

Study on Application Effect of 6S Management Mode in Infection Control Management of Fangcang Shelter Hospital of National Exhibition and Convention Center

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Abstract: *Objective:* In 2022, a pneumonia caused by novel coronavirus broke out in Shanghai. A large number of medical personnel were deployed nationwide to support the Fangcang Shelter Hospital of National Exhibition and Convention Center (Shanghai). Because of the underdeveloped infrastructure and the disorganized layout process, the phenomenon of infection among medical personnel was rampant given the highly contagious nature of the Omicron variant. This paper discusses the effect of 6S management in infection control management of Fangcang Shelter Hospital of National Exhibition and Convention Center (Shanghai). *Methods:* A series of 6S management practices were carried out based on the evaluation of the control management of Fangcang Shelter Hospital of National Exhibition and Convention Center (Shanghai) during the anti-epidemic period, and the effect of the implementation of 6S management was studied based on the rapport among team members and the overall control system process, the management of wearing and stripping channels, the time of wearing protective articles and the psychological and emotional changes of the team members. *Results:* After the implementation of 6S management mode, the management of dressing room, epidemic prevention materials, and occupational protection awareness and infection control safety were significantly improved. More than 95.5% of the team members believed that improving the working environment in the shelter increased the confidence of victory in the fight against the epidemic, reduced the preparations before entering and leaving the cabin, improved the work efficiency and ensured occupational safety. It ensures the realization of the goal of "zero infection" and is set as a benchmark of control work of Fangcang Shelter Hospital of National Exhibition and Convention Center (Shanghai). *Conclusion:* The application of 6S management mode to the shelter infection control management can create and maintain a good working environment in the shelter, promote the implementation effect of various systems and processes of infection control, reduce the potential infection risk in the shelter and improve the efficiency of infection control management.

Keywords: Mobile cabin hospital; Infection control management; 6S management; Application effect

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1. Introduction

6S (Sort, Set in Order, Shine, Standardize, Sustain, Safety) management is a field management concept and method originated from Japanese enterprises^[1]. “Sort,” “Set in Order,” and “Shine” are the specific contents. “Standardizing” is to institutionalize and standardize the implementation of the above 3S, implement and maintain the results. “Sustain” refers to the cultivation of every employee to develop good habits, with “Safety” is the basis. The 6S’ requirements for environmental management standardization, as well as the concept of paying attention to details and safety in management, doing things carefully and in place, and continuous optimization and improvement are very consistent with the institutionalization, rigor and meticulousness required in Fangcang shelter management. In recent years, many hospital nursing units have adopted this mode of management^[2]. The principle of “three immediate,” the principle of “problem vision” and the principle of “autonomy”^[3] in 6S management have had a positive effect on the infection control management of Fangcang shelter. The application of the principle of “three direct and three present” requires the control personnel to personally be present at the site of the shelter and directly deal with whatever problems that are present. The principle of “problem vision” requires the control personnel to take a professional point of view, carefully to inspect the scene, and find out the details. The “autonomy” principle requires the medical staff to change their mindset from “I obey” to “I need to obey” and improve their autonomy to comply with the system. The 6S management mode has been applied to the infection control management of the Fangcang shelter by the third team of Shanghai International Exhibition Fangcang Shelter 5.1, which has effectively improved the infection control awareness of the members, forms good epidemic prevention habits, improved work efficiency, and has brought the maintenance and of various systems in the infection control management into a virtuous circle.

2. Data and preparation

2.1. Personnel training in the preliminary preparation

The staff of the infection control group learned and understood 6S management method through online courses and offline self-study. The work procedures and emergency plans were discussed, inferred, improved, and reformulated. Besides, other units that had opened the cabin or infection control staff with anti-epidemic experience were consulted in order to make a more comprehensive preparation.

