The Decision Making for the Admission of Febrile Geriatric Patients

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The whole world has entered the aging society. Due to economic considerations and care needs, some elderly were taken care by responsible foreign domestic helpers, and some received care at long-term care facilities, but other healthy elderly can take care by themselves. This study mines and analysis data of 615 febrile geriatric patients visiting the emergency room in the past three years with a retrospective method. Our study reveals that associated factors: “pyuria” or “not well functional status of the body” provides an important reference for the clinical physicians to make the elderly patients hospitalization. The decision-making tree inducts useful rules for clinical doctors to follow, especially for the new staffs.

Keywords: primary; decision-making; data mining; decision support systems
1. Introduction

The average human life expectancy extends due to advances in medical technology. With the degradation of the recession organ physiology, immune function (Yoshikawa TT, 1994), malnutrition, the prevalence of chronic diseases and invasive medical procedures etc, The elderly get the higher rate of infection (Zhang Jiaming, Feng-Hwa Lu, Wen-Chien Ko, 2005). In addition to the fever phenomenon, the infected geriatric patients can also present in the following manners, for example, become less appetite, poor digestion, decreased urine output, faster breathing rate, or drowsiness, eyes become more sluggish and physical weakness, etc. There may be infection or sepsis (Ye Hongming, Lin Sen, Cai and U.S., 2003; Berman P, Hogan DB, Fox RA, 1986). Therefore, besides perceptible febrile signs, the subtle changes in everyday life are important clues to understanding whether the elderly are already infected. But it depends on the patient's self statements or the primary caregiver observation and description. That can assist the clinical physicians to obtain important clues, and then piece together the whole picture of infectious disease of older people.

Because most of the elderly have combined dementia, old stroke, mental and physical disorders and chronic diseases, the symptoms are often not clearly complained, so that the physicians want to get clues for the disease diagnosis from patients statements are often difficult (Jónsson A, Bernhöft I, Bernhardsson K, 2005). As growing older, the chronic comorbidities and complications are also increased. The proportion of the elderly population
who are unable to describe their symptoms will be higher and higher. When doctors could not
get important diagnostic clues from older patients complaint, they must find the clues from
the caregiver supplementary notes.

Due to changes in the social structure and increase the proportion of the elderly population,
some home care can apply for and obtain foreign caregivers to help care for the elderly, but
there are still many elderly who could not get such care assistance. Many types of long-term
care facilities thus developed and grew, such as: nursing home care agencies, nursing homes,
mental nursing home or long-term care centers and other classes (Reuben DB, Schnelle JF,
Buchanan JL, 1999); Therefore, the main caregivers of the elderly are generally made of
"families" to "foreign caregivers" or "long-term care institutions caring staff." When the
febrile geriatric patients visiting the emergency room, if they could not state their symptoms,
then doctors get help from the primary caregiver descriptions. However, the emergency
physician often obtain the limited information from the primary caregiver, and unable to make
diagnosis due to lack of enough. The main reason is that primary caregivers, the staffs of
long-term care facilities, have to take care of many elderly people and could not complete a
full account of the symptoms of the individual patient. Besides, if the caregivers are
foreigners, they encounter language barrier and communicating problems. Therefore, to make
diagnosis of the disease for the febrile geriatric patients at the emergency department,
emergency room physicians often face the aforementioned diagnostic challenge (Chou MY, et

When the elderly presents mild fever at the emergency department, the fever symptoms may be not necessarily related to the infectious disease (Castle SC, Norman DC, Yeh M, Miller D, Yoshikawa TT, 1991). However, to the emergency room clinicians, to make diagnosis of fever in the elderly patients is in addition to refer to the patients themselves, their families and caregivers, but also hope to have some clear indicators. Following these indicators, the emergency room physicians can take appropriate disposal, for example, need to recommend high-risk patients inpatient treatment, or low-risk patients outpatient treatment.(Chen Ding Da, et al. 2005; Dosa D, 2005; Aizen E, Swartzman R, Clarfield AM, 2001). When the emergency room physicians can accurately hospitalized elderly patients to make the right assessment results will lower hospital costs for these patients. Besides, to provide adequate medical care for these high risk patients can make less complication and mortality and reduce health insurance spending and medical disputes. With the development of information technology, it is becoming an essential clinical practice guidelines and tools for teaching and research in medicine. Data mining technology in the medical field have become the most valuable application of a technology tool that provides medical staff diagnosis, treatment and disposal of decision support (Zhang Yuntao, Gong Bell, 2007). Therefore, this study attempts to use data mining techniques in the classification analysis for inpatient or outpatient treatment of the febrile geriatric patients at the emergency room which mining analysis of the
decision-making factors and exploration elderly hospitalization rules. That can assist the medical team to conduct more appropriate assess, improve health care quality and reduce waste of health insurance resources.

