

# The Application of Healthcare Information System for Comprehensive Geriatric Assessment

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**ABSTRACT:** *This paper is to integrate information technology and medical-related technologies to develop a healthcare information system for Comprehensive geriatric assessment (CGA). This system not only can process geriatric consultation services and ensure that all patient's information are stored in standardized format, but also provide medical personnel for statistical analysis and processing purposes. Moreover, this paper uses the Apriori algorithm of data mining for helping doctors to find out the relationship of geriatric syndrome. The systems of this study can enable organizations to meet their business objectives for increasing service capacity, cost control, revenue generation, while maintaining high quality of care for the patients in geriatric care. Furthermore, making the theories and applications of medical informatics will be more extensive and convenient for researches and healthcare-related industry.*

**KEYWORDS:** *Comprehensive Geriatric Assessment, Healthcare Information System, Data Mining, Association Rules, Elderly, Hospitals.*

## 1. Introduction

The number of older persons in Taiwan requiring healthcare will progressively increase over the next few decades. However, the population group that currently constitutes the majority of the health-care workforce will remain virtually stable (Kuo, 2010). Information technology (IT) plays an increasingly central role in the Taiwan healthcare industry. Using IT in a strategic and innovative manner to support health-related decision making represents a serious challenge for health care organization management, as well as for system developers (Chen, 2009). The hospitals also consider how to handle mutual relationship with patients by IT planning and evaluation. Thus, it is key issues to establish good connection to meet the needs by means of decision support information system (Dowling, 1980). The applications concentrate on giving an organization an IT-based strategy for meeting competitive challenges (such as by using emerging Web technologies to integrate healthcare organizations internally and externally) (Yang & Hwang, 2006).

Comprehensive geriatric assessment (CGA) is a core procedure in specialist geriatric care. There is evidence that this process improves functional recovery, reduces morbidity

and attenuates demand for long-term institutional care (Stuck et al., 1993). It is central to geriatric consultation services which are the vehicle for delivering CGA to hospital patients who are not located in specialist geriatric units. Evidence of the impact of geriatric consultation on patient outcomes is mixed (Gray, 2007). However, geriatric consultation incorporates important triaging decisions to inpatient geriatric assessment, rehabilitation, long-term institutional care and complex community support programs. The system of this paper can upgrade administration information, increase service capacity, reduce personnel costs, and improve the quality of patient care in geriatric medicine. The system not only can help medical institutions to collect patient's relevant information and allow the contents of standardized assessment's form in order to increase diagnostic accuracy, but also enhance the quality of geriatric care environment in medical centre.

## **2. Background**

### *2.1 Comprehensive geriatric assessment*

CGA is a kind of integration of a variety of professional areas of assessment methods. It's a multidimensional assessment consisting of functional, emotional and cognitive components, and focused on a few of the many possible domains that are often reflected in the geriatric and gerontology literature (Overcash et al., 2005).

A CGA can be effective only if there is a process for identifying elderly patients who may benefit from it. In most cases, they are elderly individuals who are frail and disabled or have multiple interacting conditions, as opposed to relatively healthy older people (including those whose health conditions are addressable by usual medical approaches) and those with serious focal chronic conditions for whom disease management by primary care with input by other subspecialists is appropriate (Leung, 2004). Examples include an older patient who appears to be on a rapid downward trajectory toward nursing home placement and a previously functional senior who is requiring increasing assistance to accomplish daily tasks, triggered by the project through the assessment concluded that the results with a variety of professional diagnostic and disposal of frail elderly people to discover the physical, psychological, social and functional problems, and pinpoint the problems and to present a complete package of programs and appropriate treatment, thus improving the elder's disease symptoms (Maas et al., 2007).

CGA offers a healthcare model that integrates medical care with social support, and could be carried out in wide variety of settings including: acute hospital units, chronic hospitals, inpatient geriatric consultation, outpatient department, nursing home, and home visits, helping medical personal to assess older patients include the measure of ability in different areas, monitor changes, evaluate treatment effects, quality assurance,

care planning and funding arrangement. Table 1 provides a list of basic components usually included in a CGA. While the detailed elements vary, virtually all CGAs -- whether relatively simple multidimensional assessments for screening purposes or fully elaborated team assessments -- include medical, psychological, social, and environmental components, as well as functional components (at the level of activities of daily living [ADLs] and instrumental activities of daily living [IADLs]) (Solomon, 1988).

