ORIGINAL RESEARCH

A Semi-Quantitative Risk Assessment and Management Strategies on COVID-19 Infection to Outpatient Health Care Workers in the Post-Pandemic Period

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Background: In the pandemic of COVID-19, due to asymptomatic patients and high personnel fluidity in outpatient clinics, health care workers (HCWs) in outpatients were facing severe threat from infection. There is an urgent need for a risk assessment to recognize and prevent infection risks.

Purpose: To establish a semi-quantitative risk assessment model on COVID-19 infections for HCWs in outpatient departments, and apply it to practices. Further to provide infection risk management strategies to reduce infection threats in the post-pandemic of COVID-19.

Methods: We used the method of Brainstorm, Literature study and Analytic Hierarchy Process (AHP) for risk factors selection and model construction, we also created corresponding indicators for each risk factors, in order to collect data in assessment practice.

Results: Eighteen risk factors were recognized and selected for model construction, by scatter plot, these risk factors had been classified into four parts, spanned the scopes of diagnosis and treatment, environment, personal protection and emergency handling, with specific management suggestions provided. In the practice, outpatient clinics were divided into three risk levels, 5 clinics in high risk level, 9 in medium risk level and 11 in low risk level.

Conclusion: A proper comprehensive risk assessment model for COVID-19 infections has been successfully established. With the model, the ability to COVID-19 prevention in outpatients can be easily evaluated. The strategies on disinfection, surveillance and personal protection were also valuable references in the post-pandemic of COVID-19.

Keywords: COVID-19, health care workers; HCWs, outpatient, risk assessment

COVID-19 first emerged in the city of Wuhan, China, and spread rapidly throughout the country and the world. The WHO declared a global health emergency on 31 January 2020, due to the severe spread of COVID-19.

COVID-19 has more powerful pathogenicity and transmissibility than SARS and MERS.[1] The main transmission method of COVID-19 were droplets and contact,[2] which can be confirmed within a very short exposure time in the absence of personal protective equipment (PPE) like masks.[3]

During the pandemic of COVID-19, the health care workers (HCWs) in outpatient clinics faced high risks of hospital-related transmission of COVID-19.[4,5]

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The severe challenges of COVID-19 control and prevention among HCWs came from three aspects. The first one was the weakness and insufficiency of surveillance ability, infrastructure upgrade, and resource supplement;[6] The second one was the difficulty of identification to COVID-19 infected patients in outpatient;[7] The third one was HCWs themselves, they were vulnerable to both common and novel respiratory pathogens,[8,9] and the non-normative behavior and manipulations of HCWs played the role of vehicles for transmission of COVID-19, which may cause more serious damage, and even nosocomial outbreaks in outpatient settings.[10]

In the post-pandemic of COVID-19, like the condition of China, the infection risk is lower than the early phase of the pandemic period. But the HCWs are still facing uncertain infection risks and need solid protection, due to the asymptomatic or pre-symptomatic patients.[11] On the other hand, the large financial cost, the fragile supplement chain, as well as the overuse and misuse all limited the application of PPE.[12,13] In order to solve the problem and provide more efficient protection to HCWs, it was urgent to perform risk assessment on COVID-19 infection among HCWs and provide leveled infection prevention strategies.

Risk assessment was first introduced to enterprise management by French managerialist Henri Fayol. China started the risk assessment in nosocomial infection control and prevention since 2005.[14] In these years, some research focused on the risk assessment in outpatient clinics in China. Most research focused on the department of Stomatology, the Department of Ophthalmology and the department of Otolaryngology,[15] but few of them give attention on the risk level and risk control strategy of the whole outpatient setting.

The aim of our study was to develop a risk assessment model to grade COVID-19 infection risk levels of outpatient clinics, and provide proper management strategy to meet the requirement of infection control and prevention to COVID-19 in outpatient.

Method
Study Design
We conducted a cross-sectional study to recognize the COVID-19 infection risk of HCWs in outpatients, and rank outpatient clinics into different risk levels to provide specific infection prevention strategies.

This study was conducted in two steps. We first attempted to construct a risk assessment model. Risk factors were selected according to reference research or expert consultations, then we invited experts to identify the risk weight by Analytic Hierarchy Process (AHP), a series of pairwise comparisons were used to determine the relative importance of the selected risk factors. Secondly, we created indicators for each risk factors to collect data for risk scores calculation and statistical analysis. Finally, all outpatient clinics were divide into different risk levels by the sum of risk scores, the strategies on infection control and prevention were also provided.

