

# Application of PDCA Cycle Management for Postgraduate Medical Students During the COVID-19 Pandemic

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## Research article

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# Abstract

**Background:** The COVID-19 outbreak has had an enormous impact on various industries around the world. As postgraduate students in clinical medicine have both student and resident identity characteristics, Peking University Third Hospital (PUTH), as a university-affiliated hospital for cultivating future medical talent, has been facing unprecedented challenges in regard to the management of postgraduate medical students during the COVID-19 pandemic. Therefore, the purpose of this study was to explore the management effect from PDCA cycle management on postgraduate medical students during the COVID-19 outbreak.

**Methods:** The methods of document review, questionnaire surveys and interviews were used to continuously improve the management measures of postgraduate medical students during the COVID-19 pandemic by using the PDCA cycle.

**Results:** Investigations were conducted on the management system, back-to-school arrangements, COVID-19 prevention and control training, online teaching, mentoring, laboratory management, dissertation progress, and emotional state of postgraduate medical students during the COVID-19 pandemic. We found that strengthening public health management knowledge training, increasing infectious-disease-related knowledge training, innovating online teaching methods, improving PDCA management model maps, and formulating improvement programmes are conducive to improving the quality of such management.

**Conclusion:** Aiming at the difficult problems involved in the management of postgraduate medical students during the COVID-19 pandemic, managers need to comprehensively consider and conduct overall planning and use the PDCA management model to improve the management of postgraduate medical students during the COVID-19 pandemic.

## Background

Since December 2019, cases of pneumonia from a novel coronavirus (SARS-CoV-2) infection have occurred in China and other countries, and the number of cases has rapidly increased, causing widespread concern at the global level. On the evening of January 30, 2020, the World Health Organization (WHO) announced that the new coronavirus pandemic was considered a public health emergency of international concern (PHEIC)<sup>1</sup>. Subsequently, COVID-19 has been widely spread around the world. On February 28, 2020, the WHO evaluated the global risk of the COVID-19 pandemic as "very high", and the European Centres for Disease Control and Prevention raised the European risk level to "moderate to high". In the early morning of March 12, 2020, Beijing time, the WHO officially characterized the pneumonia pandemic as a global "pandemic". When the WHO released this news, more than 110 countries and regions in the world had COVID-19 cases, totalling 118,000 confirmed cases, and more than 4,000 people had died. Joint prevention and control are an inevitable requirement for responding to infectious diseases in the context of globalization. The outbreak of the COVID-19 pandemic has had an

enormous impact on various industries around the world. Since the beginning of the COVID-19 pandemic, a large number of postgraduates with master's and doctoral degrees in China have been undergoing standardized training for residents. As a university-affiliated hospital for cultivating future medical talent, Peking University Third Hospital (PUTH) has been facing unprecedented challenges in regard to the management of postgraduate medical students.

In China, high school graduates can be selected to enter medical school by taking the unified national examination and obtain a bachelor's degree after completing 5 years of basic education and clinical medical education. Graduate students can further apply for a master's degree in clinical medicine through two methods: national examination or school recommendation. Those who have achieved outstanding results after 3 years of study can continue to apply for a three-year doctoral degree in clinical medicine, which is called the 3 + 3 continuous training model (Fig. 1). In addition to providing standardized training to residents, a master's degree in clinical medicine focuses on cultivating professional basic theories, comprehensive qualities, and innovative spirit. In addition to 3 years of standardized training for senior residents, clinical doctoral degree students must also receive 1 year of scientific research training to achieve the goal of cultivating innovative talent. Because postgraduate students in clinical medicine have both student and resident identity characteristics, student management at medical schools and hospitals has become complicated during the COVID-19 pandemic.

The plan-do-check-act (PDCA) cycle, also known as the "quality loop", is a general model in management, originated in the 1920s, and is known as the "statistical quality control father". Walter A. Shewhart proposed the concept of "plan-do-see" (PDS), and then, Dr. Deming, an American quality management expert, further developed Shewhart's PDS cycle into the "plan-do-see-check-act" cycle, also called the "Deming circle". The Deming circle was introduced in Japan and China in the early 1950s and late 1970s, respectively. It began to be used in total quality management and, then, was extended to various work areas in various industries. Similarly, the application of the Deming circle in the teaching field has also promoted the improvement of teaching quality<sup>2-4</sup>. The PDCA cycle is divided into four phases: plan, do, check, and action. PDCA performance involves the entire management system being in a four-stage cycle of "planning-execution-inspection-processing" at all levels and links, which reflects the internal logic of system operation. The management system of the entire organization constitutes a large cycle, and each part of PDCA has its own small cycle, forming a large-scale, small ring, interrelated and mutually restricted scientific cycle system.

According to the actual situation of PUTH, using the PDCA management mode, the management process and strategy of postgraduate medical students as residents during the pandemic were thoroughly explored and analysed. These management processes and strategies have important practical significance and reference value for ensuring that postgraduate medical students trained as residents can safely participate in the prevention and control of pandemics.

## Methods

# Study design

This study was conducted in the context of management measures of postgraduate medical students during the COVID-19 pandemic in PUTH. The PDCA cycle, also known as the "quality loop", is a general model in management. In this study, document review, questionnaire surveys and interviews were used to continuously improve the management measures of postgraduate medical students during the COVID-19 pandemic by using the PDCA cycle.

## Characteristics of participants

There were 276 clinical professional degree postgraduates in PUTH. The average age of 276 professional degree postgraduates was 26 years old (22–32 years old).

## Data Collection

Data collection occurred over a 2-month period since Wuhan was closed. We collected the overall return rate of students to the hospital, COVID-19 prevention and control training effect, survey of postgraduate psychological status.

## Statistical analysis

The data was managed by the Excel 2019, and the SPSS 25.0 was used for statistical analysis. The quantitative data conforming to the normal distribution was described as mean  $\pm$  standard deviation. The qualitative data was described as number (percentage), and the comparison between groups was performed by the Chi-square test. In all tests, statistical significance was set at two-sided *P* values less than 0.05.

## Results

Using PDCA for postgraduate management during the COVID-19 pandemic

### 1. Plan

At the beginning of the COVID-19 pandemic outbreak, little was known about the transmission route, pathogenesis, epidemiological characteristics, etc. Therefore, the hospitals needed to make a comprehensive plan for the management of postgraduate medical students.

Since the COVID-19 outbreak was during the Spring Festival, most of the postgraduate students returned to their homes, and some students had travelled abroad. Therefore, arranging these students to return to the hospital on time to continue to participate in their clinical rotation was the first management issue.

January to April is a special period for graduate students, as this is typically when they write dissertations, thesis reviews, and graduation defences and obtain employment, which also increases the difficulty in managing postgraduates during pandemic prevention and control.

As a comprehensive tertiary hospital, PUTH has high-risk departments, such as the infectious disease department (including the fever clinic), emergency department, and the pulmonary and critical care medicine department (including the negative pressure ward). Postgraduate medical students need to rotate through these departments and quickly conduct emergency COVID-19 protection training to reduce the risk of COVID-19 infection.

The average age of 276 postgraduates in clinical medicine at PUTH is 26 years old (22–32 years old). In the early stage of the COVID-19 pandemic, students may not have taken fully qualified protective measures due to insufficient knowledge of COVID-19 and inadequate protective materials in the hospital. With the increase in the number of new confirmed cases and deaths each day, postgraduate medical students working on the clinical frontline may have experienced negative emotions such as fear, terror, and anxiety, and their parents may have also experienced various anxieties and concerns. Therefore, it is necessary to pay full attention and respond to the psychological changes of these students.

Based on the abovementioned management problems, to ensure zero infections among these students and to steadily promote the orderly development of clinical training and scientific experiments, the hospital should immediately establish a COVID-19 pandemic prevention and control team and an emergency management system.

## 2. Do

In the early days of the COVID-19 outbreak, the hospital set up pandemic prevention and control leading and working groups as soon it could to comprehensively deploy and implement various pandemic prevention and control tasks and teaching work. According to the "Peking University Notice on Postponing the Start Time of the Spring Semester of 2020" and other documents issued by Peking University Health Science Centre (PKUHSC), the hospital successively issued the "Work Plan on Student Management during the Prevention and Control of COVID-19 in PUTH". Through the strict management of temporary student dormitories, attention to students' psychological crisis, and establishment of emergency treatment procedures for febrile students, the hospital aims to do its best to manage these students during the COVID-19 pandemic.

The postgraduate supervisor is the first person responsible for postgraduate training. PKUHSC requires the supervisor to provide remote guidance (online and offline) to the graduate student and make a record of such guidance. It is recommended that supervisors pay more attention to the physical and mental health of graduate students, clinical and scientific research work, and pandemic prevention and control.

## 2.1 Develop principles for going back to school

Considering that postgraduate medical students undertake frontline clinical work, PKUHSC and the hospital have decided to implement the principle of returning graduate students in batches the following considerations: (1) students who have not left Beijing must strictly abide by the clinical rotation arrangements of the hospital, (2) students who have returned to Hubei or passed through Hubei will not return to school, and (3) students returning to other areas, those who have no history of contact with confirmed or suspicious cases and those who have no fever or respiratory symptoms can return to school. Figure 2 shows the distribution of students on January 26, 2020.

## 2.2 Management process after returning to school

To ensure the timely placement of postgraduate medical students returning to school, the Hospital Education Department adopts a standardized flow chart to specifically implement various management tasks. Figure 3 shows the flowchart of the management of students returning to school. Figure 4 is a flowchart of the emergency treatment of students with a fever.

## 2.3 Strengthen student pandemic prevention and control training

According to the arrangement of the Beijing Municipal Health Commission, the hospital keeps pace with the times, strengthens the training of students for pandemic prevention and control, and has organized the writing of training materials from the first to the seventh editions. The hospital has simultaneously conducted online and offline training. The training content includes the COVID-19 prevention and control management plan and workflow of PUTH, COVID-19 diagnosis and treatment and prevention and control principles. Through online theoretical and on-site operation assessment, postgraduate students can fully grasp the COVID-19 diagnosis and treatment plan and hospital infection prevention and control knowledge.

## 2.4 Using online teaching to ensure postgraduate students' teaching quality

On February 5, 2020, the Ministry of Education of China issued the "Guiding Opinions on Doing a Good Job in the Organization and Management of Online Teaching in Ordinary Colleges and Universities During the Pandemic Prevention and Control Period", requiring that online teaching during the pandemic be guaranteed. <sup>[7]</sup> On February 5, PKUHSC issued the "Pedagogical University's 2020 Spring Semester Pandemic Prevention and Control Teaching Implementation Plan" to promote the reform of learning methods with the innovation of teaching and learning that integrates information technology and

education. According to the requirements of the PKUHSC documents, the hospital actively organizes teachers who undertake teaching tasks, strengthens the construction of online courses during the pandemic, and adopts online teaching in the form of both recorded and live courses.

## **2.5 Reasonable arrangement of clinical work during pandemic prevention and control**

According to the "Opinions on Deepening the Cultivation of Clinical Medicine Talents of Medical Education Collaboration", issued by the Ministry of Education of China, and the "Opinions of the State Council General Office on Further Promoting Medical Education Reform and Development", issued by the General Office of the State Council, it is necessary to promote master's degree education to be organically connected with the standardized training of residents. [5, 8] Therefore, postgraduate students of clinical medicine degree need to complete clinical training in strict accordance with the requirements of the professional training programmes of various disciplines. As the hospital sent three batches of medical teams to support hospitals in Wuhan, there was a shortage of residents in the emergency department, and more than a dozen postgraduate medical students were temporarily arranged to rotate to the emergency department to ensure medical coverage. The clinical work of other departments has since been readjusted, as have the rotation plan and duty positions, according to the specific workload.

## **2.6 Laboratory management during the outbreak**

In addition to clinical training, postgraduate medical students also undertake scientific research. Some students need to return to school to continue the experiment due to the progress of the subject. To this end, the hospital has specially formulated a flow chart for students to enter the laboratory to ensure orderly laboratory work (Fig. 5). During laboratory experiments, postgraduate students are required to strictly abide by the relevant regulations on laboratory safety and protection, implement a daily registration system, and strengthen laboratory management during pandemic prevention and control.

