outcome indicators. Outcome data and process indicator have been used as measurement indicators of performance. The advantage of outcome indicators is that it explain the achievements of targets itself. Outcome measurement will reflect all aspect of the processes of care and not simply those that are measurable or not [24-28]. However, as Mant said, difference in outcome might sometimes be due to case mix, how the data were collected, chance, quality of care or other factors such as nutrition, life style. Outcome indicators can be improved if efforts are made to standardize data collection and case mix adjustment systems are developed and validated [7]. Process data can be redeeming indicators to understand meanings of outcome indicators. Process data is providing context information to understand the setting for the case [29-36].

This is the example of research linking process data to some outcome indicators. In this example, we set wasted rate of drugs. If physicians change their order after nurse's mixing drugs, these drugs must be wasted. It is of course necessary to inject right drugs based on up data decisions of physicians, but drug wasting would cause inefficacy of hospital management.

Figure 6. Time difference between drug mixings and injections and drug wasted rate

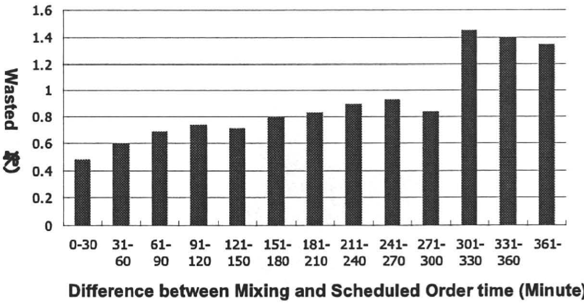
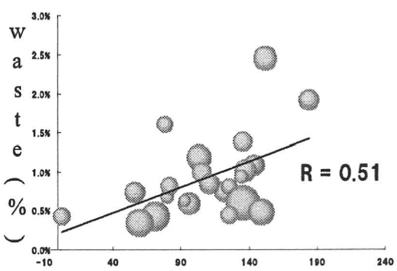


Figure 6 shows the result of analysis that beforehand mixings for laborsaving whose intervals are relatively longer have tend to be wasted by order changes. Analysis on data in unit of wards also shows wards whose intervals between mixing and injection are longer tend to waste more.

Just measuring drug wasted rate is not enough to analyze the cause of high drug wasted rate. By linking process information to outcome information and capturing process routinely, the data make us possible to investigate the reason of some outcomes.

Figure 7. Relationship between intervals and drug wasted rate



5 Conclusion

In this study, we show clearly that data captured by hospital information system provide us new research opportunities to improve quality of care and productivities. Many hospitals have been introducing hospital information system to improve operational efficiency. Secondly use of data captured by HIS hasn't become widely yet, though it has a possibility to improve quality and safety of care as well as productivity. The important thing to spread utilization of bust amount of data is providing evidences that secondly use of data can improve them.

Concern on performance measurement has been increasing rapidly and many organization including government and hospital associations and researches have been trying to set indictors for performance measurement [2]. As discussion of process and outcome indicators, both indicators have useful meanings for patients to chose hospitals and acquire healthcare information. This study will help to understand the benefits of process data and contribute to measure quality of care and improve hospital management on health care quality and safety.

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Analysis of data captured by barcode medication administration system using a PDA; aiming at reducing medication errors at point of care in Japanese Red Cross Kochi Hospital.

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Abstract

Preventing medication errors by using a barcode administration system has become prevalent in patient safety. Analyses of data captured by bar code systems provide opportunities to understand the actual situation at the point of care. Our study aims at understanding issues of medication safety as well as investigating measures taken to prevent medication accidents, by analyzing data captured by a bar code system and a personal digital assistant (PDA),. The barcode administration system named Point-of-Act-System implemented in Japanese Red Cross Kochi Hospital was designed to capture every activity at the bedside. Complete activity data captured by the system, which included injections, treatment and other nursing activity, as well as injection warning data, were used for our analyses. We describe the data and analyze them statistically to find potentially times of risk and to ascertain the relation between busyness and error. The injection warning rate as a whole was 6.1% on average. The results showed there was a negative correlation between the number of injections given and the injection warning rate (-0.48, p<0.05). The warning rate was low during the hours when a large number of injections were administered. The data also showed that a variation in activities being performed has a negative effect on medication safety. A bar code administration system is quite an effective way not only to prevent medication error at point of care, but also to improve patient safety through analyses of data captured by such a system.

