

SMART Careplan System for Continuum of Care

Young Ah Kim, RN, PhD¹, Seon Young Jang, RN, MPH², Meejung Ahn, RN, MSN³, Kyung Duck Kim, MPH¹, Sung Soo Kim, MD, PhD⁴

¹Division of Medical Information and Technology, Yonsei University Health System, Seoul; ²Office of Quality Improvement and ³Division of Nursing, Severance Hospital, Seoul; ⁴Department of Ophthalmology, Yonsei University College of Medicine, Seoul, Korea

Objectives: This paper describes the integrated Careplan system, designed to manage and utilize the existing Electronic Medical Record (EMR) system; the system also defines key items for interdisciplinary communication and continuity of patient care. **Methods:** We structured the Careplan system to provide effective interdisciplinary communication for healthcare services. The design of the Careplan system architecture proceeded in four steps—defining target datasets; construction of conceptual framework and architecture; screen layout and storyboard creation; screen user interface (UI) design and development, and pilot test and step-by-step deployment. This Careplan system architecture consists of two parts, a server-side and client-side area. On the server-side, it performs the roles of data retrieval and storage from target EMRs. Furthermore, it performs the role of sending push notifications to the client depending on the careplan series. Also, the Careplan system provides various convenient modules to easily enter an individual careplan. **Results:** Currently, Severance Hospital operates the Careplan system and provides a stable service dealing with dynamic changes (e.g., domestic medical certification, the Joint Commission International guideline) of EMR. **Conclusions:** The Careplan system should go hand in hand with key items for strengthening interdisciplinary communication and information sharing within the EMR environment. A well-designed Careplan system can enhance user satisfaction and completed performance.

Keywords: Continuity of Patient Care, Patient Care, Interdisciplinary Communication, Electronic Health Records, Information Storage and Retrieval

Submitted: December 26, 2014

Revised: January 23, 2015

Accepted: January 25, 2015

Corresponding Author

Sung Soo Kim, MD, PhD

Department of Ophthalmology, Yonsei University College of Medicine,
50-1, Yonsei-ro, Seodaemun-gu, Seoul 120-752, Korea. Tel: +82-2-
2228-9551, Fax: +82-2-362-1292, E-mail: SEMEKIM@yuhs.ac

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

© 2015 The Korean Society of Medical Informatics

I. Introduction

Patient safety and care are basic rights for patients in hospitals. Patient safety is defined as the avoidance, prevention, and amelioration of adverse outcomes or injuries stemming from the process of care [1-3] and any failure of system and human aspects across the patient care may cause adverse event occurrence. Adverse events related to medical care include all errors, mistakes, or accidents regardless of the existence of harm to patients [1,2], which lead to poor quality of care and greater cost. The Joint Commission, a US non-profit organization for healthcare accreditation, emphasizes

that teamwork is a critically important strategy for the prevention of adverse events and provision of a safe environment. In complex healthcare situations, teamwork promotes multidisciplinary cooperation and effective communication, which has a subsequent positive impact on safety culture and patient satisfaction [3,4].

Patient safety strategy related to information technology (IT) is effective in improving healthcare quality and reducing malpractice [5,6]; therefore, the implementation of health IT is recognized as an effective method to enhance healthcare quality and safety. If the architecture of health IT is poorly designed or has poor user interfaces and makes work flow more complicated, it can create hazards for patient safety and difficulties in clinical decision-making [2,6]. Thus, it is necessary to prepare a well-designed system, and furthermore, to prepare a well-integrated IT system within an Electronic Medical Record (EMR) environment, for accurate gathering of patient information with collaboration and communication between organizations [3-6].

The main reason for a healthcare organization's existence is patient care. To support and respond to each patient's unique needs and provide the most appropriate care requires a high level of planning and coordination [3].

Patient care uses data from various types of assessment, such as physical examination, health history, and an evaluation of physical, psychological, social, and economical factors across multiple care settings and departments and services. Healthcare practitioners identify and prioritize care and treatment to be provided to an individual patient using those data and revise the plan of care based on changes in the patient's condition as needed. A careplan is a record of the integrated care process, which involves prioritized problems, goals, target dates, and its revision history.

