Applying Contextual Analysis on Investigating Potential Physical Therapy Contraindications

Wei-Yi Fan[1], Yung-Tai Yen[2], Chi-Hsien Chen MD, PhD[1][3], Chien-Yeh Hsu, PhD[1*]

[1]Graduate Institute of Medical Informatics, Taipei Medical University, Taiwan
[2]Graduate Institute of Medical Sciences, Taipei Medical University, Taiwan
[3] Taipei Municipal Wan-Fang Hospital
[*]Corresponding Author
m110094008@tmu.edu.tw, tedyeng@tmu.edu.tw, chichen@tmu.edu.tw, cyhsu@tmu.edu.tw

Abstract

Recent years, several severe medical errors happened in Taiwan. Many of the adverse events were caused by medical errors because of human carelessness. Based on the findings of one major study (in Colorado and Utah), about 44,000 people were killed due to medical errors in U.S. hospitals each year. Another study puts the number much higher, at 98,000. More people die from medical mistakes each year than from highway accidents, breast cancer, or AIDS. Therefore, the patient safety has become a very important topic.

Medical knowledge and information technology grow so rapidly that it is difficult for practitioners to keep up. However we can use them to prevent problems of patient safety and improve medical qualities. Although many patient safety platforms have been developed such as the drug-drug interaction analyzing platform, surgical patient safety platform, adverse drug event reporting platform, and high risk results analyzing platform, very few research reports have been published for the patient safety issue in physical therapy.

Contraindications may occur when physical therapy is intervened especially for some patients who have specific diseases or in special conditions. People who have electronic implants and pregnant woman, for example, are not safe to apply Transcutaneous Electrical Nerve Stimulation (TENS) therapy in some body areas. Several doctors and therapists in the department of rehabilitation participated in this project. After studying many literatures, textbooks, and guidelines, we established two useful tables: the "physical therapies and possible contraindications" and the "mapping table of ICD-9 code to possible contraindication". The occurring rates for different levels of contraindications were obtained by analyzing the medical records of physical therapy. We found that for the first level contraindication, cardiovascular disease has the highest occurring rate. This indicates that doctors need to pay more attention when ordering the therapy of Cervical/Lumber Traction.

We used Vector Space Model and word segmentation algorithm to analyze the literatures retrieved from PubMed MEDLINE. All the literatures were related to physical therapy and classified according to different contraindications using the information retrieval algorithms. The contraindication analyzing methods for physical therapy was designed by analyzing the patient's medical records and the ordering physical therapy. The main effects of these analyzing methods can detect possible contraindications and we will build a contraindication reminding system in the future.

Key Words: Patient Safety, Information Technology, Rehabilitation, Physical Therapy, Contraindication

1. Introduction

After the Institute of Medicine (IOM) published several references like "To Err is Human" and "Crossing The Quality Chasm", the whole world's public health bureaus started to take patient safety seriously and the World Health Organization especially paid much attention to patient security as a weight-bearing point. However, in Taiwan, because of several malpractices such as misuse of Hepatitis B vaccine that make patients to suffer severe injure and shock the entire habitants' confidence in medical center. Therefore, it puts the health bureau to look squarely at this kind of patient safety problems.

From the previous study, 4% patients suffered medical injures and medical errors occupied 66% of all in New York State each year [1]. Furthermore, the book "To Err is Human" estimated about 98,000 people were killed by medical errors in U.S. hospitals each year [2].

"Medicine safely using is the most important factor of improving patient safety in seven targets", JCAHO indicated that in 2004. According to "India's First Newspaper for the Healthcare Business" in 2002, there are 180,000 people dead of adverse events in U.S. And other statistics revealed that adverse drug events occupied 20% of medical errors, more than 7% inpatient rate and 0.03% death rate [3, 4].

Moreover, there are 80% inpatients with falling down experience in hospital. Several research results were showed that the medical fee of falling down inpatients each year was almost four billion U.S. dollars in Australia [5] and one hundred billion U.S. dollars in United States of America [6]. These kinds of injures not only decrease patients' living quality, but also shorten elders' life-span for 10 years [7].

In this study, we classified malpractices into two types: the first type of medical error is external factors such as loud noise or overworked. These kind of external factors are easy to overcome. The second kind of medical error is internal factors such as lacking knowledge or the carelessness of the doctor. Sometimes inadequate therapies also can cause medical error [8-10].