Selection of Risk Factors
In this research, a expert panel with excellent theoretical knowledge and practical skills was established for consultation, including 13 clinical physicians, 5 nurses, 7 administrators on nosocomial infection, 2 administrators in outpatient management and 2 administrators in nursing management.

Several widely used electronic databases, like PubMed, NCBI(Chinese) and CNKI(Chinese), were critically reviewed with keywords including "COVID-19," "outpatient infection control," "infection control," "health care workers," "respiratory tract infection," "respiratory infection," "risk," "risk assessment," and "risk factor." The articles searching and summarizing was conducted by two research assistants of expert panel, then a pool of articles was established for selection.

The article selection was conducted by an expert panel. The exclusion criteria were: 1) Articles without abstract or was unavailable for download; 2) Article types were: conference article, letters, case report and overview (not systematic review); 3) Articles' scope were associated with psychology, clinical trail, clinical therapy; and 4) Articles with no explicit risk factors recommended, or with unreliable data analysis. Finally, we searched 33 articles in Chinese and 63 articles in English, and a total of 35 articles were included for further study after selection.

From the selected articles, a total of 33 risk factors were extracted. The selection of risk factors was conducted by the expert panel using questionnaire consultation and team discussion.[16,17] The inclusion criteria were: 1) Risk factors were highly recommended in selected articles or documents published by the National Health Commission of the People's Republic of China; 2) Risk factors could be easily observed in practice; and 3) Risk factors should have accurate representativeness on the risk of COVID-19 infections to HCWs.

According to these three criteria, experts selected high quality risk factors, and classified them to construct a risk assessment model.

Evaluation of Risk Factors

We attempted to use a scatter plot to evaluate the selected risk factors. We collected the data of "grade of risk probability-(P)" and "severity of risk consequences(C)" from expert panel through questionnaires, and constructed a scatter plot with P as X axles and C as Y axles. Then we used the transparency of spots to represented P grade and the size to represented C grade. We also drew two crossed lines of X=average(P) and Y=average(C) to divide the scatter plot into four quadrants to formulate proper management strategy.

Analytic Hierarchy Process (AHP)

All selected risk factors were classified into four categories according to content and characters. In categories, each risk factors was compared with other ones, according to its relative contribution to the risk of respiratory infections on HCWs in outpatient. A score scale of 1–9 points was conducted for the pairwise comparison, in which score 1 stands for equal importance, and scores of 3, 5, 7, and 9 denoted weakly, strongly, very strongly, and absolutely more important, scores 2, 4, 6, and 8 were used when slight differences existed between criteria.[18,19]

From the expert panel, we invited 19 experts who had the experience of nosocomial infection control management to participate questionnaires interviews to conduct the AHP process. Consistency index (CI) and consistency ratio (CR) were calculated to evaluate the consistency of the pairwise comparisons. The CI and CR were generally considered to be lager than 0.10 to guarantee a acceptable comparisons quality.[20]

All calculation process were done by the software of Yaahp (Yuanjuecue Software Technology Co., Ltd). The final weighting of risk indicators were the average of AHP process result from 19 experts.

The Risk Assessment Practice

The assessment practice was conducted during Jun 16 to July 3, 2020, in the outpatient of Xuanwu Hospital Capital Medical University, which was built in 1958, renowned for neuroscience and geriatrics. The annual number of outpatient visits of Xuanwu Hospital reached more than 2.9 million in 2019. Xuanwu Hospital is the chairman of the hospital infection control professional committee of Beijing Preventive Medical Association and Beijing Hospital Association.

On the basis of assessment model we established, the expert panel created indicators for each risk factor to perform semi-quantitative risk assessment practice. The indicators included three types: 1) Single Selection (SS), several graded risk levels were presetted by expert panel, assessor select the matched risk level according to clinics' characters and reality. The risk score of this indicator is the score of this selection; 2) Multiple Selection (MS), several equal-level risk possibilities were presetted, assessor select all matched ones according to clinics' characters and fact. The risk score of this indicator is the sum of scores of all selections; and 3) Normalized Ratio (NR), a special ratio was created by the expert panel to reflect risk severity.

