Improving staff safety with checklists during novel coronavirus disease (COVID-19) pandemic
A quasi-experiment study in vascular surgical department

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Abstract
Novel coronavirus disease (COVID-19) emerged in Wuhan in December 2019, has spread in many countries affected people globally. In response to the economic requirement of the nation and meet the need of patient’s, a momentous event was going back to work step by step as fighting against COVID-19. Safety in clinical work is of priority as elective surgery in the department of surgery progressing. We used checklists based on our experiences on COVID-19 control and reality of clinical work from February to March in the West China Hospital, involving events of screening patient, chaperonage, and healthcare workers. Checklist summarized the actual clinical nursing work and management practices, hope to provide a reference for the order of surgery during the epidemic prevention and control, and standardize the clinical nursing work of surgery during pandemic.

Abbreviations: COVID-19 = novel coronavirus disease, CRAs = chlorine-releasing agents, RT-PCR = reverse transcription-polymerase chain reaction.

Keywords: checklists, novel coronavirus disease, staff safety

1. Introduction
Novel coronavirus disease (COVID-19) due to the severe acute respiratory syndrome corona virus 2 (SARS-CoV2) that causes a cluster of acute respiratory illness has affected people worldwide.[1] Studies before indicated that the endothelium, one of the largest organs in the human body, was a target organ in COVID-19.[2] As of April 16, 2020, globally there were 1991,562 confirmed cases of COVID-19, and 130,885 deaths. The rapidly evolving of COVID-19 epidemic and the increasing reported number of confirmed cases and deaths had resulted in a World Health Organization (WHO) officially declared pandemic on March 11. The pandemic impacted the psychology and social economy in an unprecedented manner, with social distance and travel restrictions, closures of schools and many businesses, and fear of shortages of basic living needs.

While preventing the virus, hospitals were also responsible for the provision of health care which had the potential to expose medical staffs to COVID-19. As time went by, hospital admission rate and surgical amount in vascular surgery department increased gradually. The growth of workload and the flow of people made not only healthcare environment more sophisticated[3] but also the risk of cross infection between medical staffs and patients higher. In this setting, safety was a comparatively inevitable topic, strict and effective infection control protocols are urgently needed.

One positive tool for the improvements in patient safety was “surgical safety checklists,” which had been proposed by the World Health Organization (WHO), and wildly used to improve care processes and patient safety.[4] Several studies had shown the positive effect of checklists in clinic, including effectiveness in decreasing central line-related infections, reducing treatment errors, and improved communication in ICUs.[5-8] Nowadays, the safety checklists originally designed by the WHO has been adapted to the specific needs worldwide. So checklists could also standardize clinic tasks and help healthcare workers adopt good behaviors in a high-stress scenario during COVID-19 pandemic.

In order to protect the safety of patients and staffs, and maintain the normal order of hospital, we provided a try for the design, context, and structure of checklists adapted for healthcare workers and vascular surgery department when operating prevention and control work. The transfer of expert knowledge and best evidence to the healthcare workers in vascular surgery department via a checklist intervention may help to improve quality of care and procedural performance. The high risk of procedures and operations in clinic during pandemic and the low cost of a checklist intervention made this a promising target. The results may provide basis for further prevention and control of COVID-19 in vascular surgery department.
2. Materials and methods

2.1. Checklists

We obtained the required approval from the west China hospital. Checklists were designed based on National Health Commission of the People's Republic of China and our institutional policies and we aimed to design an easy-to-use tool that requires little time but provides order, logic, and systematization and increase the level of both workers and patient safety in vascular surgery department during COVID-19 pandemic. The checklists should be as short as possible, easy to administer, yet be detailed enough so critical items were not omitted. As a one-page paper checklist, this tool needed to be completed by operators before leaving hospital every day to remind staffs standard procedures.

The checklists included evaluation and management of new patients and inpatients, key steps in protective equipment wearing before contacting patients, the right times for hand hygiene, and the ways to disinfect the surface and object in wards and working areas. (Tables 1–4).

While many patients with confirmed COVID-19 infection developed fever and/or signs of respiratory illness such as cough and shortness of breath, most patients were either asymptomatic or only mildly ill. Special attention was paid to screening the new patients because asymptomatic patients were capable of spreading infection. Wearing facemasks was especially important for all the people in hospital for the virus were most commonly spread via respiratory route which required close person to person contact (within 6 ft.). Keeping social distance from others, avoiding crowds and group events, and staying 6 ft. away from other people, was equally important. Transmission of virus may occur if a person touched a surface or object that has the virus on it and then touched their own mouth, nose, or possibly their eyes. SARS-CoV-2 may remain viable in aerosols for up to 3 hours and up to 72 hours on plastic,[9] but can be effectively inactivated from surfaces with a solution of either ethanol (62–71% alcohol), hydrogen peroxide (0.5% hydrogen peroxide), or sodium hypochlorite (0.1% bleach) in just 1 minute. Hence, strict compliance to infection control and hand hygiene was important, handwashing with soap or alcohol-based (minimum 60%) hand sanitizer for at least 20 seconds was the most effective way to minimize exposure. Meanwhile, touched objects and surfaces have to be thoroughly wiped-down after used with appropriate disinfectants.

