Toward Design of an Agent-based Writing Support System for the SOAP Note: A Content Analysis of the Video-based Survey

Lukman HERAYAN,*,# Purnomo Husnul KHOTIMAH,** *** Osamu SUGIYAMA,** Goshiro YAMAMOTO,** Luciano Henrique de Oliveira SANTOS,** Angga Eko PRAMONO,† Kazuya OKAMOTO,*, ** Tomohiro KURODA*, **

Abstract Subjective, objective, assessment, and plan (SOAP) notes are widely used by physicians to document clinical reasoning in assessing, diagnosing, and treating patients. SOAP notes are also used in medical coding tasks for reimbursement of insurance claims. In Indonesia, medical coders who are independent from physicians assess SOAP notes to assign diagnostic codes and medical procedure codes based on the corresponding International Classification of Diseases standards. Discrepancies between physicians who write the SOAP notes and coders who assign diagnoses and treatments, may occur. These discrepancies were assessed by performing a video-based survey to understand the coder’s perspective, allowing the development of a writing support system to achieve unproblematic SOAP notes. This survey found that problematic SOAP notes were not caused by a single problem but by multiple problems. Abbreviations used by physicians are the major problem in assigning diagnostic codes, whereas incomplete data are the major problem in determining planning. This survey also showed that problematic SOAP notes may contain helpful keywords for coders that can help in determining diagnosis and treatment. The findings show that the system should be able to recognize separate sections of the SOAP note to provide writing support features and identify helpful keywords to encourage physicians to write unproblematic SOAP notes.

Keywords: SOAP note, Medical coding, Indonesia, coder’s perspective, agent, writing support system.

Adv Biomed Eng. 9: pp. 146–153, 2020.

1. Introduction

Subjective, objective, assessment, and plan (SOAP) notes are widely used by physicians to document clinical reasoning in assessing, diagnosing, and treating patients [1]. These notes are written in a structured and organized manner, consisting of subjective (S), objective (O), assessment (A) and plan (P) parts. The discharge summary for inpatients must include a summary of

SOAP notes by physicians.

SOAP notes are also used in medical coding tasks for reimbursement of insurance claims [2]. In Indonesia, medical coders who are independent of physicians evaluate physician-written SOAP notes to produce diagnostic codes based on the International Classification of Diseases (ICD) standards. ICD standards contain standardized diagnostic and medical procedure terms and their correlated codes, as well as rules by which codes are assigned based on the standardized diagnostic terms and medical procedure terms [3]. One problem during medical coding is the inability of coders to decipher SOAP notes written by physicians. Coders who find descriptions in SOAP notes to be problematic should speak with the physicians to resolve any problems [3]. Coders must confirm any problematic part in SOAP notes to calculate reimbursement for insurance claims, and physicians must rewrite these notes based on their discussions. These revisions of SOAP notes are quite frustrating and burdensome for both physicians and coders, indicating a need for computer systems to provide writing support for medical coding tasks.

The present study describes the results of a survey.
The present study proposes the development of system features that optimize medical coding tasks. To our knowledge, this is the first study designed to understand the coder’s perspective in developing features of the system. Although several previous studies assessed the coder’s perspective [7, 8], those studies focused on improving the coder’s expertise of [7] and the physician’s attitude toward [8] medical coding tasks. In contrast, the present study proposes the development of system features that optimize medical coding tasks. To our knowledge, this is the first study designed to understand the coder’s perspective in developing features of the system.

2. Analysis of Medical Coders

To understand the coder’s perspective, an experiment was performed, in which physician’s writing of SOAP notes was modeled in the medical coding task. Figure 1 illustrates the medical coding procedure used in Indonesia. The coders assign codes by assessing the SOAP notes and, if required, other medical records and inpatient discharge summaries. The assigned codes are input into the Diagnosis Related Group (DRG) software, which is a patient treatment episode grouping system that groups patients with similar hospital resource utilization and similar clinical characteristics [9]. The DRG system requires diagnostic codes and medical procedure codes to group patients using a United Nations University (UNU) grouper and to determine reimbursement for insurance claims. The UNU grouper is a universal software grouper employing ICD-10 for diagnosis classification, and ICD-9CM for medical procedure classification [10]. The last step for insurance claim reimbursement is validation of the codes and verification of the insurance claim by the internal verifier in the hospital; i.e., to determine whether these codes accurately represent the contents of the SOAP notes and the amount being requested. After verification, the final insurance claim document is sent to the National Health Insurance (NHI) agency for external verification and reimbursement.