With these indicators, the data of all risk factors was collected by field observation and Outpatient Management Database searching.

Statistical Analysis

A Non-parametric statistical method Weighted Rank Sum Ratio (WRSR) was conducted for risk level evaluation. After data collection, WRSR value was calculated in each clinic, and probability unit Probit was used to express the distribution of WRSR to divide outpatient clinics into different risk levels.

In WRSR process, a linear equation was constructed with WRSR values as independent variables and Probit as dependent variables. The risk level was divided by the Probit equal to 5.0 and 6.0. The WRSR in different levels should meet the requirement of homogeneity of variances and significant difference.[21]

Result
The Risk Assessment Model

A total of 18 risk factors were finally brought into the risk assessment model on COVID-19 infections of outpatient HCWs, and divided into four constructs (Table 1). The information of supporting articles to risk factors were showed in Table 2. In this model, "Diagnosis and treatment" had 7 risk factors; "Environment and layout" had 5 risk factors; "Personal protection" had 5 risk factors and "Emergency handling" had 1 risk factor. The risk factor "Close respiratory tract examination (with aerosol generation possibility)" had got the highest weight (0.1241).

The Indicators for Risk Factors

All indicators were showed in Table 3. The applicable conditions were: 1) indicators were not available in

Table 1 The Risk Assessment Model on Respiratory Infection of HCWs in Outpatient Settings

Risk Categories	Weight	Risk Factors	Weight
A. Diagnosis and treatment process	0.2630	a. Density of outpatient patients	0.0361
		b. Critical level of primary disease	0.0912
		c. Average length of time for diagnosis and treatment	0.0230
		d. Patients' correlation with respiratory tract disease	0.0384
		e. Close respiratory tract examination (with aerosol generation possibility)	0.1241
		f. Normativity of pre-examination and triage	0.0646
		g. Compliance of hand hygiene	0.0605
B. Environment and layout	0.1874	h. Normativity of air cleaning and ventilation	0.0407
		i. Normativity of environmental cleaning and disinfection	0.0339
		j. Usable floor area of patients waiting zone	0.0243
		k. The one-patient limitation for one consulting room	0.0404
		l. Results of environmental cleaning and disinfection	0.0464
C. Personal protection	0.3818	m. Participation rate of training on infection control and prevention	0.0221
		n. Qualification rate of training on infection control and prevention	0.0253
		o. Proportion of HCWs wearing correct mask	0.1207
		p. Proportion of outpatient patients wearing correct mask	0.1077
		q. Proportion of HCWs receiving influenza vaccine	0.0409
D. Emergency handling	0.1678	r. The ability of emergency handling on respiratory infectious exposure	0.1137

Fever Clinic; 2) all the indicators based on observation should conducted in an identical week; 3) the standard of pre-examination and triage should at least include "checking body temperature" and "inquiring about fever history"; and 4) the consulting room with nonstandard air ventilation was the room without windows, mechanical ventilation nor air-cleaning equipment.

The Classification and Evaluation of Risk Factors

The average values of P and C were 2.5 and 3.0 respectively, we use them to divide 18 risk factors into four quadrants (Figure 1).

The top right quadrant was the "High Probability and High Consequences (HPHC) risk factors" (e, g, p, and q), they pose the highest threat to HCWs' COVID-19 infections, and play a critical role in infection control.

The top left quadrant was the "Low Probability and High Consequences (LPHC) risk factors" (b, f, h, i, l, o,

and r), they may not be frequently observed in outpatient settings, but can pose a severe threat to HCWs' COVID-19 infection when they existed.

The lower right quadrant was the "High Probability and Low Consequences (HPLC) risk factors" (a, c, d and j), they had high probability to be observed in outpatient settings but made limited contributions to HCWs' COVID-19 infection.

The lower left quadrant was the "Low Probability and Low Consequences (LPLC) risk factors" (k, m and n), they had both low level in probability and threat to HCWs' COVID-19 infection.

The Risk Level of COVID-19 Infections of Outpatient Clinics

The result of statistical analysis showed significant correlation between WRSR and Probit (r=0.987,p=0.058), the linear equation was WRSR=0.366+0.034 Probit.

