

Case And Evaluation of Lean Management in Hospital Blood Collection Center

Xinzhu Yu^{a,*}, Siqi Zhang^b and Dongyuan Ma^c

Business school, Sichuan University, Chengdu, 610000, China

^ayxzscu@163.com, ^b1245197721@qq.com, ^cduncan_ma@163.com

*Corresponding author: yxzscu@163.com

Keywords: medical service quality, lean management, blood collection center, questionnaire

Abstract: Blood collection center is an important department of Hospital clinic, so its medical service quality is meaningful for hospital management. In order to improve the blood collection environment, reduce patient queuing time, improve work efficiency and service quality, a large hospital in a city of China adopted the idea of lean management to improve process, optimize blood collection process and evaluate it. Lean management and value stream analysis method were used to solve the waste problem in the process. The waiting time of patients was calculated. At the same time, Patient satisfaction questionnaire was designed to identify the dissatisfied factors of patients in the process of blood collection service and to assess the effect after renovation. The operation mode of demand-driven service in blood collection center was established, and the average waiting time of patients was reduced from 35.3 minutes to 6.8 minutes. At the same time, through questionnaire survey, patient satisfaction was significantly improved. This lean management has achieved success in the renovation of blood collection centers. Lean management is a very successful experiment, extending from the initial management practice in manufacturing production system to the medical industry. It can be used for reference to improve the quality of medical services.

1. Introduction

Blood collection center is an important outpatient department of the hospital, which mainly undertakes the collection of blood samples and blood routine examination of patients. Blood examination, as an essential part of diagnosis and treatment, has a large number of patients waiting for examination every day. In order to improve the blood collection environment, reduce patient queuing time and improve work efficiency, the blood collection center of a large hospital in a city decided to optimize and reform the blood collection center. We have consulted the relevant literatures on the reconstruction of blood collection centers in the past and found that nursing intervention, improvement of blood collection technology, process reengineering and other methods have positive effects on the optimization and reconstruction of blood collection centers and improvement of patient satisfaction. [1] However, these researches focus on solving a specific

problem and lack of comprehensive reconstruction of blood collection centers. Therefore, we will focus on the improvement of the hospital's clinical laboratory to seek successful experience. Many hospitals have tried to improve medical services. Lean management has achieved remarkable results in this process. [2]

Lean management theory originates from lean production and is a management philosophy derived from Toyota production mode. The main idea of lean management follows five principles: (1) accurately define the value of products, and the value is determined by customers; (2) identifying the value stream of the product; (3) Make the value flow continuously and improve the operation efficiency; (4) customer demand drives production; (5) Continuous improvement. [2]

Due to large patient flow and less hospital resources, the patient waiting phenomenon is obvious. At the same time, the hospital treatment process is also very complicated. When a hospital has good doctors, but the performance system indicators do not perform well, these contradictions highlight the necessity of implementing lean management. [10] Applying lean management to hospital management is of great significance for improving the quality of medical services. Therefore, the renovation of a blood collection center in a large hospital decided to take lean management as the guidance, adopt value flow analysis, and collect patient satisfaction through questionnaire survey to evaluate the effect of lean management practice.

2. Problems in the blood collection process

According to the five principles of lean management and the practical experience of lean management from hospitals, civil aviation and other industries [3], this paper mainly adopted the value stream analysis method to solve the waste problem in the process, and identified the dissatisfied factors of patients in the process of blood collection service perception through questionnaires.

