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Evaluating the Benefit of Introducing Medical Clerks as Transcriptionists to Assist Physicians in Outpatient Clinics: A Quantitative Analysis of Medical Records by Counting Characters

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Abstract— **This study evaluates the effects of the medical clerks introduced to reduce physicians' workloads in outpatient clinics by assisting with their documentation processes (e.g., the production of electronic medical records (EMRs)). The volume of information written in narrative text in EMRs from 2007 (pre-introduction of medical clerks) to 2012 (post-introduction) was measured by counting Japanese characters. The total number of medical records for analysis was 1,577. The average number of characters in EMRs increased from before the introduction of medical clerks to afterwards regardless of the types of documents (subjective or objective data) or visits (first or second visits). We conclude that introducing medical clerks improves the quantity of outpatients' medical records and that such a character-counting method is useful for evaluating the benefit of the introduction of medical clerks to assist physicians.**

I. Introduction

With the revision of medical fees in Japan in April 2008, incentives for providing medical clerks (MCs hereafter) to assist physicians' administration work were established with the aim of reducing physicians' workloads. This incentive system has since been improved twice through revisions in 2010 and 2012. Of the 804 hospitals in Japan, 196 (24.4%) had registered incentives by 2009 and 352 (43.8%) by 2011 [1]. The evaluation of the introduction of MCs to assist physicians' administration work has also steadily been reported over the past four years. According to the surveys reported by the Central Social Insurance Medical Council [1], [2], 47.4%, the largest number of hospital administrators, replied that such incentives were most effective at reducing physicians' workloads.

However, the percentage of hospitals that allow MCs to enter electronic medical record (EMR hereafter) data is between 27.5% [1] and 29.0% [3], less than that for writing paper-based medical records such as referral forms. Further, there is a growing need for MCs to take on EMR data entry to assist physicians [2], [4]. Most studies that have evaluated the introduction of MCs have used subjective evaluation indicators [1], [2], while some have been case reports [5] – [8]. Further, a minority has used the shortening of examination time in outpatient clinics and the rate of completing discharge summaries within two weeks as objective evaluation indicators [6], [9]; however, only one study has evaluated the quantity and quality of EMR information directly [10]. Moreover, although this study employed the character-counting method and examined the rate of typographical errors, statistical testing was not used, while only two evaluation points (before and after the introduction of MCs) were used.

The benefits of introducing MCs for patients include increases in the time available for direct treatment owing to improvements in medical care efficiency and better quality medical care because of enhancements in medical recordkeeping. Moreover, the benefits of introducing MCs for healthcare professionals include a reduction in workload as well as an improvement in earnings conditions for hospital managers because of the increase in outpatient visits. Of the above-presented advantages, in this study we specifically focus on improvements to the quality of medical care owing to enhancements in medical recordkeeping.

In 2007, only one in ten hospitals and clinics had implemented EMRs [11]; however, this proportion is expected to have increased since then. Because EMR data entry by MCs contributes to a reduction in physicians' workloads, the continuous evaluation of the quantity and quality of EMR information is required. This study thus establishes and examines an EMR evaluation methodology using Japanese character counting in order to evaluate the effect of introducing MCs into outpatient clinics. We focus on the number of characters in EMRs at both first visits and revisits (second visits hereafter).

II. Method

A. Study Setting

This study was carried out in the ear, nose, and throat clinics that provide clinical services for outpatients in Osaka prefecture in Japan. A client server-based EMR system with a computerized provider order entry and receipt was implemented in April 2006. Image filling and reservation systems were then connected to the EMR system, and diagnostic images were automatically retrieved when a patient record was opened (Figure 1). Five client PCs were connected to an EMR server: two in the reception, one in an interview room, one in an examination room, and one in a treatment room. EMR data were stored in an MS Access database. There were two types of clinical data in the EMR: structured data and non-structured narrative text. The former included prescriptions and treatments, while the latter included problem-oriented medical records that consisted of subjective (S hereafter) (e.g., chief complaint, present illness) and

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objective (O hereafter) (e.g., clinical impression, laboratory data) information.

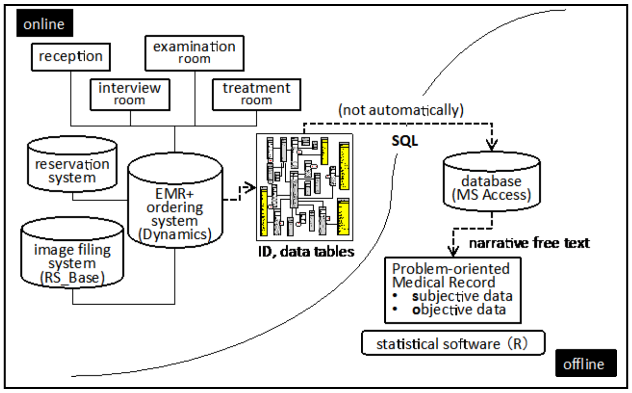

Figure 1. The EMR and ordering system in the clinic and a database for analysis.