***Keywords:* Point of Care System, Medication Errors, Administration and Organization, Handheld Computer, Patient Safety**

1. Introduction

It is widely believed that patient safety is an important issue for health care systems. Many organizations and hospitals have been accumulating information on patient safety and medication errors to improve patient safety based on the data collected. These data is accumulated to provide information on threats to patient safety. Such data are quite useful in understanding the threats and actual situations related to medication errors in hospitals. However, most of this evidence is basically information on medical accidents and incidents, compiled from voluntary reports submitted by medical workers. This information is not detailed enough to enable the discovery of underlying general principles, because accidents and errors are part of the reality in a hospital setting. A complete picture of the situation in hospitals, including details of medical accidents and incidents, is essential to identifying general causes and frequencies of medical errors. However, it is extremely costly to obtain by observational research sufficient data to enable an understanding of all the activities conducted in a hospital, and furthermore, the accuracy of data collected by observation is sometimes defective. Information technologies such as electronic medical records and barcode administration systems at the point of care have the potential to provide new opportunities for us to understand the overall picture of medical activities by digital capturing data on daily medications and patient care in hospital settings. By using information systems for all patients in all wards, data captured by the systems become useful resources to understanding various phenomena in medical situations and investigating research questions. In terms of medication accidents, the point of care is a potentially risky area in medical activities [1-3]. Therefore, data captured at the point of care is quite effective in understanding medication accidents. One potential candidate system for this is a barcode administration system for safe injections and medication. Barcode medication administration systems prevent medication errors by authenticating the "5 Rights" of medication: right patient, right drug, right dose, right time, right route. Performed at the bedside, the system offers an excellent opportunity to gather data on medications [4-7]. In addition to their contribution to the authentication of the 5 Rights, data captured by barcode administration systems have the potential to provide sources of research to improve patient safety in terms of actual injections and medication data.

Our study aims to use and analyze complete data on medical activities captured at the point of care by the system to understand all the activities and issues related to medical safety, and to investigate preventive measures for medical accidents to manage healthcare situations. We focused on injections, which a major cause of medical accidents, and investigated the relation between mistakes and the context of medical activities including how busy staffs were, and shift work.

2. Materials and Methods

2.1 Settings and items to be addressed

Japanese Red Cross Kochi Hospital has 482 registered beds and approximately 290,000 out-patients and 9,355 in-patients per year. The hospital implemented a hospital information system called "Point of Act System," or POAS, in 2004. POAS is a real time bar-code capturing health information system designed to prevent medication errors by capturing the barcodes of patients, workers and drugs, and then authenticating the 5 Rights of each medical action [10-12]. Figure 1 shows a Personal Digital Assistant (PDA) for barcode capturing, nursing work management, and risk management for injections and intravenous drips (IV). When nurses scan the barcodes of drugs or IV bags for patients, the system checks the correctness of the injections and IVs against real-time accurate information in a computerized order entry system and electronic health record within 2 seconds.

At the same time, POAS captures complete data on each medical action including 6W1H information (When, Where What, Why, for What, to Whom and How) conducted in the hospital. The units of data recorded by the system are: Who—the implementer (the person who initiated the order, or the person who carried it out), to Whom—the patient, How—medical activities and changes in them, What—materials used (pharmaceuticals, medical materials and others), How much—amount of materials used and number of applications, for What—name of patient receiving medical services, When—date the order was placed, implemented and discontinued and the activities that were implemented, and Where—place of implementation (department, hospital, ward, etc.). The principal characteristics of data captured by this system are (1) complete data at a specific place including every action recorded in real time and accurately and (2) process data-based process management that enables POAS to ensure the correct process of medication and assures it captures complete data. The collection of complete data including 6W1H information is an innovative source in understanding actual situations directly without estimation or bias, and enables the investigation of solutions to prevent errors.

2.2 Data

Data captured at the sites of the injection process were used for our analyses of medication administration. In this study, data on injections means both injections and IVs. 6W1H information was captured at each point of the injection process: Order to give injection, Drug selection, Drug audit, Drug mixing, and Injection. Although the first objective of a bar code administration system is to ensure patient safety by verifying the 5 Rights of medication, another objective is to record the activities of nurses to support nurses' request of drugs and devices consumed, and enforce medication for patients.