Considering dynamic and complicated healthcare settings, the development of a Careplan IT system can be a useful strategy to support effective communication and multidisciplinary

cooperation and to improve patient safety in medical services.

In this paper, we describe Severance's integrated Careplan system, which was designed to manage and utilize the existing EMR. The system also defines key items for interdisciplinary communication.

II. Case Description

Designing the Careplan system architecture proceeded in four steps.

Step 1: Defining target datasets and making a conceptual framework

We established a conceptual framework based on reviewing the domestic medical certification and the Joint Commission International (JCI) guidelines. The conceptual framework includes target datasets and items from care delivery for all patients, care of high risk patients and provision of high risk services, food and nutrition therapy, pain management, and end-of-life care according to a care process.

Step 2: Construction of the main user interface (UI) and its architecture based on the conceptual framework

We used Microsoft Visual Studio .NET with C# 2012 (Microsoft, Redmond, WA, USA) and the DBMS was Microsoft SQL Server 2008. To determine the arrangement and construction of each UI and related datasets in the Careplan system, we operated a Careplan task force team (TFT) for six months.

Step 3: Screen layout and storyboard making

The basic strategy, 'using regardless of type of health care practitioner' was conceptualized. Therefore, the Careplan system was designed for integration and specialization at once. We were able to create a summary screen and detailed sub screens to be used for each need.

Step 4: UI design and development, and implementation

We completed the scope of UIs and functions through

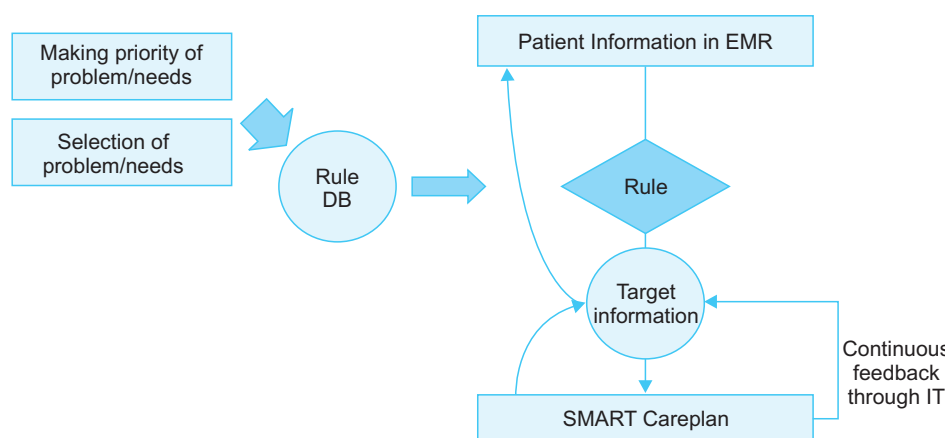


Figure 1. Overview of the Careplan system and its architecture. EMR: Electronic Medical Record.

review by the Careplan TFT and quality improvement (QI) experts in addition to step-by-step evaluation by an International Patient Safety Group (IPSG) TFT.

An overview of the Careplan system and its architecture is shown in Figure 1.

The conceptual framework includes sections and elements from care delivery for all patients as shown in Table 1.

The Careplan system has client UIs and algorithms to retrieve each dataset. When a user selects a patient, the Careplan system will spontaneously display information

that leaders and healthcare practitioners should know for preventive, palliative, and rehabilitative care. Information can reflect newly created datasets to receive medical records and information from the EMR system matched with the algorithms. The Careplan system reviews and writes a newer careplan and its goals directly. Figure 2 shows the main screen of the Careplan system rendered from the process described above.