B. Transition of the Data Entry Role after the Introduction of EMRs

In this clinic, the clinical providers involved in filling out EMRs (except receipt data) included a physician as a medical director, an MC as an interviewer (termed MCi hereafter), and an MC as a transcriptionist (MCt). The MCi interviewed a new patient at the first visit before his or her medical examination and entered information as narrative text into the EMR system via a client PC in the interview room. There was one client PC in the examination room, interconnected with two displays and keyboards, which the physician shared with the MCt. The MCt listened to the communication between the physician and patient, converted it into narrative text, and entered it into the EMR system. The MCt also entered structured data such as prescriptions and treatments in order to assist physicians.

Figure 2 shows a flow diagram for the transition of the EMR data entry role between 2007 and 2012. The physician entered all clinical data into the EMR system from 2006 until

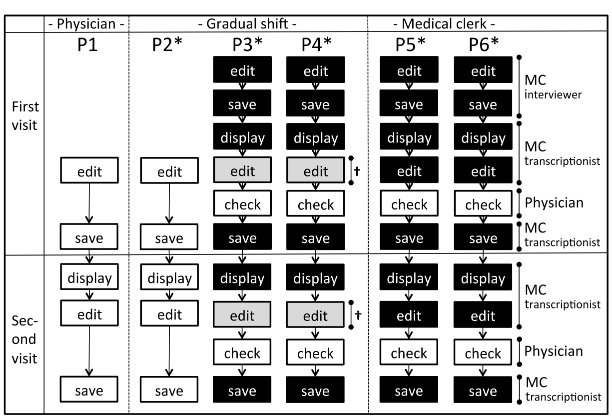

Figure 2. Transition of the role to editing problem-oriented medical records. * MC inputs data on prescriptions and treatments to assist physicians. † Both the physician and the MC edit the text in problem-oriented medical records.

2007 (termed P1 hereafter). This data entry role then gradually shifted from physicians to MCs from 2008 (P2) to 2010 (P4): the MCt entered only structured data following physicians' verbal instructions in 2008 (P2), while the MCi entered EMR interview information independently and the MCt entered examination information following physicians' verbal instructions in 2009 (P3). Finally, both the MCi and the MCt entered most data independently from 2011 (P5), which the physician confirmed and approved before saving.

The reuse of previously saved records is one of the advantages of the EMR system. The copy-and-paste command allows the first visit's notes to be copied and used as a template for the next visit's notes. To save time and effort, both the physician and the MC use this function before editing (deleting and adding) the records for the second visit when they complete it.

C. Data Collection

The medical records of outpatients were extracted from May 2007 to May 2012 (P1 to P6) by month. The data needed for analysis were exported using an SQL query from the EMR server database. Of the 15,683 medical records, 14,106 were excluded because they did not meet the following criteria: (a) records created by part-time physicians, not the medical director; (b) records used for consultation with a patient's family (no O data); (c) records of patients only receiving prescriptions (no S or O data); (d) records with missing visit information; and (e) records not including both first and second visits in a single month. The final number of records for analysis was therefore 1,577.

This study was reviewed and approved by the ethics review board of the Graduate School of Health Care Sciences, Jikei Institute, and participants provided written informed consent (the medical director's consent was granted for accessing patient medical records).

D. Data Analysis

S and O data were measured by counting the number of characters entered as narrative text. Paired t-tests were used to compare the volume of information between first and second visits. Pearson product-moment correlation coefficients were used to evaluate the association of this visit information. A one-way ANOVA and Tukey's multiple comparison post hoc tests were used to test the difference in the volume of information throughout the study period. The coefficient of variation (CV; SD/mean) was used to assess variability in the number of characters between subjects.

The O(NP) difference algorithm was used to ascertain the differences between the text presented in the medical records from the first and second visits. The number of deleted characters from the medical record for first visit and the number of added characters for that on the second visit were calculated and represented as the median values (25th–75th percentile). Mann–Whitney U-tests were then used to compare the number of deleted and added characters between S and O data, while Kruskal–Wallis tests assessed the differences in these numbers throughout the study period. Statistical analysis was performed using R.