2.2. Assessment

An assessment of hand hygiene compliance was conducted for a week prior to the introduction of the checklists. The checklists

| Categories                 | Items                                                                 | Do and confirm |
|----------------------------|----------------------------------------------------------------------|----------------|
| Self-check                 | Have a fever                                                          | Yes            |
|                            | Have a shortness of breath, cough, or other symptoms                  |                |
|                            | Have the results reported                                             |                |
| Personal protective equipment | Wear surgical mask and change every 4 hours                         | Yes            |
|                            | Wear cap and gloves                                                  |                |
|                            | Wear face-shield, fluid-resistant gown, eye-protection when necessary |                |
|                            | Change units everyday                                                 |                |
|                            | Take full advantage of buffer zone                                   |                |
| Shift-change               | Less than 30 minutes                                                  | Yes            |
|                            | Less than 3 staffs                                                   |                |
| Hand hygiene in and out of hospital | Through route for workers                                             | Yes            |
|                            | Use private elevator for workers                                      |                |
| Other precautionary behaviors | Keep distance (>1 m) with others                                      | Yes            |
|                            | The number of participants limited to 2 every physician–patient communication |                |
|                            | Bring meals or eat in the canteen of hospital                         |                |

Table 1
Verify that new patients were screened and complied with criteria.

| Categories | Items                                                                 | Do and confirm |
|------------|----------------------------------------------------------------------|----------------|
| Epidemiologic | Traveled to Wuhan or a place where COVID-19 is spreading in the past 14 days. | Yes            |
|            | Have a close contact with people from Wuhan or other areas with ongoing transmission of COVID-19 and with symptoms in the past 14 days. |                |
| Symptoms   | Fever                                                                | Yes            |
|            | Cough, short of breath, persistent pain or pressure in the chest, confusion |                |
| Tests      | Tested positive for COVID-19 by throat swab                          | Yes            |
|            | Tested positive for COVID-19 by RT-PCR                               |                |
|            | Chest CT                                                             |                |

Table 2
Verify oneself well-equipped.

| Categories             | Items                                                                 | Do and confirm |
|------------------------|----------------------------------------------------------------------|----------------|
|                         | Have a fever                                                          | Yes            |
|                         | Have a shortness of breath, cough, or other symptoms                  |                |
|                         | Have the results reported                                             |                |
| Personal protective equipment | Wear surgical mask and change every 4 hours                         | Yes            |
|                         | Wear cap and gloves                                                  |                |
|                         | Wear face-shield, fluid-resistant gown, eye-protection when necessary |                |
|                         | Change units everyday                                                 |                |
|                         | Take full advantage of buffer zone                                   |                |
| Shift-change           | Less than 30 minutes                                                  | Yes            |
|                        | Less than 3 staffs                                                   |                |
| Hand hygiene in and out of hospital | Through route for workers                                             | Yes            |
|                        | Use private elevator for workers                                      |                |
| Other precautionary behaviors | Keep distance (>1 m) with others                                      | Yes            |
|                        | The number of participants limited to 2 every physician–patient communication |                |
|                        | Bring meals or eat in the canteen of hospital                         |                |

Frequency: daily. Responsible party: nurse and doctors. Checklist of self-protection for doctors and nurses.
were then introduced to staffs through formal teaching sessions and 2 repeat assessments were conducted 4 weeks apart. A nurse, acted as the assessor, assigned to collect data on 30 opportunities for hand hygiene of all workers.

2.3. Analysis

Statistical analysis was conducted using SPSS Inc. (Chicago, IL, USA) for Windows version 19. Compliance was analyzed using chi-squared test. Statistical significance was deemed when the 2-tailed P-value was <.05.

3. Results

During the study period, 840 hand hygiene opportunities were identified. Overall hand hygiene compliance increased from week 1 (72.4%) to week 4 (91.0%) (P < .01 based on chi-squared test) (Fig. 1).

4. Discussion

The outbreak of COVID-19 made clinic work more complicated and increased emotionally and physically strain of healthcare workers. The human factors literature demonstrated conclusively that cognitive functions such as memory and arithmetic calculation were vulnerable to error or even complete failure, especially during periods of stress or time pressure. For both inexperienced workers and specialists may make mistakes, safety for both patients and workers were threatened, and attracted more and more attention of hospital. Because of the complexity of health care processes, checklists were introduced and of load memory and safeguard the correct recall of critical items, ensure that critical steps were not missed and also helped ensure the use of current best practices.