Apart from Indonesia, other countries that have systems requiring separate coders and using DRG systems for reimbursement of insurance claims include Australia, USA, Canada, UK, Malaysia, and Thailand [11, 12]. Those countries, including Indonesia, utilize a “dual organization” model commonly seen in traditional hospital organizations. The “dual organization” model results in physicians who emphasize autonomy and support staff who efficiently manages physician-patient pre-encounter and post-encounter tasks such as coding, billing and record management [13].

In this study, dichotomous responses and free text responses were collected from the video-based survey. The contents of the free text responses and comments were processed to yield categorized comments, which were further evaluated to yield spatialized comments corresponding to coder labeling of comment location. A spatialized comment was defined as categorized comment that was mapped to its position in the SOAP note typing video screen. The dichotomous responses, including categorized and spatialized comments, were labeled as “problematic” and “not problematic” based on the coder’s perspective.
2.1 Experiment material
Videos were embedded into PDF files to provide coders the capability to record their comments and the time sequence of their comments. Videos were created by recording SOAP note typing in video format. The 11 SOAP notes used in this experiment were problematic pseudo-SOAP notes in the Indonesian language, which were prepared by an experimenter who is a medical coding lecturer. One SOAP note typing video was embedded into a single PDF file as a trial, with the other 10 videos divided evenly into two PDF files. The supporting materials included a readme file that contained instructions on how to perform the experiment in a rundown format and a video tutorial that explained how to assess and comment on the video using the commenting feature in Adobe Acrobat.

2.2 Experimental procedure
The experiment was conducted in the computer laboratory in Indonesia. Each coder used a desktop computer with a Windows operating system and equipped with internet connection. The survey was undertaken by five professional coders working at four different Indonesian hospitals. Two coders work in the primary level hospital, while three others work in the secondary level hospital that has more various coding task. Table 1 shows the working information of the five coders. One experimenter remotely supervised the experiment from Japan using Skype [14], while the other experimenter from Indonesia supervised the experiment in situ.

2.2.1 Part 1: Analysis of dichotomous responses
Coders were initially asked to identify the problematic SOAP notes after playing the SOAP note typing videos in the PDF file. Coders opened the PDF file using Adobe Acrobat software, played the video and labeled SOAP notes on the video as “problematic” or “not problematic”.

The summative assessments made by the coders in evaluating the SOAP notes were summarized to determine whether the general perspective of the coders correlated with each other and could be broken down into detailed perspectives.

2.2.2 Part 2: Analysis of comments
Coders were asked to provide comments about the SOAP notes. The comments could be problematic, such as “the diagnosis is not specific” or not problematic, such as “this information is helpful for coding”. The comments were placed in the specific part of the SOAP notes by replaying the SOAP note typing videos, pausing the videos at specific parts of the videos and inserting comments. This procedure allows determination of each coder’s comments and the time sequence of these comments.

2.3 Results
2.3.1 Part 1: Analysis of dichotomous responses
The five coders each assessed 11 SOAP note typing videos, providing a total of 55 SOAP note typing video assessments. Of these 55 assessments, 44 (80%) were regarded by the coders as “problematic”. Figure 2 shows the distribution of the SOAP notes regarded “problematic” and “not problematic”. Although all 11 SOAP notes were regarded as “problematic”, the coders who work in the secondary level hospital such as coder 1, coder 2, and coder 4 were able to evaluate some problematic SOAP notes as “non-problematic”.