For postgraduate students nearing graduation, the hospital started pre-reviewing theses in the hospital in early February 2020 and invited experts in various fields to review them by e-mail and other forms. The review content included the content of the thesis, writing form, and statistical methods.

## **2.7 Pay attention to the psychological changes of students during the COVID-19 pandemic**

In the period of the COVID-19 pandemic, special attention should be paid to the psychological changes of students, especially those nearing graduation, who are faced with multiple pressures, such as the anonymous review of dissertations, thesis defences, employment, and stage assessment, and are more

prone to psychological problems. Therefore, the hospital specially set up a psychological prevention and control team for students and found that students with psychological problems must be promptly guided.

## 3. Check

### 3.1 Training of postgraduate medical students returning to the hospital

In late January 2020, after the closure of Wuhan, the hospital urgently arranged temporary dormitories for postgraduate medical students. As of January 31, 2020, the overall return rate of students to the hospital was 79.3%. As of February 14, 2020, the overall return rate of students reached 92.8%. At the beginning of the outbreak, nationwide, most of the students who had left Beijing had already returned to the hospital for clinical work. All students returning to the hospital adopted a centralized management approach for limited regional isolation. In the early stage of the outbreak, professional degree graduates returned to the hospital to participate in clinical work. All the returned students were quarantined under centralized management. In the early stage of the outbreak (late January to early February), limited areas were quarantined. During the middle of the outbreak (from early February to mid-February), a strict 14-day quarantine was put into effect for each room (Fig. 6).

### 3.2 COVID-19 prevention and control training effect

On February 6, 2020, postgraduate medical students will learn the knowledge of COVID-19 prevention and control online and participate in the online assessment. The specific assessment situation is presented in Table 1, which shows that the average score of postgraduate students is relatively low. We conduct intensive training on the weak links of online assessment, such as the route of transmission, precautions when coughing and sneezing, the disposal of discarded masks, and how to improve immunity. Through such targeted and intensive training, postgraduate medical students have fully mastered the knowledge of pandemic prevention, and the final assessment pass rate was 100%.

Table 1  
The statistical table of graduate students' online assessment in PUTH

Graduate student type	Number	Number of respondents	Answered questions per capita	Average score
Professional master's degree	180	358	1.99	84.65
Professional doctoral degree	96	207	2.16	87.52

### 3.3 Online course teaching effect

Since February 17, 2020, the hospital has completed the course construction work of the online teaching of graduate courses and has adopted online teaching via recorded and live courses, seminars, and teaching methods. The 8 postgraduate courses led by the hospital are being taught as scheduled. To ensure the quality of teaching, the preparation and uploading of each courseware have been designated to the person in charge of the course. Questions that arise during the process should be reported to the teacher in time to improve the quality of online teaching. At present, the effect of graduate student feedback regarding online learning is basically the same as that regarding offline classroom teaching.

### 3.4 Degree thesis and award

As of March 27, 2020, the submission rate of academic dissertations by professional degree graduates was 83.9% (47/56). Among them, there are some graduate students who are affected by the COVID-19 pandemic, and they need to add experiments and data before they can complete their thesis writing. To this end, both schools and hospitals have drawn up plans for awarding degrees and plan to add a degree evaluation committee and subcommittee from July to August 2020 to ensure that all students complete thesis defence and are awarded degrees.

### 3.5 Survey of postgraduate psychological status

On February 12, 2020, the hospital conducted an online questionnaire survey on postgraduate psychology-related issues during pandemic prevention and control. A total of 276 postgraduate students were surveyed, and a total of 198 valid questionnaires were recovered, with an effective questionnaire recovery rate of 71.7%. Table 2 shows that 66.4% (77/116) of master's degree students have some anxiety or depression in the face of the pressure from the pandemic; 31.9% (37/116) do not feel obvious psychological and mental pressure. A total of 59.8% (49/82) of doctoral degree students have some anxiety or depression, and 40.2% (33/82) do not feel obvious psychological and mental pressure. Comparing the two types of postgraduate students,  $P > 0.05$ , the difference is not statistically significant. The specific results are shown in Table 2. However, compared with doctoral students, master's degree students are more prone to anxiety or depression. This shows that doctoral students have more clinical experience in the face of pandemics and are more rational in the face of emergency situations. These master's degree students are more prone to psychological problems such as tension and anxiety, which suggests that the teaching management department, clinical departments and supervisors should pay more attention and provide key guidance to these postgraduates.

Table 2  
Survey table of psychological status of postgraduates in PUTH [n (%)]

Question	Options	Professional master's degree (n = 116)	Professional doctoral degree (n = 82)	$\chi^2$	<i>P</i>
Reacting to the pandemic, I had a self-assessment of my mental state in the past 7 days	Do not feel obvious psychological and mental pressure	37(31.9)	33(40.2)	2.692	0.260
	Have some anxiety or depression, can bear it and adjust themselves, and can now gradually adapt and improve	77(66.4)	49(59.8)		
	Very anxious or depressed, does not continue to alleviate, seriously affects the normal study and work	2(1.7)	0		

### 3.6 Survey of supervisor guidance for students

On February 27, 2020, an online questionnaire survey was completed by 84 postgraduate students. The main content was the frequency and method of supervisor guidance. The effective questionnaire recovery rate is 100%. The feedback from the postgraduate students suggested that the supervisor guides 2 or more times per week and once per week, accounting for 50.0% (42/84) and 39.3% (33/84) of the sample. The method of supervisor guidance is mainly through WeChat (graphic message), telephone, online voice or video chat and e-mail.

### 3.7 Postgraduate temperature monitoring

Full-time teachers of the Education Department monitor the temperature of postgraduate students daily. From January 27, 2020, to March 27, 2020, a total of 7 postgraduate students in the hospital developed a fever. The emergency management process for fever students was strictly followed, and isolation measures were immediately adopted. Among these students, 3 suffered from fever accompanied by fatigue, dry cough, or chest tightness. New coronavirus nucleic acid tests were negative. The other 4 postgraduate students had only transient low fevers. After symptomatic treatment, their body temperature returned to normal, and normal training resumed after 3 days of normal body temperature. As of May 31, 2020, no postgraduate students had COVID-19.

# Discussion

## Act

### 1. Multiform fine management

In addition to the daily monitoring of body temperature, completion of online teaching, and guarantee of thesis quality, the managers of postgraduate students adopted methods such as simulation teaching, PBL teaching, CBL teaching, and video conferencing to provide training programmes. The next stage will focus on enhancing the diversity of clinical training methods for postgraduate students. In addition, for some postgraduate students still unable to return to the hospital or subject research affected by the pandemic, they can use this time to strengthen their knowledge of academic frontiers and cross-disciplinary literature, data statistics, etc., through the cloud experiment platform, etc., to strengthen their experimental operational skills.

### 2. Increase the content of training courses

During the COVID-19 pandemic, it was found that postgraduates have less training in public health and knowledge of infectious disease prevention and control. Although most of the students have taken public health and infectious-disease-related courses at the undergraduate level, the updating of this knowledge is very fast; postgraduate students need to be trained in the normalization of public health and infectious disease prevention and control knowledge. Graduate students of all majors need to have a deep understanding of the principles of handling public health emergencies and the protection requirements for infectious diseases.

### 3. Increase the clinical training for infectious diseases

According to the requirements of the current postgraduate training programme, only students of internal medicine majors can participate in 2 months of clinical training for infectious diseases, and students of other majors have no opportunity to participate in the practice of infectious disease. To better cope with emergency prevention and control work related to infectious diseases in the future, it is recommended that flexible time in other professional graduate training programmes be used for clinical training for infectious diseases. The duration of such flexible time is approximately 2 weeks, which is sufficient to allow for postgraduate students to master the clinical treatment of common infectious diseases in that time.

### 4. Forming a PDCA model map

Through the implementation of this round of the PDCA cycle, a management model map for postgraduates under a special pandemic situation is formed. See Fig. 7 for details. In the future, we will continue to improve the content of the four stages of PDCA according to the management model map and continuously improve the quality of teaching management and management efficiency regarding public health emergencies.

## **Conclusions**

In the COVID-19 pandemic prevention and control stage, the Education Department of PUTH uses PDCA management methods and innovative work methods to form an education department for the linkage system of the hospital, clinical department, supervisor, and postgraduate students and further uses information technology to strengthen the daily management of postgraduate students, academic guidance, and online teaching, ensure the quality of such teaching, and pay attention to the physical and mental health of postgraduate students at the same time.

## **Abbreviations**

PUTH: Peking University Third Hospital; PDCA: WHO: World Health Organization; PHEIC: public health emergency of international concern; PDCA: plan-do-check-act; PDS: plan-do-see; PKUHSC: Peking University Health Science Centre.

## **Declarations**

## **Ethics approval and consent to participate**

Ethics committee is an independent organization composed of medical professionals, legal experts and non-medical personnel. Its responsibility is to verify whether the clinical trial protocol and its attachments are ethical, and provide public guarantee to ensure that the safety, health and rights and interests of subjects are protected. This study is not a clinical trial, furthermore, the data in this study were obtained with the informed verbal consent of the participants.

## **Consent to publish**

This manuscript has not been published before and is not being considered for publication elsewhere.

## **Availability of data and materials**

All data generated or analysed during this study are included in this published article

## **Competing interests**

All authors declare that there are no competing interests.

## Funding

None.

## Authors' contributions

SG: specific implementation of teaching management, literature review, data analysis and thesis writing; AZ, GH, WY and YL: specific implementation of teaching management; JH: teaching management planning and implementation and thesis guidance; and NS: master plan for teaching management. All authors have read and approved the manuscript.