2.1 Value Stream Analysis

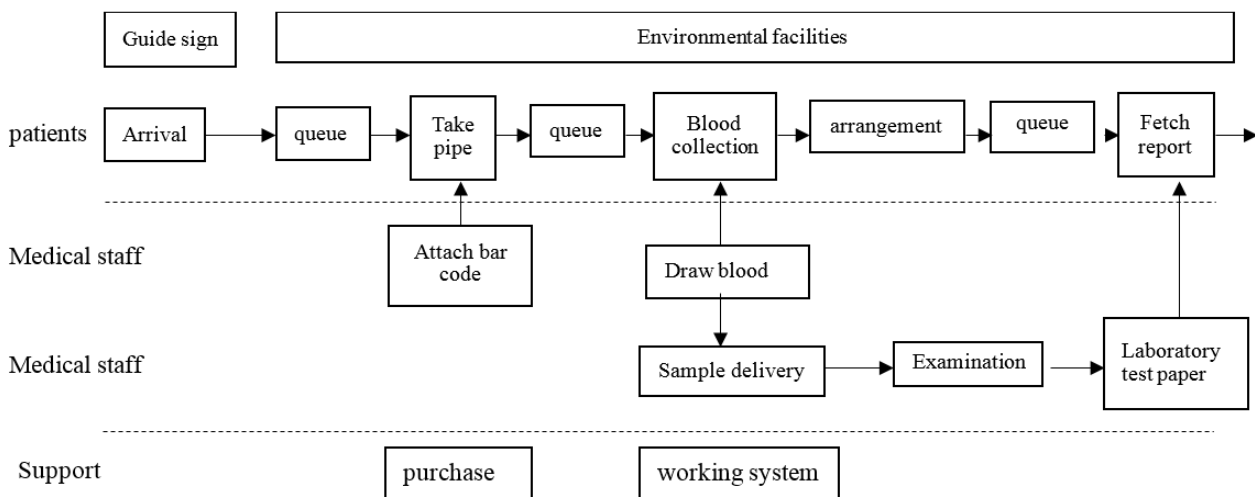


Figure. 1 Value Flow Chart before Transformation

Lean management always focuses on "value". We analyzed and determined the value of blood collection service from the perspective of patients and found out the waste in the blood collection process. Considering the characteristics of interaction, this paper thought that the service blueprint

can reflect the characteristics of value flow in the medical industry better than the general flow chart. The main purpose of value stream analysis is to reveal the waste problems in the process. The principle of lean management is to define service value by customers. According to whether value can be created, medical services can be divided into value-added activities and non-value-added activities. In the medical industry, it is usually shown as two major links of identity confirmation and expense payment. Such waste is usually called Type 1 waste. There are also many steps that do not create value and can be removed immediately called type 2 waste. In addition, after the obvious waste steps have been eliminated, the value flow analysis should make the remaining value-creating steps flow to eliminate the waste of waiting time between the two services as much as possible.

2.1.1 Identification of non-value-added activities

It can be clearly seen from the value flow chart that the patient experienced two queues during the blood collection process. Pipe picking and labeling is carried out between queues, but pipe picking and labeling cannot generate value added. However, this activity is necessary to identify the patient information, so we identify the pipe picking and labeling as type 1 waste. In order to avoid repeated queuing, reduce the time occupied by non-value-added activities and simplify the process, in the improved process, it may be considered to merge the tube picking and labeling service with the blood collection service. Since the blood collection service process is relatively simple, taking tubes, pasting codes and blood collection are necessary activities, there is no type 2 waste in the process.

2.1.2 Non-value-added time waste

When there is no obvious waste in the blood collection process, it is necessary to continue to eliminate the waste of waiting time between each process so that the value can flow quickly in the service process. In this study, we took 30 minutes as a time interval to record the queuing time of patients in each morning of the week (the afternoon was not counted due to the small number of people taking blood in the afternoon). In order to obtain the queuing time in the process, the recorder randomly issues a time recording card to the queuing patients. When distributing, record the time point when the patient starts queuing, and when collecting blood, the nurse records the corresponding time, and the time difference between the two is the queuing time. (The queue time we recorded = two queue times + the time to fetch and stick codes) The results are shown in Table 1.