2.3.2 Part 2: Analysis of comments
The five coders provided a total of 166 comments. Based on keywords, these comments could be separated into four categories [15]. Comments such as “what does ROM stand for?” and “text is not understood” were classified into the “abbreviation problem” category. Comments asking about missing data, such as “where is the disease history?” and “there is no chief complaint” were classified into the “incomplete data” category. Comments such as “immunization is not needed for coding” were classified into the “other problem” category. Comments that were positive or encouraging, and those that could help the coder perform accurate coding, such as “the

| Participant | Working experience | Coding activities per day | Type of the hospital or working place |
|-------------|--------------------|--------------------------|-------------------------------------|
| Coder 1     | 2 years            | 300 cases                | Secondary hospital                   |
| Coder 2     | 9 years            | 320 cases                | Secondary hospital                   |
| Coder 3     | 4 years            | 150 cases                | Primary hospital                     |
| Coder 4     | 7 years            | 800 cases                | Secondary hospital                   |
| Coder 5     | 5 years            | 150 cases                | Primary hospital                     |

Fig. 2 The distribution of SOAP notes labeled as "problematic" and "not problematic".
small hematoma supports the coding” were classified into the “helpful” category.

**Figure 3** shows the distribution of comment categories among the coders. Of the 166 comments, 77 (46.4%) were classified into the “abbreviation problem” category and 68 (41.0%) into the “incomplete data” category.

**Figure 4** shows the location of comment categories in the SOAP note typing videos. Before labeling the location of each specific comment, each SOAP note was manually separated into four parts: S (subjective), O (objective), A (assessment) and P (plan), and the comments were assigned to each specific part by the coders. Of the 166 comments, 41 (24.7%) were assigned to part S, 49 (29.5%) to part O, 46 (27.7%) to part A, and 30 (18.1%) to part P of the SOAP note. These comments consisted of 113, 116, 65, and 185 words, respectively. The ratio of the number of comments to the number of words was calculated to determine the relative problematic extent of the four parts of the SOAP note, with a higher ratio indicating that the part was more problematic (**Fig. 5**). We consider that when more words are written, the contents of that part in the SOAP note is more interpretable. We also consider that a larger number of problematic comments indicates that the part is more problematic. As seen in **Fig. 5**, part A had the smallest number of words, implying that part A is least interpretable compared to parts S, O and P. Meanwhile, the number of problematic comments in part A is the second highest, next to part O, which had more words. Based on the comparison, part A is least interpretable and most problematic. We present this comparison as the ratio of number of comments to number of words because both numbers measure the problematic extent of the less interpretable part. These findings showed that part A (assessment) was regarded by the coders as the most problematic part of the SOAP note.

We also created a map showing the percentage of the four problem categories in each part of the SOAP notes (**Fig. 6**).

**Figure 6** showed that there were specific problem categories in each part of the SOAP note. For example, 31 of 41 comments (75.6%) in part S and 23 of xx comments (76.7%) in part P of the SOAP note were associated with “incomplete data”, whereas 37 of 49 comments (75.5%) in part O and 30 of 46 comments (65.2%) in part A were associated with abbreviations or texts that were not understood.
3. Discussion: Design of a Writing Support System for SOAP note

The present study confirmed that SOAP notes are frequently problematic, with incomplete data [16] and abbreviation problem [17] often encountered by coders. These problems correlate with the informal writing style of most physicians, making it difficult for other persons to understand their notes [18].

Indonesia, similar to Malaysia, Thailand and USA, utilizes a “dual organization” model commonly seen in traditional hospital organizations. With the “dual organization” model, the coders are a separate entity or persons that code the physicians’ SOAP notes. Compared to “non-dual organization” model adopted by countries such as Japan, in which physicians do the medical coding by themselves, more issues in medical coding tasks are encountered in the ‘dual-organization’ model. In Indonesia, particularly, physicians’ SOAP notes may not be interpreted correctly by coders. To bridge the interpretation gap, co-writing approach could be developed. One approach is human-human co-writing.

In human-human co-writing, one possibility may be for physicians and coders to write SOAP notes together in a cooperative manner. Thus, during every patient’s check-up, a coder should accompany the physician. This type of professional communication and team collaboration is a hallmark of health care systems [19], as cooperation among healthcare professionals is necessary to optimize patient care and hospital operation. This approach, however, is limited by the lack of human resources and competence.

Rather than assigning one coder to each physician, we adopted human-machine/agent co-writing, which is a computer agent system that represents the coder’s perspective, resulting in virtual coder-physician communication. This agent is an autonomous representative with its own purposes, which senses its environment and the people with whom it interacts [20]. Several of such autonomous agents have been developed in medicine, including agents that support the delivery of mental health therapies and those that incorporate automated responses to text-based teleconsultation systems. Most agent-based systems to date have focused on physician-patient interactions [21]. In addition, agent-based systems may resolve some of the physical limitations of a human representative. For example, the agent can be duplicated almost without limit and have greater availability than human representatives.