Each section represents characterized information served as data sources from the EMR system server. A data recorder

Table 1. Section and elements for developing of the Careplan system

Section	Element
Preventive care (sore, falling)	Nutrition status, predictive potential of falling and sore development, subjective and objective indication according to dynamic patient condition, its goal and intervention
Medication	Reason for medication (e.g., pain), drug name, dose and interval, indication for taking, goal of order.
Anesthesia & surgery	Planned date, department, staff and participants, emergency or not, pre/post operation name, pre/post diagnosis, length of stay post operation
Multidisciplinary careplan	Supportive therapies (physical/psychological/social/speech), high-risk services
Food and nutrition therapy	
Pain management	Pain evaluation (tool, score, intensity, assessment, etc.), medication for pain control (drug name, started date, dose and interval, etc.)
End-of-life care	No cardiopulmonary resuscitation
Administration & discharge, follow-up	Discharge plan, readmission plan (if needed)
Education	Education in progress, content, materials, manner, outcome, educator and educatee

The screenshot shows the main interface of the Careplan system. It features a top navigation bar with tabs for 'Summary', 'Anesthesia & surgery', 'Pain management', 'Medication', 'Food and nutrition therapy', 'Administration & discharge', and 'Education'. Below this, there are seven main sections, each with a title and a table of data. Section 1, 'Anesthesia & surgery', shows a table with columns for 'Anesthesia & surgery', 'Planned date', 'Department', 'Staff', 'Participants', 'Emergency or not', 'Pre/post operation name', 'Pre/post diagnosis', and 'Length of stay post operation'. Section 2, 'Supportive therapies high-risk services end-of-life care', shows a table with columns for 'Supportive therapies', 'High-risk services', and 'End-of-life care'. Section 3, 'Multidisciplinary careplan', shows a table with columns for 'Multidisciplinary careplan', 'Supportive therapies', 'High-risk services', and 'End-of-life care'. Section 4, 'Pain management', shows a table with columns for 'Pain management', 'Pain evaluation', 'Medication for pain control', and 'Pain control'. Section 5, 'Medication', shows a table with columns for 'Medication', 'Drug name', 'Dose and interval', 'Indication for taking', and 'Goal of order'. Section 6, 'Food and nutrition therapy education preventive care (sore, falling)', shows a table with columns for 'Food and nutrition therapy', 'Education', 'Preventive care (sore, falling)', and 'Nutrition status'. Section 7, 'Administration & discharge, follow-up', shows a table with columns for 'Administration & discharge', 'Discharge plan', 'Readmission plan (if needed)', and 'Follow-up'.

Figure 2. Main screen of the Careplan system.

Detail elements for each section:

- 1) Anesthesia & surgery: planned date, pre/post operation name
- 2) Supportive therapies, high-risk services, end-of-life care: problem, goal, planned date by doctor's order
- 3) Multidisciplinary careplan: problem, goal, planned date by healthcare practitioners' plan
- 4) Pain management: data source, pain evaluation, score, intensity
- 5) Medication: medication for pain control, drug name, started date, dose and interval
- 6) Food and nutrition therapy, education, preventive care (sore, falling): data source, nutrition status, predictive potential of falling and sore development, activities of daily living (ADL) score
- 7) Administration & discharge, follow-up: discharge plan, readmission plan (if needed)

Pain management

환자관리 (Patient Management)

구분	내용	작성일	작성부서	작성자
의원기록	통증여부: Yes, 통증강도: 5 Goal: 통증이 완화되어 통증점수 : 3 이하로 감소한다. 목표일: 2013.02.22, 수정목표일: 2013.02.26, 통증강도: 1	2013-02-26	정형외과	조 진-S
간호기록		2013-02-26	121병동	이 비-N