Although problems of patient safety are getting more and more serious, related reports are very rare presently. Clinical doctors indicated that patients' embedded metal devices were not usually recorded in medical records. There will be very serious adverse events such as arrhythmia if patients are treated by electrotherapy or electromagnetic wave without any reminding.

Contraindications of physical therapies are complicated. According to a result of questionnaire survey, the information from contraindication related references is out of date [11]. Furthermore, the report of Consumer Products Safety Commission revealed that there are more than 1500 electric heating pads scalded cases each year [12], however we found these kinds of case were not reported in general journals.

There is no relative research about contraindications in physical therapy in Taiwan. In this study, we have analyzed literatures and medical records for physical therapy and investigated possible contraindications.

2. Methods

In order to build a contraindication knowledge base in form medical records, physicians and rehabilitation therapists were invited to attend expert meetings. Those participants have provided lots of medical knowledge and suggested many clinical experiences. The research methods are described as follows:

2.1. Literature analysis.

After the expert meetings and literatures reviewing, possible contraindications correlative to physical therapies were determined by the rehabilitation physicians and therapists. This gave us a background of the patient safety problem involved in therapy contraindications. The main resource of medical reference we referred is PubMed MEDLINE of National Library of Medicine (NLM). We used the key words provided by participating experts to search the related references containing physical therapy contraindications by using the Entrez platform. And we used Vector Space Model to retrieve the most relevant contraindication documents from the references we collected.

In vector space model, document and key word are represented by two vectors and the cosine measure of the two vectors is used to be the similarity basis between a document and key word. Furthermore, this model will use *tf* (term frequency) and *idf* (inversed document frequency) to calculate cosine measure.

tf ： The frequency of each word appears in each document of all references.

$$tf_{i,j} = 1 + \log(freq_{i,j}) \tag{1}$$

idf ： The frequency of the key word appears in all references.

$$idf_i = \log((N+1)/n_i) \tag{2}$$

where N is a total number of all references. n_i is a total number of a specific word in all references. According to *tf* and *idf,* we can calculate the similarity between documents and key words.

$$SIM(Q,D) = \frac{\sum_{W \in Q \& D}(tf_Q w \times (tf_D w \times idf w))}{\sqrt{\sum_{W \in D}(tf_D w \times idf w)^2}} \tag{3}$$

2.2. Physical therapy contraindication knowledge base creation.

After rehabilitation physicians and therapists attending the expert meetings and referring to lots of medical references, three topics about the physical therapy contraindications were studied:

(1) Physical therapy contraindications of specific conditions: Rehabilitation physicians and therapists should avoid some therapies when patients have some specific conditions such as patients with dermatitis, hemophilia and acute arthritis should avoid ultra red ray therapy.

(2) Physical therapy contraindications related to ICD-9 codes: When patients have some diseases treated by physical therapy, contraindications may happen caused by the disease. For example: there is usually a symptom of acute arthritis when patients got gout. This kind of disease should avoid the therapy of hot compress, ozocerite and ultra red ray.

(3) The severe levels of contraindications: To give us a judgment for the importance and prevalence of a

contraindication, we divided the collected contraindications into two severe levels. The first level included the contraindications which may cause the severest injuries to the patients. The second level contained the contraindications which have the higher rates of occurrence.

2.3. Electronic Medical record analysis.

In order to investigate the order of severity and prevalence of potential physical therapy contraindications, we extracted electronic medical records (Jan, 2004 to May, 2005) of the department of rehabilitation from the database of Taipei Municipal Wan-Fang Hospital. According to the physical therapy contraindication knowledge base, we identified potential contraindications by patients' ICD-9 codes and therapy items and calculated prevalence of each contraindication.

3. Results

According to the keywords provided by rehabilitation physicians and therapists, we collected 1,330 abstracts from MEDLINE by the following Entrez query:

"rehabilitation"[All Fields] OR "physical therapy"[All Fields] OR "occupational therapy"[All Fields] OR "side effect"[All Fields] OR complication[All Fields] OR "adverse effect"[All Fields] OR contraindication[All Fields] OR precaution[All Fields] AND hasabstract[text] AND English[Lang]

After collecting medical articles from MEDLINE (from 1966 to 2003), we used Vector Space Model of Information Retrieval to calculate the articles, which are most relative to physical therapy and contraindications. Those articles were then reviewed and confirmed by participating rehabilitation physicians. For example, there were 32 articles that were relevant to acute injury.