## Acknowledgements

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## Figures

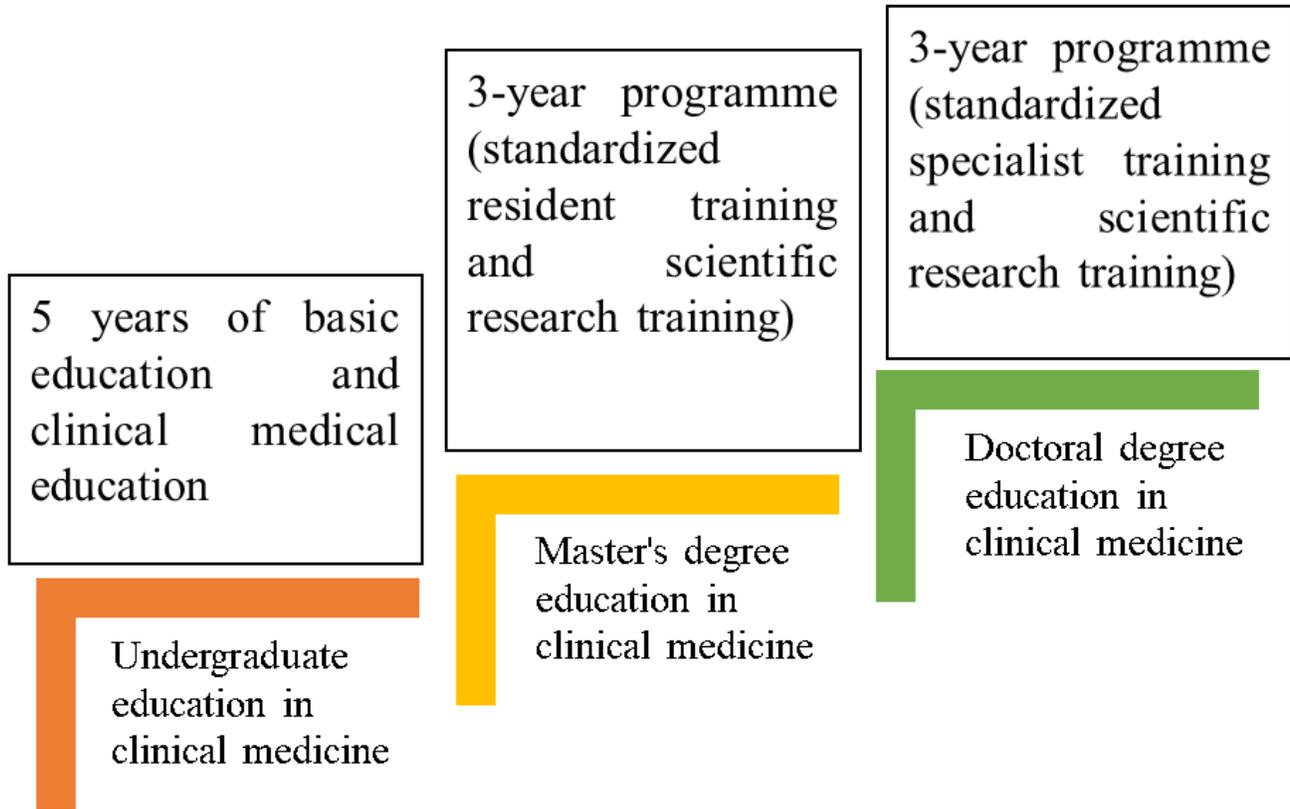


Figure 1

Chart of training mode for postgraduate clinical medical students

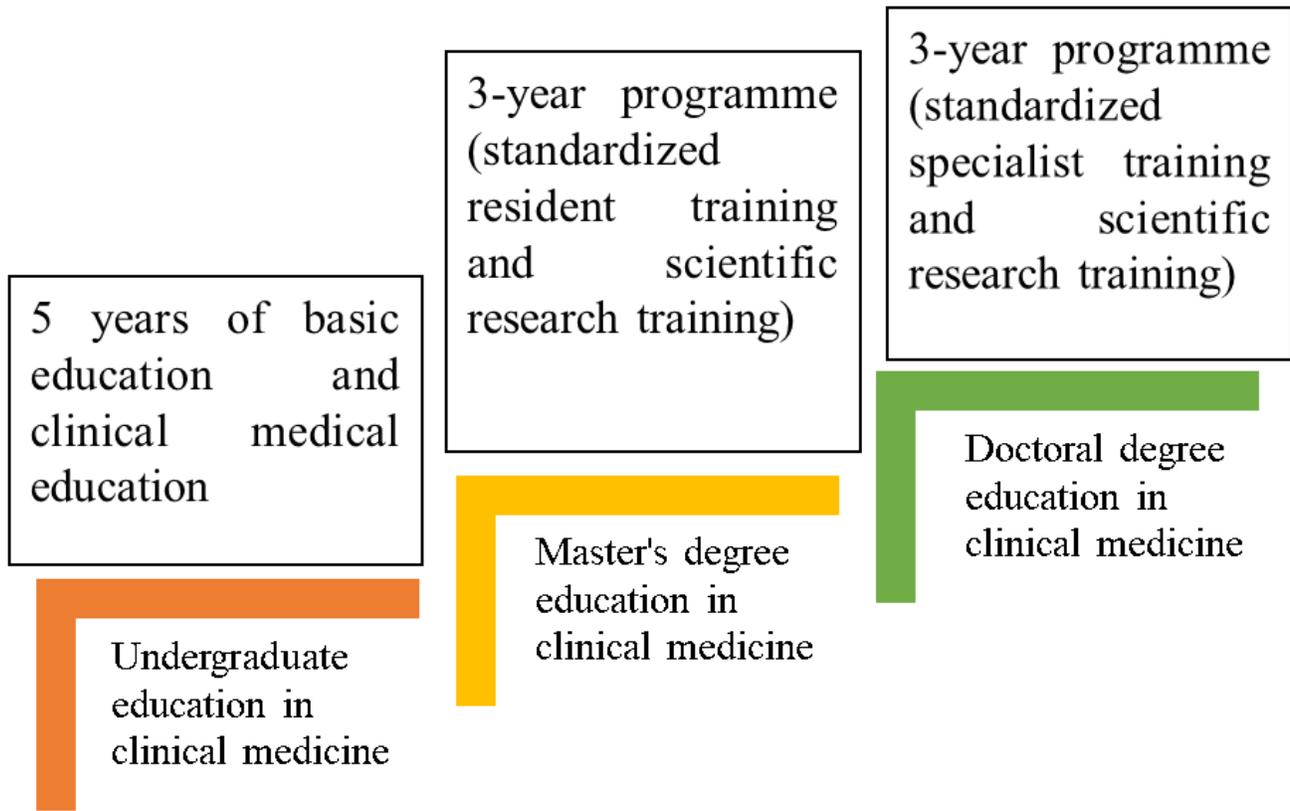


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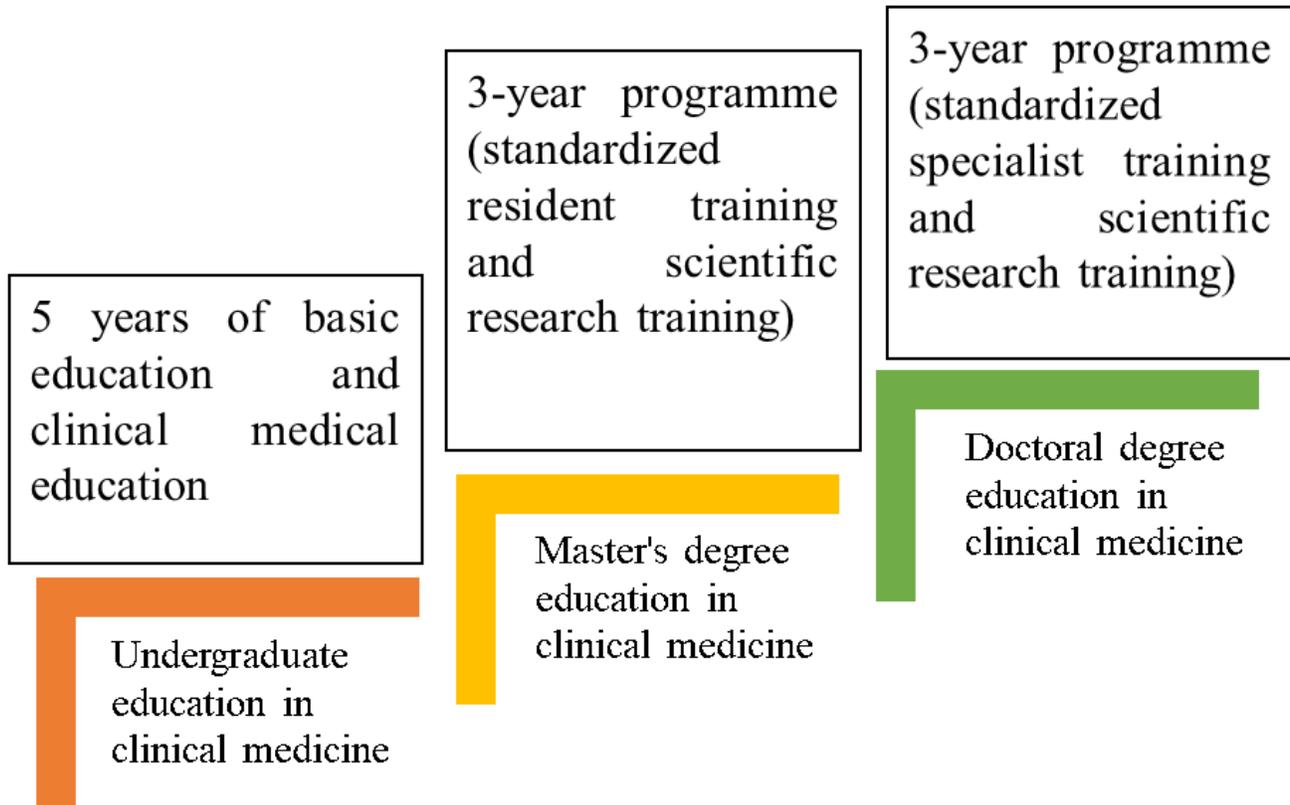


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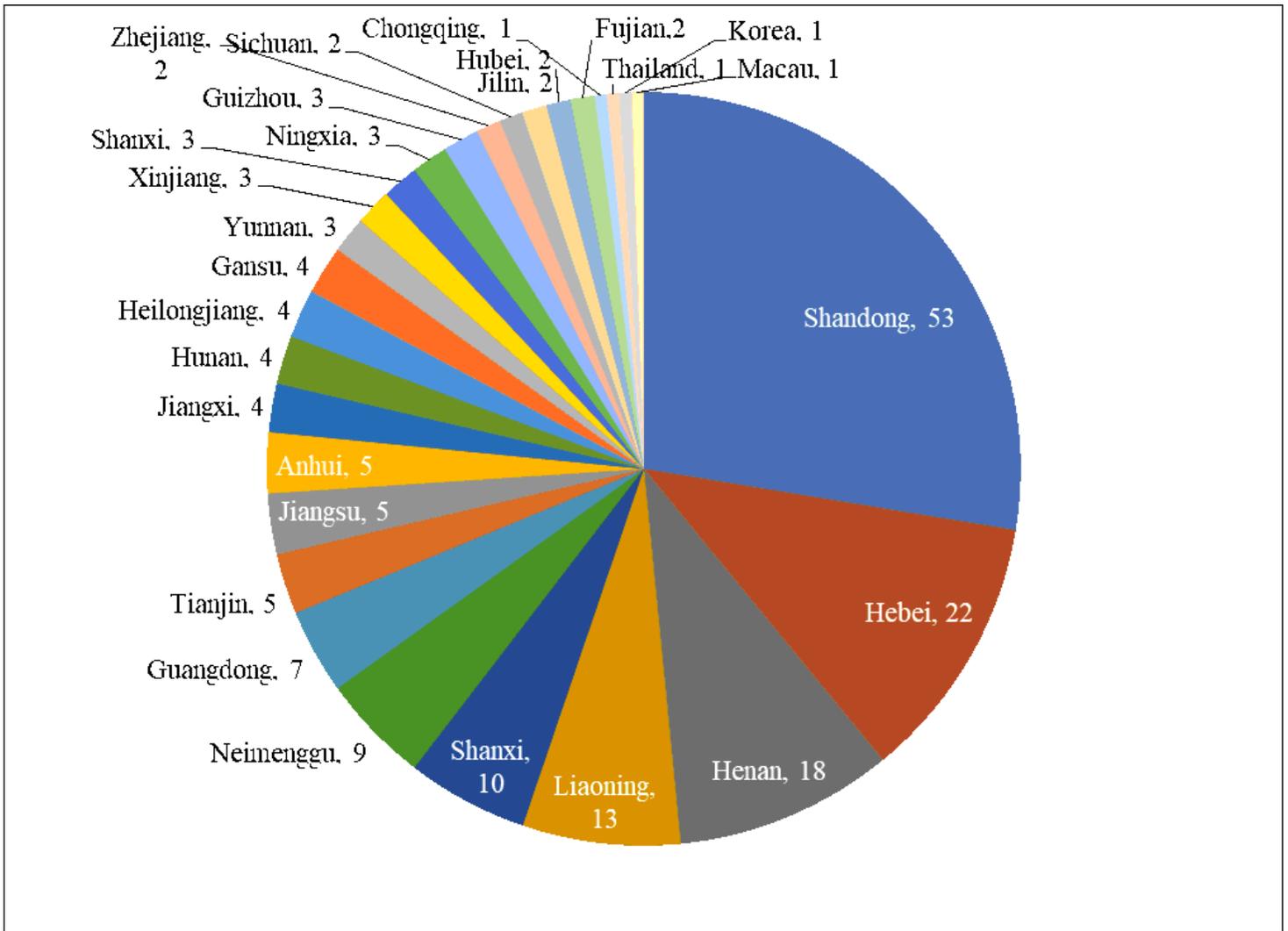
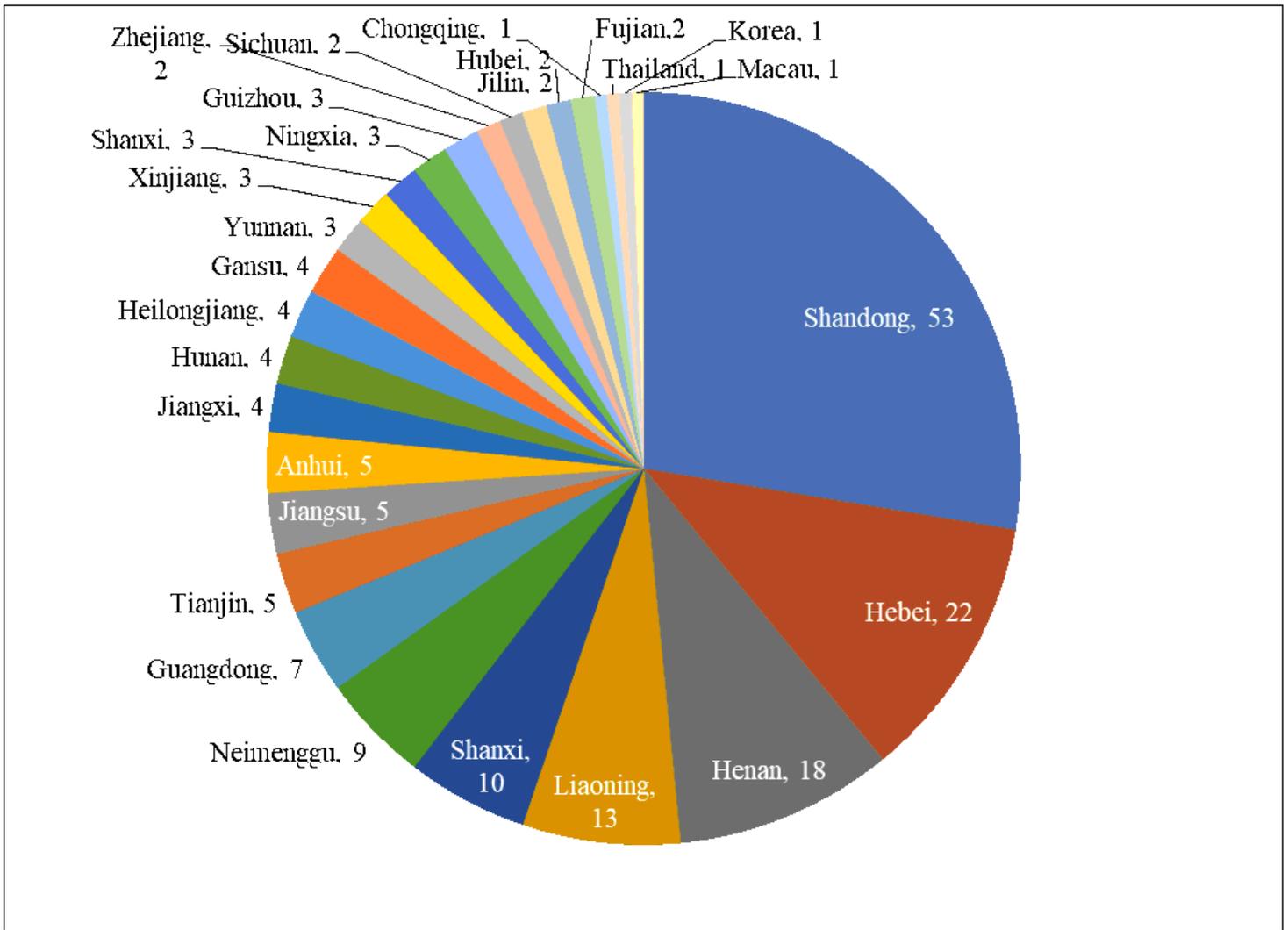