Table 1 Patient Queue Time

Date Time interval	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
07:30-08:00	67	42	63	63	33	34	NA
08:00-08:30	49	34	56	56	27	42	16
08:30-09:00	48	45	60	60	32	35	19
09:00-09:30	54	47	52	52	35	43	21
09:30-10:00	46	39	53	53	28	23	9
10:00-10:30	38	34	35	35	15	13	NA
10:30-11:00	37	NA	30	30	14	NA	NA

At the same time, this study obtained three days of blood collection service time. The recorder uses a stopwatch to observe and record the time of blood collection service outside the window that

does not affect the operation of the nurse (i.e. when the patient sits down, the timer starts to count until the patient gets up and leaves, and at the same time, in order not to bring psychological burden to the nurse, the nurse will be informed in advance that the record will not affect the performance evaluation).

Table 2 Service Time of Blood Collection

Date \ Num. windows	Monday	Tuesday	Wednesday
1	NA	0.66	3.3
2	1.2	2.31	NA
3	1.29	2.34	1.66
4	1.23	NA	2.71
5	1.46	2.87	2.14
6	1.7	NA	1.53
7	1.49	2.16	3.05
8	2.3	2.93	1.81
Average duration	1.52	2.21	2.31

Table 3 Percentage of Value-Added Time

Date \ Duration	Monday	Tuesday	Wednesday
blood collection	1.52	2.21	2.31
queue	48.43	40.17	49.86
Proportion	3.05%	5.22%	4.44%

As can be seen from the blood collection time and the queuing time on Monday, Tuesday and Wednesday in the whole process, the valuable value-added time for patients is too small, and to a large extent, the patient's time is wasted.

2.2 Questionnaire Analysis of Patients' Dissatisfaction Factors

Through the questionnaire survey, we mainly want to achieve two purposes:

- 1) Finding the process insufficiency from the patient's point of view to provide the basis for optimizing the blood collection center;
- 2) Evaluate the effect of lean management practice.

Since the five-level Likert scale is adopted, this paper considers that the index with an average score of less than 3 is the factor that the patient is dissatisfied with, the index with an average score of 3-4 is the factor that the patient considers general, and the index with an average score of more than 4 is the factor that the patient is satisfied with. Therefore, this study found that the factors that patients are not satisfied with are time consuming blood collection and health knowledge propaganda. Patients are not satisfied with the blood collection time, which is consistent with the conclusion that the queue time is too long in the blood collection process analyzed earlier. As for the patients' dissatisfaction with health knowledge propaganda, the investigators did not observe any readers or maps on the spot, and the nurses did not have corresponding health knowledge propaganda to the patients when collecting blood.

3. Lean blood collection service operation

In the problem analysis in the previous section, the blood collection center has two main problems. They are:

- 1) Process waste;
- 2) Lack of health knowledge propaganda

In order to solve the above problems in the blood collection center, this study proposes the following solutions from the perspective of lean management.

3.1 Optimization of Blood Collection Process

In order to eliminate the repeated queuing, reduce the time taken by the tube picking and pasting codes in the blood collection process and improve the time value of patients, we combined the tube picking and pasting codes and the blood collection process in the same place during the reconstruction. After the patient picked the number, he began to wait in his seat. After calling the number, he came directly to the blood collection window, and the automatic labeling instrument printed and pasted the barcode, which was taken out by the nurse and served for the patient to collect blood.