The value range of WRSR of high risk level was from 0.5824 to 0.6340, including: Emergency Clinic,

Table 2 Detailed Characteristics of Articles Included in the Selected Risk Factors

Risk Factors	Study Name	Methodological Design	Research Conclusion	Odds Ratio (95% CI)
a	Mehmet Aydin (2020)[35]	Comparative study	The horizontal distance travelled by droplet was1.7 m due to breathing or talking and 2.94 m due to sneezing or coughing.	NA
b	Fu-Der Wang (2007)[36]	Cross-sectional serosurvey	Risk of contracting SARS for HCWs in the emergency room was much greater than in the ordinary ward.	25.94 (7.07–95.14)
c	Ran L (2020)[37]	Retrospective cohort study	Cumulative proportion of infection-free HCWs would be decreased with daily workhour.	NA
d	Charlotte V Hobbs (2020)[38]	Case-control study	Infected individuals were more likely to have had close contact with a person with known COVID-19.	3.2 (2.0–5.0)
e	C R Macintyre (2014)[33]	Prospective study	HCWs who performed a HRP were at significantly higher risk.	2.9 (1.42–5.87)
f	Qiaoxia Wang (2020)[39]	Cross-sectional survey	The triage procedure effectively screened the patients and identified the high-risk population.	NA
g	Yen MY (2011)[40]	Retrospective study	Suboptimal handwashing before or after patient contact is a risk factor of COVID-19 infection.	3.10 (1.43 −6.73); 2.82 (1.11–7.18)
h	Manoj Kumar Satheesan (2020)[41]	Comparative study	Air change is highly recommended to lower infection risk	NA
i	Vincent Chi-Chung Cheng (2020)[42]	Cross-sectional survey	5.0% (19/337)environmental samples close to COVID-19 patients were positive by RT-PCR assay.	NA
j	World Health Organization (2018)[43]	Official guideline	Acquiring respiratory diseases was associated with crowding.	NA
K	Mehmet Aydin (2020)[35]	Comparative study	The horizontal distance travelled by droplet was 1.7 m due to breathing or talking.	NA
l	Tianxiang (2020)[44]	Cross-sectional study	Routine disinfection procedures were effective in reducing the potential risk of healthcare associated infection.	NA
m	Xiaodong Guo (2020)[45]	Cross-sectional study	Participation in training on prevention measures have a protective effect against COVID-19.	NA
n	Shivalingesh Krishnappa Kamate (2020)[46]	Cross-sectional study	Good knowledge and practice scores were important to combat COVID-19.	NA
o	World Health Organization (2014)[47]	Official guideline	Masks were recommended to protect healthcare workers (HCWs) from seasonal influenza.	NA
p	Vittoria Offeddu (2017)[48]	Systematic Review	Masks provide a protective effect against SARS.	0.13 (0.03–0.62)
q	Vittorio Demicheli (2018)[49]	Systematic Review	Vaccines probably reduce influenza in healthy adults from 2.3% without vaccination to 0.9%.	0.41 (0.36–0.47)
r	Zixing Huang (2020)[50]	Prospective study	Emergency strategic planning can help protect patients and staff against a highly infectious disease.	NA

Paediatrics Clinic, Stomatology Clinic, E.N.T.Clinic and Pneumology Clinic. The medium risk level was from 0.5424 to 0.5718, including 9 departments. The low risk level was from 0.4771 to 0.5305, including 11 departments (Table 4). The WRSR in three levels meet the requirement of homogeneity of variances (Levene=0.878, P=0.430) and significant difference (F=35.614, P≤0.001).