Figure 2

The distribution of 192 PUTH postgraduate medical student outside Beijings (as of January 26, 2020)



**Figure 2**

The distribution of 192 PUTH postgraduate medical student outside Beijings (as of January 26, 2020)

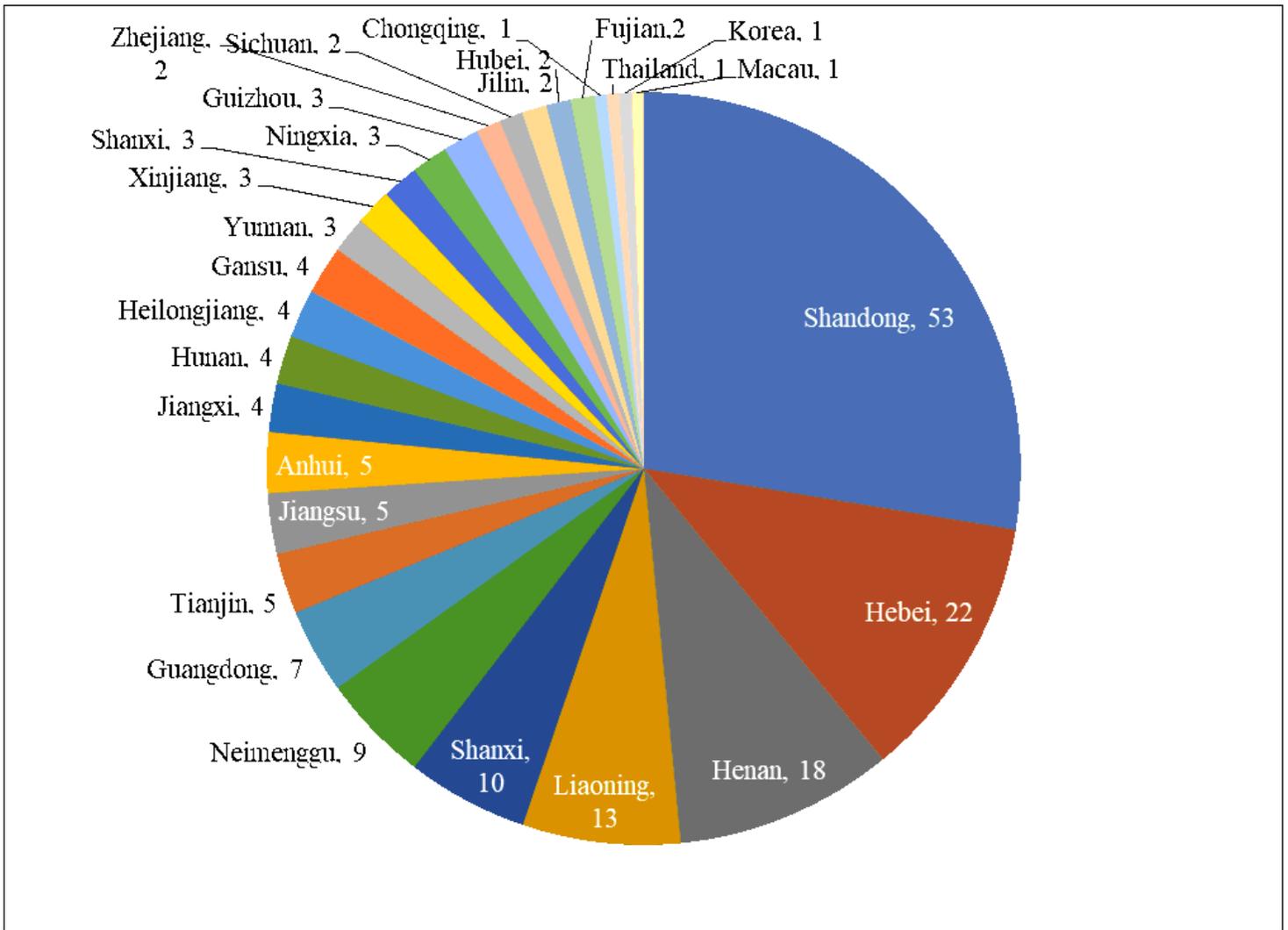


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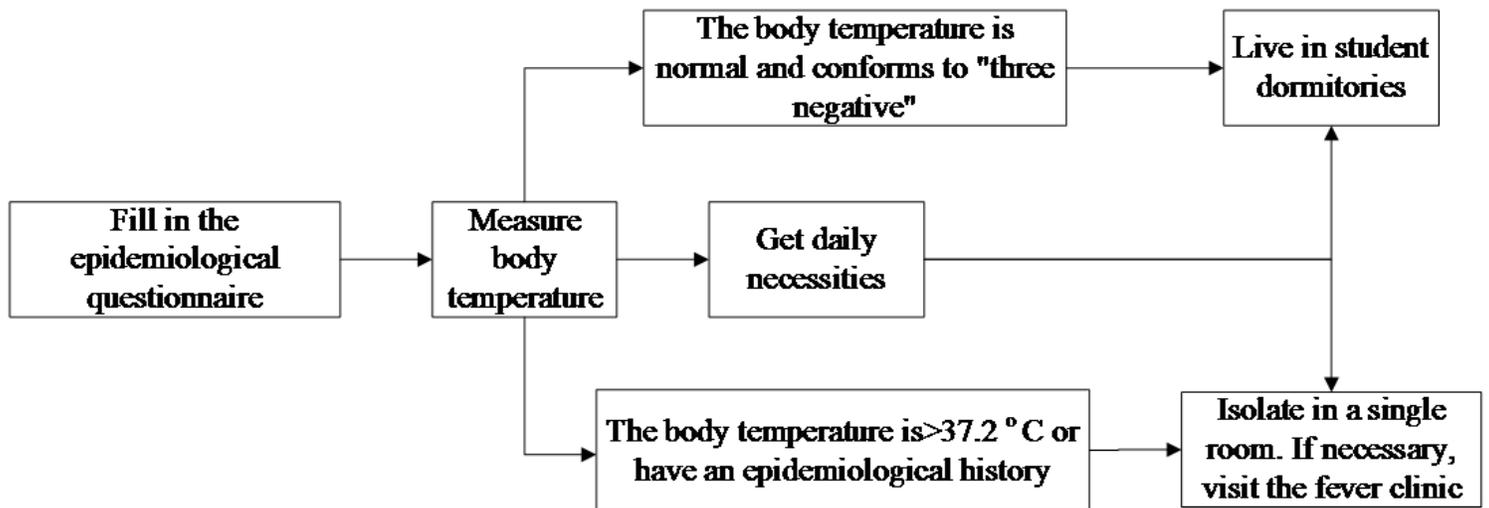


Figure 3

Flowchart of the management of PUTH postgraduate medical students returning to school

