# Development of Clinical Advanced Viewer "CA-V" for Supporting Clinical Practice

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## Abstract

We have developed the Clinical Advanced Viewer "CA-V" for supporting the clinical practice of physicians. The system can appropriately narrow down clinical information based on the problem, and can display the patient's information on a timeline on one screen. The physician can thus more easily diagnose and decide a treatment strategy, by referring to the aggregated clinical information of this system. The system is expected to enable physicians to more effectively understand the condition of a patient.

## 1. Introduction

In recent years, medical technology has become highly sophisticated, which has greatly increased the amount of information, such as examination images, sampling data, medication data and vital information.*1 Physicians need to refer to such information in their daily clinical activities to make a diagnosis of an individual patient or to decide his or her treatment plan.

In clinical practice, physicians select and carry out examinations according to the symptoms of the patient and, comparing the results with the past medical records, they identify changes in the patient's conditions, make diagnoses and consider treatment plans.

However, in cases when long-term follow-up observation is necessary or when the patient suffers from multiple diseases, the amount of data required for clinical practice becomes enormous and it takes much labor to collect and refer to them; therefore, a system has been requested that efficiently organizes and presents diverse information.

To respond to that demand, we developed the clinical advanced viewer CA-V.*2 The system narrows down, by patient and disease, the information required for physicians to make diagnoses or consider treatment plans, aggregates the time-series changes in the patient's conditions in a single window and thereby supports them with their clinical practice.

In addition to displaying diverse information after efficiently organizing it, the CA-V in conjunction with our medical-use image information system, SYNAPSE,*3 allows easy viewing of examination images. Moreover, in combination with our 3D image analysis system, Volume Analyzer SYNAPSE VINCENT, it is also possible to view the 3D image analysis results of examination images.

This report describes the clinical usefulness and system characteristics of the CA-V that we released via FUJIFILM Medical Co., Ltd. in July, 2013.

## 2. CA-V

This system provides two types of views: Time Line View (TLV) that visualizes and displays the clinical information of each patient as a graph on a timeline; and Time Slice View (TSV) that displays a table of numeric data for all the clinical information items. They can be selected depending on the current purpose. Our own database technology has enabled the quick display of the aggregated clinical information.

*1 Values and waveform information indicating the current conditions of the human body (pulse, heart rate, respiratory rate, blood pressure, body temperature, etc.)

*2 Acronym for Clinical Advanced Viewer

*3 The collective name for FUJIFILM radiology PACS (Picture Archiving and Communications System) products. The PACS is a medical-use image information system that electronically stores, retrieves and analyzes examination image data from medical-use image diagnosing systems such as CT, MRI and CR equipment.

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## 2.1 Characteristics of the system

(1) Display of changes in the patient's conditions on a timeline in a single window

The TLV (Fig. 1) aggregates information required for clinical practice, such as basic information about the patient, examination images, sampling data, medication data and vital information, and instantaneously converts the data into a time-series graph in the window via simple user operations.

The display period can be changed via the intuitive operation of sliding the time scale setting bar. The graph can also be scaled up or down. That enables the easy, visual understanding of changes in the patient's conditions.

(2) Display of clinical information narrowed down by major disease using an original function

We have developed a smart function incorporating opinions from physicians, which allows the narrowing-down of clinical information items for each major disease. That streamlines the extraction process of data required for the disease from among enormous quantities of information.

(3) Display of a table containing numeric data for all the clinical information items

The TSV (Fig. 2) displays and enables easy reference of data of all the examination items without omission. In this view window, it is possible to check data even before the disease is identified, for example, at the first visit of the patient. After the identification of the disease, even when clinical information narrowed