Based on the coder’s perspective, we propose a multi-feature agent-based system to support or guide physicians in writing SOAP notes, based on the structures required by coders to produce accurate medical codes. The detailed descriptions of each feature are as follows.

3.1 Recognition of “abbreviation” part

Based on Fig. 6, the coders agreed that most of the problems in parts O and A of the SOAP note were caused by abbreviations or texts that were not understood. The coder’s perspective was used by the agent to focus on recognizing these abbreviations and texts in parts O and A of the SOAP note. Physicians frequently utilize abbreviations in part O to describe the results of physical examinations. Although abbreviations are standardized in most hospitals [22], physicians may be unaware of or forget these standard abbreviations while working. The agent should be designed to recognize non-standard abbreviations and change them to standard abbreviations. Upon presentation to the physician, the physicians can accept or decline the standard abbreviation.

In part A of the SOAP note, physicians often use diagnostic terms or texts that may not be understood by coders. Coders expect that the texts used in diagnosis are similar to standard diagnostic terms in the ICD [23]. Coders therefore have difficulty matching the language and expressions used by physicians with the ICD diagnostic codes [24]. The agent should be designed to recognize the physicians’ diagnosis texts and match them with similar terms in the ICD standard, and present them to the physicians. The physicians can accept or decline the standardized diagnostic terms.

The agent requests doctors to use standard medical abbreviations/words except when rare/advanced medical abbreviations are not in the list of abbreviations that are accepted for use in SOAP note. Otherwise, the agent directly autocorrects the abbreviations to those in the list of accepted abbreviations.

3.2 Recognition of “incomplete” part and auto-completion support

Based on Fig. 6, the coders agreed that most of the problems in parts S and P of SOAP notes were caused by incomplete or non-specific data. This coder’s perspective is used by the agent to complete the missing information in part S and to complete the medical procedure text in part P, making them more specific according to ICD standards. Part S of the SOAP note contains sub-parts, which reflect the patient’s subjective complaints and history. This subjective information is used by physicians to choose relevant physical and other examinations in part O. If some-sub parts in part S are missing, the examination may not be sufficiently specific, resulting in a non-specific diagnosis.

The completion of sub-parts in part S of SOAP note can improve the accuracy of medical codes [25]. The
agent supports the physicians in completing these sub-parts by providing a sub-part completion system. This feature is similar to a template completion system [26]. The sub-part completion system is activated by the agent if the agent detects a missing sub-part.

Part P of the SOAP note contains a description of medical procedures. However, physicians may indicate a non-specific medical procedure [27]. The specificity of ICD codes is based on the specificity of medical procedures indicated by the physicians, resulting in greater reimbursement of hospitals for insurance claims and enhancing hospital cash flow management [28]. The agent helps the physician record specific medical procedures by providing a text completion system. This system presents the physician with the most likely standardized medical procedures based on the ICD standard.

3.3 Identification of parts of SOAP notes
In our case, the SOAP notes were not explicitly separated into four parts. Ideally, SOAP notes should be divided into four text boxes [29]. If these four parts are explicitly separated, the agent simply activates the related feature without identifying the position on the note containing that designation by the physician. If the comment is in the S text box, the agent activates the sub-part completion system. If the comment is in the O text box, the agent activates the abbreviation recognition system. However, in the absence of explicit separation of the text boxes as shown in Fig. 4, the agent will be unable to determine the feature to activate. Therefore, the agent has a feature to identify the different parts of the SOAP note. Using this feature, the agent can support the physician in writing a SOAP note that conforms with the structures required by the coders.

3.4 Indicator of SOAP note problems
This feature is based on findings by coders that a SOAP note was problematic, with comments by the coders supporting these findings. Also, one coder assessed problematic SOAP notes as not problematic without providing any comments as shown in Fig. 2 and Fig. 3. We observed a correlation between problematic SOAP note labeling and the list of SOAP note problems. This indicator is useful when physicians who type SOAP notes with support from the agent want to submit their SOAP notes and want to know whether these SOAP notes remain problematic. This indicator constitutes a type of progressive feedback report to physicians, improving their motivation to write SOAP notes that are not problematic [30].