2. Materials and Methods

2.1 Study

This study retrospectively collected clinical data required for analysis from the emergency department of a regional teaching hospital in southern Taiwan. There are 709 beds available for the acute and chronic care in the healthy insurance system. In 2011, the average occupancy rate was 73.87%. The average person visits of the emergency department patients was 702 person visits per month. The study collected total febrile geriatric patients visiting the emergency room in three-year period during January 2009 to December 2011. The definition of fever of elderly at the emergency room was when the patient's forehead or axillary temperature is greater than the temperature at 37 °C (Dean C. Norman, 2000; Castle SC, et al. 1993). The patient’s age who is older than 65 years of age is considered elderly or geriatric cases. This study had excluded the cases that didn’t complete the course at the emergency room due to referral or discharge against advice. Because that could not be judged whether hospitalization or not is related to the severity of illness. Meanwhile, when the cases were too many gaps in the data entry will be deleted. This study collected 615 cases, with an average
age of 83.8 years old, including 531 male (86.3%) and 84 females (13.7%). Among those who have their own place of residence is 350 people (56.9%) and live in long-term care facilities are 265 people (43.1%). There are 227 people (36.9%) who are able to take care of themselves. The remainder 388 people (63.1%) relies on the assistances of others or are in bedridden status. After receiving the emergency management, there are 452 people (73.5%) need to be hospitalized for the further treatment and 163 (26.5%) need outpatient treatment.

2.2 Dimensions and variable of data

This study had explored the three major dimensions which presented when the geriatric patients visiting the emergency room. The study collected the variable from vital signs checking, physical status description and laboratory and examination results. And then they are used to extract rules from the decision tree by data mining analysis to decide outpatient or inpatient treatment by the emergency doctors. Three dimensions of patient data described in this study were (1) supportive care system and physical functions, (2) vital signs, (3) laboratory and examination results.

The meaning and operational definitions of the variables in three dimensions are as following:

(1). Supportive care system and physical functions:
a. Age: The body function decline with the age. The immunity function will be relatively poor as older.

b. Patient residence (source): Patients in this study will be divided simply into two dwelling categories from self-house and long-term care facilities. In general, the patients who live in home mean they have better self-care functions. Despite they have been cared by foreign caregivers at home, they usually get the ratio of 1 to 1. Then they can get better care and better interaction with the patient's family members. If the patient accommodation for long-term care facilities, caregivers often have to care for a number of elderly living. Cases collected in this study, if its residence is long-term care institutions, the source of long-term care sector contains the Veterans Home, the nursing homes attached to the hospital, and community nursing homes.

c. Physical functions (High KP, Bradley S, Loeb M, Palmer R, Quagliarello V, Yoshikawa T, 2005): If the elderly can take care of themselves, they have better function of expectoration of sputum or urine voiding, and they will also have better immunity. If the elderly need to rely on others to take care or are long-term bedridden, they often need assistance from the caregiver for expectoration of sputum and changing position to prevent from bedsores occurrence. These cases often require foley catheters, urine bag, or a nasogastric tube and other invasive medical tubing facility. Therefore, physical function and immunity in these cases is poor, by contrast, infection rates will be higher.
(2). Vital signs:

a. Body temperature: If the patient's body temperature reaches fever extent, represents the patient's body has inflammation or infection in progress.

b. Respiration rate: When the patient's respiratory rate gets faster, it means the body needs more gas exchange of oxygen and carbon dioxide; it also means that the body cannot cope and has a distress situation.

c. Heart rate: The faster heart rate means that the body feels physical discomfort. Sometimes, the faster heart rate is to compensate for low blood pressure. Sometimes, heartbeat too fast is because arrhythmia, or induced severe heart disease.

d. Blood pressure: high systolic blood pressure means that the body has a distress response and will increase the chance of stroke at the same time. Besides, low blood pressure means that the body organs are under low perfusion and lose their function so called shock phenomenon.