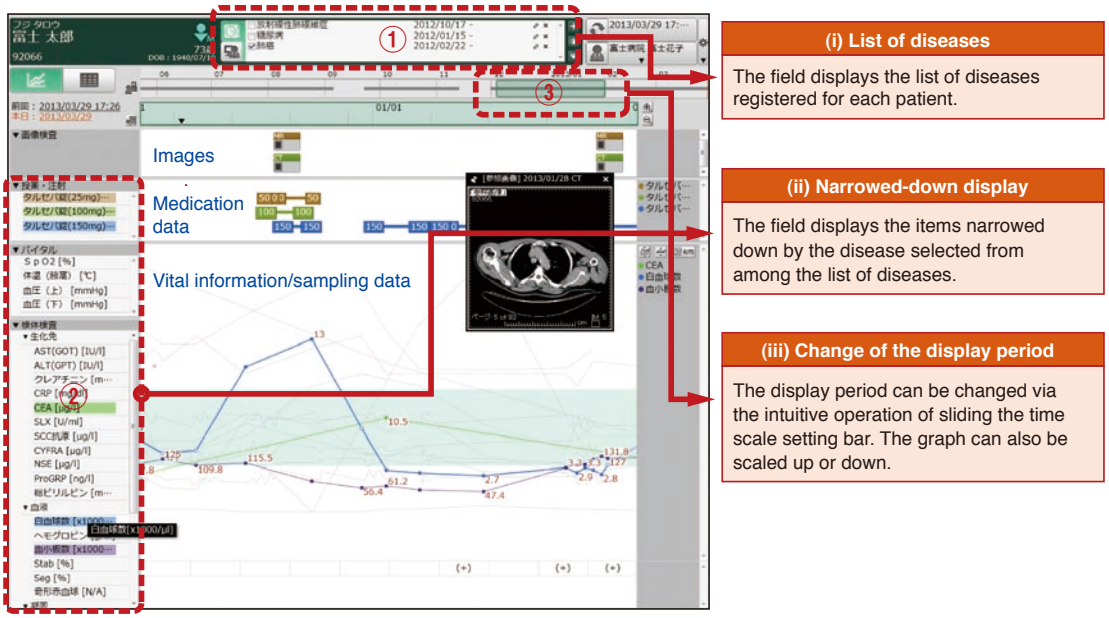


Fig. 1 Time Line View (TLV).

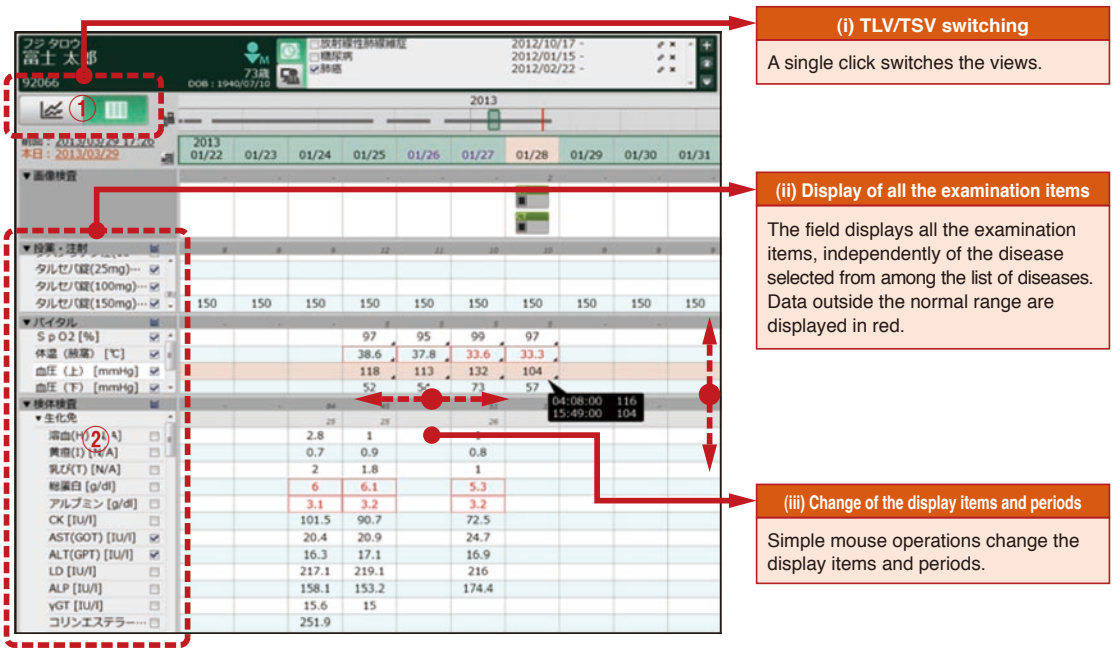


Fig. 2 Time Slice View (TSV).