3.5 “Helpful” keyword identification for encouraging physicians
Some coders assess SOAP notes as being generally not problematic, despite comments indicating that they are problematic as shown in Fig. 2 and Fig. 3. These findings suggest that the agent should identify a “helpful” keyword, representing a positive or “not problematic” comment in the SOAP note. “Helpful” keywords identified by coders can be used to classify whether a SOAP note is problematic or not. The feature has a novel “encouraging” characteristic by providing positive feedback to physicians, while also helping coders produce appropriate codes.

3.6 Limitations
This study had several limitations. First, this study included only five coders. Second, the SOAP note typing videos used in this study were made from pseudo-SOAP notes, which may not represent actual SOAP notes in Indonesian hospitals. Finally, the coders’ comments were not well distributed, with one coder providing 41% and another providing only 5% of the total comments. The remaining comments (54%) were provided by the other three coders.

In this study, we collected detailed comments toward SOAP notes from a small number of subjects. Based on the results of this study, quantitative analysis of a larger number of subjects concerning the general claims toward the real SOAP notes in Indonesia could be conducted in the future.

3.7 Generalizability
This study can be applied to other countries with the same situation as Indonesia, including the use of coders for medical coding tasks and a DRG system for insurance claims. For example, countries such as Thailand and Malaysia have the same problem with medical coding [31] as Indonesia.

4. Conclusion
This study assessed problems with SOAP notes from the perspective of medical coders. The coders showed 80% agreement in their assessments of problematic SOAP notes. Evaluation of their comments showed that the two most frequent problem (87%) faced by coders when encoding physicians’ SOAP notes were abbreviations or texts that could not be understood and incomplete or non-specific data. Coders also agreed that the four parts of the SOAP note have different problems. Solving these problems requires an appropriate agent with features proposed in this study. Evaluation from the coder’s perspective can help develop an agent that can address specific parts of the SOAP notes. For example, in part O, we can focus on developing an abbreviation recognition system, and in part S, we can focus on developing a sub-part completion system. The agent should also be able to
identify parts of the SOAP note when they are not explicitly separated by text boxes. This study provides the coder’s perspective for developing features of an agent-based writing support system.

Acknowledgement

The authors express their special thanks to the five medical coders in Indonesia for their participation and cooperation throughout this study. This study is supported by JICA Innovative Asia Scholarship.