(3). Laboratory data and examination results

a. White blood cell counts: When the total counts of white blood cells in patients are higher and lower than normal limit means that may present a serious infection status.
b. Inflammation index CRP (C-reactive protein) value: if patients were detected CRP index greater than the normal range, it means that the body currently has inflammation or infection in progress.

c. Chest X-ray results: According to the physician's interpretation, to decide whether the patient has signs of pneumonia.

d. Urine routine test result: check whether patients have pyuria signs. When the urine samples of patients under microscopic examination present the number of white blood cells in urine greater than to five counts or nitrate test result is positive, then the patient will be judged to have pyuria signs.

2.3 Analysis methods

This study apply C4.5 decision tree model to extract rules which the emergency department physicians make inpatient treatment decisions. But also to facilitate the interpretation of the rules obtained made sense, this study will be conducted in accordance with the variable conversion table to convert a standard of nominal variables (table 1).
Table 1. data converted to nominal variables according to the scale

<table>
<thead>
<tr>
<th>variable</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years old): Age</td>
<td>≥ 85</td>
<td>65–85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients Source: source</td>
<td>Selft home</td>
<td>Lon-term care facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical function: Activity: Able of taking self care</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body temperature (°C): Temp: Temp</td>
<td>≥ 38.3°C</td>
<td>37.0–38.2°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiration rate(times/min): Resp</td>
<td>≥ 21</td>
<td>≤ 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate(times/min): Heart: Heart</td>
<td>≥ 101</td>
<td>≤ 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg): Pressure:</td>
<td></td>
<td></td>
<td>&gt; 140</td>
<td>140–110</td>
</tr>
<tr>
<td>Total white blood cell count (/mm3): CBC:</td>
<td></td>
<td></td>
<td>&gt; 11000</td>
<td>11000–4000</td>
</tr>
<tr>
<td>Inflammatory index CRP value (mg/dl): CRP</td>
<td></td>
<td></td>
<td></td>
<td>≥ 0.6</td>
</tr>
<tr>
<td>Chest x-ray results: X-ray: Not checked</td>
<td></td>
<td></td>
<td>Infiltration</td>
<td>No infiltration</td>
</tr>
<tr>
<td>Urine routine test results: Urine: Not tested</td>
<td></td>
<td></td>
<td>pyuria</td>
<td>Not pyuria</td>
</tr>
<tr>
<td>Inpatient treatment or not: Admission:</td>
<td></td>
<td></td>
<td>Inpatient treatment</td>
<td>Outpatient treatment</td>
</tr>
</tbody>
</table>
3. Results

Table 2 reveals the **statistical characteristics of cases.** The constructed decision tree (figure 1), have a total of 17 rules. The correct classification rate is 77.4%. This study followed support (prevalence) and reliability to extract the most symbolic decisions.

So inpatient treatment can be summarized as the following rules:

(1). Physical functions present that the elderly does not have the ability to take care of themselves and urine routine test is pyuria.

(2). Physical functions present that the elderly does not have the ability to take care of themselves and urine routine test is normal, but X-rays showed the pneumonic infiltration.

(3). Physical functions present that the elderly have the ability to take care of themselves, but the urine routine test is pyuria.

Outpatient treatment may be summarized to the following rules

(1). Physical functions present that the elderly have the ability to take care of themselves, urine routine test is normal and white blood cell counts are within the normal range.
Table 2. Statistical characteristics of cases with the variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1: 274</td>
</tr>
<tr>
<td></td>
<td>2: 341</td>
</tr>
<tr>
<td>Patients source</td>
<td>1: 350</td>
</tr>
<tr>
<td></td>
<td>2: 265</td>
</tr>
<tr>
<td>Physical function: Activity</td>
<td>1: 227</td>
</tr>
<tr>
<td></td>
<td>2: 388</td>
</tr>
<tr>
<td>Body temperature: Temp</td>
<td>1: 358</td>
</tr>
<tr>
<td></td>
<td>2: 257</td>
</tr>
<tr>
<td>Respiration rate: Resp</td>
<td>1: 197</td>
</tr>
<tr>
<td></td>
<td>2: 418</td>
</tr>
<tr>
<td>Heart rate: Heart</td>
<td>1: 271</td>
</tr>
<tr>
<td></td>
<td>2: 344</td>
</tr>
<tr>
<td>Systolic blood pressure: Pressure</td>
<td>1: 319</td>
</tr>
<tr>
<td></td>
<td>2: 241</td>
</tr>
<tr>
<td></td>
<td>3: 55</td>
</tr>
<tr>
<td>White blood cell counts: CBC</td>
<td>1: 279</td>
</tr>
<tr>
<td></td>
<td>2: 319</td>
</tr>
<tr>
<td></td>
<td>3: 17</td>
</tr>
<tr>
<td>Inflammatory index CRP: CRP</td>
<td>0: 105</td>
</tr>
<tr>
<td></td>
<td>1: 181</td>
</tr>
<tr>
<td></td>
<td>2: 329</td>
</tr>
<tr>
<td>Chest x-ray results: X_ray</td>
<td>0: 38</td>
</tr>
<tr>
<td></td>
<td>1: 343</td>
</tr>
<tr>
<td></td>
<td>2: 234</td>
</tr>
<tr>
<td>Urine routine test results: Urine</td>
<td>0: 166</td>
</tr>
<tr>
<td></td>
<td>1: 216</td>
</tr>
<tr>
<td></td>
<td>2: 233</td>
</tr>
<tr>
<td>Inpatient treatment or not: Admission</td>
<td>1: 452</td>
</tr>
<tr>
<td></td>
<td>2: 163</td>
</tr>
</tbody>
</table>
Figure 1 decision tree
4. Conclusion