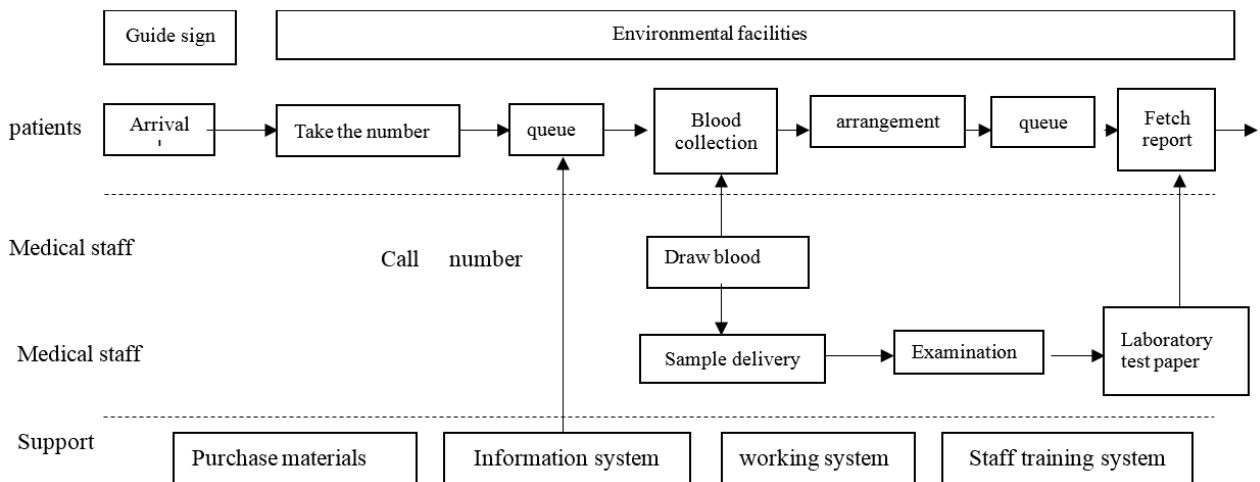


Figure. 2 Is an improved flow chart.

Figure 2 Value Flow Chart after Transformation in order to realize the above process, the blood collection center has introduced two sets of equipment:

- 1) Automatic labeling instrument

The use of automatic labeling instrument saves the time of selecting tubes and labeling codes, and also saves the number of nurses who are full-time in selecting tubes and labeling codes.

- 2) Self-service number picking machine

This method increases the comfort in the queuing process. Moreover, patients can get the approximate expectation of the queuing time through the current calling number and their own number, which can eliminate the waiting anxiety of patients at the end of the queue to some extent. [16]

3.2 Blood Collection Service Supply Driven by Patient Demand

We analyzed the arrival rule of patients and reasonably arranged the number of nurses taking

blood to reduce the cost of the hospital.

3.2.1 Analysis of patient demand law

In this paper, the arrival quantity and arrival rate of patients in different periods within one week in the same period were collected. The acquisition starts from 7:30 to 8:00 this time, but many patients arrive before 7:30 to start queuing, and patients arriving after 7:30 longer in line.

Table 4 Arrival of Patients in Different Periods

Date Time interval	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Average number of patients
7-7:30	170	121	NA	87	100	81	76	106
07:30-08:00	93	42	36	100	100	75	NA	74
08:00-08:30	109	142	125	106	128	89	74	110
08:30-09:00	115	97	88	113	114	99	92	103
09:00-09:30	107	114	94	99	55	73	67	87
09:30-10:00	98	104	71	95	72	53	39	76
10:00-10:30	91	61	66	92	79	27	NA	69
10:30-11:00	52	15	47	66	26	NA	NA	41
Average number of patients	104	87	75	95	84	71	70	

Table 5 Arrival Rate of Patients in Different Periods

Date Time interval	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
07:30-08:00	3.1	4.2	3.6	6.67	3.5	3	NA
08:00-08:30	3.63	4.87	4.17	3.53	4.27	2.97	2.64
08:30-09:00	3.83	3.23	2.93	3.77	3.8	3.3	3.83
09:00-09:30	3.56	3.87	3.13	3.3	1.83	2.43	2.23
09:30-10:00	3.26	3.43	2.37	3.17	2.4	1.6	1.3
10:00-10:30	3.03	1.87	2.2	3	2.6	1.59	NA
10:30-11:00	1.73	1.07	1.88	2.06	2.16	NA	NA
average arrival rate	3.16	3.22	2.9	3.64	2.94	2.48	2.5

The reaching rate before 9:00 was significantly higher than that after 9:00. A large number of patients began to queue up before the 7:30 blood collection window started service. And the peak time of patient arrival is from 7:30 to 9:30, with the average arrival rate reaching up to 6.67 people/minute. With the passage of time, the patient arrival rate gradually decreased, with an average of 2 people per minute around 11:00. The number of patients arriving each day showed a decreasing trend from Monday to Sunday.