According to textbooks of physical therapy, medical references and experiences of rehabilitation physicians and therapists, we concluded 110 contraindications. For each physical therapy, the possible corresponding contraindications were identified and were built in the physical therapy contraindication knowledge base. For example, Cervical/Lumber Traction may have 11 contraindications such as claustrophobia and osteoporosis. We also studied the relationship between the ICD-9 codes and the physical therapy items and concluded 724 items related ICD-9 code.

According to the experiences of rehabilitation physicians and therapists, we classified contraindications into two levels in this research.

The first level: cardiovascular disease, over the eye, over open spinal cord, over pregnant uterus, over plastic implants, metal objects, over gonads, contact lenses, over all electronic implants, severe cardiac disturbance, congestive heart failure, acute pulmonary edema, displaced fracture, over the heart.

The second level: spondylolisthesis, cardiovascular disease, osteoporosis, acute injuries, previous spinal surgery, ischemic areas, metal objects, over all electronic implants, over-mobilization, severe diabetes.

We analyzed 4,075,718 order entries from the database of Taipei Municipal Wan-Fang Hospital and collected 5,492 patients' medical records, which may involve in therapy contraindications in rehabilitation department.

Table1 shows that there are 42,521 therapy prescriptions in 25,391 medical orders and we detected 6479 medical orders possible cause contraindications (25.52%). Furthermore, we detected 26,830 contraindications occurred in following 12 therapies.

Table1. Statistics of contraindication for physical therapy.

Therapy item	Therapy Prescription Frequency (%)	Possible Contraindications Frequency (%)
Cervical/Lumber Traction	9013 (21.20)	4158 (15.50)
Hot/Cold Pack	11088 (26.08)	11248 (41.92)
Infrared	972 (2.29)	1371 (5.11)
Parafin Bath	611 (1.44)	602 (2.24)
Ultrasound	1765 (4.15)	1312 (4.89)
Shortwave	3327 (7.82)	2462 (9.18)
Microwave	817 (1.92)	759 (2.83)
Interferential therapy	10897 (25.63)	4500 (16.77)
Transcutaneous Electrical Nerve Stimulation-TENS	3287 (7.73)	181 (0.67)
Low Power Laser	574 (1.35)	167 (0.62)
Magnetic Field Therapy	138 (0.32)	138 (0.20)
Circulator	32 (0.08)	32 (0.06)

The highest ratio of contraindication is hot / cold packs (41.92%). The second and third is interferential therapy (16.77%) and traction (15.50%).

Besides, according to 26,830 contraindications, we concluded the occurring times and ratio of the first level and the second level contraindications as following table.

Table2. Prevalence of contraindication classified by severe level.

The first level of contraindication:
(Occupied 6.40% of all possible contraindications)
Cardiovascular disease: 846 times (3.15%)
Over the eye: 12 times (0.04%)
Over open spinal cord: 11 times (0.04%)
Metal objects: 69 times (0.26%)
Over gonads: 56 times (0.21%)
Contact lenses: 4 times (0.01%)
Over all electronic implants: 712 times (2.65%)
Congestive heart failure: 5 times (0.02%)
Acute pulmonary edema: 2 times (0.01%)
The second level of contraindication:
(Occupied 21.27% of all possible contraindications)
Cardiovascular disease：846 times (3.15%)
Osteoporosis： 257 times (0.96%)
Acute injuries： 748 times (2.79%)
Ischemic areas： 2778 times (10.35%)
Metal objects： 69 times (0.26%)
Over all electronic implants： 712 times (2.65%)

Cardiovascular disease (3.15%) is the highest frequency of the first level and ischemic areas (10.35%) is the highest frequency of the second level.

4. DISCUSSION

By analyzing the physical therapy contraindications database, diagnosis knowledge base and patient's medical records, we can determine if there is any contraindication may occur according to the continual diagnosis in the medical history and new ordered physical therapies. For example: if a patient was diagnosed to get degenerative spondylolithesis, he may get structural disease due to tumor or infection too. So the treatment of cervical / lumber traction is inappropriate to this patient's situation.

By these analyzing methods, we can detect the possible contraindication according to the diagnosis in patient's medical records. The patient's health status may have been changed, so the result can only be a reference to doctors for making clinical diagnosis and treatments. In addition, the results show that cold/hot pack, interferential therapy and cervical / lumber traction have the highest probability of contraindication occurrence in the sampled records.