III. RESULTS

A. Demographics

The total number of records for analysis was 1,577 (212 in P1, 273 in P2, 273 in P3, 292 in P4, 295 in P5, and 227 in P6) (Table 1). The analyzed records involved only one medical director as a physician; however, four MCs were involved in data entry as an MCi or an MCt in shifts. There were no differences in the case mix of patient diagnoses (ICD-10 codes) during the study period.

B. Volume of Information between First and Second Visits

Table 1 summarizes the data characteristics of first and second visits by period. In all periods, the average number of characters in S data was less than that in O data. Further, the average number of characters in both S and O data decreased significantly from first to second visits in all periods (paired t-test, $p < .001$). The comparison of the average number of characters in S data between first and second visits showed a weak correlation in all periods (r = .28 to .41), whereas in O data it showed a strong correlation in all periods (r = .44 to .80). Both in S and in O data, the correlation coefficient increased from P1 to P6. Finally, in all periods, the median number of deleted characters in S data was more than that in O data (e.g., 28 (20–41) vs. 8 (0–20) in P1, 32 (17–48) vs. 7 (0–26) in P6). Similarly, the median number of added characters in S data was more than that in O data (e.g., 11 (7–18) vs. 2 (0–9) in P1, 7 (3–11) vs. 0 (0–11) in P6) (Mann–Whitney U-test, $p < .001$).

TABLE I. NUMBER OF CHARACTERS BETWEEN FIRST AND SECOND VISITS BY PERIOD

Period	n	First Visit		Second Visit		Paired t-test *P*-value	r
S data							
P1	212	39.9±17.3	(.43)	21.8±10.5	(.48)	<.001	.28***
P2	273	43.3±18.7	(.43)	30.0±12.4	(.41)	<.001	.31***
P3	273	62.1±26.6	(.43)	32.4±12.7	(.39)	<.001	.32***
P4	292	47.6±18.1	(.38)	34.9±14.4	(.41)	<.001	.30***
P5	295	45.7±21.9	(.48)	28.8±13.7	(.48)	<.001	.41***
P6	227	55.1±24.6	(.45)	29.5±15.1	(.51)	<.001	.41***
O data							
P1	212	48.0±19.9	(.42)	43.1±15.9	(.37)	<.001	.44***
P2	273	58.8±26.9	(.46)	53.1±24.7	(.47)	<.001	.69***
P3	273	63.6±25.7	(.40)	59.3±24.3	(.41)	<.001	.68***
P4	292	68.4±26.9	(.39)	62.1±24.7	(.40)	<.001	.69***
P5	295	67.5±29.1	(.43)	64.7±27.7	(.43)	<.001	.80***
P6	227	75.3±34.7	(.46)	68.7±33.0	(.48)	<.001	.74***

The data are represented as means ± standard deviation (CV). Statistical significance compared between first and second visits (paired t-test). R represents Pearson product-moment correlation coefficients between first and second visits (*** p <.001).

C. Volume of Information between First and Second Visits by Period

Figure 3 shows the upward trends in the average number of characters in S and O data for all periods. The average number of characters in S data for first (second) visits significantly increased from 39.9 (21.8) in P1 to 55.1 (29.5) in P6, while that in O data for first (second) visits increased from 48.0 (43.1) in P1 to 75.3 (68.7) in P6 (Tukey's post hoc test, $p < .05$). Further, Table 1 shows that the CVs in S data for first and second visits and those in O data for first visits were not different between P1 and P6. However, the CVs of second visits in O data increased from .37 in P1 to .48 in P6. Further, the median numbers of deleted and added characters in S data were significantly different among all study periods (Kruskal–Wallis test, $p < .001$), whereas those in O data were not.

IV. DISCUSSION

A. Effect of the Introduction of MCs as Transcriptionists

In the present study, our results were difficult to compare with the data presented by other studies because the volume of information in O data was more than that in S data. We found that the volume of information for second visits was less than that for first visits in contrast to the findings of previous research [12] – [14] and opinions [15]. The copy and paste of text in the EMR system degrades its quality [14], because there is no deletion, only addition, and thus medical records become progressively longer [15]; this behavior also leads to errors in EMRs [13]. However, our results showed the opposite findings to these opinions. In other words, there were many deletions and only a few additions, especially in S data. Further studies are therefore needed to identify whether the copy-and-paste function has a positive or negative effect on the quality of EMRs.

The strong correlation between first and second visits in O data suggests that the volume of information rewritten in O data was less than that in S data. Moreover, the increasing correlation coefficients throughout the study period imply that the volume of information rewritten by MCs was less than that by physicians. However, because the volume of information for first visits markedly increased throughout the study period, the quantity of EMRs thus improved after the introduction of MCs.