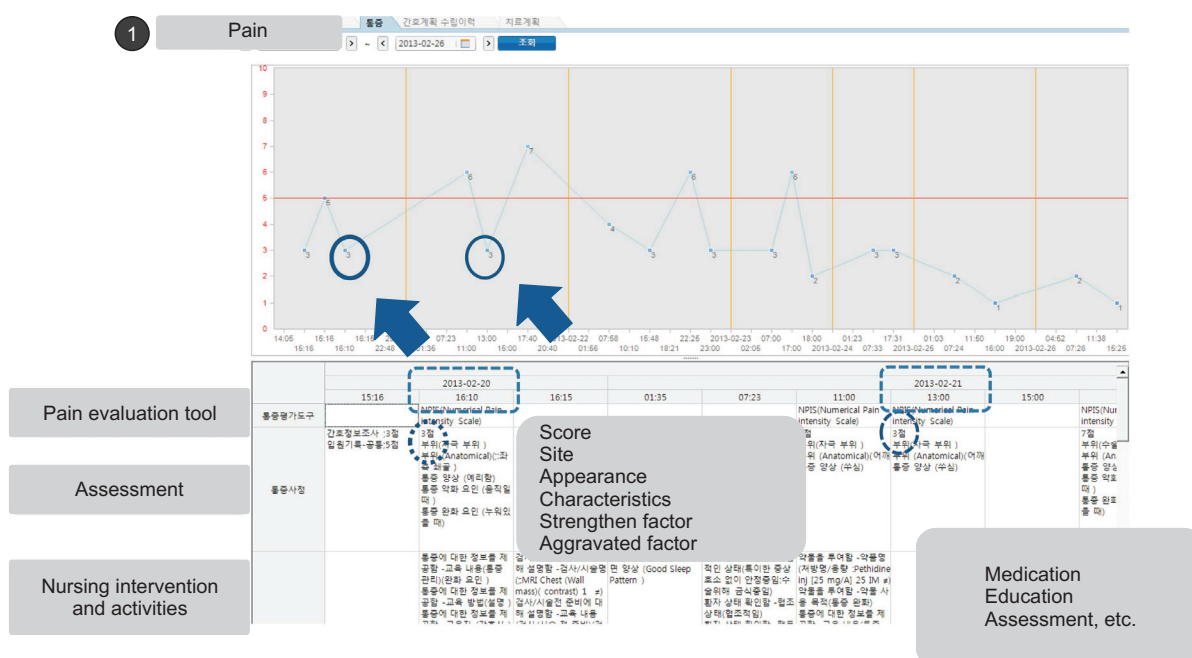
Data source	Content	Registered date	Registered department	Registered participant
Admission note	Pain or not : Yes, Score :3, intensity : 5	2013-02-20	Orthopedics	A-Doctor
Nursing record	Goal: pain subside and control under score 3 Initial planned date: 20130221 Revised date: 20130223 from 3 to underscore 1	2013-02-26	121 ward	B-Nurse

1 Pain

This screen provides more detailed information with a pain graph and pain table, which come from admission notes and nursing records. Pain table includes pain evaluation tool, site, score, intensity, appearance, characteristics, strengthen factor, aggravated factor, treatment to subside pain, assessment, etc. Pain graph shows pattern and timely progress with pain score in nursing records.

2 Nursing plan

This screen serves as a flow sheet, which organizes the nursing process in an easily accessible manner; it includes recording date, nursing diagnosis, related intervention and activities, and nursing goals.



3 Summarized information from admission note and nursing record

Admission note

📄 문서를 불러오기

🗨️ 대화를 나누어 보기

입원기록-공동 (2013-02-20)

normative

Bowel sound ● No ○ Yes

Tenderness 🟡 No ○ Yes
 ☑️ No

Palpation of organ

☐ liver

☒ kidney

☐ spleen

Shifting dullness ● NO ○ YES

Fluid wave ● NO ○ YES

Rack and Extremity

LOM ● No ○ Yes

CVA tenderness ● NO ○ YES Lt. / Rt. / Both

Pruritus edema ● NO ○ YES

Hemastasis ● NO ○ YES

(Physical Exam)

others (Physical Exam) ☒ NO ☐ YES

통증평가 통증각도 ○ NO ● YES

통증이 있을지 저장함학

① 평가 도구 NPIS(The Numerical Pain Intensity Scale)

⑤ 5 ~ "통증 강도는 가늠할 수 없을 기준."
non-specific
④ non-specific

주관적인 Rule out pyogenic arthritis, SC joint Lt.
계측 Curretage, cement bead insertion