3.2.2 Optimize the Number of Windows Opened

After analyzing the arrival rate of patients in each period and the average service rate of blood collection, we can use queuing theory to dynamically optimize the blood collection opening window.

First of all, considering that a large number of patients have arrived before 7:30, the more the number of these patients, the longer the queue time of the following patients, the starting time of blood collection service is considered to be advanced to 7:00.

Then, taking 95% of the patient's blood collection time not more than 15 minutes as the optimization target, and taking the number of windows open in each time period as the decision

variable, a queuing model is established to obtain the optimal number of windows open.

3.3 Standardization of blood collection operation

Standardization of blood collection operation has the advantages of reducing operation cost, reducing fluctuation of service quality, increasing convenience of staff operation, accumulating blood collection experience, etc. In the training of blood sampling nurses, we mainly emphasized the following methods:

1) Select blood collection needles according to patient characteristics

Straight needle is suitable for the vast majority of ordinary patients, butterfly wing needle is suitable for pediatric patients, injection needle is suitable for patients with thin veins or difficult to find.

2) The correct use method of pressure pulse belt

Tie it 7.5~10cm above the blood collection site. The binding time shall not exceed one minute. If it exceeds the time limit, loosen the pressure band and re-bind it after two minutes.

3) Sequence of use and mixing method of blood collection vessel

4) Ensure blood collection after disinfectant is dried

5) Blood collection vessels shall be placed vertically after collection.

3.4 Publicizing Health Knowledge

The propaganda of health knowledge mainly focuses on the propaganda of knowledge related to blood collection by sticking warm tips around the wall of the blood collection center. For example, "What should I pay attention to before taking blood?" "Correct pressing posture after blood collection?" Posters on related issues such as blood collection are pasted on the wall of the blood collection center for patients to read and watch while waiting.

4. Evaluate the satisfaction degree after renovation

4.1 Questionnaire Design

Questionnaire is an important tool to measure patient satisfaction. Many scholars have conducted a questionnaire survey on the satisfaction of inpatient, outpatient and emergency patients. For outpatient satisfaction scale, there are scales including waiting time, medical care and nursing, informed choice, medical auxiliary services, expenses, treatment results and environment [18], and there are scales including five dimensions including service environment, service efficiency, service attitude, service technology and medical expenses. [19] There are also some scales at the department level of the blood collection center, including the technology of blood collection personnel, attitude of blood collection personnel, waiting time, and environment of blood collection room. Blood collection environment, waiting time for blood collection, nurse's service attitude, nurse puncture technique, result feedback time, waiting time for taking a form, quality of report sheet, nurse's notification and guidance, etc. [1, 21] To sum up, the factors included in the patient satisfaction scale are different, which is due to the specificity of blood collection centers in various hospitals and the different service modes. Therefore, other people's scales can provide reference for us to develop scales, but they cannot be copied as they are. The personalized scale should be customized according to the characteristics of the investigated hospitals.

In this article, the patient satisfaction questionnaire of blood collection center mainly includes three dimensions of blood collection process, staff and blood collection environment. The design of

the questionnaire is divided into six parts, the first part is the basic information such as age, gender, etc. The second part is the patient's satisfaction with the blood collection process, including the overall waiting time, the process setting before blood collection and the clarity of the process after blood collection. The third part is the patient's satisfaction with the staff, including three indicators: operation technology, service attitude and timeliness of response. The fourth part is the patient's satisfaction with the blood collection environment, including five indicators: guidelines, medical order, comfort, health knowledge promotion and privacy protection. The fifth part is the overall satisfaction of patients with the blood collection center. The sixth part is the patient's advice.

4.2 Respondents

The first questionnaire survey was conducted before the renovation of the blood collection center. After 4 days of questionnaire survey, 84 questionnaires were collected. The second questionnaire survey was conducted after the reform. We experienced 3 days and collected 110 questionnaires. The basic information of the patient's sex and age is shown in Table 6.