References

1. Lisenby KM, Andrus MR, Jackson CW, Stevenson TL, Fan S, Gaillard P, Carroll DG: Ambulatory care preceptors’ perceptions on SOAP note writing in advanced pharmacy practice experiences (APPEs). Curr Pharm Teach Learn. 10(12), pp. 1574–1578, 2018.
2. Adams DL, Norman H, Burroughs VJ: Addressing medical coding and billing part II: a strategy for achieving compliance. A risk management approach for reducing coding and billing errors. J Nat Med Assoc. 94(6), p. 430, 2002.
3. Phillips CD, Hillman BJ: Coding and reimbursement issues for the radiologist. Radiology. 220(1), pp. 7–11, 2001.
4. Wasserman D, Herskovitz M: Epileptic vs psychogenic nonepileptic seizures: a video-based survey. Epilepsy & Behavior. 73, pp. 42–45, 2017.
5. Smith CP: Content analysis and narrative analysis. In: Reis HT & Judd CM (Eds.), Handbook of research methods in social and personality psychology. Cambridge University Press. pp. 313–335, 2000.
6. Fuchs M, Funke F: Video web survey. Results of an experimental comparison with a text-based Web survey. In: Challenges of a changing world. Proceedings of the Fifth International Conference of the Association for Survey Computing. pp. 63–80, 2007.
7. Butz J, Brick D, Rinehart-Thompson LA, Brodnik M, Agnew AM, Patterson ES: Differences in coder and physician perspectives on the transition to ICD-10-CM/PCS: A survey study. Health Policy and Technology. 5(3), pp. 251–259, 2016.
8. Tang KL, Lucyk K, Quan H: Coder perspectives on physician-related barriers to producing high-quality administrative data: a qualitative study. CMAJ open. 5(3), pp. E617, 2017.
9. Busse R, Geissler A, Aaviksoo A, Cots F, Håkkinen U, Kobel C, Mateus C, Or’Z, O’Reilly J, Sérédín L, Street A: Diagnosis related groups in Europe: moving towards transparency, efficiency, and quality in hospitals? BMJ. 346, pp. f3197, 2013.
10. Aljunid SM, Hamzah SM, Mutaiba SA, Nur AM, Shafie N, Sulong S: The UNU-CBGs: development and deployment of a real international open source Casemix grouper for resource challenged countries. BMC Health Serv Res. 11(Suppl 1), p. A4, 2011.
11. McKenzie K, Walker SM, Dixon-Lee C, Dear G, Moran-Fuke J: Clinical coding internationally: a comparison of the coding workforce in Australia, America, Canada and England. In: Bannen J (Ed.) The 14th International Federation of Health Records Organizations (IFHRO) Congress and the 76th AHIMA National Convention Proceedings. American Health Information Management Association, United States, pp. 52–64, 2004.
12. Mathauer I, Wittenbecher F, World Health Organization: DRG-based payments systems in low-and middle-income countries: Implementation experiences and challenges (No. HSS/HSF/DP. E. 10.2). World Health Organization, 2012.
13. Hu Y, Sørensen OJ: Revisiting network organization in practice: network organization or dual organizations. In: ISMD Conference for Markets and Developments, 2012.
14. Nehr K, Smith BD, Schneider HA: Video-conferencing interviews in qualitative research. In: Enhancing qualitative and mixed methods research with technology, IGI Global, pp. 140–157, 2015.
15. Grossman MR, Zak DK, Zelinski EM: Mobile Apps for caregivers of older adults: Quantitative content analysis. JMIR mHealth and uHealth. 6(7), pp. e162, 2018.
16. Lefter LP, Walker SR, Dewhurst F, Turner R: An audit of operative notes: facts and ways to improve. ANZ J Surg. 78(9), pp. 800–802, 2008.
17. Barrows Jc RC, Busuicu M, Friedman C: Limited parsing of notational text visit notes: ad-hoc vs. NLP approaches. In: Proceedings of the AMIA Symposium, American Medical Informatics Association, pp. 51, 2000.
18. Smith LE: Spread of English and issues of intelligibility. In: Kachru BB (Ed.) The other tongue: English across cultures. Urbana: University of Illinois Press. pp. 75–90, 1992.
19. O’Daniel M, Rosenstein AH: Professional communication and team collaboration. In: Patient safety and quality: An evidence-based handbook for nurses. Agency for Healthcare Research and Quality (US), 2008.
20. Epley N, Waytz A, Cacioppo JT: On seeing human: a three-factor theory of anthropomorphism. Psychol Rev. 114(4), pp. 864–886, 2007.
21. Oh KJ, Lee D, Ko B, Choi HJ: A chatbot for psychiatric counseling in mental healthcare service based on emotional dialogue analysis and sentence generation. In: 2017 18th IEEE International Conference on Mobile Data Management (MDM), IEEE, pp. 371–375, 2017.
22. Carneiro SM, Dutra HS, da Costa FM, Mendes SE, Arreguy-Sena C: Use of abbreviations in the nursing records of a teaching hospital. Revista da Rede de Enfermagem do Nordeste. 17(2), pp. 208–216, 2016.
23. Hunt PR, Hackman H, Berenholz G, McKeown L, Davis L, Daniel M, Rosenstein AH: Professional communication and team collaboration. In: Patient safety and quality: An evidence-based handbook for nurses. Agency for Healthcare Research and Quality (US), 2008.
24. Goodman DC, Fisher ES: Physician workforce crisis? Wrong diagnosis, wrong prescription. N Engl J Med. 358(16), pp. 1658–1661, 2008.
25. Koyuncu HH, Yeniceri F, Eryildirim B, Sarica K: Family history in stone disease: how important is it for the onset of the disease and the incidence of recurrence? Urol Res. 38(2), pp. 105–109, 2010.
26. Wu W, Meng W, Su W, Zhou G, Chiang YY: Q2P: Discovering query templates via autocompletion. ACM Transactions on the Web (TWEB), 10(2), p. 10, 2016.
27. Kasman DL: When is medical treatment futile? J Gen Intern Med. 19(10), pp. 1053–1056, 2004.
28. Riley GF: Administrative and claims records as sources of health care cost data. Med Care. 47(7 Suppl 1), pp. S51-S55, 2009.
29. Grogan EL, Speroff T, Deppen SA, Roumie CL, Elasy TA, Dittus RS, Rosenbloom ST, Holzman MD: Improving documentation of patient acuity level using a progress note template. J Am Coll Surg. 199(3), pp. 468–475, 2004.

