International Journal of
Science and Engineering Investigations vol. 5, issue 59, December 2016
ISSN: 2251-8843

The Study on Evaluating Length of Hospital Stay for Myomectomy

Chun-Lang Chang[1], Pei-Yu Lu[2]
[1,2]Institute of Industrial Engineering and Management, National Formosa University, Huwei, YunLin, Taiwan, R. O. C.
([1]jcchang@nfu.edu.tw, [2]tropicalfish@yahoo.com.tw)

Abstract- According to clinical statistics, on average a quarter of females are diagnosed with uterine fibroid, one very common benign tumor found in female's reproductive organs and the most common procedure in OB/GYN practices as well. In this study, particle swarm optimization was used together with back-propagation neural network and support vector machines in data mining as tools to evaluate the predictions on length of stay in the hospitals due to surgery of uterine fibroids. The results indicate that the correct classification rate on the laparoscope using PSO with SVM is 94.74%; that on the laparotomy using PSO with SVM is 90.62%. In short, the above results indicate the actual feasibility of the system, in which by evaluating the length of hospitalization, the system provides references to the physicians in diagnosis at clinical practices, enhances health care quality, and ensures proper planning of medical care resources so patients can receive better quality of care and services.

Keywords- *myoma, data mining, particle swarm optimization (PSO), back-propagation neural network (BPN), support vector machines (SVM)*

I. INTRODUCTION

Myoma is one of the most common diseases in the obstetrics and gynecology (OB/GYN) clinic. It is estimated that approximately 20% of women over the age of 30 have fibroids of different sizes [1]. According to Lee's study in 2009[2], about 70~75% fibroids are subtle or cannot be detected. The presence of uterine fibroids can cause infertility and recurrent miscarriage. Based on the clinical statistics of Bureau of National Health Insurance, [14] approximately one out of four women are found to have fibroids, showing that on average one fourth of women is diagnosed with uterine fibroids at outpatient examinations in the obstetrics and gynecology clinic. Uterine fibroids are the most commonly seen benign tumors in female pelvic cavity and call for the second largest number of surgeries in gynecology department as well.

Currently data mining technology has been widely used in many different fields. It is a very popular technique in medical applications domestically or internationally. In clinical practice, myomectomy, such as laparoscopic myomectomies and laparotomic myomectomies, is the primary treatment for uterine fibroids. Hence, using patient with myomectomies as the cases, this study adoptes the data mining approach to discuss the predictions on women having uterine fibroids who have undergone different surgeries and the corrosponding length of hospital stay and to further analyze the impact factors. The results will be used to help construct a predictive model of hospitalization days for patients with uterine fibroids, which would be accounted for an important referential basis on medical resource allocation management for hospitals and medical care personnels.

II. LITERATURE REVIEW

A. Uterine Fibroid

Uterine fibroids are the most common benign tumors in the pelvic cavity of women; myomectomies are the second largest procedure conducted in obsteritic and gynocology department. A fibroid is a benign tumor originated from the spiral-shaped muscle tissues, and it can occur in any smooth muscles in the body. It occurs most frequently in uterua in the pelvic cavity. The onset rate for uterine fibroids is about 20% in women at reproductive ages; 40~50% pre- or post-menopause. Most fibroids may be asymptomatic or symptoms are not obvious, so routine ultrasound every 3 months to 6 months at outpatient services is required to keep close observation of these fibroids. As long as they do not produce any changes, fibroids would shrink after menopause due to the decrease of hormones. For patients still showing symptoms at that point, the physicians would then recommend necessary surgical treatments. Typically symptoms include abdominal pains, heavy periods, urinarary frequency and retention as a result of fibroids pressing the bladder or rectum, and infertility or recurrant miscarriage because of fibroids. In rare cases, fibroids can lead to the enlargement of uterus at the size of an uterus during 9th to 12th week in pregnancy [1]. In general, surgery is the major treatment for uterine fibroids in practice. According to research findings, approximatly 77% of women has uterine fibroids throughout their lives, and 33% of which receive surgeries. Obsteritric and gynochology patients who receive surgeries due to uterine fibroids take up 38% of all procedures in the Ob/Gyn department. [15]