We found that cardiovascular disease has the highest frequency in the first level of contraindications even though the probability is only 3.15%. However, patients' blood vessel of cardiovascular disease is narrow. Patients should be treated carefully as applying cervical / lumber traction to prevent severe injury such as stroke.

At the mean time, according to the regulation of the hospital, some useful information is not included in the medical records such as the detailed data about the applied region of a physical therapy. Without this information, we are unable to identify if the therapy and the contraindication are applied at the same body regions. Further studies are needed to resolve this problem. Another limitation of this study is that the analysis of contraindication is based on a patient's whole medical records 6 months prior to the order of the therapy. However, the patient may have recovered from diseases during the 6-month period. And, this change of status may not be reported in the patient's medical records.

5. CONCLUSION

In this study, we have investigated the contraindication for physical therapy for a medical center in Taiwan and established the mapping table of physical therapies and possible contraindications and the mapping table of ICD-9 code related to possible contraindication detection. These mapping tables were adopted in the analyzing methods to detect possible contraindications according to specific physical therapy.

Retrospective study can help us to discover and establish knowledge base for further contraindication reminding system design. By analyzing the mass clinical data and articles, rules and guidelines can be presented more clearly. According to the study results, we will build a contraindication reminding system and expect the system can provide doctors a better way of detecting contraindications when generate therapy orders.

In conclusion, we expect these analyzing methods can not only save resources of the hospital, but can also increase the medical quality and improve patient safety in the future.

6. REFERENCES

[1] Ruei-Yung, Yang. Why Doctors Make Mistakes?. *Chang Gung Medical Journal* 2003;24:2-4.
[2] Chau-Hsin, Chang. Discuss malpractices of inpatients in U.S.A. and Taiwan. *Medicine Jouenal*

2003;131.

[3]   Robert A. Raschke, MD, MS; Bea Gollihare, MS,
      RN; Thomas A. Wunderlich, RPh; James R Guidry,
      PharmD, BCPs; Alan I. Leibowitz, MD; John C.
      Peirce, MD, MA, MS; Lee Lemelson, RPh; Mark A.
      Heisler, PharmD; Cynthia Susong, RN, MS.. A
      Computer Alert System to Prevent Injury From
      Adverse Drug Events. *JAMA* 1998;280(15):1317-
      1320.

[4]   Blum KV. Abel Sr. *et al.*. Medication Error
      Prevention by Pharmacist Am. *J Hosp pharm*
      1988;45:1902-1903.

[5]   Mathers C, Penm R. Health System Costs of Injury,
      Poisoning   and   Musculoskeletal   Disorders   in
      Australia 1993－1994. Canberra: Australian Institute
      of Health and Welfare. *Health and Welfare Series*
      1999;No 6.

[6]   Sattin RW. Falls among Older Persons: A Public
      Health Perspective. *Annu Rev Public Health*
      1992;13:489-508.

[7]   Berg RL, Cassells JS, eds. The Second Fifty Years:
      Promoting Health and Preventing Disability, Falls in
      Older   Persons: Risk   Factors   and   Prevention.
      Washington,   D.C.:   *National   Academy   Press*
      1990:263-90.

[8]   Jau-Jiun, Ji. *et al.*. Discuss the cause of malpractice
      with clinical pharmacologist. *Hospital Pharmacology
      Journa* .1994;11:189-192.

[9]   E.L. Allen, K.N. Barker, M.R. Cohen, N.M. Davis,
      R.E.Pearson.   Draft   Guidelines   on   Preventable
      Medication Errors, *American Journal of Health-
      System Pharmacy* 1992;49:640-648.

[10] Leape, Lucian L.;Bates, David W.;Cullen, David
      J.;Cooper, Jeffrey *et al*. Systems Analysis of Adverse
      Drug Events. *JAMA* 1995;274(1): 535-543.

[11] Scott F. Nadler, DO, Michael Prybicien, ATC,Gerard
      A.Malanga,   MD,   Dan   Sicher,   ATC,   MD.
      Complications From Therapeutic Modalities: Results
      of a National Survey of Athletic Trainers, *Arch Phys
      Med Rehabil*. 2003 Jun;84(6):849-53.

[12] Bill TJ, Edich RF, Himel HN. Electric Heating Pad
      Burns. *J Emerg Med* 1994;12:819-24.

[13] R. B and B. RN, "Modern Information Retrieval",
      Addison Wesley Longman 1999.

[14] Kenney Ng. Survey of Approaches to Information
      Retrieval of Speech Message. *Draft SLSG MIT*, 1996.