**Table 1** Components of Comprehensive Geriatric Assessment

Component	Elements
Medical assessment	Problem list Comorbid conditions and disease severity Medication review Nutritional status
Assessment of functioning	Basic activities of daily living Instrumental activities of daily living Activity/exercise status Gait and balance
Psychological assessment	Mental status (cognitive) testing Mood/depression testing
Social assessment	Informal support needs and assets Care resource eligibility/financial assessment
Environmental assessment	Home safety Transportation and telehealth

## 2.2 Data mining

The successful application of data mining in highly visible fields like e-business, marketing and retail have led to the popularity of its use in knowledge discovery in databases (KDD) in other industries and sectors. Among these sectors that are just discovering data mining are the fields of medicine and public health. This research paper provides a survey of current techniques of KDD, using data mining tools for healthcare and public health. It also discusses critical issues and challenges associated with data mining and healthcare in general. The research found a growing number of data mining applications, including analysis of health care centers for better health policy-making, detection of disease outbreaks and preventable hospital deaths, and detection of fraudulent insurance claims (Bellazzi & Zupan, 2008; Huang, Chen & Lee, 2007).

In computer science and data mining, Apriori is a classic algorithm for learning association rules. Apriori is designed to operate on databases containing transactions (for

example, collections of items bought by customers, or details of a website frequentation). Other algorithms are designed for finding association rules in data having no transactions, or having no timestamps (DNA sequencing). As is common in association rule mining, given a set of itemsets (for instance, sets of retail transactions, each listing individual items purchased), the algorithm attempts to find subsets which are common to at least a minimum number  $C$  of the itemsets. Apriori uses a “bottom up” approach, where frequent subsets are extended one item at a time (a step known as candidate generation), and groups of candidates are tested against the data. The algorithm terminates when no further successful extensions are found (Agrawal & Srikant, 1994; Delen, 2009).

### ***2.3 The aims of the system***

The system for delivery of CGA was developed in response to three primary challenges (Kuo, 2011; Kuo & Chung, 2010):

- (1) The assessment information of patient is not easy to save and hard to further data analysis (e.g., data mining).
- (2) Geriatric consultation is delivered by geriatricians and gerontic nurses, sometimes with support from other allied health specialists. This process is time consuming and involving much human resource.
- (3) The dependence on rare and expensive geriatrician time is reduced without compromising quality of care or accuracy of decisions.

To resolve these problems, this paper combined information technology and medical-related technology to develop a healthcare information system. The system is a computer-based medical information system. It also is an interactive computer information system that can help medical personal to complete their job.

## **3. The proposed system**

### ***3.1 Case description***

This case study, selecting a medical center of Taiwan Teaching Hospital in northern. This medical center was established in 2005, which includes 10 bed geriatric units, 4 clinic rooms, with four attending physicians, a number of specialist physicians, case specialist and assistant to provide elder patients a full range of services.

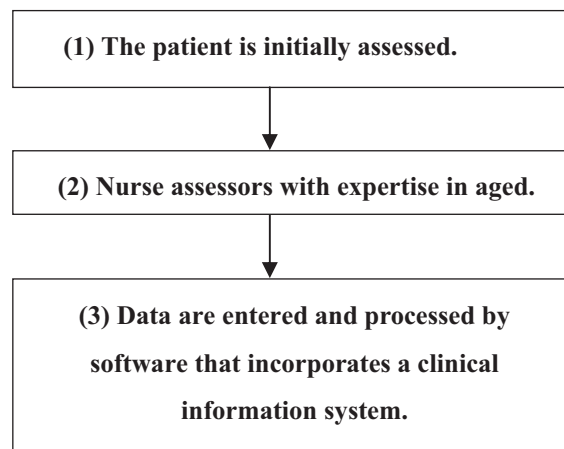
The geriatric consultation service assesses patients who may require health care or permanent residential care. Case specialist provides the initial assessment and comprehensive geriatric assessment, and assistant entered online by the information

system. After finished the assessment, the report will show on the system, the patient's data can further statistics analysis automatically and generating further reports immediately. These comprehensive reports can replacement for hand-written progress notes. The attending physicians or specialist physicians will assess the patient's symptoms and propose data, with the physician's own professional knowledge and long-term accumulated experience to do a correct medical diagnosis.