Many scholars in the past focus on the performance factors of the surgery when it comes to myomectomies, such as laparoscopic myomectomies, laparotomic myomectomies, virginal surgery, etc.. When it comes to health care quality, it is believed that the overall medical fees and man power resource usage can be more effectively monitored and controlled if more studies can be done to assess and discuss the factors that influencing the length of hospital stay after myomectomies.

B. Length of Hospital Stay

In 2012, the total amount of the medical care expenditures is NT4911 billions in Taiwan, with a 4.2% increase than that of year 2008. Among the huge health insurance medical care costs, the fees for hospital stay accounts for 31.3%, of which over half is closely related to the length of hospital stays. Thus, monitoring and the control over the length of hospital stays directly impact the use of medical resources and the efficiency of hospital management. How to effectively assess the length of hospital stay have become a critical issue and a challenging task in medical resource distributions and hospital management.

Domestic and international studies on days of hospital stay now are organized in three general different types as listed below:

1. Review on differences of hospital stays based on types of wards: Focusing on patients in emergency rooms, intensive care units, hospital wards for moderate to severe illnesses, and respiratory care ward (RCD), etc. as subjects, these studies discuss the impact on medical resource utilization.
2. Studies on the duration of hospital stay for common diseases: Taking patients of different common diseases like stroke, appendectomy, heart failure, respiratory failure, scald/burn, orthopedic surgery, etc. as subjects, these studies discuss and analyze medical resources utilization.
3. Studies on factors that affect the duration of hospital stays: Using patient information (gender, age, severity of diseases), physicians (surgical services, age), hospital characteristics (such as the rating and hierarchy level), regions and years (health insurance payment) for more in-depth studies on medical resources.

In this study, we organize domestic and international studies that discuss factors influencing length of hospital stay due to common diseases and details are as shown in Table 1.

Based on the following relevant studies worldwide, the majority focuses on the discussion and assessment of the length of stay and medical costs incurred concerning the major illnesses that have immediacy. For the medical system, these studies can help control medical costs effectively; for patients and their families, the results can assist them with sustainable follow-up care planning both emotionally and practically.

TABLE I. RELEVANT STUDY ON LENGTH OF HOSPITAL STAYS DOMESTICALLY & INTERNATIONALLY

Content of Study	Scholars
Use retrospective study, focusing on past internet information to conduct mining, and apply neural networks to the predictive analysis of length of stay for patients with cardiac catheter unit.	[3]
Readmission rate influences the physical health and finances of stroke patients' length of stay and medical care recovery. Use retrospective study as the major approach, focusing on the information in the database to conduct mining as well as using logistic regression and neural networks to stroke patients' readmission rate for predictive analysis.	[4]
Discuss factors influencing the length of stay of stroke patients who accept rehabilitation treatments. Use functional independence scale to evaluate daily living functions and Canadian neurological scale to evaluate the damage condition of nervous system of stroke patients. Collect the socio-demographic information of patients, clinical diagnosis data, and the FIM & CNS score results of patients when they were recently hospitalized to conduct multiple regression analysis and predictive factors for length of stay of rehabilitation treatments.	[5]
For major abdominal surgery patients, influences on postoperative length of stay using total parenteral nutrition (TPN) and other related factors. Using retrospective approach to discuss factors that affect postoperative length of stay. Statistical test methods are used to locate major impact factors.	[6]
Terminal cancer patients, in addition to general emergency care, have alternative choice of care, i.e. hospice. Compare the length of hospital stay for patients with hospice and non-hospice care using the health insurance database information. Also, adjustments are made to use multiple logistic regressions to randomize the probability of terminal cancer patients choosing hospice and/or non-hospice cares. Further comparisons then are done on the average medical cost of the two types of cares.	[7]
A study on the correlation of hospital stay and medical expenditure for the elder of age over 65 and the length of hospital stay over 30 days. Which indicate that for the female elder, with catastrophic illness; perform a surgical operation during hospital stay, private medical institute, with respiratory diseases, the length of hospital stay and medical expenditure usually much higher.	[8]
Discuss the influence of surgical volume on morbidity and mortality of radical hysterectomy for cervical cancer, which indicate that the higher surgical volume, the lower relapse rate, the length of hospital stay and blood transfusion will also decrease.	[9]