At the point of care, nurses uses PDAs to scan the barcodes of ampoules or vials containing the medication to be injected or scan the barcodes of activities to enter information on their actions such as treatment, care, observations, counseling and emergency. This information is primary used for the documentation of nursing activities. However, this information can also be used not only for hospital management—by understanding the workloads of nurses and the actual costs of administering medications—but also for patient safety by understanding the prevailing situations when mistakes are made. In addition to these data entered by nurses, we also used warning data demonstrating mistakes that can be made in scanning the barcodes on drug vials. Warning data do not directly mean data on medication errors, because the system prevents error by alerting staff before a mistake is made. However, warning data are useful sources of information in analyzing the causes of medication errors, because a warning means a potential medication error without a barcode administration system. Therefore, high warning rates at specific times, places, situations and workers mean risky times, places, situations and workers in terms of patient safety. Basic types of warning are basically: a wrong or expired vial scanned by a nurse for a patient; wrong patient; and mixing error meaning incorrect mixing of drugs. Data collected from January 2005 to June 2008 were used for the analyses. The total numbers of activities represented by the data are 14,824,046 individual acts, and the number of injections and IVs administered were 604,847. The data covered almost 100% of the injections and 99% of the activities by nurses in the hospital according to internal research.

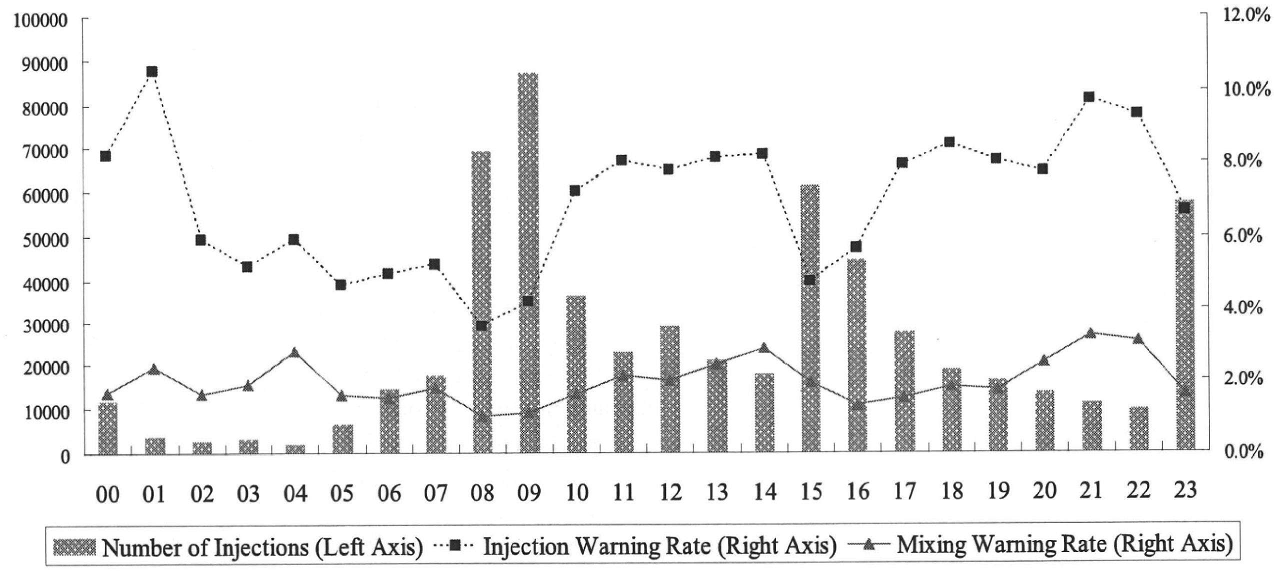

Fig. 1 Number of injections per hour and warning rate

2.3 Data Analysis

We accumulated data for each hour (for 24 hours a day) to identify times of high risk so as to understand the big picture of medical activities and medical errors in hospital wards. Warning rates were computed for each hour. These rates were treated as indicators to show risky times and situations.

We described these data, and analyzed them statistically to investigate correlations between situations and warning rates. Total number of injections per hour, total number of activities, total number of injections per PDA by hour, and total number of activities per PDA by hour were used as indicators for a nurse's workload at the time. The fraction out of total activities spent giving injections was used as an indicator for variation in hours. We calculated the proportion of the number of injections among total activities at that time. We employed Pearson Correlation Analysis to investigate relations and the significant level was 5%.

