

Lean Management Promotes Compliance and Satisfaction of Rabies Vaccines

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Objective: This study aimed to explore the application effect of lean management in rabies vaccination.

Methods: Lean management in rabies vaccination was implemented from July 2020. A total of 2306 patients vaccinated from January to June 2020 were enrolled as routine management group, and 2718 patients vaccinated from July to November 2020 were enrolled as lean management group. The relationship between potential factors and rabies vaccination with 1:1 propensity score matching (PSM) was analysed. The compliance, waiting time for vaccination, and satisfaction of patients of routine and lean management group were statistically analyzed. The changes in the three indicators before and after the implementation and their application effects were compared.

Results: Compliance rate in lean management group (98.72%) was significantly higher than that in routine management group (93.87%) ($\chi^2=32.902$, $P<0.001$). The waiting time for vaccination was also significantly shortened ($t = 9.209$, $P < 0.001$), and the satisfaction of patients significantly improved ($X^2 = 39.611$, $P < 0.001$).

Conclusion: Implementing lean management in all aspects of rabies vaccination can significantly improve patient compliance and work efficiency of nursing staff and improve the patient medical experience.

Keywords: lean management, rabies, vaccination, compliance, satisfaction rate

Introduction

Rabies is a disease that can only be prevented, not cured. It is a serious threat to human life and health. Vaccination is one of the core methods to prevent rabies.¹⁻³ Vaccination compliance is directly related to the immune effect and is the key to effective prevention. Many studies have demonstrated that the phenomenon of missed vaccination still exists, especially for the last two doses.⁴⁻⁶ Therefore, it is urgent to analyze the causes of missed vaccination and advanced intervention methods to reduce or even eliminate the phenomenon of missed vaccination and prevent the occurrence of rabies. This is of great significance to patients' health levels. Lean management eliminates time and resource waste by "precision" and make valuable contributions to the development of rabies vaccination by "profit" Lean management is a refined management method. It has the characteristics of precision, accuracy, detail, and strictness. It can eliminate difficulties in practical work with systems, processes, and management methods. It realizes process optimization, efficiency improvement, and quality improvement.^{7,8} At present, the application of lean management in the rabies vaccination system management is in the initial stage. In this study, lean management was integrated into all aspects of

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vaccination to improve the compliance of rabies vaccines and improve patient satisfaction and safety. The details are reported as follows.

Data and Methods

General Information

Lean management of rabies vaccination was started in July 2020. From January to November 2020, people who got rabies vaccination, completed the questionnaire, and met the inclusion/exclusion criteria were included in our study. A self-designed questionnaire was used, which was administered and collected by trained staff at the same time as the patient was vaccinated. Information obtained by the questionnaire included gender, age, education level, marriage status, and living situation. Subjects vaccinated from January to June 2020 when was before lean management were assigned to routine management group. Subjects vaccinated from July to November 2020 when was after lean management were assigned to the lean management group. Inclusion criteria: (1) Subjects with category II and III bite according to the Technical Guidelines for Rabies Prevention and Control (2016); (2) Subjects receiving rabies vaccination in our hospital for the first time (3) Subjects living in Yuhang District for more than 6 months (4) Subjects vaccinated with 2-1-1 immunization procedures; (5) Adults with primary school education or above, and parents of children with primary school education or above (6) Informed consenters. Exclusion criteria: (1) the elderly without communication devices (2) people who received primary immunization in our hospital and planned to get second and third injection out of Yuhang District (3) Subjects who were not vaccinated in our hospital for the first time (4) Subjects with serious heart, brain, lungs or other vital organ diseases that affect their activities. Routine management group had 2306 cases and lean management group had 2718 cases after random sampling.

Methods

Approval for this study was obtained from the Ethics Committee of The Fifth People's Hospital of Yuhang District, Hangzhou. Before implementation, rabies vaccination was managed according to routine methods. The patients filled in the application form according to the doctor's order and waited in line. They were informed of the relevant precautions and vaccinated. Patient information was registered in paper files, and patients were recalled for the next vaccination.