C. Data Mining

Data Mining (DM) is knowledge discovery in database (KDD). According to Fayyad et al [10], the ultimate goal of the effective, innovative, and potentially effective process is to understand data format.

Han and Kamber [11] believed that data mining consists of the following steps:

1. Data cleaning: to remove corrupt or inconsistent data.
2. Data integration: to combine data residing in different sources and providing users with a unified view.
3. Data selection: to determine and select the appropriate data that is related to the subject of the research.
4. Data transformation: to convert or unify data from a source data format into a suitable format for data mining.

5. Data mining: to conducting analysis using appropriate algorithm based on the need.
6. Pattern evaluation: to determine useful type using the measures.
7. Knowledge presentation: Presenting the excavated knowledge to users visually.

D. Particle Swarm Optimization

Particle Swarm Optimization (PSO) is a concept that has swarm intelligence that belongs to the field of evolutionary search method (Chao-Hong Lin, 2000).

The initial particles of PSO are randomly generated. It iteratively tries to improve a candidate solution. During each iterative process, the swarm of particles changes the search direction by two kinds of memory search, as shown below:

1. Best memory of the individual variables (pbest)
2. Best memory of group variables (gbest)

Use the PSO algorithm for calculation, the optimal solutions for the two methods can be obtained based on the best variable memory. Typical particle velocity and position is as illustrated in Figure 1.

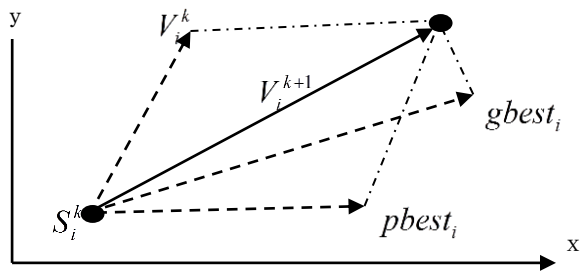

Figure 1. Particle Velocity and Position Illustration

E. Artificial Neural Network

Neural Network is used by humans to imitate the biological neural network data processing system. Artificial neurons are simple simulations to biological neurons, which obtain information from outside environment or other artificial neurons, calculate the data with simple operations, and output the results to the outside environment or other artificial neurons [12]. It has fast speed calculation, memory, learning, noise filtering, and fault tolerance abilities, thereby being utilized to solve many complex classification and predictive problems. BPN belongs to supervised learning network whose structure includes the input, output and hidden layer. It is suitable for diagnostic, predictive, and classificatory problems.

F. Support Vector Machine

Support vector Machine (SVM) is a kind of statistical learning theory first proposed by Vapnik in 1995 which was mainly applied to structured minimum error method in statistical learning theory. SVM is based on the theory of VC dimension and structural risk minimization principal. As a result, it has become one of the popular machine learning functions recently; it is suitable for classification, function approximation, and time series prediction, etc. [17].

G. Receiver Operative Characteristic Curve (ROC Curve)

ROC curve, also called "Receiver operative Characteristic Curve" or "Relative Operative Characteristic Curve", was first developed and utilized in the radar detective technology and psychophysics; it is extremely helpful in comparing and differentiating two models. ROC is used to evaluate the classification performance of a binary variable. The area under the ROC curve (AUC) can be used to evaluate the predictive accuracy. For a specific model, the ROC curve can depict the degree of compromise between the sensitivity or the true positive rate (TPR) of the y axes and the specificity or the false positive rate (FPR) of the x axes [13].