### 3.2 The basic schema

The proposed system basic schema for CGA is as follows (Figure 1).

- (1) The patient is initially assessed by a training doctor of the clinic.
- (2) Assessments are administered by nurses with expertise in aged care. They draw on information derived from patient interview and observation, interview of direct care staff and family members and from the medical record.
- (3) Enabling assessment record sharing among the consultation team and other stakeholders.



**Figure 1** The Proposed System Basic Schema

### 3.3 System function framework

The proposed system is divided into three subsystems: data management, follow-up, query and analysis.

#### 3.3.1 Data management subsystem

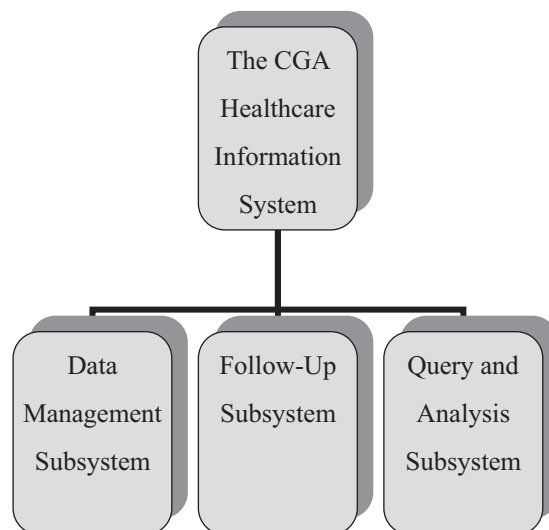
It contains the patient data management, patient functional assessment, drug evaluation, the overall project evaluation and treatment satisfaction survey.

### 3.3.2 *Follow-Up subsystem*

It contains the patient recorded the data of assessment, follow-up management and satisfaction survey the views of inspection. The subsystem mainly uses the object as an assistants and case specialists. Follow-up patients' change is also an important part of the assessment, it can be an efficient filter to help users keep track of patient and record whether the patient's body function decline of the situation, and necessary in order to provide patient-related assistance and treatment.

### 3.3.3 *Query and analysis subsystem*

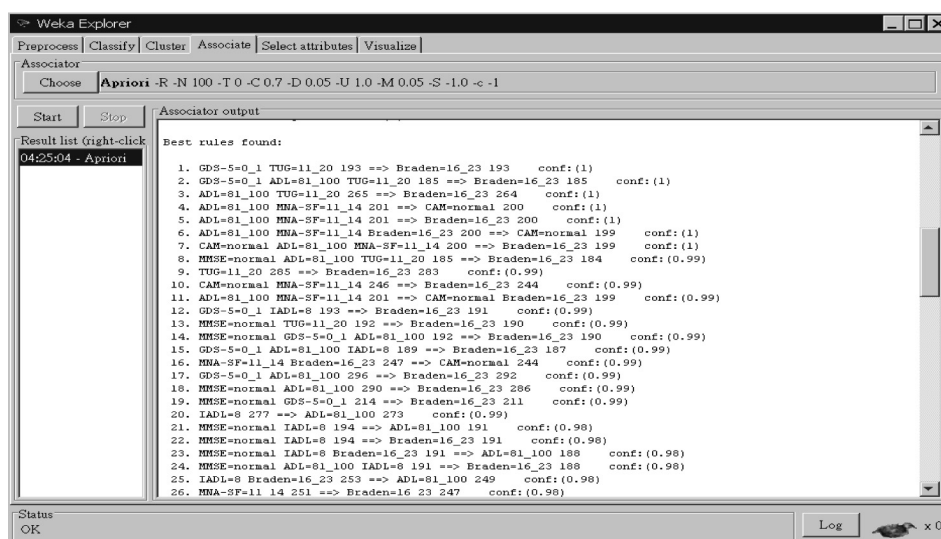
This subsystem contains the results of patient assessment information, the assessment scale analysis diagram and satisfaction survey analysis diagram. The subsystem of the main user is attending physicians and specialist physicians. Query and analysis subsystem can assist doctor quick overview an assessment of each patient's complete information in order to give a proper diagnosis and follow-up treatment of movement; the subsystem can also analysis the contents of the database, integrated the information into a clear image, so that physicians can be targeted medical center for all patients, making a comprehensive assessment in order to understand the majority of patients prone to common diseases. The completely function interface of healthcare information system see Figure 2.