down by disease is being referred to in the TLV, the window can be switched easily to the TSV, allowing the confirmation of numeric data of all the other clinical information items that are not displayed in the TLV.

(4) Linkage with SYNAPSE and VINCENT

Linking with SYNAPSE, the CA-V allows easy reference of examination images simply by setting the cursor over the target image icon. It can also display image diagnosis results in combination with our reporting system. Moreover, it is possible to view 3D image analysis results of SYNAPSE VINCENT from the CA-V.

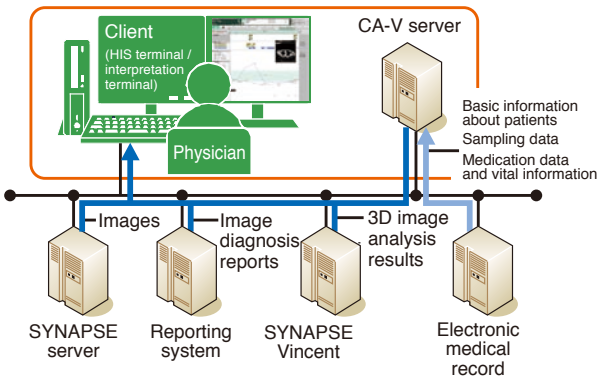


Fig. 3 Example of system configuration.

## 2.2 Configuration of the system

The system consists of a CA-V server and client terminals. The client terminals display clinical information using a web browser. The basic information about patients, sampling data, medication data and vital information are recieved from the Electronic medical record server. Fig. 3 illustrates a configuration example.

# 3. Database technology that enables high-speed display

Figs. 4 and 5 illustrate our original database technology that has realized high-speed data access. As shown in Fig. 4, this system does not recieved data as a set of all the necessary detailed information of each patient but creates purpose-specific summary tables (dimentions are data type and time : month · day), which enables rapid data reception.

In addition, as shown in Fig. 5, stratified reception of data required for display solves the issue of slow access observed in a conventional system when a large amount of clinical information is gathered in the case of longer treatment periods.

# 4. Product concept and value of the CA-V

The system was developed to visualize the clinical information and support physicians with their clinical decisions based on

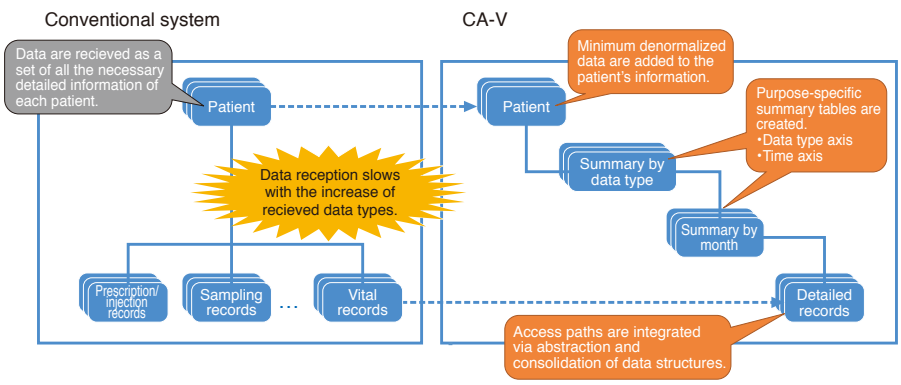


Fig. 4 Building a database summary for each object.