H. K-Fold Cross-Validation

Cross-validation is a technique designed for effectively estimating the generalization error of a statistical model. K-fold cross validation is to divide data into k equal-sized groups; each sub-group is the test data, while the remaining groups are the training data. After going through K tests, the average error of the K test data is calculated [12].

III. RESEARCH METHOD

According to the motivation and objectives, factors affecting the length of hospital stay for patients who have uterine fibroids and receive surgery treatments are found from the literatures in this study. Then having professional ob/gyn doctors screen and select the potential impact factors that might have major influence, this study targeted the ob/gyn data base of a case hospital in the Yunlin areas as its subject. With the use of data mining technique, a predictive model for the length of hospital stay is then established.

This study used the PSO diagnostic model to search the weights of relevant factors influencing the length of hospital stay and find out the best weight as indicator of its predictive model.

The predictive model in this study adopted Clementine 13.0 published by SPSS to construct the diagnostic model of BPN and SVM. Also, it uses trial-and-error method to divide sample data into the training data set (70%) and the test data set (30%) to find the best parameters of the predictive model. Then the sample data was placed into three folds for cross validation. Since the ROC curve has higher accuracy with higher AUC, among the two models, we can find out the best (the most optimal) model as having the higher sensibility towards case information. The framework of this study is as illustrated in Figure 2.

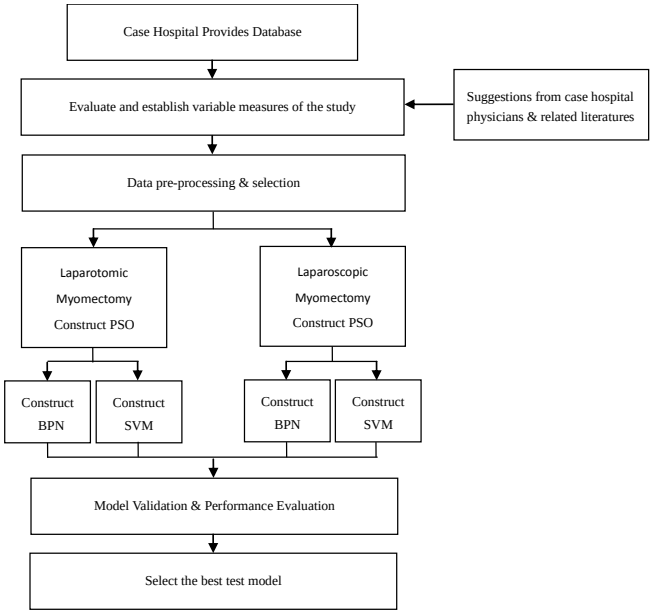

Figure 2. Research Framework

A. Data Pre-Processing and Selection

After going through all relevant literatures and having the discussions with professional physicians, factors influencing the length of hospital stay are selected under consideration of the clinical medicine perspectives.

Based on the information provided from the case hospital's OB/GYN department, a total of 320 patients with uterine fibroids and receive myomectomies during January 1st 2000 to April 31st 2010 are selected as the sample subjects of the study.

The data is organized and then divided into classification type of data and continuous type of data. Continuous type of data, upon normalization, is between 0~1, reduce the magnitude caused by the difference.

IV. Myomectomy Length of Hospital Stay Predictive Results

A. PSO Experimental Study

MATLAB 7.1 is used in this study to conduct the research on the hospital stay for myomectomy patients, and to obtain weights of relevant impact factors as the input weights for artificial neural network and support vector machine models. In this study, two different types of myomectomies, laparoscopic and laparotomic were used respectively to construct models and conduct test analysis of different cycles. The trial-and-error method was used to conduct experimental analysis using different settings and select the minimal cycle of the target function values as the basis. The analysis results indicate that the initial number of particles is 20 for laparoscopic myomectomy; 65 cycles; also, the initial number of particles for laparotomic myomectomy is 20; 57 cycles, in order to reach the minimal objective of the overall error sum of the output solutions and evaluation solutions.