퇴원계획

통증 및 치료 시야 여부 ☒ N ☐ Y

후유 증상 기록 ☐ 감감시사멸소 ☐ 초음파초

사회 복지 시나리오 연계 필요성 ☑️ N ☐ Y

가환 불응치 요구사항

Nursing record

Registered date	Nursing diagnosis	Nursing intervention	Nursing activities	Detail content
설치일자(시간) 2013-09-20 16:10	간호진단(문서화내용) 신체적 불편감 통증 관련	간호중재 통증 관리	간호활동 통증 측정 통증 기록 통증 평가 통증 완화 조치 환자 교육 가족 교육	상세내용 수술 후 통증 통증 강도 측정 통증 기록 통증 평가 통증 완화 조치 환자 교육 가족 교육

Figure 3. Division of pain management including its structure and details.

with the pre-defined role of recomposing data to structured datasets. Additionally, if a user wants to know more detailed information and data sources, the Careplan system can provide related clinical documents or specific records from the hospital information system (HIS) according to the rule of the category master (Figure 3).

III. Discussion

The Careplan system could be expanded to include all health-care participants who are involved in a patient's care step-by-step.

To begin applying the Careplan system within a hospital, it is difficult to understand what the Careplan is and why there is a need to establish a Careplan despite the fact that the EMR system with diverse handover is already being used. In our study, there was not enough awareness to share among health participants. The Careplan system is not only be a system for organizing care; rather, it also defines conceptual activities itself and creates a bridge between scattered data and guidelines to provide proper service with a uniform level. As time passes, most health participants may realize how important an overall careplan is in providing efficient, high-quality healthcare. However, the performance was not improved as much as we expected. One possible reason is that the participants did not have enough time, and they may have felt some difficulty in making careplans and measurable goals.

The Careplan system focuses on how establishing a careplan that should be systematized, of a high quality level, and individualized. Integrated client UIs and algorithms can reduce work burdens and provide accessibility to each data source (e.g., EMR documents and many types of order).

We discovered key elements for strengthening interdisciplinary communication and information sharing and developed the Careplan system for users to create careplans within an EMR environment. After expanding the Careplan system, we evaluated it by means of a survey, and we analyzed the factors influencing user satisfaction and performance to complete careplans. The most interesting result is that health participants (e.g. therapists) in a supported department show the highest user satisfaction. Additionally, employees who had been working 7–9 years had the highest recognition of careplans by working years, and employees who had been working for less than 1 year showed high user satisfaction.

Careplan recognition, system quality, and information quality led to varying results of user satisfaction [7,8]. Also, our analysis showed that the enhancement of system quality and information quality and continuous training support

from organizations are factors that improve user satisfaction considering organization factors, such as how much top management buy-in had a positive effect on user satisfaction [8].

The results show that the Careplan system can play an important role in assisting leaders and health participants in the real planning and completion of careplans, visualization of careplans, convenience, sharing of careplans between departments, and training regarding careplan concepts and usage.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

This study was supported by a grant from the Korea Health R&D Project, Ministry of Health & Welfare, Republic of Korea (No. HI13C1485).

References

1. Agency for Healthcare Research and Quality [Internet]. Washington (DC): US Department of Health and Human Service; 2014 [cited at 2015 Jan 15]. Available from: <http://www.ahrq.gov/>.
2. Institute of Medicine. Health IT and patient safety: building safer systems for better care. Washington (DC): National Academies Press; 2011.
3. Joint Commission International. Joint Commission International accreditation standards for hospitals. 4th ed. Oakbrook Terrace (IL): Joint Commission Resources; 2011.
4. Meterko M, Mohr DC, Young GJ. Teamwork culture and patient satisfaction in hospitals. *Med Care* 2004;42(5):492-8.
5. Gaylin DS, Moiduddin A, Mohamoud S, Lundeen K, Kelly JA. Public attitudes about health information technology, and its relationship to health care quality, costs, and privacy. *Health Serv Res* 2011;46(3):920-38.
6. Kim SH. Patient safety: achieving a new standard for care. *J Korean Hosp Assoc* 2006;35(5):87-96.
7. Park CS, Koh SH. A review of hospital information system quality evaluation from the viewpoint of software usability. *Inf Syst Rev* 2007;9(2):169-87.
8. Ryu I, Kim M. An empirical study on the success factors and performance model of hospital information systems. *Asia Pac J Inf Syst* 2002;12(1):45-65.