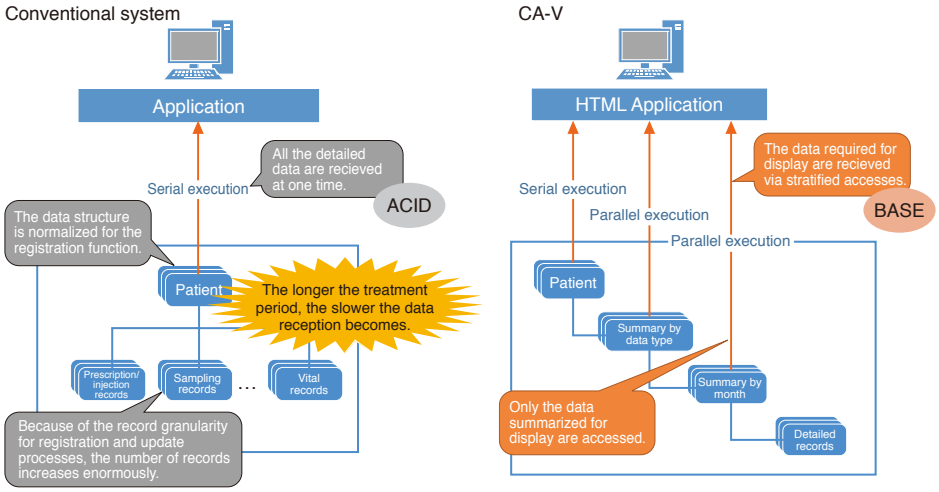


Fig. 5 Parallel data acquisition by BASE transaction.

the following concepts.

(i) Simple presentation of numerous types and enormous quantities of independently managed medical data

(ii) Pin-point reception of essential data

(iii) Visualization of important patterns and relations

It visualizes clinical information by displaying an aggregated item of values and graphs and their changes on a timeline.

### 4.1 Difference from conventional systems

(1) Issues of conventional systems

Current hospital information systems consist of several independent subsystems, such as the Electronic medical record system, examination system, nursing system and PACS, and the data are managed individually by the associated subsystems, for example, examination results by the examination system, nursing information by the nursing system and images by the PACS.

The main purpose of keeping Electronic medical record is to manage clinical descriptions as well as medication and examination orders; therefore, although being the primary tool to view a variety of data, they are not sufficient to display comprehensive data integrated from detailed records.

In the light of clinical practice, it is sufficient to view the examination results of a single day at the first visit of the patient but, when he or she is hospitalized, it is important to observe changes with time, comparing treatment and/or medication with the consequence (examination results) including side effects.

However, it is unrealistic to display all the raw medication and examination data on a timeline in a single window because the number of display items will then be enormous. In addition, such a volume of information will cause problems of system performance. Consequently, proper operability of Electronic medical record has not been realized.

(2) Solutions provided by the CA-V

The extent of medication and the role and importance of examinations vary depending on the patient. Sometimes, in addition to those to check the conditions of the current disease, examinations are carried out to detect other unexpected symptoms. In the former examinations, time-series display is useful while, in the latter, an indication of the results per examination may be good enough.

In medication, minor information, such as those about medicine for chronic maladies not directly related to the main disease and about intravenous infusions, is not necessary to confirm the condition of the treatment of the main disease.

That is, if the display items are limited to only those requiring the time-series confirmation of data essential for the clinical practice of the target disease, the number can be reduced greatly, which can fit into a single-window display.

We then developed and incorporated into the system a function in which users can display only essential data on a timeline by simply selecting the target disease according to the pre-defined display items for each disease (the "disease-specific display item set"). That has enabled physicians to easily refer the data of interest and to reduce the considerable amount of time and labor required to confirm the details.

Furthermore, by displaying medication data and examination results on a timeline, it has become possible to easily find the relationships between cause (treatment and/or medication) and effect (improvement and/or side effect). That allows physicians to concentrate on their original duties, clinical decisions and practice, without being bothered by the manipulation of tools.