2.2. Field visit

The Fangcang Shelter Hospital of International Exhibition Center is the largest one in Shanghai with the largest number of patients. There are 8 cabins in the hospital, and there are 1,300 beds in the 5.1 cabin where the third detachment is located. The daily intake of patients is more than 900, and a total of 13,087 people have been treated in 44 days. An average of 120 medical personnel enter the cabin every day, and the average number of third-party security personnel, janitors, police, fire department personnel and other personnel that enter the cabin is more than 600. Faced with a large number of personnel and a complex structure, the infection control team rearranged the passageways of the dressing room outside the shelter, and set up special passageways for third-party, police, fire and medical personnel in different zones. In order to avoid cross-infection among third-party personnel, the police and fire passageways in cabins 5.1 and 6.1 are relatively adjusted to the third-party passageways, and the subdivision management of third-party personnel is implemented to avoid the risk of cross-infection among all kinds of people.

3. Implementation

In the initial stage of receiving treatment in the shelter, there were some problems such as substandard infrastructure and non-ideal layout, no ventilation system in some rooms of the stripping room, inadequate

ultraviolet lamps and air disinfectors for prevention and control disinfection equipment, and failure to formulate and implement relevant regulations on environmental management. Due to poor cabin conditions, there was rampant infection of coronavirus among medical staffs. As the world's largest makeshift hospital, unprecedented challenges, and the extremely contagious nature of Omicron variant, we should not only carry out the treatment in a timely manner, but also strive to achieve "zero infection" among the team members. 5.1 Cabin team-three infection control team gradually applied 6S management mode to the infection control management of cabin. As a result, there was no infection among the whole team, and it achieved the target of epidemic prevention and control which is a significant achievement. Therefore, this was set up as a benchmark for the infection control management of Fangcang Shelter Hospital of National Exhibition and Convention Center (Shanghai).

3.1. Methods

Sorting is the beginning of improving the work site and acts as a basis for setting in order. It is necessary to classify the necessities and non-necessities of the articles in each area of the shelter, clarify the use, usage and frequency of each item, and classify them, focusing on checking the articles placed in each room in the strip passage. According to the function of the room area and the number of medical team members, the items left in the dressing and undressing passages were removed. The unnecessary items such as cabinets, tables, and epidemic prevention supplies were removed. Only the necessities were placed in the room, so that the area of the square cabin can be reduced. A smaller dressing room frees up more space, prevents misuse and optimizes room layout.

Setting in order refers to replanning and sorting out the necessary items on site and is consolidation of the rectification. Items left in each area of the cabin are classified into common, urgent, and less frequent items according to the frequency of use, and were placed in fixed locations, categories, and quantities. Commonly used items were placed in a convenient place for medical staff to take, and emergency items are placed at fixed points, and those not commonly used are placed in the warehouse. It is necessary to reasonably plan the area and space of the cabin room. In a locker room, the locker and room entrance were arranged into a "hui" –shaped corridor to protect the privacy of the team members when changing clothes. Lockers and shoe lockers were assigned individually according to the group. The red zone shoes and combat boots were placed neatly in the lockers. It was necessary to select the widest area in the second changing room to install two shelves, and put the epidemic prevention materials into the shelves according to the order of wearing. The shelf height standard were designed based on the average height of the team members. The number of epidemic prevention materials shall be determined according to the number of 120 medical personnel per day, and each item shall be clearly marked. The epidemic prevention materials of each room should be reasonably allocated according to the different functions of the region. To create a clear, clean and tidy dressing environment for the team members, it was necessary to change the phenomenon of haphazard stacking of goods' boxes, disorderly arrangement of epidemic prevention materials, and team members moving around and rummaging in the early stage of the anti-epidemic campaign, so as to reduce the time of searching for goods. The stripping room were also be reorganized, the treatment process of medical waste was done in the stripping room, thus forming a virtuous circle. The number of articles provided in each area of the stripping room were determined according to the size and function of each area of the stripping room, and the epidemic prevention materials and disinfection equipment were placed in each area at a fixed point. Strip procedures, procedures and warning signs were posted in the strip room. According to the examination of the stripping room, quite a number of mobile ultraviolet lamp and air disinfection machines were in need of fixing. A bench was placed outside each strip block in the stripping room, and hand disinfectant, stain avoidance paper and disinfection wipes were placed there to ensure that the team members were able to directly take the epidemic prevention materials needed in the process of

stripping, so as to reduce the frequency of walking in the stripping room. After the implementation of 6S management, the team members' staying time in the stripping room was significantly reduced, and the walking frequency was reduced. The medical waste disposal process in the stripping room improved significantly. The full-time infection control personnel in each shift carried out environmental sanitation disinfection according to the standard operating procedure, and the environmental disinfection register was implemented in a timely manner.

