COVID-19 Antibody Surveillance Among Healthcare Workers in A Non-COVID designated Cardiology Centre

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Abstract

BACKGROUND: Reports on healthcare worker antibody response to COVID-19 infection are scarce. We aim to determine the COVID-19 antibody prevalence among healthcare workers in a cardiology centre and the relationship between case definition criteria with the COVID-19 antibody result. METHODS: Convenience sampling was applied. Healthcare workers in Sarawak Heart Centre (SHC) cardiology, radiology, and emergency unit were recruited. A survey form on clinical symptoms and close contact history was distributed. HEALGEN COVID-19 IgG/IgM rapid test was performed using serum/ whole blood specimen. Staff with positive COVID-19 antibody results were referred to the infectious disease specialist for assessment. RESULTS: A total of 310 staff were screened. 220(71%) were female, and the mean age was 36±7.7 years old. 46(14.8%) staff reported having clinical symptoms at some stage from the end of January 2020 to the time of this surveillance. Number of staff who had a history of overseas travel, close contact with confirmed COVID-19 patients, or had visited places with identified COVID-19 clusters were 4(1.3%), 24(7.7%) and 24(7.7%) respectively. There were 14 staff (4.5%) with positive tests positive, 2 for IgM, and 12 for IgG. All those with positive antibody were subsequently tested negative with RT-PCR test. The history of having clinical symptoms and exposure to COVID-19 cluster area were independently associated with a positive IgG result. CONCLUSION: The application of COVID-19 antibody serology rapid tests could determine true exposure of staff to the infection and allow us to reassess existing measures of infection control within the hospital.

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ABSTRACT

BACKGROUND:

Reports on healthcare worker antibody response to COVID-19 infection are scarce. We aim to determine the COVID-19 antibody prevalence among healthcare workers in a cardiology centre and the relationship between case definition criteria with the COVID-19 antibody result.

METHODS:

Convenience sampling was applied. Healthcare workers in Sarawak Heart Centre (SHC) cardiology, radiology, and emergency unit were recruited. A survey form on clinical symptoms and close contact history was distributed. HEALGEN COVID-19 IgG/IgM rapid test was performed using serum/ whole blood specimen. Staff with positive COVID-19 antibody results were referred to the infectious disease specialist for assessment.

RESULTS:

A total of 310 staff were screened. 220(71%) were female, and the mean age was 36±7.7 years old. 46(14.8%) staff reported having clinical symptoms at some stage from the end of January 2020 to the time of this surveillance. Number of staff who had a history of overseas travel, close contact with confirmed COVID-19 patients, or had visited places with identified COVID-19 clusters were 4(1.3%), 24(7.7%) and 24(7.7%) respectively. There were 14 staff (4.5%) with positive tests positive, 2 for IgM, and 12 for IgG. All those with positive antibody were subsequently tested negative with RT-PCR test. The history of having clinical symptoms and exposure to COVID-19 cluster area were independently associated with a positive IgG result.

CONCLUSION:

The application of COVID-19 antibody serology rapid tests could determine true exposure of staff to the infection and allow us to reassess existing measures of infection control within the hospital.

Keywords: COVID-19, Healthcare worker, Antibody, Surveillance, Sarawak

Introduction:

The novel coronavirus disease (COVID-19) or SARS-CoV-2[1] gained attention after a citywide lockdown was implemented in Hubei, China.[2] To date, COVID-19 had infected more than 3,000,000 people in the world. This pandemic has currently left more than 230,000 dead and almost two-thirds of the world's countries locked down.[3,4]

Malaysia recorded its first confirmed COVID case on 25th January 2020.[5] At the time of writing, Malaysia tallied 6176 confirmed cases and 103 deaths.[6] Kuching, the most populated city in Sarawak, was among the areas with most confirmed COVID-19 cases and death in Malaysia.[7] Majority of the cases in Malaysia were contributed by a few clusters, including one religious assembly event in East Malaysia.[8]

SARS-CoV-2 virus displayed high transmissibility (R_0 of 2.68)[9] and longer incubation period (6 days)[9] compared to the Middle East Mediterranean virus. The virus can transmit form human-to-human via respiratory droplets, aerosol, and fecal-oral route. These natures of the virus may explain the rapid spread of the global pandemic and high case-fatality rate.[10]

Healthcare workers are not spared from this disease.[11]China[12] recorded 3.47% and Netherlands 4-9.5% of infected healthcare workers (HCW).[13] Contact tracing revealed most of the infected HCW acquired the

infection from the community.[14] The total number of HCW with COVID-19 infection will continue to rise, given that many countries have yet to reach the peak of the outbreak.