Lean management was applied to the whole process of rabies vaccination after implementation.

(1) Sort, tidy, sweep, and clean items by 6S management to make them visualized and staff could easily get the items: Clean items that are useless for rabies vaccination, arrange appropriate amounts of rabies vaccine, syringes, sharps boxes, and sterilisation supplies in appropriate place orderly. Dispose medical waste in a standardized way and clean the rubbish after work. It is important to create a comfortable working environment that could make the staff keep a good mood and push for the institutionalization and normalization of management. (2) Improve the overall quality of staff: the staff should summary the work experience monthly. Make rules, train the staff, and organize some interesting events such as PDCA to improve their working ability and passion. Help the staff get a sense of achievement and happiness in the work which could raise their working enthusiasm, improve the enforcement of rules, and promote the team stick together. (3) Optimise the rabies vaccination process with information technology: ①Diversify form of propaganda and education: make a video to popularize the importance of vaccination against rabies and some instructions after bite; build a module of rabies vaccine on hospital website and wechat public account to spread knowledge on rabies vaccine. ②Humanise vaccination notice: remind patients with message 3 days before vaccination and call them again 1 day before vaccination, counting the number of second and third vaccinations every day, summarise the information of the patients who did not get vaccination and call them the next day to ask for reasons and solve the problems in time. ③Personalize way of appointments for outpatients: Provide the patients kinds of appointment methods such as phone, WeChat public account, Alipay mini-program and on-site appointment so that patients could make an appointment according to their own time. Convenient appointment methods make the patients receive vaccinations more easily and decrease the patients' waiting time.

Observation Indexes

Completing the whole course of rabies vaccination on time was regarded as compliance. Not completing the whole course was regarded as non-compliance. The evaluation indexes before and after the implementation were compared. Vaccination compliance rate = number of patients vaccinated in compliance/total number of patients in the study $\times 100\%$. Dropout rate = 1- compliance rate. The waiting time for vaccination was from the date of making the vaccination appointment to the first vaccination. The

related data were exported from the hospital information system. The patient satisfaction survey was based on the short message and telephone follow-up of patients and the comprehensive evaluation of the questionnaire.

Statistical Analysis

SPSS22.0 was used for data processing. The Kolmogorov–Smirnov normality test was used to analyze the distribution of data. Normally distributed measurement data were expressed as mean \pm standard deviation ($x \pm SD$) and compared between two groups using independent sample *t*-tests. Non-normally distributed data were expressed as median and 2.5 and 97.5 percentiles (P2.5 and P97.5) and compared between two groups using rank–sum tests. Percentages were compared using Chi-square tests.

To eliminate potential selection bias caused by confounding, propensity score matching (PSM) adjusted for balancing covariance distribution in the two groups. A propensity score was calculated using logistic regression. The routine management group was matched with the lean management group according to 1:1 nearest-neighbor matching using a caliper width of 0.05. The *t*-test was applied for equilibrium analysis. $P < 0.05$ was considered statistically significant.

Results

Patient Characteristics and Compliance Rate of Vaccination

Among the 5024 patients receiving rabies vaccination, there was no significant difference in vaccination compliance between males and females ($P > 0.05$). Significant difference of vaccination compliance was observed in age, education level, marital status and residence status ($P < 0.05$). 4861 (96.76%) patients completed the full course of vaccination. Of the 2306 patients in routine management group, 2189 (94.93%) completed the vaccination. Of the 2718 patients in lean management group, 2673 (98.34%) completed the vaccination (Table 1).