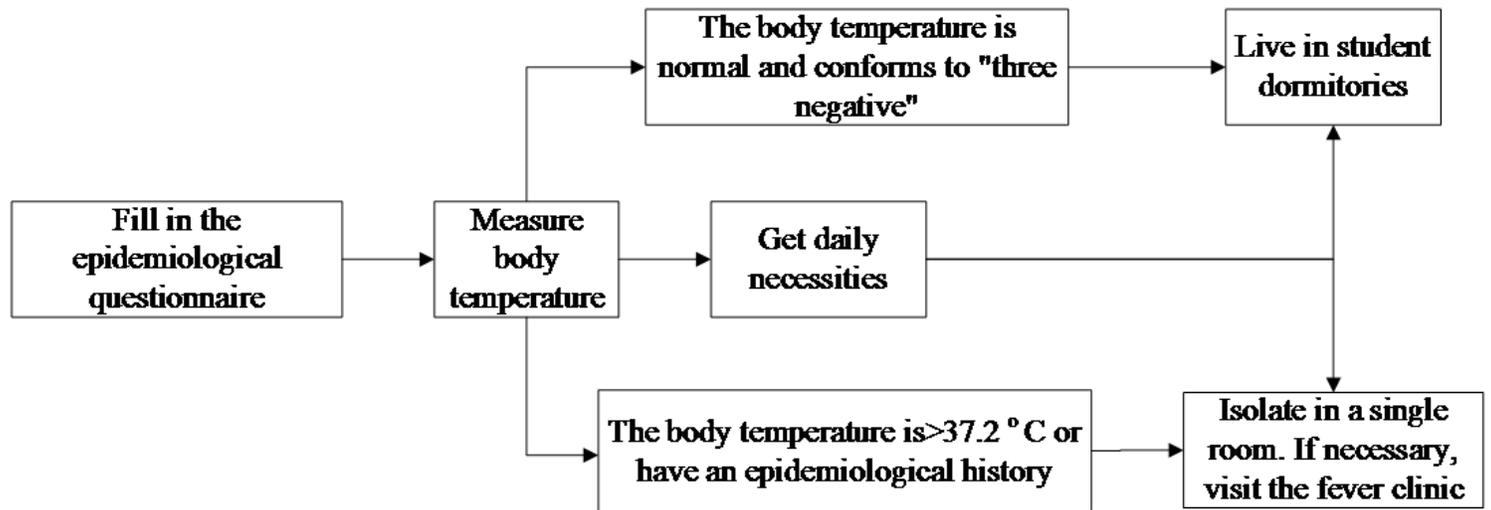


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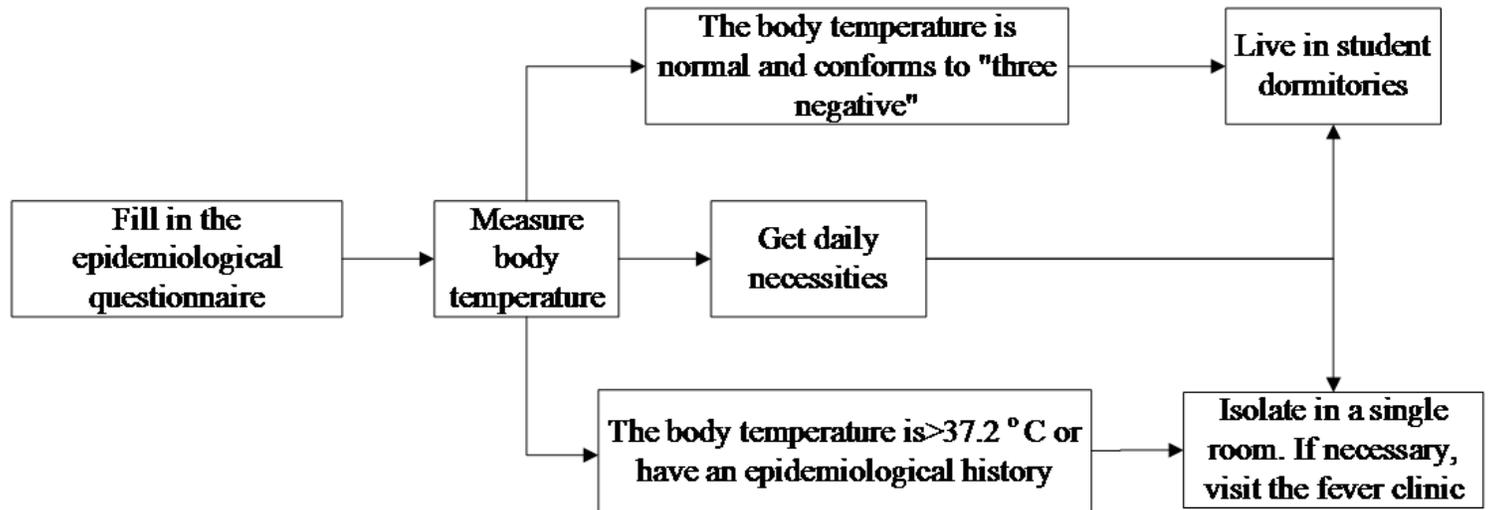


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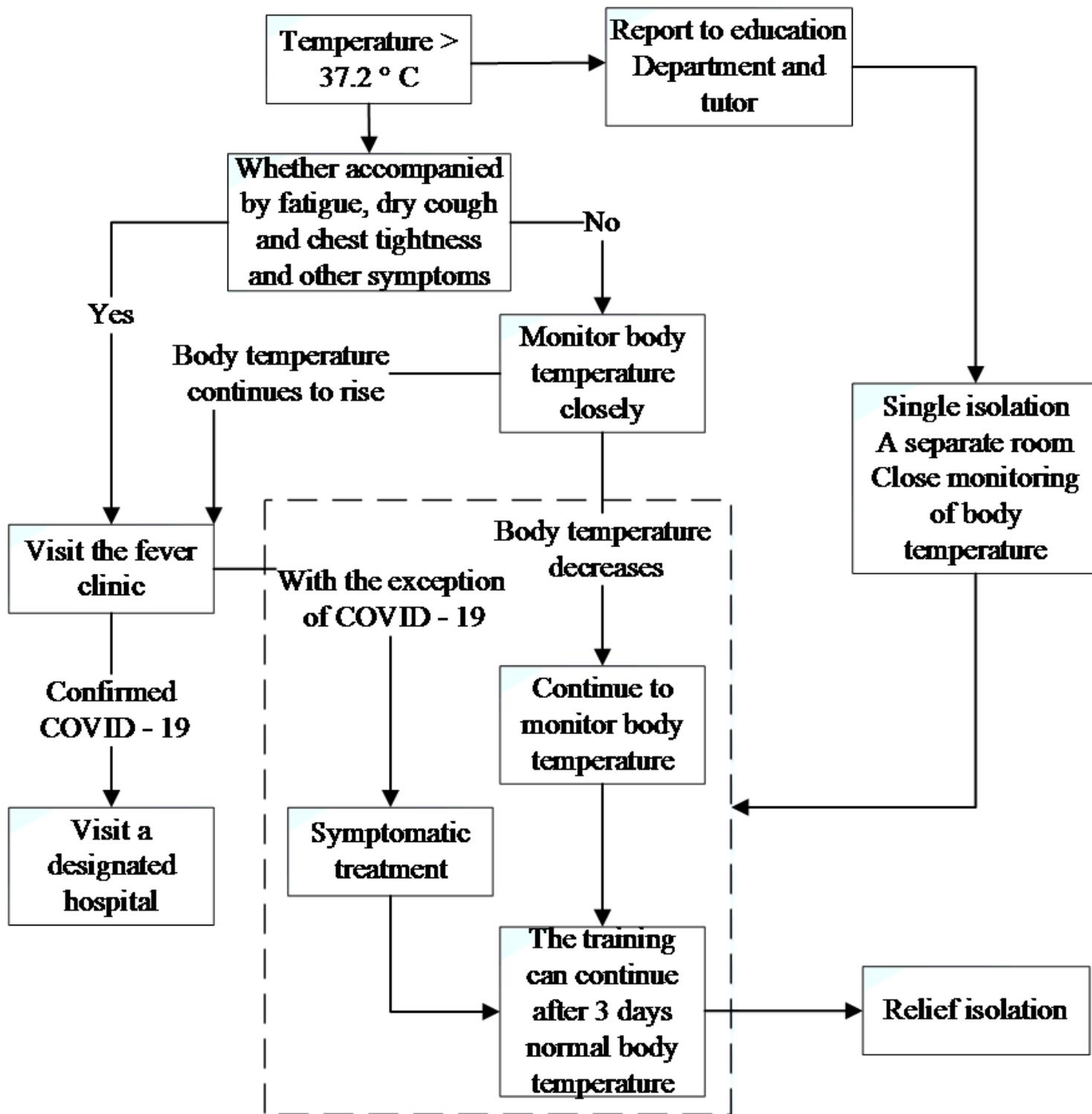


Figure 4

Flowchart of the emergency treatment of students with a fever in PUTH

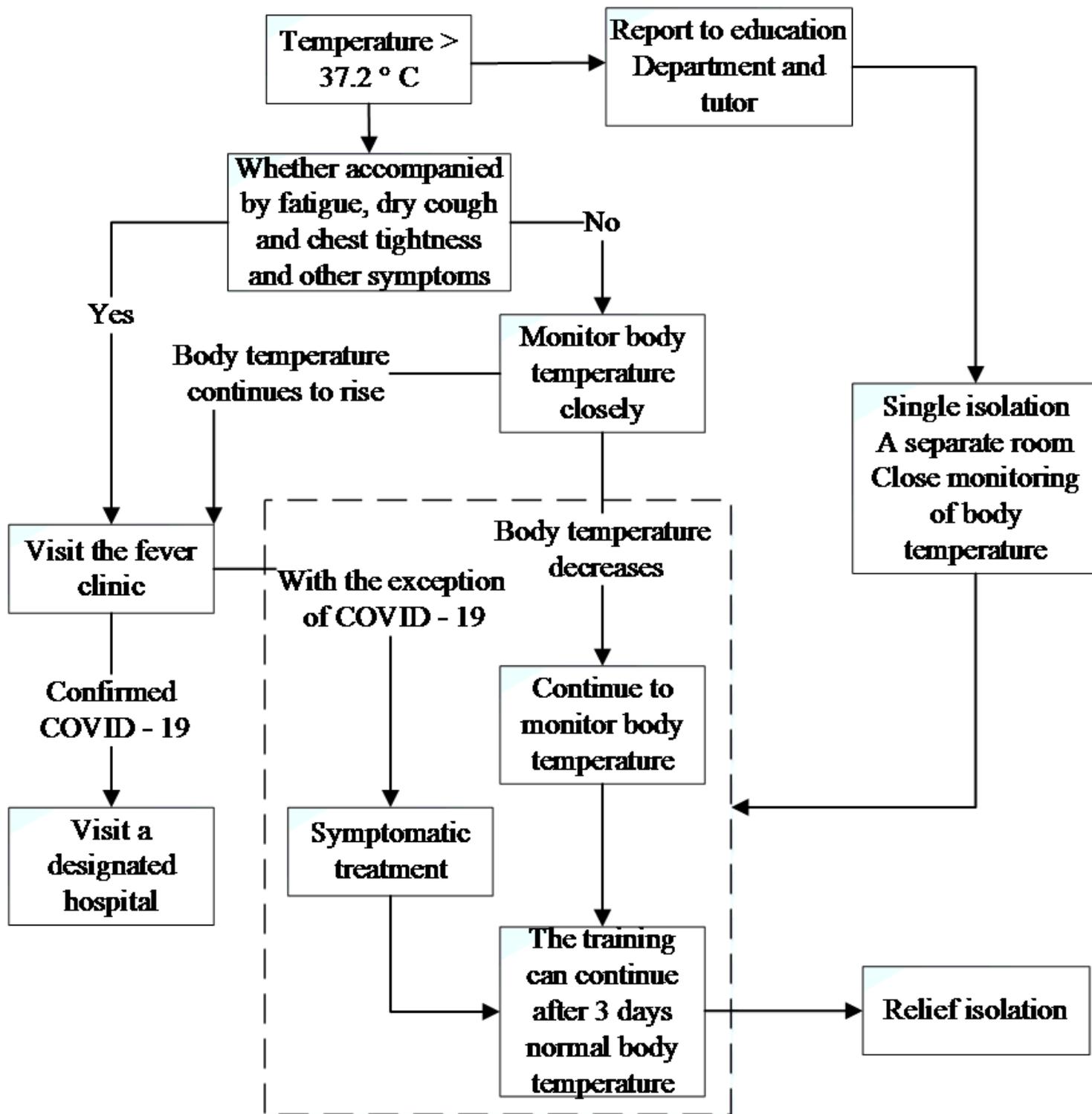


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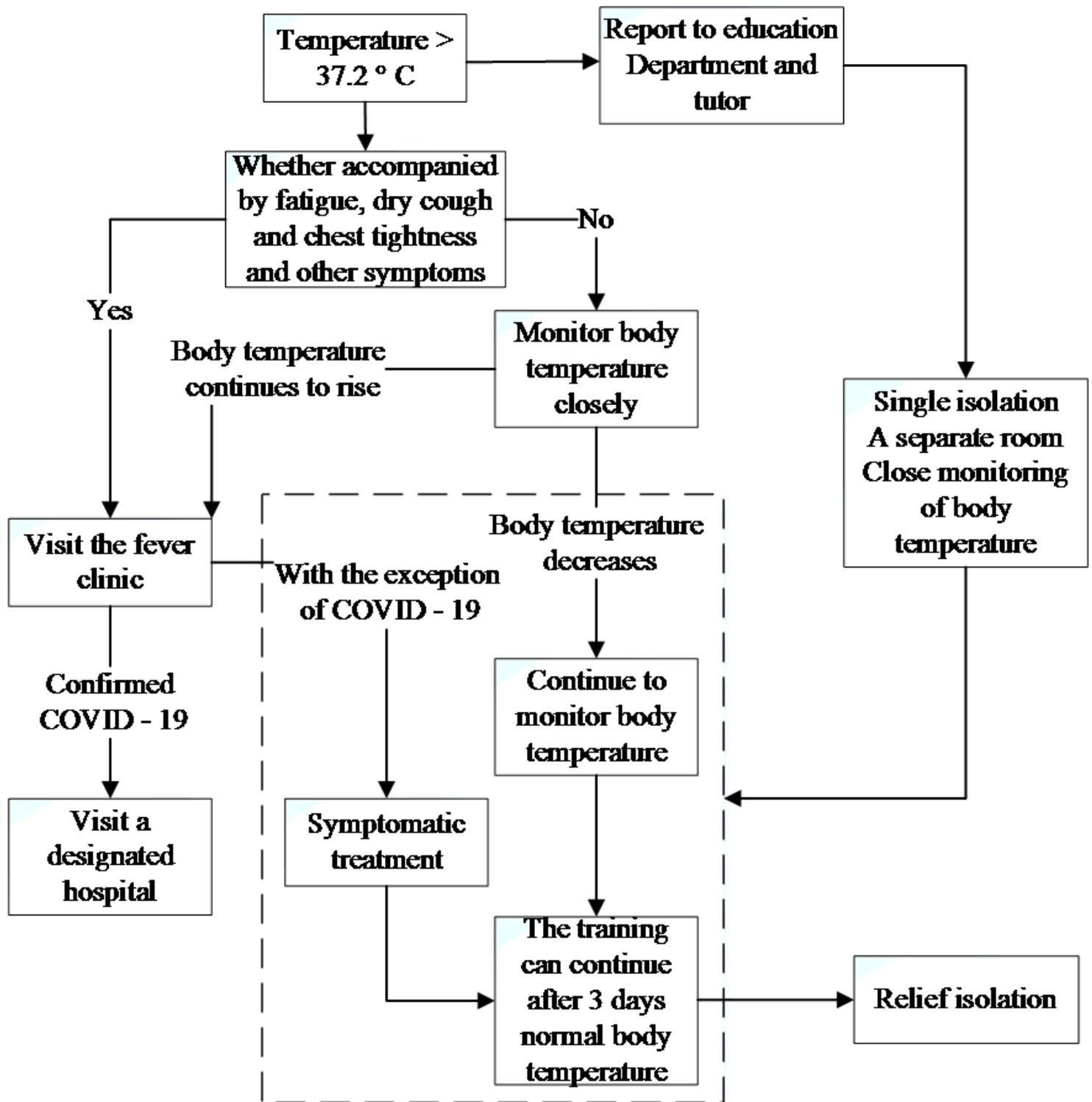