Table 6 Socio-demographic Characteristics of Respondents

Sex	Male	42	57
	Female	42	53
Age	<18	6	10
	18-25	14	25
	25-40	35	32
	40-60	20	25
	>60	9	18

Most of the patients surveyed for the first time are aged 18-60, accounting for 80% of all patients. The ratio of male to female patients surveyed is 1:1, accounting for half of all patients. Most of the patients surveyed for the second time were also aged 18-60, accounting for 75% of all patients, 57 men and 53 women were surveyed. The age and gender of the two respondents are basically the same, and the two surveys are all in line with random sampling. The results obtained are scientific and comparable.

4.3 Results

4.3.1 Overall Satisfaction

In the first survey, more than 59% of patients (59+2=61) were satisfied with the blood collection center, and 10% of patients expressed dissatisfaction with the blood collection center. In the second survey, about 64% of the patients were satisfied with the blood collection center, and 8% of the patients expressed dissatisfaction with the blood collection center. In the third survey, 97% of the patients (60+47) were satisfied with the blood collection center, of which 55% were very satisfied.

The average scores of the overall satisfaction of the two surveys are 3.59 and 4.52 respectively. The difference test of the overall satisfaction of the two surveys shows that the overall satisfaction of the two surveys has significant difference.

To sum up, compared with the previous two surveys, patients' satisfaction with the blood collection center was significantly improved in the third survey.

Table 7 Significance Test

T test for equality of mean value						
t	variance	significance	average deviation	Standard error difference	95% confidence interval of difference	
					Lower limit	Upper limit
-9.978	179	.000	-.927	.093	-1.110	-.743

4.3.2 Reliability Test of Scale

1) Reliability verification

The split-half reliability and Cronbach' α coefficient were used to test the reliability of the scale. Cronbach' α coefficients of the first and second scales were 0.77 and 0.916 respectively.

The α coefficients of the first-stage treatment process, staff and environment were 0.618, 0.712 and 0.655 respectively. The α coefficients of the treatment process, staff and environment in the second phase were 0.837, 0.851 and 0.888 respectively. It can be seen that the content reliability of the two scales is good.

2) Validity check

The correlation coefficient between each item of the first stage scale and the overall satisfaction of the scale is between 0.2 and 0.0.5, and the correlation is relatively weak. Except for item 7, the other test differences are statistically significant ($p < 0.05$). The correlation coefficient between each item of the second scale and the overall satisfaction of the scale is between 0.5 and 0.8, with strong correlation. The test difference of correlation coefficient is statistically significant ($p < 0.01$), as shown in table 8.

Table 8 Correlation Coefficient between Scores of Items in Satisfaction Scale and Overall Satisfaction

1	The first survey	0.403**	7	The first survey	0.204
	The second survey	0.629**		The second survey	0.593**
2	The first survey	0.236**	8	The first survey	0.451**
	The second survey	0.508**		The second survey	0.739**
3	The first survey	0.312**	9	The first survey	0.510**
	The second survey	0.551**		The second survey	0.570**
4	The first survey	0.278*	10	The first survey	0.316**
	The second survey	0.523**		The second survey	0.628**
5	The first survey	0.394**	11	The first survey	0.348**
	The second survey	0.647**		The second survey	0.579**
6	The first survey	0.320**			
	The second survey	0.692**			

* $P < 0.05$, ** $P < 0.01$

5. Conclusion

The operation mode of demand-driven service in blood collection center was established, and the average waiting time of patients was reduced from 35.3 minutes to 6.8 minutes. At the same time, through questionnaire survey, patient satisfaction was significantly improved. This lean management has achieved success in the renovation of blood collection centers. Lean management is a very successful experiment, extending from the initial management practice in manufacturing production system to the medical industry. It can be used for reference to improve the quality of medical services.

Acknowledgements

The authors gratefully acknowledge the support from my tutor and the cooperation of the blood collection center.