3. Results

Total number of activities was 14,824,046 including 69,276 injections (0.4%), 535,571 IV starts (3.6%), 483,770 IV finishes (3.3%), 1,979,804 care giving (13.3%), 10,437,250 observations (70.4%), 14,713 counseling (0.1%), 824,743 treatments (5.6%) and 478,919 emergencies (3.2%). The number for observations is extremely high. The total number of injections including IVs was 604,847, and the total warnings for injections were 37,046 (6.1%). The injection warning rate during early periods of implementation was around 9%, but has decreased to around 6 %.

Figure 1 shows the trend in warning rate and activities by the hour. The bar graph shows the number of injections by hour. There is a variability in the number of injections by hour, with three peeks for injections administrated: 9:00, 15:00 and 23:00. Most injections were administrated around these three peaks. The two line graphs show injection warning rates and mixing warning rates by the hour. Minimum and maximum of injection warning rates were 4.2% and 10.5%, while the minimum and maximum mixing warning rates were 1.0% and 3.2%. These figures vary quite a bit over the hours. This graph shows the warning rate was lower when nurses where administrating a large number of injections. For example, the warning rates between 8:00 and 10:00 are lowest, although the numbers of injections are highest. The warning rates between 15:00 and 17:00 are also lower compared with the warning rates around the time.

In this hospital, the nurses work three shifts: Day shift (8:00-16:40), Evening shift (16:00-0:40), and Night shift (0:00-8:40). The warning rates per shift were 5.5% Day shift, 7.3% Evening shift, and 6.0% Night shift. Some researchers have reported that warning rates during nighttime are higher than during daytime [5]. However, there is no clear evidence to support the statement in our analyses. The trends in injection warnings and mixing warnings have basically the same tendency, although the tendency can be recognized more clearly in the injection warning rates. Especially during Day shifts, this tendency was demonstrated quite clearly.

We ran some statistical analyses to investigate the relation between warning rate and other variables. According to the results of a correlation analysis between variables, there was a negative correlation between the number of injections and injection warning rates. Figure 2 is a scatter plot of the number of injections per nurse and injection warning rate. The correlation coefficients between the number of injections and injection warning rates was -0.48 ($p<0.05$), and that between the number of injections per PDA and injection warning rates was -0.34 ($p<0.05$). Both results were statistically significant at the 95% level. This results show there is a tendency that more injections means safer injections at specific times as described above.

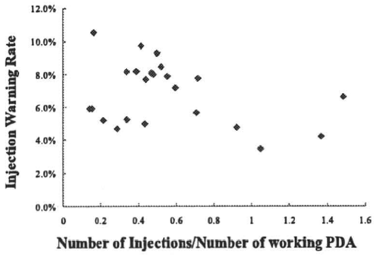

Fig. 2 Scatter plot showing number of injections per nurse and warning rate

Variation in activities had a negative effect on the injection warning rate according to other correlation analyses. Figure 3 is scatter plot showing the relation between the injection fraction of total activities computed by the number of injections divided by the total number of activities and injection warning rates. The correlation coefficient between the treatment fraction of total activities and injection warning rates was 0.35 ($p<0.05$) and statistically significant. This indicator implied a high fraction of treatment, meaning nurses should administrate injections along with other treatments for patients and discourage nurses from concentrating on injections.

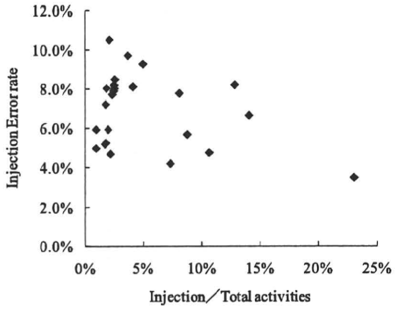

Fig. 3 Scatter plot showing number of injections and warning rate

4. Discussion

There are some differences between our study and previously published literature. In past literature on patient safety, many studies had said workloads and busyness are the principal cause of medication errors, based on observatory studies of nursing practice [13-14]. These studies implied that it was acceptable that healthcare workers were so busy that they had to rush tasks, which caused a lack of due care and attention to be given to the administration of medications, and sometimes resulted in the certification processes being skipped. However, this study shows an opposite tendency in the medication errors rate. This study implies that people made mistakes not because they were doing too many things, but because they were doing too many different kinds of things. During a high frequency time for injections, nurses can concentrate on administrating injections to patients. Literature on human factor engineering indicate the same kinds of conclusions to ensure quality of activities [15-16]. It basically says that doing too many kinds of things is not a good way to ensure quality and reduce costs of activities, and that specialization is essential to redesigning workflow to improve management.