With the ability for prevention and foreseeability of errors in medical servers, checklists had been widely used in healthcare system to ensure that important steps in a process were not forgotten and improve safety in clinic. Levels of worker performance were seen to deteriorate during periods of high workload. “Do and confirm” can be useful both for information that relied on perception and for determining which actions were or were not completed. Checklists were positive for the healthcare workers by creating a shared set of standards and goals and improving compliance in precautionary behaviors. In this way, checklists could be useful in increasing effectiveness in self-protection, thus minimizing risk. And the daily goals checklists

| Categories        | Items                                                                 | Do and confirm |
|-------------------|----------------------------------------------------------------------|----------------|
| Inpatients wards  | Limit the number of patients to 3 every room and keep distance (≥3m) | Yes            |
|                   | Disinfect air 3 times a day and last for 30 minutes                  |                |
|                   | Wipe-down the floor and surface of furniture after disinfection with CRAs twice a day |                |
| Duty rooms        | Disinfect air or ventilate for 30 minutes twice a day                |                |
|                   | Wipe-down the floor and surface of furniture with CRAs everyday      |                |
| Doors             | Full-time manager                                                   |                |
|                   | Keep closed                                                         |                |
|                   | Check access control system and keep it working                      |                |
|                   | Screening people entering and exiting hospital                       |                |
|                   | Register people entering and exiting hospital                        |                |
| Frequency: daily. Responsible party: care workers. Checklist for management of environment. CRAs = chlorine-releasing agents. |                |

Table 3
 Verify that all the inpatients and chaperonage informed and adopted good behaviors.

| Categories        | Items                                                                 | Do and confirm |
|-------------------|----------------------------------------------------------------------|----------------|
| Preventive measures | Monitor temperature fourth a day                                    | Yes            |
|                   | Wear masks                                                          |                |
|                   | Change masks                                                        |                |
|                   | Clean hands                                                          |                |
|                   | Cough and sneeze etiquette                                           |                |
| Care givers       | ≤1                                                                  |                |
|                   | Personnel with duties at >1 patient restricted to 1 patient         |                |
|                   | Decline any visiting                                                |                |
| Diets             | Supplied by hospital                                                |                |
|                   | Avoid crowds and queue when food delivered                          |                |
|                   | Avoid talking when having meals                                     |                |
| Others            | Limit the number of luggage                                         |                |
|                   | Call healthcare workers immediately if you have symptoms             |                |
|                   | such as fever, cough, or difficulty breathing                       |                |
|                   | Sign an informed consent form related to COVID-19 pandemic          |                |
|                   | Enter and exit hospital through routes for non-staff                |                |

Frequency: daily. Responsible party: nurse. Education checklist for inpatients and chaperonage.

Table 4
 Verify the environment of department tidy and clean.

| Categories     | Items                                                                 | Do and confirm |
|----------------|----------------------------------------------------------------------|----------------|
| Inpatients wards | Limit the number of patients to 3 every room and keep distance (≥3m) | Yes            |
| Duty rooms     | Disinfect air 3 times a day and last for 30 minutes                  |                |
| Doors          | Check access control system and keep it working                      |                |
|                | Screening people entering and exiting hospital                       |                |
|                | Register people entering and exiting hospital                        |                |
| Frequency: daily. Responsible party: care workers. Checklist for management of environment. CRAs = chlorine-releasing agents. |                |
helped to identify new protection issues and sparked management discussions.

One known example of a cognitive aid was the use of checklists, which aimed to implement evidence-based and best-practice strategies routinely and universally. During a crisis such as COVID-19 pandemic, people sometimes reverted to what they originally learned, not what was the latest recommendation. Checklists made knowledge explicit and applicable in the particular situation in clinic rather than only being in people’s mind.

Checklists can also improve the confidence of nurses and surgeons. Human memory of actions delegated and performed is vulnerable, especially when great pressure existed. Checklists had a notable impact on the mental preparation of the workers for the upcoming operations and the use of which were relatively easy and good to prevent missing steps that can be critically. With the checklists, workers seemed to think more about possible risks associated with the virus.

Of importance, checklists were not 100% effective and a checklist may resulted in failure, some healthcare workers recollected the sequence of steps with a conscious effort of when the checklists were actually used prior to implementation. Operators required proper training before widespread implementation of a checklist and becoming familiar with the layout and purpose of the checklists can helped staffs use them effectively.

5. Conclusion

Checklists can have impact but were not the single solution to many safety problems in clinic. Regardless of the specific steps, such a checklist that verifies the presence of key safety items was helpful for safe delivery of healthcare during COVID-19 pandemic.

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