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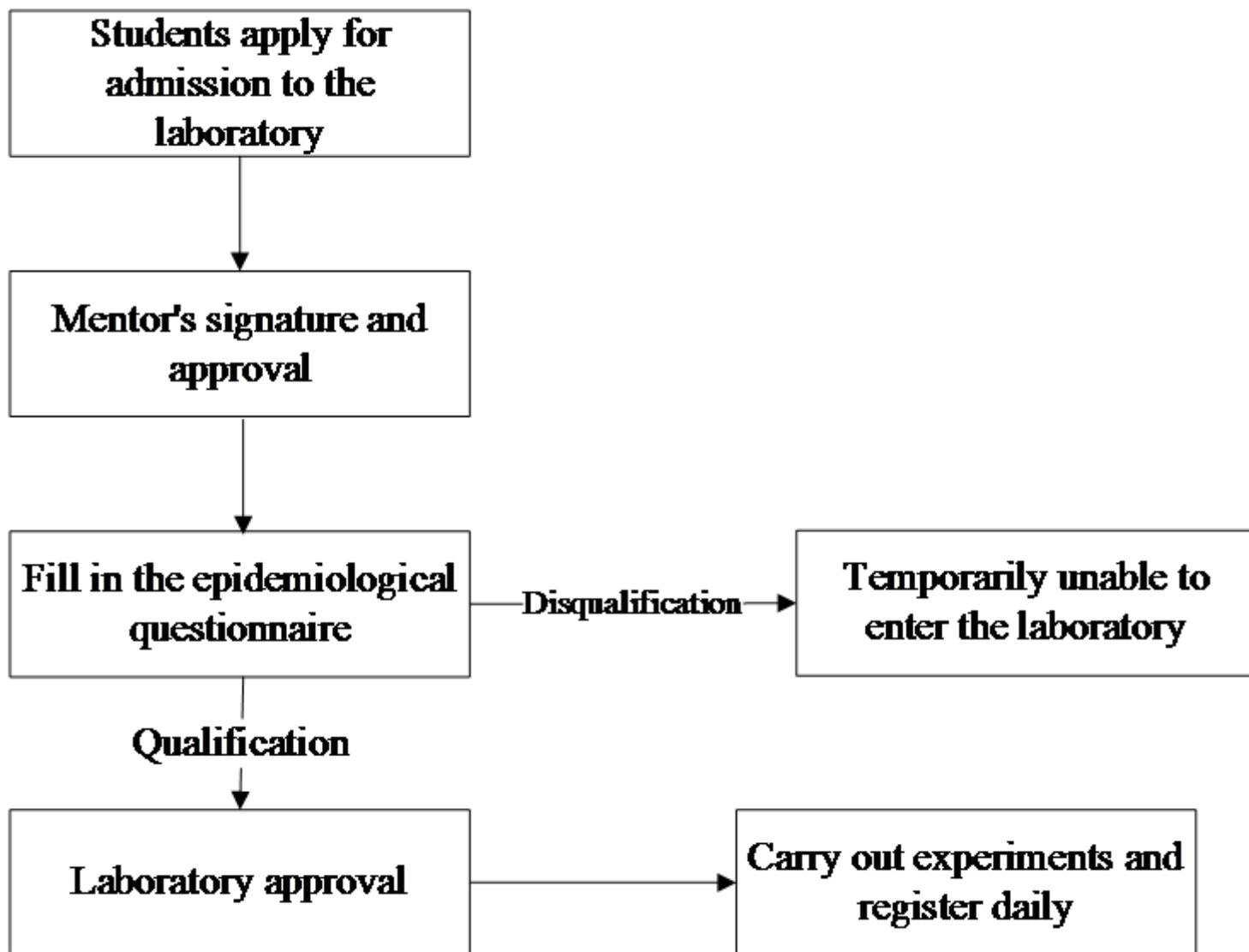


Figure 5

Flow chart for students to enter the laboratory

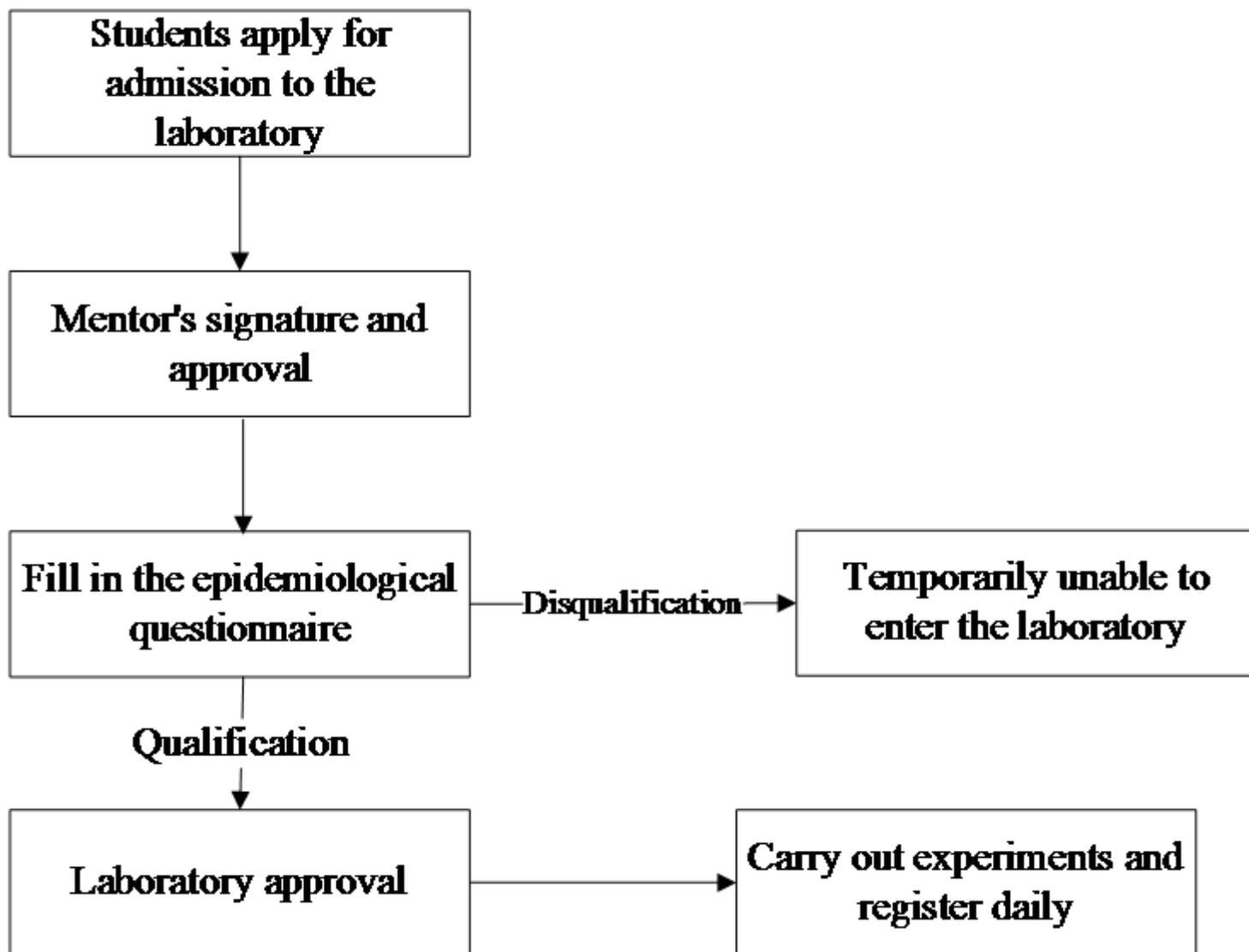


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Flow chart for students to enter the laboratory