There is also another difference in our results compared with previously published literature. Injection warning rates in this study were relatively high compared to other studies on administration errors in injections [1-3, 13-14]. Many researchers have assumed injection error rates by observation of daily work, and their results gave a figure of around 4% for injection error rates as opposed to the 6.1% found in our study. Of course, there is a possibility that the difference in the injection warning rate came from environmental or other factors. However, the accuracy of data used in the analyses and detection of mixing errors could be regarded as the cause of the difference in results. Data captured by observational study has a bias in that people administrate more carefully when being observed. Therefore, the data captured by observational studies might be better than in reality. Other reason for the difference stem from the fact that other studies could not detect incorrect mixing of drugs. To identify incorrect mixing, drugs need to be managed not by a drug name ID but by a serialized ID [11]. A serialized ID on each product makes it possible to distinguish mixed and unmixed vials by recording the mixing for each drug and injection.

Clarification by time is an aspect of related factors for medication processes. Multivariate analyses with risk adjustment are needed to investigate more precisely reasons for medication errors. It is possible to accumulate data by place and people to identify a risky situation more precisely and in more depth, instead of clarifying by time. Figure 4 shows an example of another type of analysis, a scatter plot for the number of injections and injection warning rates per ward. The numbers of injections administered are totally different, but the injection warning rates are similar.

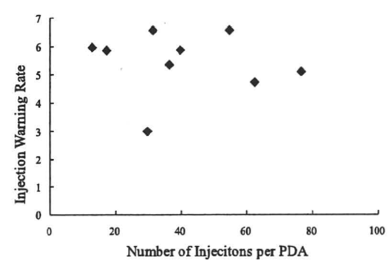

Fig. 4 Scatter plot showing number of injections and warning rate per ward

We can identify one outlier whose warning rate is lower than for the other wards. To investigate the reason for this result, we need more in-depth analyses based on multiple variables and qualitative analyses.

One limitation to our research is in treating injections and other activities as the same workload activities, though actually there are quantitative and qualitative differences between these activities. It is necessary to assign weighs to each activity based on a time study or some methodology so as to capture more deeply and accurately the workloads of nurse for subsequent analysis. Another issue to be developed in this kind of analysis is privacy protection. In this analysis, data accumulated by hour and ward was utilized. The results did not contain personal data such as health care workers performance or data on patients. All patients and healthcare workers have unique identification numbers in this hospital. Therefore it is possible to analyze data using the identification numbers—including patient identification and worker identification. To utilize digital data from electronic health records and other hospital information systems, discussions on the utilization of data and privacy protection is essential for the development of methodologies for data utilization and protection, as well as for frameworks supporting and sometimes restricting the use of data.

5. Conclusion

This study showed general trends in medication mistakes in practice using data captured by the hospital information system "Point-of-Act System" in real time and accurately. The results suggested that a high variation in activities performed might have negative effects on patient safety, and that busyness could not be regarded as the main causes of errors. Our study also implied the possible effects of bar code administration systems. According to the results, the injection warning rate was about 6%, and these warnings prevented nurses from committing errors and accidents. The lack of accidents with respect to injections in the hospital provides the system's ability. In conclusion, the bar code administration system might be quite an effective way not only to prevent medication errors at point of care, but also to improve patient safety through the analyses of data captured by them, if a system were designed correctly. Further research is needed to make progress in digital data usage and the utilization of healthcare IT.

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保健医療の最適化と医療情報学の役割

要旨

少子高齢化の進展の中、経済不況と相まって深刻な財政危機に陥っている。財源が限られた中では、いかに資源（ヒト・モノ・カネ）を有効利用するか、保健医療体制を最適化していくのかが非常に重要になる。その際に、医療情報学は、様々な観点から大きな貢献をなし得る可能性がある。第1に、IT 化を行うことによる様々なメリット、例えば、在庫の削減やベッドサイドでの安全性向上、コミュニケーションの向上、保険支払いの効率化・迅速化などの直接的な貢献が存在する。第2に、IT 化によって収集されるデータの利活用によるメリットがあり、その例としては、研究開発への応用や原価計算、経営指標・臨床指標の自動測定などがあげられる。第 3 に、情報工学・経営工学的な分析手法を医療分野に導入することで、医療の質・安全生・生産性の測定や向上に繋がる可能性がある。医療情報学は、これら 3 つの観点から、医療のマネジメントに大きく貢献する可能性があり、本セッションではその可能性を模索する。