**Figure 2** The System Function Framework

## 4. Result discussion

The 980 samples of assessment scale in this paper will be collected and categorized, which contained all elderly patients over 65 years old (630 males and 350 females). Using the Weka software tool for further analysis (data mining), which with built-in association rules of the Apriori algorithm (Figure 3). Weka is an open source data mining framework, integrates multiple algorithms for classification, clustering, association rule, etc., and supports abundant data Input/Output (I/O) and visualization functionalities (Sigurdardottir, Jonsdottir & Benediktsson, 2007).



**Figure 3** The Association Results of Apriori Algorithm

Making multiple association rules analysis and summarized a holistic integration result, we found out five common aging diseases (symptoms) for helping doctors to find out the relationship of geriatric syndrome to identify potential patients in the assessment and the relevance of the information (Table 2).

The five symptoms were dementia, disability living, malnutrition, falls and polypharmacy as follows:

### 4.1 Dementia

Clock drawing test (CDT) contains the evaluation function of action behavior, planning and implementation, graphics construction, visual-spatial understanding, number sense and other cognitive mental status, so the evaluation can directly judge the relationship with dementia. Mini nutritional assessment (MNA) and falls risk assessment



**Table 2** The Five Aging Symptoms Analysis

	Dementia	Disability living	Malnutrition	Falls	Polypharmacy
MMSE (mini mental state examination)	--	•		•	
CDT (clock drawing test)	•				
GDS (geriatric depression scale)		•	•	•	•
ADL (activities of daily living)		--	•		
MNA (mini nutritional assessment)	•		--	•	•
Braden					
Falls (falls risk assessment)	•	•		--	
TUG (timed up and go test)		•		•	

(Falls) leading dementia of the elderly caused by malnutrition may often forget to eat food or a pica. On the other hand, the elderly fear of falling to reduce activity or prolonged bed rest, will cause some problems of variation in the metabolic response, decreased exposure to outdoor activities and the opportunity to interact with others, which will lead to the cognitive problems or dementia at the psychological level.

#### 4.2 Disability living

The main reason of mini mental state examination (MMSE) function leading disability living is abnormal for the ability of patient's memory, construction, operation and execution. This will affect the function of activities of daily living normal execution, for example, patients may have some problems to perform some daily activities, such as brushing teeth, bathing, walking.

Geriatric depression scale (GDS) may be complicated because of severe depression symptoms or dementia caused by depression cases. Patients with depression may have delusions, auditory hallucinations and other psychotic symptoms, which leading to inappropriate behavior, such as difficulty walking or unable to interact with others, these acts can lead to disability living. Patients with the elderly most common diseases of limbs problems, musculoskeletal problems, a degenerative joint disease or osteoporosis are usually easy to fall, and may be loss of the ability of daily activities.

Falls can easily connect with disability living. The elderly patients with timed up and



go test (TUG) problem often limit walking distance caused to the poor activities of daily living, it will also lead to functional disability of daily living. Sherman (2001) pointed out that if the subjects can fulfill assessment within ten seconds, we can predict the patients' activities of daily living (ADL) function will be able to maintain stability.