According to the CV results, variability in the number of characters in O data for second visits increased throughout the study period. The causes of this variability were considered to be patient factors such as diagnosis as well as data entry operator factors. Because there was no change in the case mix of patient diagnoses throughout the study period, data entry operators were considered to be the cause of the variation. Previous studies have suggested that the volume of EMR information varies according to the staff's use of the EMR system [16] and that the proportion of copy-and-paste actions varies according to the level of staff training [14]. It is therefore reasonable to suppose that the volume of EMR information depends on the level of MC training. Further studies are therefore needed to examine how the level of MC training influences the quantity and quality of EMRs.

B. Research Methodology to Evaluate the Quantity and Quality of Medical Records

The character-counting method was used in the present study to evaluate the quantity of EMR information. By contrast, the word-counting method is a popular approach in English-speaking countries. In a previous study, both word-

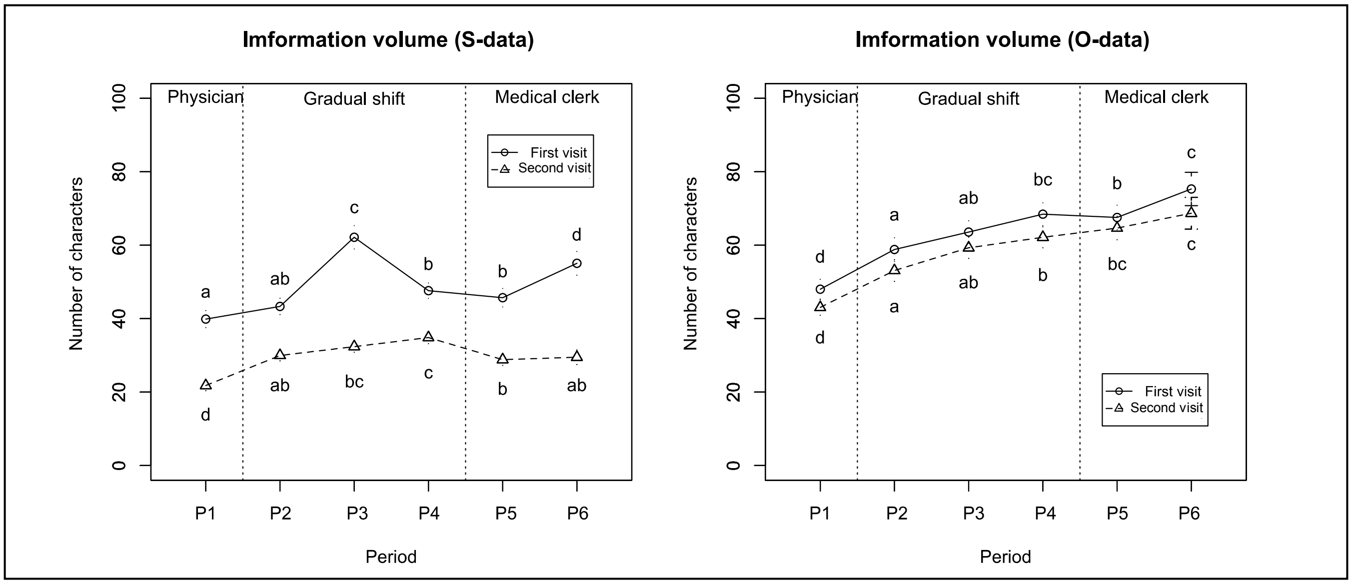

Figure 3. The average number of characters in S and O data by period. The lines connect the means for each sample set. *P*-values were determined by ANOVA using Tukey's multiple comparison post hoc test. The letters above the sample sets represent statistically significant periods (p <.05). Error bars represent SEs.

and normalized byte-counting methods were used to compare paper-based medical records and EMRs [12]. In Asian countries, character counting is more popular, however [10]. Therefore, this approach was considered to be a suitable method for evaluating the volume of EMR information. As shown in our results, we identify and examine the quantitative and qualitative effect of introducing MCs.

This study was conducted in one clinic; however; there might be different settings, EMR characters, and MC systems in other hospitals. It may be difficult for users to apply the evaluation algorithm developed in the present study to the existing EMR system because the EMR systems in most hospitals are more complex than that used in the clinic. Moreover, they also have closed data structures in contrast to the open-sourced structure used in our study. We thus suggest that while our approach may have applicability to other hospitals, these technical issues may need to be resolved first.

V. Conclusion

There were significant differences in the volume of EMR information before and after introducing MCs. This finding suggests that the introduction of MCs has great potential to improve the quantity and quality of EMRs and that the character-counting method is useful for evaluating the benefits of the introduction of MCs as transcriptionists to assist physicians in outpatient clinics. We speculate that this method would also apply to other hospitals and EMR systems.

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