英語抄録

Financial situation is getting worse with the rapid aging and economic recession. Optimization of healthcare has quite important role to utilize resources including healthcare workers, materials and money effectively under the budgetary constraint. Health informatics has a possibility to contribute to optimize healthcare from various points of view. First, healthcare IT contributes to improve efficiency and quality of healthcare thorough direct impact of system implementation. Second, Utilization of data captured by healthcare IT system has a capability to innovate researches including clinical trials, cost accounting, clinical indicators and so on. Third, the methodologies used in information sciences and managerial science can change means to investigate operation and management of healthcare. These three dimensions are significant aspects of health informatics research and healthcare informatics can contribute to improve healthcare system through the researches.

1．はじめに

少子高齢化の進展による、医療に対する需要の拡大や医療技術の高度化は、医療による財政的な負担を増加し、さらに経済不況と相まって医療分野は、深刻な財政危機に陥っている。財政全体の中で、医療をどのように位置づけるかという医療政策・経済の議論も当然重要ではあるが、財源が限られていると想定した上で、その限られた資源（ヒト・モノ・カネ）をいかに有効的に利用していくのか、言い換えると保健医療体制をどのように最適化していくのかを検討していくことが非常に重要である。保健医療体制の最適化、病院の

最適化やマネジメントを検討していく上で、医療情報学は、様々な観点から大きな貢献をなし得る可能性がある。

2．医療情報による最適化

医療情報による医療の最適化に関しては､大きく分けて３つに分けられると考えられる。

第１に、医療を情報化、IT 化することによる直接的な様々なメリットにより、医療の最適化や質の向上・効率化を推進することが可能である。例えば、物流システムによる在庫管理の向上、PDA などの認証システムを用いたベッドサイドでの安全性向上、ネットワークを用いたリアルタイムな情報共有によるコミュニケーションの向上、地域連携を通じた地域での最適化、保険支払いの電子化による効率化・迅速化などがあげられる。特にクラウドコンピューティングの進展により、より安価かつ携帯性の高い形での IT 利用が可能になり、直接的な便益がより拡大すると考えられる。

第２に、IT 化によって収集されるデータを利活用することによるメリットがある。その例としては、クリニカルデータの研究開発・創薬への応用や医療情報システムのデータを用いた原価計算、電子カルテデータを使用した経営指標・臨床指標の自動測定などがあげられる。これらの研究において、最も困難かつ費用がかかるのがデータ収集のプロセスであったが、医療の情報化により情報システムで収集されたデータを、２次・３次的に活用することで、費用の低減・効率化・質向上への道を模索することが出来る。

第 ３ に、情報工学・経営工学的な分析手法を医療分野に導入することで、医療の質・安全生・生産性の測定や向上に繋がる可能性がある。情報工学や経営工学においては、プロセスやオペレーションの最適化のための様々な手法が開発されている。代表例としては、モデリング言語を使用したプロセス分析や数学的技法を用いたオペレーションズリサーチ、シミュレーションなどをあげることが出来る。医療分野は、比較的プロセスが複雑であると見られており、こういった工学的手法の導入は他分野に比べて遅れているとされているが、医療関係者を含めてこれらの研究手法を実施することで、医療プロセスの複雑さを織り込んだモデル化や分析が可能になると考えられる。

3．ＩＴ化による最適化

ＩＴ化による最適化の例として、総合的な医療情報システムや地域連携システムの導入による医療の最適化が考えられる。電子カルテの導入により、物流システムによる在庫管理の向上、PDA などの認証システムを用いたベッドサイドでの安全性向上、ネットワークを用いたリアルタイムな情報共有によるコミュニケーションの向上、地域連携を通じた地域での最適化、保険支払いの電子化による効率化・迅速化などがあげられる。特にクラウドコンピューティングの進展により、より安価かつ携帯性の高い形での IT 利用が可能になり、直接的な便益がより拡大すると考えられる。クラウドコンピューティングによって、携帯性の高いＩＴ利用が可能になると、病診連携や在宅との医療情報連携が容易になり、