B. PSO Analysis Results

Focusing on the observations of the length of hospital stay for patients with uterine fibroids who have undergone different surgeries, based on the PSO analysis results, through literatures and discussing with professional medical care personnel on factors influencing the hospital stay due to myomectomies, the impact factors with weights greater than 0.3 are selected as the variable factors for building BPN and SVM, as shown in Table 2.

TABLE II. Weight Analysis of the Best Model using PSO Algorithm

Laparotomic Myomectomy	Weight	Laparoscopic Myomectomy	Weight
Age	0.6052	Complication	0.7806
BMI	0.5006	Anemia	0.7688
Long-term career	0.8179	Number of pregnancy	0.7671
History of Major Surgeries	0.7331	Menorrhagia (heavy menstrual bleeding)	0.7331
Marital Status	0.7276	Number of Fibroids	0.6554
Fever	0.7182	Long-term career	0.6440
Surgical Method	0.6906	Education	0.6116
(heavy menstrual bleeding)	0.6344	History of Major Surgeries	0.5547
Nutritional assessment	0.6056	Fibroid (myoma) Size	0.5410
Education	0.5717	Number of Labor	0.5365
Frequent Urination	0.5631	Fever	0.5294
Anesthesia Time	0.5371	Age	0.5017
Number of Pregnancy	0.5350	Marital Status	0.4822
Blood Transfusion	0.5195	Lower abdominal pain	0.4667
Number of labor	0.5178	Anesthesia Time	0.4652
Fibroid (myoma) Size	0.4623	Frequent Urination	0.4593
Blood loss	0.4318	BMI	0.4238
Number of Fibroids	0.4179	Operation time	0.4125
Operation time	0.2869	Blood transfusion	0.3962
Anemia	0.2729	Blood loss	0.3551
Complication	0.2726	Menopause	0.3474
Complication	0.2294	Surgical method	0.2324
Lower abdominal pain	0.1946	Nutritional assessment	0.2107
Menopause	0.1479	Complication	0.2084

C. Construct the Predictive Model & Validation

For both laparotomic and laparoscopic myomectomy, the PSO algorithm combined with BPN and SVM were applied for the prediction. Among 108 of laparotomic myomectomy cases and 126 of laparoscopic myomectomy cases, 70% was used as the training set while the remaining 30% as test set. The trial-and-error method was used to obtain the best possible parameter setting combination to construct individual predictive models. The corresponding parameters and accuracies are as illustrated in Table 3 and 4.

TABLE III. PARAMETERS OF PSO COMBINED WITH BPN FOR LAPAROTOMIC AND LAPAROSCOPIC MYOMECTOMY

Parameter Setting	Laparotomic Myomectomy	Laparoscopic Myomectomy
Input Layer	1 layer, 18 neurons	1 layer, 21 neurons
Hidden Layer	1 layer, 19 neurons	1 layer, 22 neurons
Output Layer	1 layer, 1 neuron	1 layer, 1 neuron
Learning data rate	0.1	0.5
Inertia factor	0.1	0.1
Learning times	400	900
Accuracy	90.62%	93.97%
3-fold Accuracy	89.81%	93.65%
the area under the ROC curve (AUC)	0.944	0.987

TABLE IV. PARAMETERS OF PSO COMBINED WITH SVM FOR LAPAROTOMIC AND LAPAROSCOPIC MYOMECTOMY

Parameter Setting	Laparotomic Myomectomy	Laparoscopic Myomectomy
Input Variable	18	21
Core Functions	RBF	RBF
RBF Gamma Value	0.25	0.215
Stop Condition	1.0E01	1.0E01
Regularization Parameter	10	2
Accuracy	90.62%	94.74%
3-fold Accuracy	90.74%	96.03%
the area under the ROC curve(AUC)	0.944	0.983

I. CONCLUSIONS

PSO algorithm in conjunction with BPN and SVM of data mining techniques is used respectively to establish a medical care support resource planning model.