Table 3 The Semi-Quantitative Scoring Indicators

Risk Categories	Risk Factors	Type	A (1 Point)	B (2 Point)	C (3 Point)	D (4 Point)	E (5 Point)
A. Diagnosis and treatment process	a. Density of outpatient patients	RM	The number of outpatient visitors in a week/the number of physicians available for outpatient health care in a week				
	b. Critical level of primary disease	SS	Stable condition				Critical condition without infection triage
	c. Average length of time for diagnosis and treatment	RM	The total medical working hours of outpatient physicians in a week/the number of outpatient patients in a week				
	d. Patients may associated with respiratory tract disease	SS	Not involved		Can not be excluded		In main scope of treatment
	e. Close respiratory tract examination (with aerosol generation possibility)	SS	Not involved	Respiratory tract closed, close range, over 10 min	Respiratory tract open, close range, less than 10 min	Respiratory tract open, close range, over 10 min	Respiratory tract open, close range, aerosol generating
	f. Normativity of pre-examination and triage	RM	Number of normative pre-examination and triage/number of all pre-examination and triage in observation				
	g. Compliance of hand hygiene	RM	Number of hand hygiene/all hand hygiene opportunity in observation				
B. Environment and layout	h. Normativity of air cleaning and ventilation	RM	Number of consulting room with air ventilation/number of all available consulting room				
	i. Normativity of environmental cleaning and disinfection	MS	Low frequency	Incorrect method	Sanitizer production expired	Incorrect concentration	Insufficient human resources
	j. Usable floor area of patients waiting zone	RM	Usable area of waiting zone/the number of outpatient visitors in a week				
	K. One consulting room confine one patient receiving health care	RM	Number of qualified available consultation room/number of all available consultation rooms				
	l. Results of Environmental cleaning and disinfection	SS	Excellent	Fine	Acceptable	Average level	Poor
C. Personal protection	m. Participation rate of training on infection control and prevention	RM	The number of participants of examination/the number of all HCWs in clinics				
	n. Qualification rate of training on infection control and prevention	RM	The number of qualification HCWs in examination/the number of all HCWs participating examination				
	o. Proportion of HCWs wearing correct mask	RM	The number of HCWs with correct mask wearing/the number of physician in observation				
	p. Proportion of outpatient patients wearing correct mask	RM	The number of outpatient patients with correct mask wearing				
	q. Proportion of HCWs receiving influenza vaccine	RM	The number of HCWs with influenza vaccine inoculated/the total number of HCWs in outpatient clinics				

(*Continued*)

Table 3 (Continued).

Risk Categories	Risk Factors	Type	A (1 Point)	B (2 Point)	C (3 Point)	D (4 Point)	E (5 Point)
D. Emergency handling	r. The ability of emergency handling on respiratory infectious exposure	MS	Unfamiliarity with PPE	Unfamiliarity with emergency protocol	Unfamiliarity with report protocol	Unfamiliarity with terminal disinfection	Unfamiliarity with triage for fever patients

Discussion
The Selection of Risk Factors and Statistical Indicators

We used the method of Brainstorm and literature extraction to construct a primary risk factors pool for selection, and 18 risk factors had finally passed the selection process. We paid considerable attention to the risk factors with the ability to represent the reality of outpatient infection control, and may contradict other research.

For instance, the research of Van Buynder[22] and Jiang Wu[23] suggested that both the fact of HCWs owning a car and the number of HCWs' family members with respiratory infections contributed to the infection risk. On the contrary, the expert panel of our research believed that in the reality of China, considering the degree of crowding on all types of transport, taking a public bus for daily commutes provides more threat to HCWs' infection. For the second research, the expert panel came to an agreement that the aim of our research should focus on the infections happening in outpatient settings. So these two research conclusions werenot brought into our risk pool.

We regarded the risk posed by COVID-19 infections in the process of group consultation and in the collection of medical waste as a tiny probability, but could be easily avoided, which means their representativeness was relatively low, so we finally excluded the.

Some research reported the method of counting the use of alcohol-based hand rub (AHR) to represent the compliance with hand hygiene. According to the fact of outpatient settings in China, a number of outpatient clinics used hand washing with flowing water instead of AHR, so we used the method of observation to score most risk factors in the categories of "Environment and layout" and "Personal protection," such as "Compliance of hand hygiene."[24]