Shining refers to cleaning the environment, equipment and articles of the shelter on the basis of sorting and setting in order, so as to form a clean and tidy working environment. Due to the particularity of the task of the shelter, the cleaning was thorough without leaving out any areas in order to avoid the potential risk of infection. Similarly, the ground, wall, air and object surface were all cleaned thoroughly. Trash cans were placed in different locations based on the use function and size of each area; unnecessary items, medical waste and garbage were disposed of and removed in time. In the early stage of the fight against the epidemic, the shelter cleaning personnel did not arrive in time. With the increase of the number of workers leaving the shelter in each shift, a large amount of medical waste was generated in the passageway and stripping room of the semi-contaminated area of the shelter, which seriously affected the workers' leaving the shelter and increased the potential risk of infection. In view of this phenomenon, the emergency plan of infection and control were quickly implemented, and the whole staff of infection and control were assigned to clean up the medical waste. It was necessary to spray and disinfect the ground with 84 liquid, check the operation of the disinfection equipment, and actively communicate with the maintenance personnel for installation, such as there is no ventilation system in some dressing rooms, no mobile hand washing facilities, etc., strengthen the daily exhaust wind inspection, disinfect the air with ultraviolet lamps, wipe the surface with alcohol wipes to ensure that the team members maintain a stable and good work mood in a safe and clean working environment, be more focused, and make no mistakes.

Standardizing refers to establishing standards and systems for cleaning, rectification and cleaning, long-term implementation, maintain 3S results, and constantly check and improve them. The environmental sanitation and disinfection measures of each area of the shelter were formulated according to the situation of the shelter at the time, and the infection control post of each shift were implemented according to the working process every day. The full-time infection control staff wiped and disinfected the table, ground and object table, the air disinfection machine worked in a 24-hour cycle, and the indoor ultraviolet lamp was irradiated. Based on these conditions, a three-level control management system was established in combination with the various control management systems of the national exhibition cabin which are as follows: the three-level management system of the control post, the control staff and the leader of the control group, and the "Job Responsibilities and Specific Requirements of the Third Branch of the Control Staff," "Job Infection Control Process," "Disinfection Process of Medical Staff's Dressing Room Environment," "Staff Health Management and Fever Emergency Response Plan," "Disposal Specification for Medical Waste in Dressing and Undressing Rooms," were formulated. This is to ensure the effective implementation of environmental health disinfection system as well as establish a regional environmental disinfection system. The infection control department disinfected the environment and materials according to a list created based on the process requirements in 6 shifts every day. The infection control supervisor would then check the implementation of the work and sign, and give disinfection quality feedback through the sampling results based on a daily environmental-material table. The effect of application of 6S management in wear-strip in medical waste disposal process is remarkable. Before the implementation of 6S management, the team members passively implemented the medical waste treatment process in the dressing room, and the treatment process was not in place. After the implementation, they actively cooperated and strictly carried out each step in the process; the working environment was clean and the disinfection effect was up to standard.