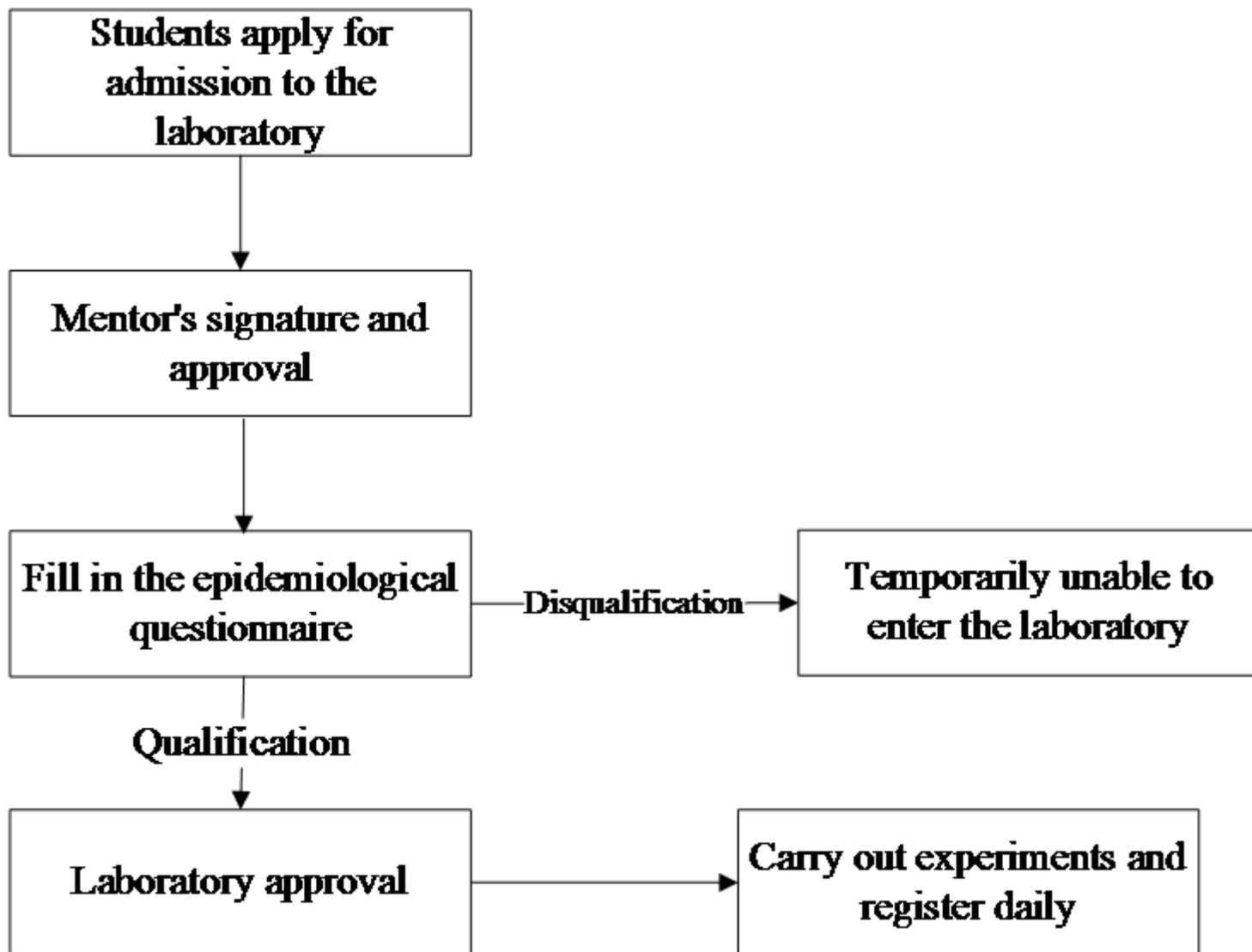
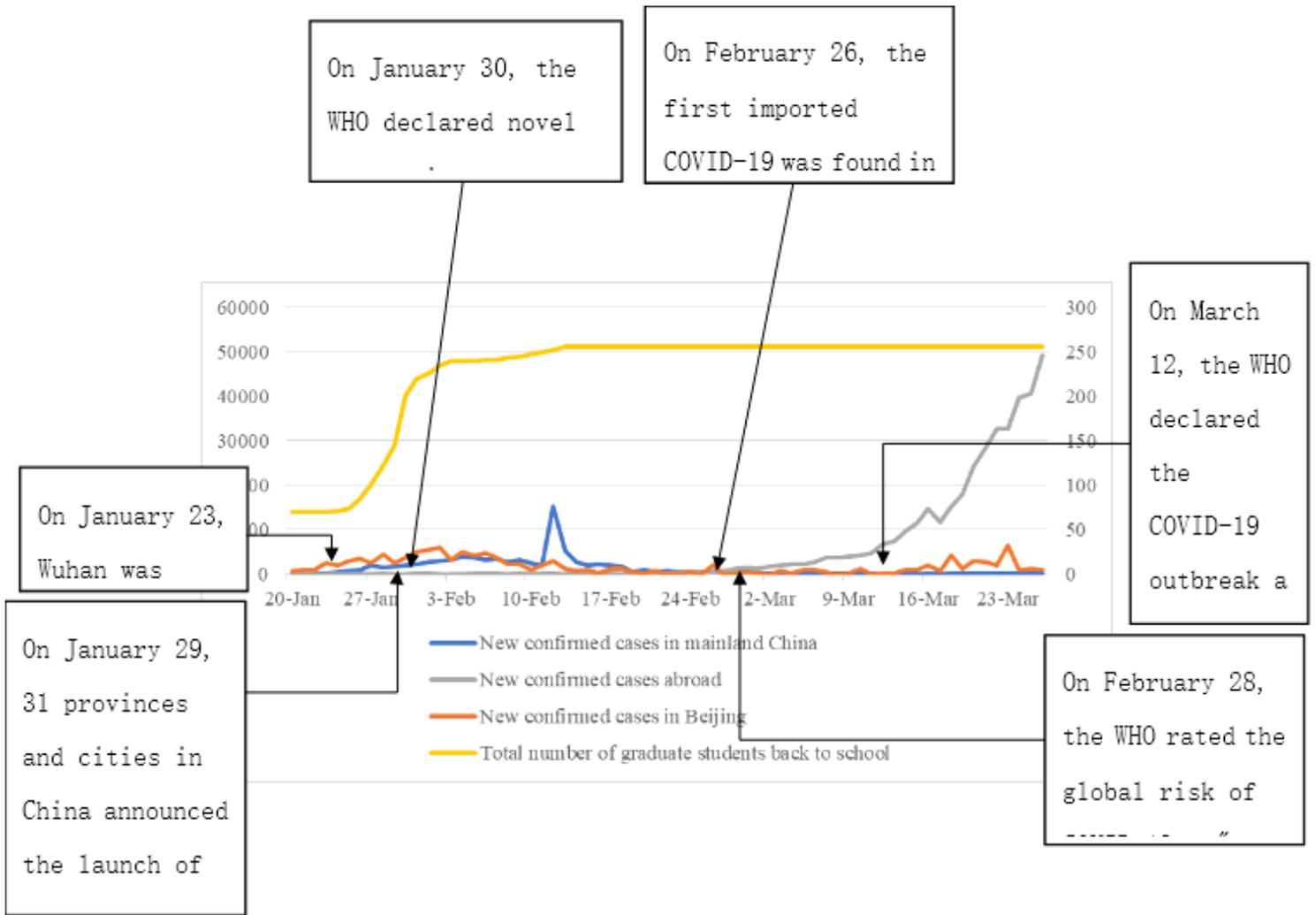


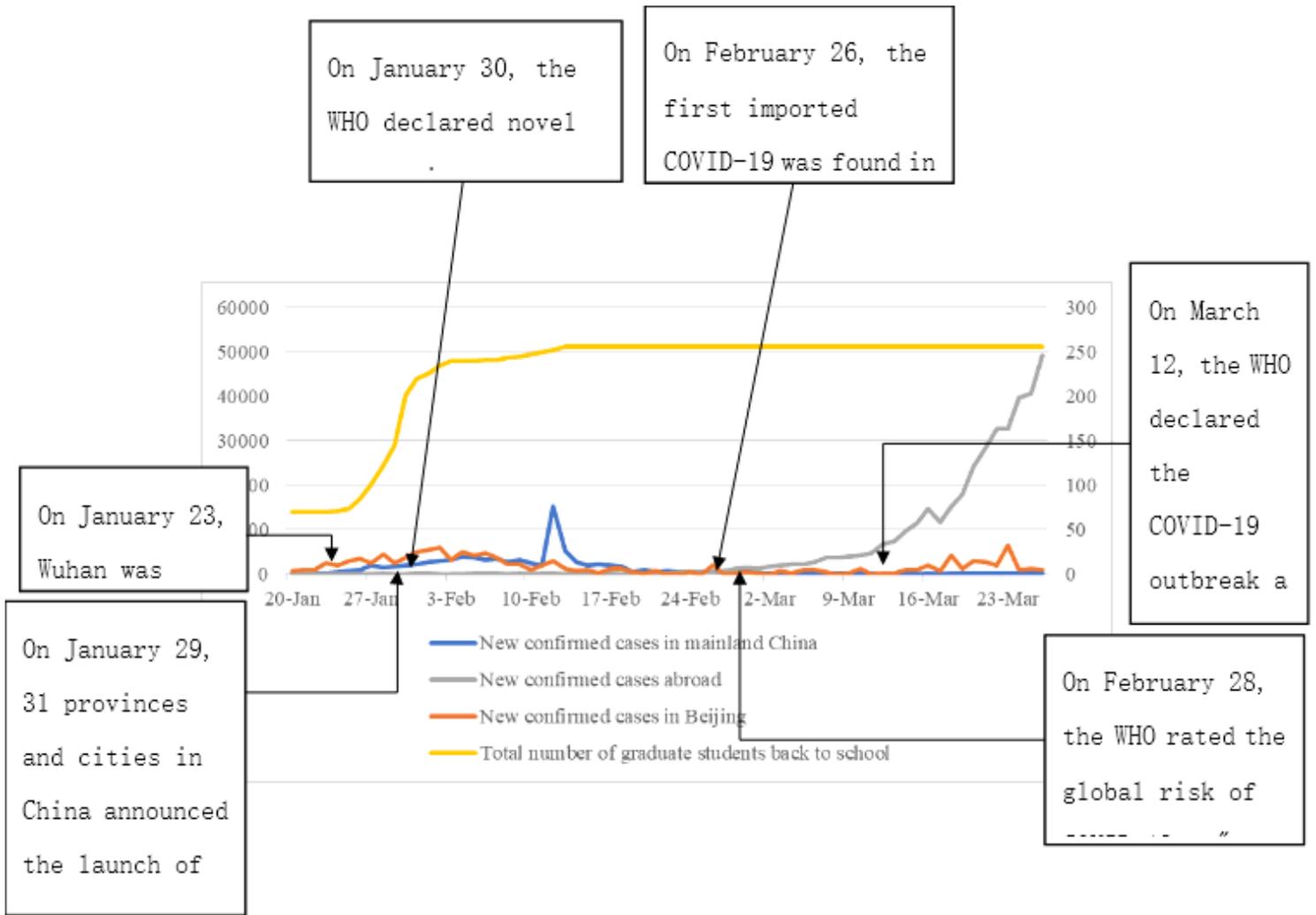
Figure 5

Flow chart for students to enter the laboratory



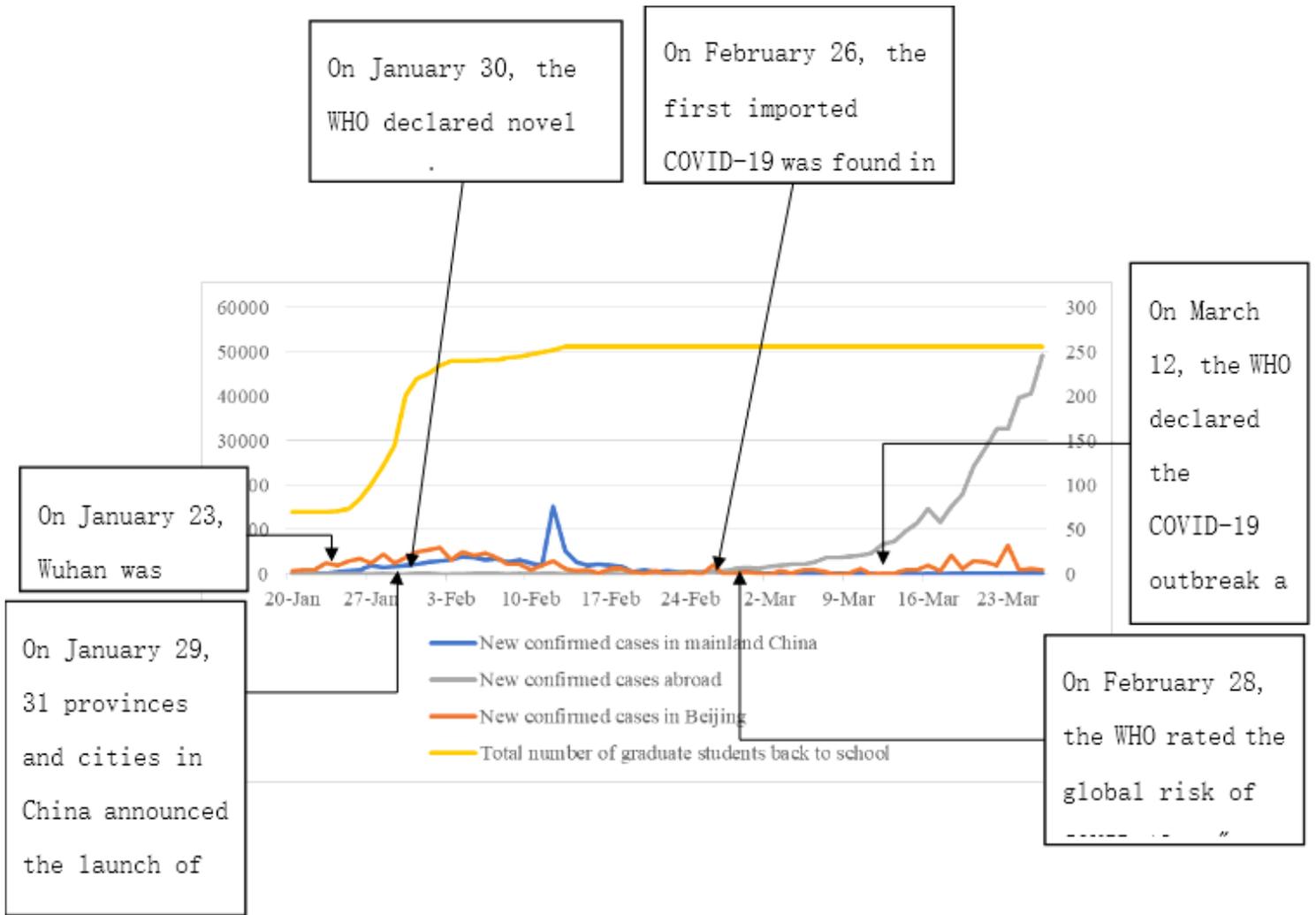
**Figure 6**

The chart of daily newly confirmed COVID-19 cases worldwide and the return of graduate students in PUTH (information on COVID-19 cases is available from the National Health Commission website)