References

- [1] Hongling Liang. *Satisfaction Survey and Analysis of Outpatient Blood Collection Patients and Intervention Measures [J]*. *Journal of snake*, 2009, 21 (3): 224-225.
- [2] Tingting Liu, Yi Zhang, Xudong Zheng, et al. *Practice of Using Quality Control Circle to Improve Satisfaction of Venous Blood Collection of Physical Examiners [J]*. *chinese nursing management*, 2013, 13 (6): 9-11.
- [3] Zhiqin Wu, Yan Fu. *Analysis of the causes of complaints from outpatients taking blood and countermeasures [J]*. *chinese nursing management*, 2012, 12 (8): 78-79.
- [4] Jing Yang, Weijiao Zhou, Metcalf JV, et al. *Analysis of key drivers of outpatient satisfaction [J]*. *chinese journal of hospital administration*, 2016, 32 (8): 578-581.
- [5] Xiaoxia Wu. *Effect of blood collection process management on blood sample testing accuracy [J]*. *Chinese Journal of Modern Nursing*, 2012, 18 (11): 1292-1294.
- [6] Xia Chen. *Effect evaluation of comprehensive nursing intervention on reducing adverse reactions of venous blood collection [J]*. *Laboratory Medicine and Clinic*, 2016, 13 (15): 2172-2174.
- [7] Guilan Xia, Shiyun Wan, Huishan Cheng, et al. *Large-angle tug-of-war puncture for venous blood collection of tumor patients [J]*. *Journal of nursing science*, 2010, 25 (1): 60-61.
- [8] Ning Wang, Jing Zhao, Haiyan Jin. *Implementing blood collection process reengineering to improve doctor-patient satisfaction [J]*. *Nursing Research*, 2006, 20 (36): 3363-3364.
- [9] James P. Womack, Daniel T. Jones. *Lean Thought: Eliminating Waste and Creating Wealth [M]*. The Commercial Press, 2005.
- [10] Mark Greban. *Lean Hospital: World's Best Hospital Management Practice: Improving Quality, Patient Safety, and Employee Satisfaction [M]*. Mechanical Industry Press, 2011.
- [11] Huan Feng, Yaling Wang, Xianli Zhou, et al. *Using the concept of lean production management to steadily develop the nursing team [J]*. *China Hospital*, 2015 (2): 69-70
- [12] Chen Zhang, Weixiang Zhu, Weicheng Chen. *Application of lean production in pharmacy dispensing [J]*. *China medical frontier*, 2007, 01 (6): 119-121
- [13] YH Liang, Zixing Chen. *Application of lean production in medical record management [J]*. *China medical record*, 2010, 11 (5): 16-18
- [14] Xiaosong Zhao, dainuan Yu, Chenying Chang. *Empirical Study on the improvement of Lean Six Sigma hospital management [J]*. *Industrial engineering and management*, 2010, 15 (4): 46-50
- [15] Yueyu Li, *study on lean value stream of patients in radiology department [J]*. *Industrial engineering*, 2014, 17 (6): 7-11
- [16] Shuangshuang Cheng. *Analysis of customer queuing psychology and management strategies [J]*. *Science and Education Journal*, 2011 (4): 134-134.
- [17] Guodong Qiu, lihua wang, Lin Jiang. *Construction of patient-centered hospital service organization system [J]*. *China Soft Science*, 2011 (10): 73-83.
- [18] Jing Yang, Weijiao Zhou, Metcalf JV, et al. *Analysis of key drivers of outpatient satisfaction [J]*. *chinese journal of hospital administration*, 2016, 32 (8): 578-581.
- [19] Guoguan Zheng, Yu Qian, Xiaohe Wang, et al. *development and validation of outpatient satisfaction evaluation scale [J]*. *China hospital management*, 2017 (3).
- [20] Lanlan Zhou, Yue He, Jianli Xing, et al. *Discussion on Improving Patient Satisfaction in Outpatient Blood Collection Room [J]*. *Nursing Research*, 2008, 22(27): 2482-2483.