Sustaining is the most unique element in 6S management, it means transforming external requirements into active and spontaneous actions of employees. Firstly, the regulations need to be instilled into the employees' minds. With that, a habits on the basis of the regulations and requirements can be developed. Implementing a new management model means negating the old process and there will always be a period of discomfort. The relevant standards and systems in the management of infection control were implemented through the incentive methods such as on-site teaching by teachers, online video training, questioning and assessment, and selection of the star of infection control. Training and assessment were given to the team members of the wearing and removal of protective equipment, the process and methods of COVID-19 occupational exposure emergency treatment, and the assessment of the related knowledge of infection control. The trainers demonstrated the whole wearing and stripping operation process on site, focusing on the core steps and error-prone details. The intensive training methods of nursing + medical group and one-to-one training + examination were adopted to ensure that everyone passed the course. With the system of signing for one's shift, of each shift, the requirements of infection control management can be integrated into the habits of medical staff, and the awareness of prevention and control at work can be manifested in their conscious actions. This establishes the team spirit that everyone is the infection controller, one for all and all for one.

Security in 6S management means that management begins with security and ends with security. The work of infection control is to ensure the safety of the team members at all times, and to eliminate the potential risks and the occurrence of infection. The infection control personnel should carry out the supervision and inspection contents according to the key work contents every day, and check the resident management of personnel, sampling of environmental materials, evaluation of disinfection effect, operation of disinfection equipment, maintenance of exhaust system, and other conditions every day to ensure that corrective measures should be formulated immediately when there is a risk of infection. There are some hidden problems in the opposite cabin, such as inappropriate zoning design, substandard infrastructure and inadequate prevention and control and disinfection equipment. Faced with a large number of entering personnel and a complex structure, the infection control team rearranged the passageways of the dressing room outside the shelter, and set up special passageways for third party, police, fire and medical personnel in different zones. In order to avoid cross-infection among third party personnel, the police and fire passageways in cabins 5.1 and 6.1 are relatively adjusted to the third-party passageways, and the subdivision management of third-party personnel is implemented to avoid the risk of cross-infection among all kinds of people. At the early stage of the task, when the third-party cleaner was not around, a large amount of medical waste was piled up in the passageway of the semi-contaminated area of the shelter and the undressing room of the detachment, which has seriously affected the team members' exit from the cabin and presented potential risks. In light of this, the infection control team immediately launched the emergency plan. The infection control staff acted as "cleaners" and "porters." They packed more than 20 bags of medical waste at one time, thoroughly cleaned the environment of the dressing room, and prevented epidemics in the dressing room. The materials were fixed in place and neatly arranged. The undressing process and warning slogans in each dressing room were made obvious to ensure the safe exit of the team members. There was no ventilation system for some dressing rooms. Therefore, the maintenance personnel should be informed of it and the daily ventilation and wind inspection should be improved. If the disinfection equipment was not in place, the joint infection control office was informed in order to work together to eliminate various risks and hidden dangers, and ensure orderly and safe anti-epidemic work.

3.2. Effect after the implementation of 6S management

95.5% of the team members were satisfied with the work through questionnaire survey and time quantification statistics. The 6S management improved the working environment of the shelter, increased the confidence of winning the fight against the epidemic, reduced the preparation for entering and exiting the cabin, reduced the exposure time, reduced the risk, ensured the occupational safety, and improved the mental state of the team members (see **Table 1**). The initiative of epidemic prevention has been strengthened to increase the confidence of the team members to overcome the epidemic. These changes have been applied effectively in the management of infection control in makeshift hospitals, and the infection control has become more efficient (**Figure 1**).

Table 1. Comparison before and after the application of 6S management in infection control work

Content	Before 6S management is implemented	After 6S management is implemented
Orderliness of cabin environment	Staff satisfaction was 25.6%	Staff satisfaction was 95.5%
Management of epidemic prevention materials	Staff satisfaction was 41.2%	Staff satisfaction was 93.5%
Duration of wearing protective clothing (Protection Level 2+)	37 minutes on average (including goggles preparation time)	Average 23 minutes (including goggles preparation time)
Duration of taking off protective clothing (Protection Level 2+)	25 minutes on average	12 minutes on average
Sense of control of the executive power	50.0%	96.4%
Epidemic prevention consciousness	58.8%	92.3%
Environmental surface nucleic acid detection	The third party took off two ground and the third team took off one handle respectively	There were no positive results
Confidence in victory against the epidemic	51.7%	95.5%