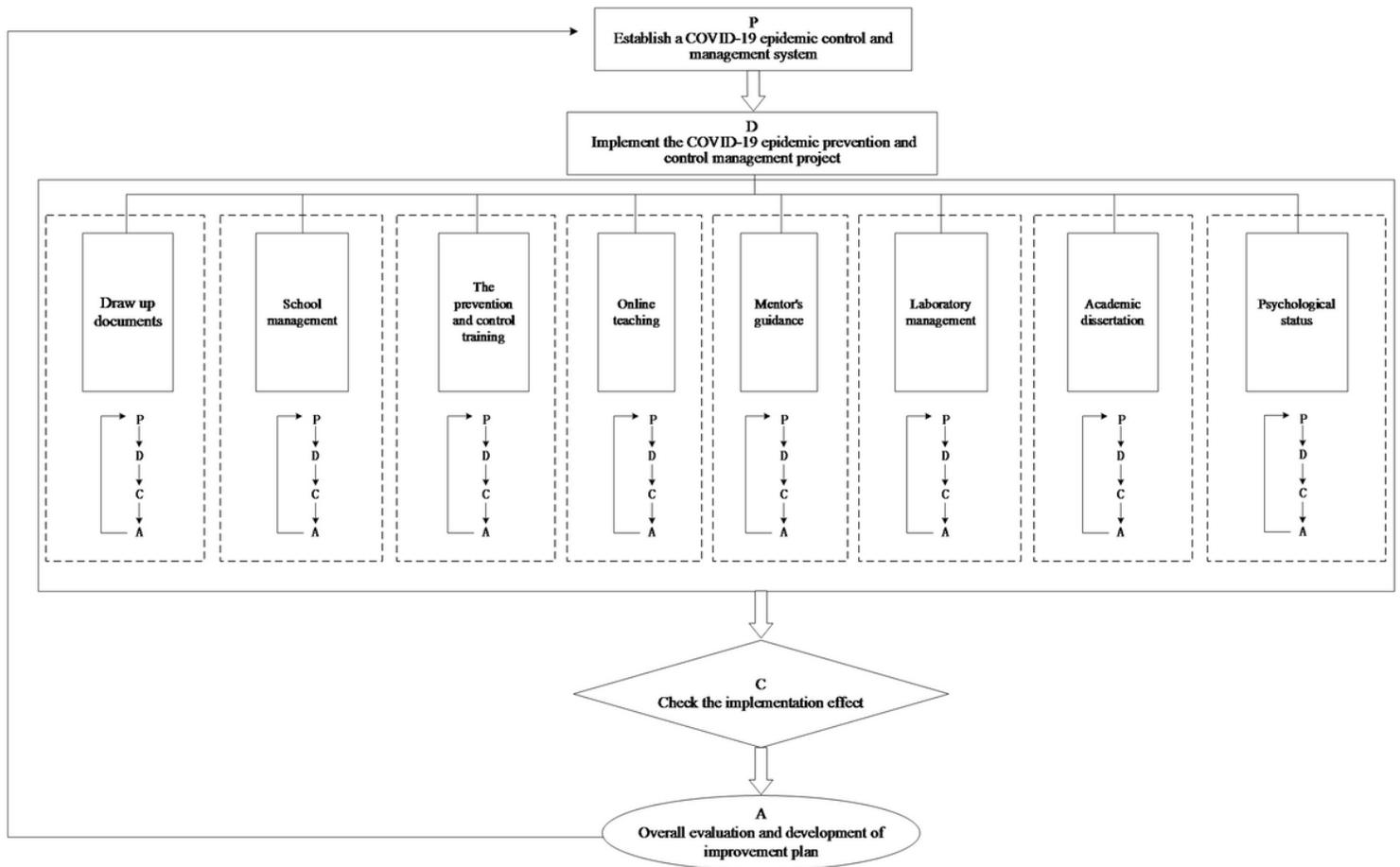
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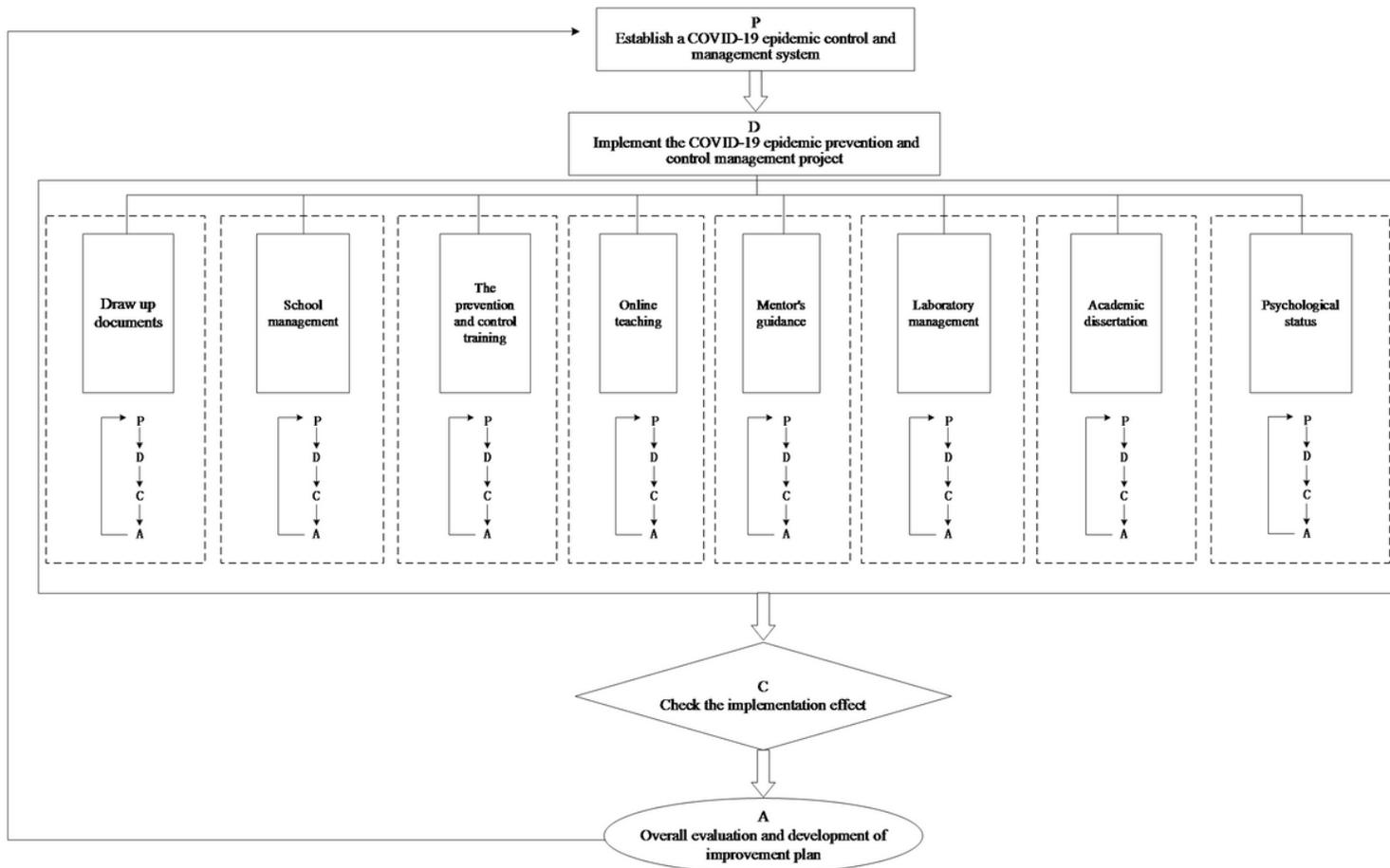
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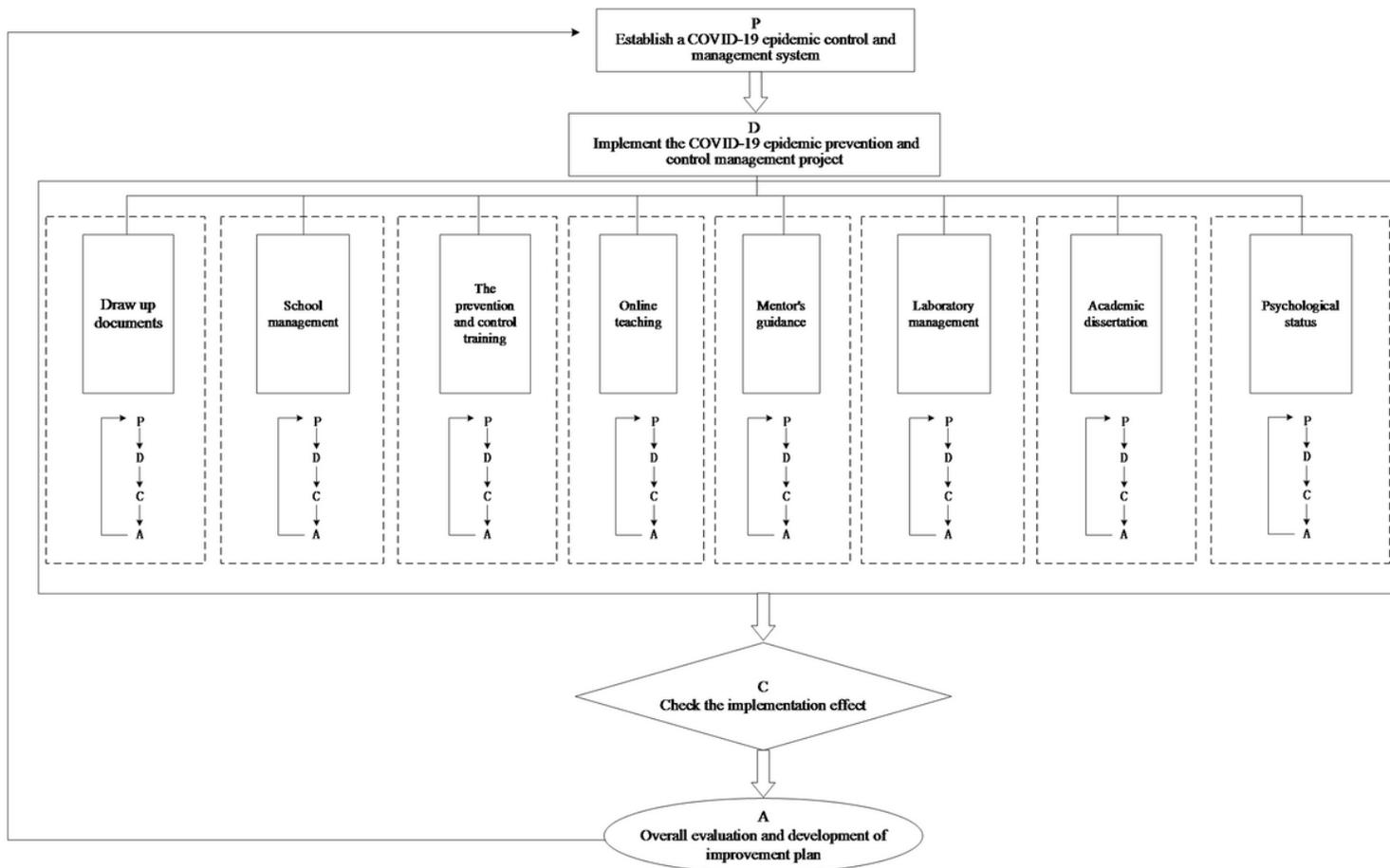
**Figure 7**

Management model of clinical medicine graduate students in PUTH during the epidemic



**Figure 7**

Management model of clinical medicine graduate students in PUTH during the epidemic



**Figure 7**

Management model of clinical medicine graduate students in PUTH during the epidemic

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [QuestionnaireSurvey.docx](#)
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