### 4.2 Supported diseases of disease-specific view

We considered possible treatments and examination purposes for individual diseases according to clinical practice guidelines, etc.,[1)-12)] and incorporated into the system a definition file of items to be displayed on a timeline for each disease (disease-specific display item set). Currently, the display item set responds to about forty diseases (Table 1). It is available for use from the moment

Table 1 Supported diseases of disease-specific view.

| | Respiratory organs | Circulatory organs | Digestive organs | | Internal secretion |
|---|---|---|---|---|---|
| | | | Stomach and intestines | Liver, biliary tract and pancreas | |
| Cancer/tumor | Lung cancer | | Stomach cancer<br>Esophageal cancer<br>Colorectal cancer<br>GIST | Hepatic tumors<br>Biliary tract cancer<br>Pancreatic cancer | Thyroid cancer |
| Other major diseases | Lung infection<br>COPD<br>Interstitial pneumonia | Ischemic heart disease<br>・Angina pectoris<br>・Myocardial infarction<br>Heart failure | Gastroduodenal ulcer<br>Ulcerative colitis<br>Crohn's disease | Hepatitis<br>Cirrhosis<br>Cholangitis/ cholelithiasis<br>Pancreatitis | Diabetes |

| | Rheumatism/ collagen disease | Urinary organs | Breast oncology | Gynecology |
|---|---|---|---|---|
| Cancer/tumor | | Kidney cancer<br>Prostate cancer<br>Bladder cancer<br>Upper urinary tract cancer | Breast cancer | Cervical cancer<br>Endometrial cancer<br>Ovarian cancer<br>Uterine fibroid |
| Other major diseases | Rheumatoid arthritis<br>Other collagen diseases | Chronic kidney disease/ renal failure<br>Dialysis | | |

the system is introduced to the site.

The disease-specific display item set is defined by broad categories of diseases. For example, lung cancer, lung infection, chronic obstructive pulmonary disease (COPD) and interstitial pneumonia are defined for respiratory organs, which can cover over 70 % of inpatients with respiratory disease.

The display item set covers major diseases, including lifestyle disease, as well as those requiring hospitalization for which examinations are essential.

Major diseases in the categories outside the scope of the current version will be supported as required in the next version onward.

### 4.3 Use of the TSV and TLV

(1) TSV

This view is designed to display the general data only around a specified date of medication and examinations performed on a patient for the confirmation of his or her condition at the first visit or unexpected symptoms in follow-up observation.

In general, Electronic medical records provide result data as a list per examination. Therefore, it is often difficult to identify the data of examinations rarely carried out if the dates are uncertain. However, this view displays a list of all the examination items, allowing easy reference of such rare data.

(2) TLV

The details of this view are illustrated in Fig. 6 below. The displayed information is not actual data but an example created for the purpose of explanation.

The list of diseases at the upper center of the window shows that this patient suffers from lung cancer and diabetes. Currently, "lung cancer" is selected and medication and examination data narrowed down by the disease are displayed. In cases where the patient has multiple diseases, selecting the checkbox for the target disease in this field displays the associated clinical data items.

The major medicines for lung cancer are anti-cancer, side-effect treatment and analgesic drugs. Analgesics are important only for advanced cancer; therefore, they are not displayed in the figure (the visibility is selectable). In this case, the first course of treatment was conducted with paclitaxel and carboplatin as anti-cancer drugs.

Examination items displayed are of vital signs (e.g., body temperature, pulse) to confirm the basic conditions of the patient, sampling data requiring caution to check for side effects of anti-cancer drugs and tumor markers to check the condition of cancer.

The figure shows a drop of the white blood cell count (WBC count), which is a typical side effect of anti-cancer drugs. When the count decreased to 900/μL, which was lower than the level that requires remedy (1000/μL), a treatment drug, Gran Syringe, was administered. It is clear at a glance that, as a result, the condition of the patient was improved. Consequently, in the second course, the dosage of anti-cancer drugs was reduced, considering side effects.

In addition, it is possible to view image data in the TLV. That allows easy confirmation of curative effects by comparing the sizes of tumors before and after anti-cancer therapy.