Patients with COVID-19 infection displayed a wide spectrum of disease severity,[14] including asymptomatic or mild symptoms.[13,15] Statistical modeling correctly predicted near to 18% of asymptomatic infection in the Diamond Princess cruise ship cluster.[16] Most HCW (80%) with confirmed COVID infection expressed mild symptoms without a strong epidemiological link.[13,17] HCW expressing mild or no symptom could be the vulnerable group to be prioritized for the COVID-19 serology screening.[18]

Because symptoms of COVID-19 infection differed across the board, it is difficult to separate the infected and the healthy by clinical and epidemiological factors alone. WHO recommended the virus nucleic acid Real-Time Polymerase Chain Reaction test (RT-PCR) test as a laboratory diagnostic tool.[19] However, the use of RT-PCR testing is currently rationalized due to testing capacity with priority given to specific individuals, i.e. higher risk.[18] Thus, human antibody rapid test may be an alternative because of this limitation.[20]

Human antibody acute response (IgM) to COVID-19 infection begins at the median timing of 5 days from illness onset.[21] IgG antibody, which represents possible past exposure is usually detectable in plasma or seroconvert from IgM after day 10 of illness.[22,23] PCR tests are more sensitive to yield positive results in the first week of illness. This sensitivity reduces towards the end of the second week.[24] Hence this antibody temporal relationship can be used to guide the COVID-19 diagnosis after one week of illness[25] and identify a person with previous undiagnosed infection.[18] It has proven good sensitivity and specificity to supplement the test of molecular laboratory diagnosis.[26]

Being the only non-COVID-19 tertiary hospital and the only public cardiology centre in Sarawak, the Sarawak Heart Centre (SHC) plays a supporting role as the healthcare burden escalated in the other regional medical facility designated as a COVID-19 hospital healthcare, the Sarawak General Hospital (SGH). To date, no cases of confirmed COVID had been admitted or treated in our centre. All cases fulfilling the criteria for person under investigation (PUI) were referred to the designated COVID-19 centre. There is a total of 757 staff, including 71 working in non-clinical field. None of the healthcare workers in our centre have been diagnosed with COVID-19 infection thus far.

Our hospital's COVID-19 taskforce team decided to assess the possibility of unknown disease transmission due to either community or nosocomial exposure among our healthcare workers. Knowing the antibody response of our staff can also give us some idea of the effectiveness of our in-hospital infection control measures. Because RT-PCR test is prioritized for high-risk patients only, we chose the COVID-19 antibody serology test as the mode of investigation. This survey is self-funded with approval from hospital administration to protect staff's wellbeing during this pandemic. Our decision echoes World Health Organization's (WHO) suggestion to prioritize COVID-19 testing among healthcare worker to prevent potential nosocomial spread.[18]

Methods:

Study Design and Participants

The Sarawak Heart Centre cardiology COVID taskforce team led this cross-sectional surveillance using convenient sampling method. It was conducted over a 3-week period from early April 2020 to mid-April 2020. Healthcare and supporting staff who works in the cardiac clinic, invasive catheterization lab, non-invasive catheterization lab, radiology unit, coronary care unit and cardiac rehabilitation wards, and emergency department were recruited after approval by the respective head of unit. Staff from the cardiothoracic team, rehabilitation clinic, pharmacy, general administration unit, and other non-cardiology wards such as geriatric were not included.

Data Collection

A questionnaire was distributed to each participating staff who had verbally consented. This questionnaire was self-completed to gather information on basic demographics, including gender, age, and current residential address showing the district they are living in. Name of the staff and their contact numbers were

recorded for contact tracing purposes if more assessments are needed after the serology test. Other details obtained include epidemiological factors for infection (possible contact with COVID positive patients, COVID clusters, or traveling to foreign countries) and clinical factors (fever, cough, sore throat, runny nose, or other specified symptoms). Participants were asked to write down the exact date of symptom onset and last travel or close contact date if present. The list of COVID clusters mentioned in the questionnaire was based on the daily statement released by our State Disaster Committee at the end of March 2020.[27]

The workflow of COVID-19 antibody surveillance test among healthcare workers in SHC (Figure 1 and Figure 2)

Healthcare workers who fulfill the person under investigation (PUI) criteria will be directed to occupational health and safety officers in our hospital and further assessed by local infection disease specialist following the PUI protocol of Malaysia.[28] The Malaysian Ministry of Health PUI criteria[29] is acute respiratory infection with or without fever and history of traveling to foreign countries, close contact, or attended an event associated with COVID-19 outbreak. Participants who were asymptomatic or with the onset of clinical symptoms for at least seven days before the survey received the antibody serology blood test. Other participants who are having symptoms for less than seven days during the survey will be tested after the symptoms had resolved seven days from the onset of illness. Staff with a positive surveillance antibody serology test, either IgM or IgG, will be referred to occupational health officer and later, the infectious disease specialist for further assessment and RT-PCR test.