In general, in predicting influences of the length of stay from both surgeries, the accuracy of the tests is both above 85%, the areas under the ROC curve are both greater than 0.9. , indicating that applying BPN and SVM to medical care fields will yield good results. Among all, PSO with SVM experimental analysis has better results, as shown in Table 5. The results in this study have proved the actual feasibility of the system. Through evaluating length of hospital stay, the information can provide doctors reference in diagnosis and enhance clinical medicine quality and medical care resource allocation so that patients can obtain better medical care and service quality.

TABLE V. COMPARISON OF ACCURACIES ON LENGTH OF HOSPITAL STAY FOR MYOMECTOMY

		Accuracy	3-fold Accuracy	The area under the ROC curve (AUC)
Laparotomic Myomectomy	PSO+BPN	90.62%	89.81%	0.944
	PSO+SVM	90.62%	90.74%	0.944
Laparoscopic Myomectomy	PSO+BPN	93.97%	93.65%	0.987
	PSO+SVM	94.74%	96.03%	0.983

To construct a predictive model for the length of hospital stay, this study mainly focuses on the following two procedures: the laparoscopic and laparotomic myomectomy. Based on the established predictive system in this study and its validation results, a few points can be organized as listed below:

A. Laparoscopic Myomectomy

Among all factors influencing the length of hospital stay after myomectomies, after PSO algorithm, the impact factors with greater weights are like complication, anemia, number of pregnancy, heavy menstrual bleeding, number and size of fibroids, long-term career, etc. The accuracies are 93.97% and 94.74% respectively after conducting analysis combining BPN and SVM. Their AUCs are 0.987 and 0.983, showing that using SVM to predict the length of hospital stay after laparoscopic myomectomy has good performance, thereby having important referential values in clinical practices.

B. Laparotomic myomectomy

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads. Among all factors, screened through PSO algorithm, influencing the length of hospital stay after myomectomies, the impact factors with greater weights include age, BMI, long-term career, major surgeries, marital status, fever, method of surgery, excess menstrual bleeding, nutritious assessment, etc. The accuracies are both 90.62% after the analysis using BPN combining SVM. Their AUCs are both 0.944, showing a good performance in using BNP and VSM to predict the length of hospital stay after receiving laparotomic myomectomy to treat uterine fibroids. It has important referential values in clinical applications.

Below are clinical explanations made in this study from the hospital, physicians, family and NHIA perspectives:

A. For the hospital

Using data mining techniques can help understand the relevant factors influencing the length of hospital stay more clearly in practice, thereby initializing a length of stay assessment for physicians to establish their standard procedures for diagnosis in advance. Within the constraint of limited medical resources and man power, evaluating the length of hospital stay for patients allows more effective control and monitoring of medical resource allocation and enhances quality care.

B. For the physicians

predicting the length of hospital stay in advance can help assist doctors and related personnel understand patients'

current conditions in advance. For patients who might exceed 7 days of hospital stay, the doctors can provide better medical care and different medical care policies to help patients recover as early as possible to avoid over-lengthy hospital stays. The prediction will help the doctors to diagnose more effectively within the predicted length of stay and to avoid any waste of medical resources.

C. For patients and their families

Conducting assessment and prediction early on patient's duration of hospital stay allows patients and families to be better prepared psychologically, decreases the uncertainty on the length of stay, and alleviates the psychological and psychological pressure.

D. For the NHIA

The evaluation of this study on length of hospital stay for Myomectomy shall serve as a reference for the NHIA to improve or revise the payment system in the future.

REFERENCES

[1] Yang, Z.X., Yang, Y.S., 2001, A New Minimally Invasive Surgery of Uterine Fibroids Treatment, Formosan Journal of Medicine, 5(3), 357-361.