The above example is a case of a short-period display. The time scale can easily be changed as required. For example, it is possible to set a longer display period for image data and tumor marker information to about one year for follow-up observation after cancer therapy. Setting a long time scale enables the recognition of gradual changes in tumor markers that are not easily detected.

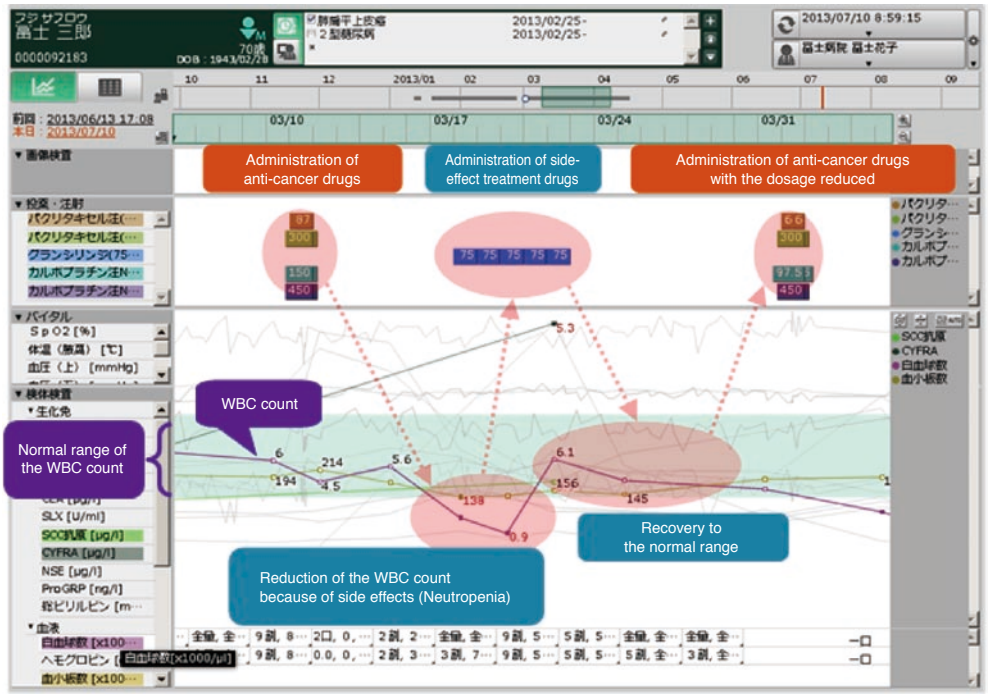


Fig. 6 Case of using Time Line View in clinical practice.

In reality, even after a diagnosis is made, the conditions of the disease vary depending on the individual patient and the confirmation of extra examination values may become necessary. In such cases, the display items of the TLV can be added via the TSV. The added items are saved together with the disease information of the patient. Therefore, next time the data of the same patient are referred, they are displayed in the TLV without setting again.

As described, the CA-V provides, via simple operations and in an easy-to-understand way, the information useful for a series of clinical processes such as the understanding of the contents of treatment, confirmation of its curative effects, recognition and treatment of any side effects, creation of new treatment plans and follow-up observation.

(3) Snapshot function

The timeline windows also display the summary of the course of important information for patients.

This system has a function that takes "snapshots" of the windows, saves and refers them at any time. It is expected that the function will be useful on various occasions, such as conferences, where physicians and health-care providers need to be involved in clinical practice, sharing the conditions of patients.

## 5. Conclusion

We developed the CA-V to efficiently provide optimal views of information at clinical sites where it is necessary to refer to enormous quantities of diverse clinical data and make decisions about diagnoses and treatment strategies based on them. The system thus aims to help physicians to make clinical judgments.

We are planning to add support functions and to further improve the information sharing function in the future.

We hope that the system will be introduced widely into clinical sites and will contribute to various clinical activities conducted there.

## 6. Acknowledgement

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## Trademarks