Management Strategies for Risk Factors

Risk assessment is a scientific method for effectively improving HAI management. The implementation of
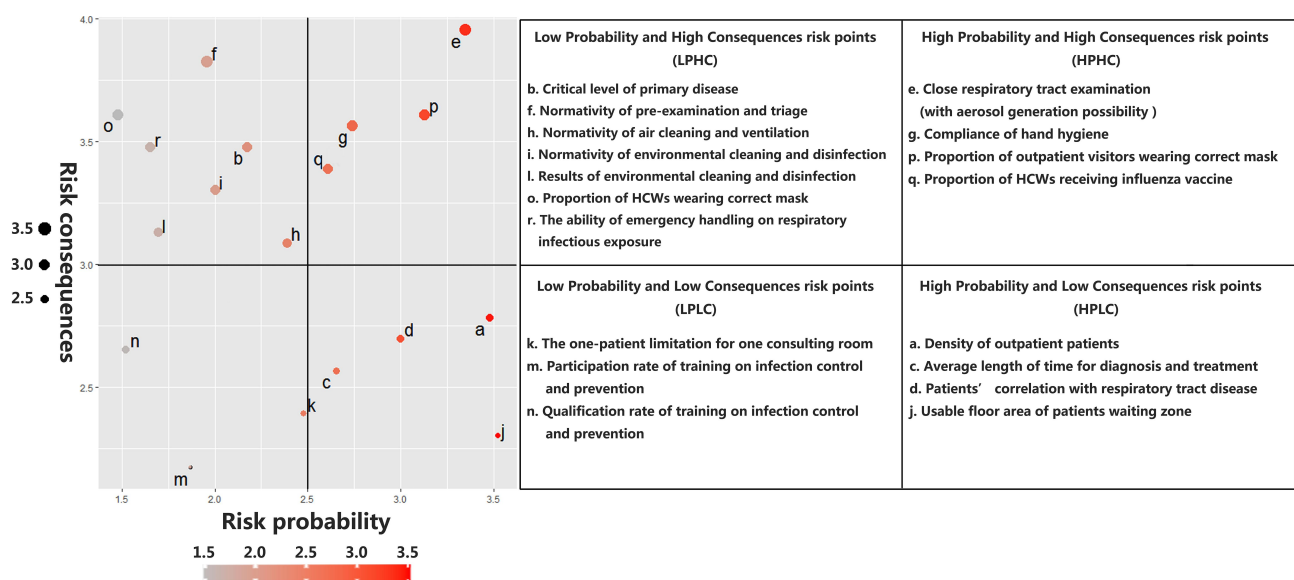
Figure 1 The scatter plot of risk factors and the four management quadrants.

Table 4 The Risk Level of COVID-19 Infections of Outpatient Clinics

Clinics	WRSR	Probit	WRSR	Risk Level
Emergency Clinic	0.6340	7.43	0.618	High
Paediatrics Clinic	0.5859	6.85	0.599	High
Stomatology Clinic	0.5844	6.51	0.587	High
E.N.T.Clinic	0.5839	6.27	0.579	High
Pneumology Clinic	0.5824	6.09	0.573	High
Traditional Chinese Medicine Clinic	0.5718	5.94	0.568	Medium
Rehabilitation Clinic	0.5589	5.81	0.563	Medium
Neurosurgery Clinic	0.5582	5.68	0.559	Medium
Thoracic Surgery Clinic	0.5562	5.57	0.555	Medium
Hematology Clinic	0.5547	5.46	0.552	Medium
General Surgery Clinic	0.5464	5.35	0.548	Medium
Vascular Surgery Clinic	0.5461	5.25	0.545	Medium
Osteology Clinic	0.5457	5.15	0.541	Medium
Ophthalmology Clinic	0.5424	5.05	0.538	Medium
Endocrinology Clinic	0.5305	4.95	0.534	Low
Gastroenterology Clinic	0.5304	4.85	0.531	Low
Neurology Clinic	0.5268	4.74	0.527	Low
Cardiology Clinic	0.5254	4.63	0.523	Low
Dermatology Clinic	0.5247	4.52	0.520	Low
Functional Neurosurgery Clinic	0.5205	4.39	0.515	Low
Pain Treatment Clinic	0.5170	4.26	0.511	Low
Urology Clinic	0.5156	4.11	0.506	Low
Nephrology Clinic	0.5002	3.93	0.499	Low
Rheumatology and Immunology Clinic	0.4876	3.69	0.492	Low
Obstetrics and Gynecology Clinic	0.4771	3.35	0.480	Low

proper and targeted management, based on risk assessment, may achieve acceptable results.[21,25]

In the pandemic of COVID-19, we suggested targeted management for risk factors in different quadrants. For the risk factors of HPHC, which played a critical role in the HCWs' respiratory infections. We suggestimplementing top level management, including tight surveillance, severe punishment, and emergency handling drill, to improve the consciousness of COVID-19 infection prevention. For the risk factors of LPHC, we suggested to apply Work Log, Standard Operating Procedure (SOP) to institutionalize and standardize the daily risk prevention measures, such as disinfection, ventilation, and training. For the HPLC, we should pay attention to reducing the risk probability of controlling the risk threat. The effective measurements may include optimization of diagnosis and treatment processes, optimization of environment cleaning and layout, and supplement of management stipulation. For the risk factors of LPLC, because of the low level of risk probability and consequence, we suggestproviding low level attention and strength to these risk factors, and include the management of LPLC into the list of regular surveillance.