Figure 1. The insides of the Third Unit of Third Branch, Fangcang Shelter Hospital of National Exhibition

and Convention Center(Shanghai)

3.3. Emergency management

In the early stage of the fight against the epidemic, medical waste was piled up on the ground in the passageway and stripping room of the semi-contaminated area of the shelter when the cleaning personnel were not in place, which seriously affected the evacuation of the team members and increased the risk of infection. As a result, the infection control group launched the emergency response plan immediately, using the principle of “three immediate” from 6S management which are described as follows: wear protective clothes immediately, face the square cabin site, see the pile of medical waste, and understand the current situation of potential infection risks. The infection control personnel immediately acted as “cleaners” and “porter,” packing 20 bags of medical waste, cleaning the environment of the stripping room thoroughly, formulating the treatment process of medical waste in the stripping room according to the situation of the shelter, fixing the epidemic prevention materials in the stripping room, place them neatly; and posting the stripping process instructions, steps and warning slogans to ensure the safe exit of the team members. After the implementation of 6S management, the improvement of medical waste disposal process in the stripping room was remarkable, and the full-time infection control personnel in each shift carried out environmental sanitation disinfection according to the workflow steps. In order to ensure the effective implementation of the environmental sanitation and disinfection system for the passage of the stripping room, a registration record book for environmental disinfection in the stripping room was formulated. The infection control team carried out the disinfection work of air and environmental objects in 6 shifts a day according to the process requirements, and the infection control supervisor followed the shift to perform quality inspection. The required documents were signed and feedback regarding the disinfection quality was given based on a daily environmental and material checklist by the infection control supervisor. So far, among the 1,600 points collected by the team, except for the abnormal results (positive) collected from the door handle of buffer room no.1, the rest are normal. After the implementation of 6S management in the stripping room, the environmental hygiene can be improved, and the environmental hygiene disinfection system can be effectively implemented in each shift to reduce the risk of infection in the stripping room (**Figure 2**).



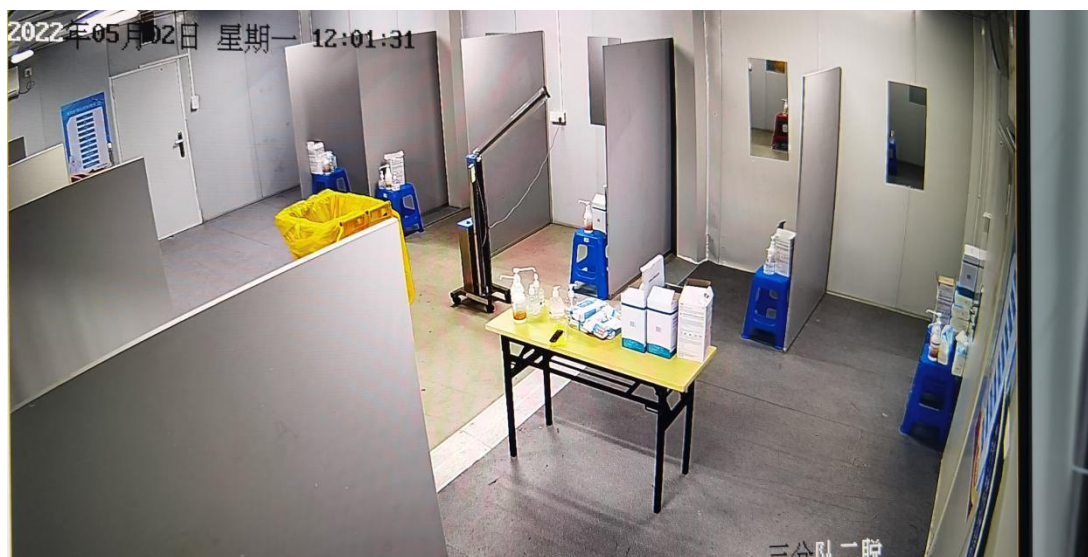


Figure 2. More pictures of the insides of the Third Unit of Third Branch, Fangcang Shelter Hospital of National Exhibition and Convention Center (Shanghai)

3.4. General summary of results

Up to now, the third branch of the Fangcang shelter hospital of the National Exhibition Center is the only branch that has achieved “zero infection.” At the same time, among the various infection control inspections in the branches, the team's infection control management belongs to the benchmark in the branches, indicating that all medical staff work hard together, and the application the 6S management model to the infection control management of Fangcang shelter hospitals can improve work efficiency and reduce the risk of infection, and the application effect is remarkable.