30. Ng F: Am I there yet? Probing the effects of goal progress feedback on cognitive motivation (Doctoral dissertation, Princeton University), 2015.

31. Zafrinah SA, Nur AM, Puteh SEW, Aljunid SM: Potential loss of revenue due to errors in clinical coding during the implementation of the Malaysia diagnosis related group (MY-DRG®) Case-mix system in a teaching hospital in Malaysia. BMC Health Serv Res. 18(1), pp. 38, 2018.

Lukman HERWAN
Lukman HERWAN is currently a Ph.D. student at Department of Social Informatics, Graduate school of Informatics, Kyoto University, Japan. He received his bachelor degree (S.T.) and master degree (M.T.) degrees in informatics from Institut Teknologi Bandung, Indonesia. His current research interest includes software engineering, machine learning, and medical informatics.

Purnomo Husnul KHOTIMAH
Purnomo Husnul KHOTIMAH is a Researcher in the Research Center for Informatics, Indonesian Institute of Sciences (LIP). She received her bachelor degree (S.T.) in Electrical Engineering from University of Indonesia, master degree (M.T.) in Electrical Engineering from Institut Teknologi Bandung, and Ph.D. in Informatics from Kyoto University, Japan. She was with Kyoto University Hospital, where she served in a postdoctoral program from 2018 to 2020. Her current research interests are data engineering, data mining, machine learning, and health informatics.

Osamu SUGIYAMA
Osamu SUGIYAMA is currently a Program-Specific Associate Professor in Graduate School of Medicine, Kyoto University. He received his B.E., M.E., and Ph.D. in engineering from Keio University, Japan. His major interests are Human-Computer Interaction and Medical Informatics.

Goshiro YAMAMOTO
Goshiro YAMAMOTO is currently an Associate Professor in Kyoto University Hospital after being an Assistant Professor in Okayama University and Nara Institute of Science and Technology. He received his B.E., M.E., and Ph.D. in engineering from Osaka University, Japan. His major research interests are human-computer interaction, augmented reality, and medical informatics.

Luciano Henrique de Oliveira SANTOS
Luciano Henrique de Oliveira SANTOS is currently an Assistant Professor at Kyoto University, Division of Medical Informatics. He received his bachelor’s degree in Computer Science and his master’s degree in Informatics both from University of Brasilia, Brazil, and his Ph.D. in Informatics from Kyoto University, Japan. His current research interests include pervasive games, augmented reality and gamification in different health applications, such as rehabilitation therapy and supporting elderly people.

Angga Eko PRAMONO
Angga Eko PRAMONO is an Assistant Professor at Vocational College of Universitas Gadjah Mada. He received his bachelor degree (S.KM.) from Muhammadiyah University of Surakarta and M.P.H. from Universitas Gadjah Mada, Indonesia. His research interests include classification of diseases and health information management. He is a secretary of Indonesian of Higher Education for Health Information Management Association (IHE-HIMA).

Kazuya OKAMOTO
Kazuya OKAMOTO is an Associate Professor of Division of Medical Information Technology and Administrative Planning of Kyoto University Hospital, Japan. He received B.S., M.S. and Ph.D. degrees in informatics from Kyoto University, Japan. His current research interests include Medical Informatics, Hospital Information Systems, and Artificial Intelligence in Medicine.

Tomohiro KURODA
Tomohiro KURODA is currently a Professor of Kyoto University. He received his B.S. in information science from Kyoto University, M.S. and Ph.D. in Information Science from Nara Institute of Science and Technology, Japan. His research interests include Human Interface, Virtual/Augmented Reality, Wearable Computing, and Medical & Assistive Informatics. He is a member of IEEE, ISVR, HISJ, JAMI, and others.