Besides the conventional measures used in infection control and prevention, some novel techniques have been reported to apply in the improvement of infection control and prevention. The Unannounced Standardized Patient (USP) is the method that using highly trained actors to observe and measure the quality of medical practice and health-care associations with standard checklist.[26,27] The USP is considered as a gold standard for evaluating healthcare providers in many domains, and has the ability to reduce Hawthorne effect to avoid inherent observational bias.[28–30] So, if possible, the USP might be a good choice for surveillance and management of HPLC risk factors.

Several techniques have gone beyond training and lectures, such as reminder sounds, practical simulations, videos surveillance, and audiovisual media, which showed more effectiveness in the improvement of self-management and compliance.[31] We considered that these methods might be the proper approach for the management of LPLC risk factors.

The Analysis of Risk Level of Outpatient Clinics

In high risk level, the emergency clinic took first place. In the medium level, the rehabilitation treatment clinic, the ophthalmology clinic and the traditional Chinese medicine clinic took the top three.

The main reason for the ranking, to a large extent, was their high risk scores in the high weighted risk factors like "Close respiratory tract examination (with aerosol generation possibility)," "Diagnosis and treatment were associated with respiratory tract disease" and "the critical

level of primary disease." These risk factors played key role in the respiratory infection of HCWs,[32,33] and also constituted part of the risk characters of these clinics, so the list of high level risk clinics may probably maintain stabilization in long-term, especially in the pandemic of COVID-19.

What we should notice was that the medium risk level clinics may have more uncertainty, because most of the scores of risk factors in the categories of "Environment and layout" and "Personal protection" were collected by observation or calculation, they reflected the current outcomes and consciousness of infection prevention, and also made more contribution to the ranking of medium level. So the staff of nosocomial infection control departments should pay more attentionto improve the clinics at the medium risk level. Methods like personnel training, targeted interventions, clinical supervision, and the novel techniques discussed above could be taken into consideration.

Suggestion for Personal Protective Equipment (PPE)

In the COVID-19 pandemic, we suggested to conduct hierarchical PPE to prevent different risk level respiratory infection of HCWs.[34] The basic PPE should include surgical mask, medical uniform, and medical caps and should be worn by all HCWs working in outpatient settings. In every hospital, the PPE standard should be carefully evaluated by a MDT group including the expert of nosocomial infection control, outpatient management and nurse management, in order to match the situation of different hospitals.

For the high level clinics, we suggest providing medical respirators and medical examination gloves. For the staff associated with respiratory tract examination, medical face screen, and isolation gown should be provided. The normalization of PPE and respiratory tract examination process should attract highly attention.

For the medium level clinics, regarding basic PPE as the prerequisite, we suggest providing medical respirators and face screens according to the COVID-19 pandemic risk in local community. For the clinics ranked high within the medium level, we should focus on the risk factors with high scores, and conduct improvement projects with more supervisions and guidance.

For the low level clinics, we believe that basic PPE can meet the requirement of infection control and prevention, the key point should be the maintenance of low scores in risk factors.

It was a notable fact that the PPE standard we discussed should stand on the basis of normative pre-examination and triage, which can keep patients with fever or highly suspected COVID-19 infection out of outpatient.

Strength and Weakness

The highlight of our research was that we built a risk assessment model on COVID-19 infection of HCWs in outpatient clinics, we also designed semi-quantitative scoring indicators for each risk factors, and successfully brought the risk assessment to practice. The management strategies we provided can be valuable references for infection prevention to COVID-19.

A weakness of our research was that we did not take the interactive effect among risk factors into consideration, which may provide extra consequences to the risk level grading. We hope this problem could be solved in our next research.

Ethics Statement

This research was not associated with human or animal subjects, human cell lines or human tissues, and was exempt from ethics approval.

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Disclosure

The authors report no conflicts of interest in this work.

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