4. Discussion

It is a long-term and persistent job to promote 6S management in the infection control work of makeshift hospitals. Therefore, it is important to stick to the bottom line of “zero infection” for the team members in order to win against the epidemic and achieve maximum prevention. In the implementation of 6S management, the infection control management of makeshift hospitals should adhere to the following three

aspects.

First is to rely on the system which is mandatory. Institutionalized management is the premise of the work of infection control. It is necessary to quickly develop various infection control degrees in line with the practical conditions of the shelter when moving into the new working environment. The team quickly established a three-level infection control management mechanism for the third team, and formulated the “Responsibilities and Specific Requirements of the Third Team’s Infection Control Personnel,” “Infection Control Manual,” “The Environmental Disinfection Process of Medical Staff’s Undressing Room,” “Medical Disposal in Wearing and Undressing Room,” “Residential Hotel Management Regulations,” “Staff Health Management and Fever Emergency Response Plan” and other infection control management systems. Necessary registration records including environmental sanitation and disinfection, nucleic acid sampling of environmental surface, fluorescent labeling of environmental surface, ventilation system inspection, supervision and inspection of shelter infection control, problems in wearing and stripping monitoring, and disposal process of emergency plan were established in each area of the shelter to ensure the effective implementation of various infection control management systems

The second point is humanization and flexibility. The key to promote 6S management in the work of sense control is to optimize both of these aspects. It is necessary think about how to make the system more humanized, more convenient to comply with and to maintain. A suitable amount of flexibility should be present and suitable modification should be made in the system while retaining its original framework. The work of infection control is meticulous and requires team effort. The infection team members are ought to remind each other when there are any negligence; if any spots were missed out by the team, the supervisor checks and rectifies it; in this way, the flexibility of the work can be increased.

The third point is to rely on motivation and initiative. Implementing a new management model means negating the old process and there will always be a period of discomfort. In view of the large flow of shelter personnel, high difficulty in management and control, and high-risk level of safety hazards, make full use of the high coverage monitoring system to understand the implementation of red-green zone infection control in full time, space, elements and coverage. In addition, it carries out 24-hour real-time monitoring and supervision on the wearing and taking off of the protective clothing of the team members in and out of the cabin, and uses the principle of problem vision to find out the existing problems in the process of wearing and taking off the protective clothing of the team members, so as to help them correct in time and prevent infection. The time of the crew’s exit has reduced from initially 60 minutes to now 18 minutes on average. The effective way to solve these problems is to abide with the principle of autonomy in 6S management, carry out evaluation and stimulate competitiveness among the infection control team members. Daily infection control stars can be selected, commended, and rewarded in order to stimulate the enthusiasm of the team members so that the prevention and control of hospital can move towards a virtuous circle.

5. Conclusion

In conclusion, through the introduction of 6S management method, the infection control management of the third unit of the Third Branch Hospital of the International Exhibition Center has effectively improved the infection control awareness of the team members, formed good epidemic prevention habits, improved the work efficiency of the team members, and maintained various rules and regulations in the infection control management into a virtuous circle. Up to now, the whole team has achieved the set goal of “zero infection,” setting a benchmark for the general hospital. Other units have visited our unit to learn from us several times, and the leaders of the general hospital have conducted field research, which provides a new reference for the formulation of rules in the prevention and control management of temporary hospitals in the future. It has been proven by practice that 6S management model is advanced, replicable and applicable

to the infection control management of makeshift hospitals.

Disclosure statement

The authors declare no conflict of interest.

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