Compliance of Rabies Vaccination

Compared to the routine management group, the lean management group exhibited a significant difference in age, education level, marriage status, and living condition before PSM. Following PSM, these characteristics showed a balanced performance between the two groups (Table 2). Among 2024 patients matched by PSM, 1949 (96.29%) had a full course of vaccination; Compliance rate of lean management group was 98.72% (999/1012), which was significantly

Table 1 Patient Characteristics and Compliance Rate of Vaccination

Characteristics		Case Number	Number of Vaccination	Compliance Rate (%)	χ^2 value	P value
Gender	Male	2706	2632	97.27	0.589	0.256
	Female	2318	2229	96.16		
Age	≤ 12 years old	1568	1540	98.21	13.351	0.027
	13~60 years old	2327	2213	95.10		
	> 60 years old	1129	1108	98.14		
Education level	Illiterate	153	123	80.39	32.581	< 0.001
	Primary school	526	502	95.44		
	Middle school	1095	1071	97.81		
	High school and secondary school	1019	992	97.35		
	Junior college	1113	1085	97.48		
	Undergraduate or above	1108	1088	98.19		
Marriage Status	Unmarried	2194	2104	95.90	35.624	< 0.001
	Married	2751	2688	97.71		
	Divorce	26	21	80.77		
	Bereft of spouse	53	48	90.57		
Living situation	Live alone	1156	1065	92.13	9.354	0.011
	Live together	3868	3796	98.14		

Table 2 Characteristics of Patients Before and After PSM

Variables		Mean Value of Routine Management Group	Mean Value of Lean Management Group	t value	P value
Gender	Before PSM	0.417	0.412	0.312	0.409
	After PSM	0.453	0.459	-0.215	0.615
Age	Before PSM	41.031	42.915	-2.326	0.002
	After PSM	41.659	41.342	0.145	0.811
Education level	Before PSM	2.891	3.205	-2.518	<0.001
	After PSM	3.061	3.029	0.119	0.901
Marital status	Before PSM	1.062	1.326	-3.154	<0.001
	After PSM	1.151	1.101	1.020	0.197
Living situation	Before PSM	0.385	0.265	3.684	<0.001
	After PSM	0.324	0.294	1.353	0.103

higher than that of routine management group (93.87%, 950/1012) ($\chi^2=32.902$, $P<0.001$).

Waiting Time for Rabies Vaccination

The Kolmogorov–Smirnov normality test was used to analyze the waiting time for vaccination. Normally distributed measurement data were expressed as mean \pm standard deviation ($X \pm SD$) and compared between two groups

using two independent sample *t*-tests. After the implementation of lean management, the waiting time for vaccination reduced significantly. The waiting time was controlled within ten minutes for most patients. During peak hours, a small number of patients waited for more than ten minutes. Very few patients waited for over 30 minutes. The average waiting time for vaccination also significantly shortened ($t = 9.209$, $P < 0.001$, Table 3).

Table 3 Waiting Time for Rabies Vaccination

Group	Number	0–10 Min	Waiting Time 11–30 Min	>30 Min	Mean value of Waiting Time ($\bar{x} \pm s$) Min
Routine management group	2306	1429/ 61.97%	805/34.91%	72/3.12%	15.03 \pm 5.69
Lean management group	2718	2447/ 90.03%	266/9.79%	5/0.18%	7.93 \pm 3.61
χ^2 or t value	–	$\chi^2=555.632$	$\chi^2=469.620$	$\chi^2=71.372$	$t=9.209$
P value	–	<0.001	<0.001	<0.001	<0.001

Satisfaction of the Patients Receiving Rabies Vaccination

After implementing lean management, the satisfaction of vaccines (very satisfied and satisfied were defined as satisfaction) increased significantly ($\chi^2 = 39.611$, $P < 0.001$). In particular, the rate of very satisfied patients improved significantly (Table 4).