From the above rules, as long as the dependent or bedridden patients, with pyuria signs or X-ray abnormalities will be admitted to hospital. If the patient has significant pyuria signs, regardless of their physical functional status, is one of the indications for hospitalization. The results illustrate the "physical functions" and "pyuria or not" can be said to be the two major factors affecting the decision making of the inpatient treatment. However, as the physical functional status deteriorating, especially the bedridden patients, the pathways of their urine excretion are generally three conditions - diapers, urine bag sets and foley catheter. All these three conditions have increased the chance of urinary tract infections. Previous literature also confirmed, the elderly residence in long-term care facilities often admit to hospital due to recurrent urinary tract infections, in which the patients have a long-term placement of catheters accounted for a certain proportion (Rogers Mary, Fries Brant, Kaufman Samuel, Mody Lona, McMahon Laurence, Saint Sanjay, 2008 ). This study supports this view. The structure of the decision tree reveals the correlation of "physical functions" and "pyuria". Before entering the study, we originally expected signs of distress (including systolic blood pressure, heart rate and respiration rate) will be greater influence factors. But in the final decision tree results, systolic blood pressure and respiration rate are ranked in the third tier. Its possible explanation is when the patients have fever, the normal physiological response will accelerate the heart rate and respiration rate with higher systolic blood pressure. It is hard to
distinguish the normal physiological response from the systemic inflammatory response only
from the value on the medical chart. The above vital signs are recorded as arrival on the
emergency room. But during the emergency management, antipyretic agent would be
administrated. These rising medical data will improve and decline as physiological responses.
So its weights of impact are not as great as expected. But in the real medical situation, the
faster heart rate in addition to the physiological response, it may be a compensatory
phenomenon of before shock status. But because the incidence is not high, in our study, it is
difficult to show and discuss. This will depend on physician training and clinical observation
skill. Besides, peripheral blood tests (CBC, CRP) and body temperature level have little
impact on the decision making of hospitalization. The same situation had been mentioned in
other papers (Castle SC, et Al. 1991). Because the elderly patients have poor immunity
response, so the body temperature will not be high and white blood cell count will be within
the normal range despite they are in real infection status. The situations are frequently
encountered and overlooked at the emergency room. In addition, if the physical functional
status of elderly patients is still capable of self-care and urine routine examination is normal
and white blood cell count is within the normal range, they can be discharged home with oral
medication.
The decision making according to the above rules can facilitate the clinical physician to make
the more “correct decision” that can cure patients, reduce mortality, and lower the economic
losses. It can also provide valuable information in training process especially for the new entrant. There may be still a lot of uncertainty in clinical condition and unexpected situations that beyond the decision tree’s rules. That depends on well-trained physician to address and deal with. And the training course is many years consuming. Data mining techniques can clarify the relevance of each factor among a large group of data to improve our medical technology and the arts in short time, thus enhancing the quality of care and improve patient outcomes.
4. References


[19] Ye Hongming, Lin Sen, Cai Mei, Zhang Shuyuan, Guo Shu Miriam Wu Wan Qian, 65 years of age or older emergency department Behavior Survey - a Regional Teaching Hospital, Shouchwan Journal of Medicine, 4: 113-9, 2003.