#### *4.3 Malnutrition*

GDS related to the elderly suffering from depression, because of emotional and psychological stress impacting, it leading unwilling to eat, appetite and other phenomena, or even serious anorexia, which making elderly patients occur malnutrition caused by nutrition ingestion insufficiency.

The main reason of ADL affecting malnutrition is reducing daily activity. Whenever patients have abnormal phenomena of eating, shopping, food preparation or action function, it will let the patient being nutrition risk caused by nutrition ingestion insufficiency. Usually, these cases occurred in elderly people of living alone or lacking proper care.

#### *4.4 Falls*

MMSE and GDS are associated with falls risk. It is very important information that whenever the elderly patient with abnormal mental state, they may increase the risk of falls, we should improve the psychological impact of the falls risk disease. In addition, MMSE is not entirely abnormal psychological problems, it also occurs in neural disorders, so sometimes need to do further assessment of physical condition.

MNA associated with falls risk patients may be physical weakness caused by malnutrition. TUG and falls risk shows more direct relationship. For example, the elderly patients with poor standing in walking test performance, which often have moving problems and need rehabilitation therapist for further careful evaluation. Moreover, basic information of the elderly patients reveals the visual impairment and sleep problems also related to the falls risk.

#### *4.5 Polypharmacy*

Polypharmacy is common problem of elderly patients. The association rules shown GDS, MNA and sleep problems are associated with polypharmacy. GDS is a mental illness, there would be more easily with complicated on medication.

The elderly may take some medications (such as antibiotics, Aspirin and other drugs) causing weight loss, loss of appetite, nausea, and malabsorption problems. Sleep problems can be directly associated with sleep aids drugs. The three drugs need to be careful consideration to avoid elderly people taking too many drugs causing other physical or psychological problems.

## 5. Conclusion

Comprehensive geriatric assessment is a core procedure in specialist geriatric care. There is evidence that this process improves functional recovery, reduces morbidity and attenuates demand for long-term institutional care. This paper is intended to integrate information technology and medical-related technologies to develop a comprehensive geriatric assessment healthcare information system for geriatric care. This proposed system is divided into three subsystems: data management, follow-up, query and analysis subsystem, which not only can process geriatric consultation services, and ensure that all patient's information are stored in standardized format, but also provide medical personnel for statistical analysis and processing purposes. Making multiple association rules analysis and summarized a holistic integration result, we will find out some common aging diseases for helping doctors to find out the relationship of geriatric syndrome to identify potential patients in the assessment and the relevance of the information. Moreover, coupled with professional medical team to assess and provide comprehensive healthcare service plans for improving the situation of the elderly patients. The systems of this study can enable organizations to meet their business objectives for increasing service capacity, cost control, revenue generation, while maintaining high quality of care for the patients in geriatric care. Preliminary evaluation suggests the system to be reliable, safe, efficient and appealing to clinicians.

We have the following conclusion:

### *5.1 Electronic medical information record*

This system not only can store patient's complete information in the database, but also ensure that all patients' information stored in standard format and easy to follow-up. It not only can achieve paperless assessment, but also reduce the personnel and resource costs.

### *5.2 Standard geriatric assessment*

The assessment system therefore acts as a clinical decision support system. For less-experienced practitioners it serves the purpose of interpreting basic observations to enhance the diagnostic and evaluation performance of the assessor. It also ensures that all patient information is stored unified format to provide medical personnel for further statistical analysis purposes.

### *5.3 Enhance the quality of geriatric care environment*

Use of information system's assessment results to assist the medical personnel based on individual patient's needs and symptoms, formulate a comprehensive patient care plan,

coupled with our professional medical team to assess and provide comprehensive health care service plans to help improve the situation of the elderly patients. The system of this paper can upgrade administration information, increase service capacity and diagnostic accuracy, it also enhance the quality of geriatric care environment in medical centre.

#### 5.4 Identify the potential symptoms of patients

Making multiple association rules analysis and summarized a holistic integration result, we found out five symptoms (dementia, disability living, malnutrition, falls and polypharmacy) for helping doctors to find out the relationship of geriatric syndrome to identify potential patients in the assessment and the relevance of the information.

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