[2] Lee, C.L, Wang, C.J., 2009, Laparodcopic Myomectomy, Taiwanese Journal of Obstetrics & Gynecology, 48(4), 335-341.

[3] Bert, A.M., Leasure, R, & Davidson, L., 1995, Artificial neural network predictions of lengths of stay on a post-coronary care unit, Administrative Issues, 24(3), 251- 256.

[4] Kenneth, J.O., Smith, M.P., Illing, S.B., Richard, T.L., Roger, C.F., & Carl, V. G., 2001, Comparison of logistic regression and neural networks to predict re-hospitalization in patients with stroke, Journal of Clinical Epidemiology, 54(11), 1159-1165.

[5] Lin, J.H., Huang, M.H., Liu, C.K., Lin, Y.T., 2000, Factors Influencing Length of Stay in Rehabilitation Ward for Stroke Patients, Formosan Journal of Physical Therapy, 25(2), 1-11.

[6] Huang, S.L., Ting, G.Y., Huang, Y.H., 2006, Review of Factors Influencing Post-Operative Hospital Stay for Patients with Total Parenteral Nutrition and Major Abdominal Surgery, Nutritional Sciences Journal, 31(3), 87-94.

[7] Lo, J.M., Chen, S.C., Lai, Y.L., Lin, J.C., Chen, C.R., 2007, Effects of Care Patterns in End-of-Life Hospitalized Cancer Patients on Hospitalized Medical Expenditures and Length-of-Stay, Taiwan Journal of Public Health, 26(4), 270-282.

[8] Chiang, S.T., Wang, S.K., Kao, T.W., Fang, W.H., Chang, T.W., Kao, S.Y., Chou, C.C., 2011, Influential Factors of Medical Utilizations among Long-Stay Elderly Inpatients, Taiwan Geriatrics & Gerontology, 6(2), 86-104.

[9] Wright, J.D., Lewin, S.N., Deutsch I., Burke, W.M., Sun, X., Herzog, T.J., 2011, The influence of surgical volume on morbidity and mortality of radical hysterectomy for cervical cancer, American Journal of Obstetrics and Gynecology, 205(3), 225.e1-225.e7.

[10] Fayyad, U., Piatetsky, S, & Smyth, G.P., 1996, From Data Mining to Knowledge Discovery in Databases, American Association for Artificial Intelligence, 17(3), 37-54.

[11] Han, J. & Kamber, M., 2000, Data Mining: Concepts and Techniques, Morgan Kaufmann Press, San Francisco.

[12] Yeh, Y.C., Wu, P.R., 2009, Taguchi Method Based on Neural Networks and Cross Validation Methodology, Journal of Quality, 16(4), 261-279.

[13] Wang, P.Z., 2008, Data Mining: Concepts and Techniques, Tsang Hai Book Publishing Co, Taichung, 386-387.

[14] Bureau of National Health Insurance, (accessed April, 2010), Real-time Statistical Information. <http://www.nhi.gov.tw/index.asp>.

[15] Depart of Health, (accessed December, 2009), Executive Yuan-Publicize National Health Insurance Medical Information Quality - Hysteroscopic Myomectomy. <http://www.mhi.gov.tw/mqinfo>.

[16] Guo, X.C., Chang, J.R., Liu, C.X., 2004, Research on Particle Swarm Optimization(PSO) in Optimization Problems , Operations Research Society of Taiwan, ORSTW, 2004 Technology and Management Conference, 419-432.

[17] Vapnik, V., 1995, The National of Statistical Learning Theory, 1st ed, Springer-Verlag, New York.

Dr. Chun-Lang, Chang is a professor of Industrial Management at National Formosa University in Taiwan, R.O.C., His research interests and publications are in the areas of medical informatics, health care systems, artificial intelligence, data mining. He had a PhD from Auburn University. He is a member of CSQ, and CIIE.

Pei-Yu, Lu is an engineer in the Inotera memories company, she has an MS in the Institute of Industrial Engineering and Management, National Formosa University in Taiwan, R.O.C.