Discussion

The rabies virus can be transmitted through dog wounds to humans. It invades the nervous system and causes rabies. There is currently no cure for rabies. Its treatment depends mainly on prevention. Therefore, timely and correct cleaning and disinfection of the wound and timely and standardized implementation of the rabies vaccine and immunoglobulin injections are the key measures to prevent rabies and wound infection.⁹ People's awareness of rabies prevention is poor. Some patients lack awareness of rabies. Nurses do not provide effective health education, psychological counseling, nursing management, or nurse-patient communication. This results in some patients having poor on-time or whole-process vaccination compliance.¹⁰ Lean management is an advanced, systematic, and scientific management concept. The implementation of lean management in clinical work can reduce labor costs and improve labor efficiency. It meets the needs of patients with the concept of "patient-centered" in all aspects, realizes the optimization of clinical work, and the improvement of work quality and patient satisfaction. Through "6S" process optimization, personnel training, and other lean management measurements, rabies vaccines can recognize the importance of timely vaccination, which significantly improves their compliance.

Age, education level, marriage status, and living condition had an impact on compliance rate of vaccination before PSM. Following PSM, these characteristics

showed a balanced performance between the two groups. Compliance rate of the lean management group (98.72%) was significantly higher than that of routine management group (93.87%). Disease-centered model was transformed to patient-centered model after lean management. It is more convenient and safer for patients to receive vaccination using lean management. This result is higher than that of Wang¹¹ in reducing the rate of missed vaccination and improving patient satisfaction through a standardized rabies vaccine infusion process. However, the process still noted 10.53% instances of missed vaccination. This is also better than that of Wan¹² in an investigation into the current situation of rabies vaccination in patients incurring injuries from dogs. It was found that the timely vaccination rate of the first dose was 100%, the second dose was 99.67%, the third dose was 98.97%, the fourth dose was 95.20%, and the fifth dose was 83.53%. They were only improving compliance by optimizing the process, while in this study, all aspects of the patients and processes improved. Qiu et al¹³ used systematic, holistic nursing to improve compliance from 82% to 96% and satisfaction from 86% to 98%. The compliance of the whole course of vaccination was lower than 98.34% in that study, and the satisfaction was similar to that in this study. The cause may be that systematic, holistic nursing is only part of lean management. Therefore, only comprehensive lean management can effectively improve rabies vaccination compliance. Xu¹⁴ used optimization of the whole-process management of rabies vaccination to improve the compliance of rabies vaccination by nearly 10%, to 96.7%, and satisfaction by about 10%, to 99.6%. She only optimized one aspect of the whole vaccination process; however, her hospital was a high-grade hospital (Grade 3A), and her foundations in all aspects were better than those of this study. Therefore, the content of satisfaction was closely related to the overall level of the hospital. As a result, the rabies vaccination compliance was

Table 4 Satisfaction of the Patients Receiving Rabies Vaccination

Group	Number	Very Satisfied	Satisfied	Not Very Satisfied	Not Satisfied	Percentage of Satisfaction
Routine management group	2306	839/36.38%	1242/53.86%	172/7.46%	53/2.30%	90.24%
Lean management group	2718	1862/68.51%	791/29.10%	56/2.06%	9/0.33%	98.32%
χ^2 value	–	516.571	316.374.517	83.924	13.409	39.611
P value	–	<0.001	<0.001	<0.001	<0.001	<0.001

slightly lower than that of this study, and the satisfaction was slightly higher than that of this study.

In this study, lean management not only improved patient compliance but also reduced the waiting time for vaccination and improved patient satisfaction. It also improved the patient's medical experience. After the implementation of lean management, the waiting time for vaccination improved significantly and was basically controlled within ten minutes. Only five patients waited for more than 30 minutes. The tracking analysis revealed that this delay was mainly caused by group events. It also reminds us that emergency treatment needs to improve. After the implementation of lean management, patient satisfaction significantly improved. Improvement in the "very satisfied" rate was particularly obvious. This not only relates to humanized and flexible medical services but also to the significantly shortened waiting time for vaccination. In this study, the correlation between waiting time for vaccination and patient satisfaction was not analyzed. It is a deficiency of this study and one for the next direction of research. Another limitation of our study is that it is a single-center study. We would conduct a multi-center study with randomization in future study.

Disclosure

The authors report no conflicts of interest in this work.

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