Antibody serology rapid test kit

We used a commercial HEALGEN IgG/IgM antibody rapid test kit in our study (Zhejiang Orient Gene Biotech Co., Ltd, China).[30] HEALGEN antibody rapid test kit is a gold immunochromatographic assay for the rapid, qualitative, and differential detection of IgG and IgM to COVID 19 in human whole blood, plasma, or serum. In our study, we used finger prick whole blood or blood serum as the specimens for testing (Figure 3). We acquired serum by leaving venous blood in a plain tube under room temperature for approximately 3 hours to coagulate before carefully pipetting the serum sample, avoiding the buffy coat, or clotted blood (Figure 4). The amount of whole blood and serum samples used for serology test were five and 10uL respectively. Specimens were pipetted using the prepared plastic dropper and transferred into the sample well on the cassette. Three drops of buffers were added to the buffer well. The cassette was left for 10 minutes before the result was read.

Statistical analysis

Categorical variables were described as frequency rates and percentages, and continuous variables were described using mean and standard deviation values. Proportions for categorical variables were compared using the χ^2 test. The Fisher exact test was used when the data were limited. One way analysis of variance (ANOVA) was used to investigate the association between the mean age of staff with their IgG results. All statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) version 20.0 software (SPSS Inc). A comparison with p less than 0.05 was considered statistically significant.

Ethical Approval

Ethical approval was not obtained from the local ethical committee in this study as it was a departmental policy to do sampling for surveillance purposes. Participant's details were kept anonymous during data interpretation, and records were kept securely with Sarawak Heart Centre COVID taskforce team. Although it was a healthcare policy of the department, verbal consent was taken before the blood taking and questionnaire distribution.

Results:

Subject Demographic (Table 1)

310 staff were recruited into this study. The mean age was 36±7.6 years old (range: 23-70 years old), and 220(71%) were female. In this population, 17(5.5%) were cardiology doctors, 6(1.9%) were from clinical

research centre, 20(6.5%) worked in the non-invasive catheterization laboratory, 20(6.8%) stationed in the invasive cardiac laboratories, 26(8.4%) from the radiology department, while 132(42.6%) stationed in the wards including coronary care unit, day care ward, and cardiac rehabilitation wards. Job positions were categorized into the following groups: doctor 37(11.9%), nurse 165(53%), allied healthcare personnel 96(31%), and non-clinical staff 12(3.9%). 162(52.3%) of these staff resided in Kota Samarahan, while 107(34.5%) in Kuching, and the remainders from peripheral towns, 42(13.2%).

Clinical Symptoms (Table 1)

A total of 46(14.8%) staff reported having experienced at least one respiratory or atypical respiratory symptom on at least one occasion, between February 2020 and early April 2020. The most common symptom was cough, 32(10.3%) followed by sore throat 31(10%), fever 11(3.5%), and runny nose 22(7.1%). 3(1.0%) staff had experience shortness of breath and 1(0.3%) staff reported abdominal discomfort and diarrhoea.

Epidemiological Factors (Table 1)

4(1.3%) staff reported having returned from a foreign country in the preceding two months. There were 24(7.7%) staff with a history of possible close contact while providing medical care to patients who were later confirmed to be infected by COVID-19. 24(7.7%) of study participants also reported to having visited areas with known COVID clusters.

Antibody Serology Results (Table 1) (Figure 4)

14 staff (4.5%) tested positive, 2(0.6%) for IgM and 12(3.9%) for IgG. All 14 staff were subsequently tested negative for COVID-19 RT-PCR nasopharyngeal swab tests. The two staff with faint IgM positive results were proven to be falsely positive, confirmed by negative RT-PCR test, as well as negative IgG antibody on day 14 of symptoms onset.

Among staff who developed IgG, eight were female, four worked in the emergency unit, five under general cardiology unit and one from non-clinical unit. More nurses developed IgG response compared to other categories of staff. Majority of the staff (9) with positive IgG result resided in Kota Samarahan, which was the immediate area where SHC was located.

Epidemiological factors that were significantly associated with IgG response among the staff were cluster contact (20% vs. 2.8%, p=0.009). The presence of clinical symptoms, at least one respiratory symptom was also found to be significantly associated with the IgG response (12.2% vs. 2.7%, p=0.021). History of close contact to known COVID-19 patient or travel abroad were not found to be associated with IgG response. Hence, the presence of either a clinical symptom or having epidemiological factors were found to be significantly related to the antibody serology result.

Sub analysis excluding emergency unit staff found a weak association between IgG response with the place of work within the cardiology department (wards 0.76% vs. other areas 6%, p=0.045). Emergency unit staff showed a higher likelihood of acquiring IgG antibody comparing to the other units, albeit falling short of statistical significance (6.3% vs. 3.4%, p=0.298).

Discussion:

In this 3-week COVID-19 antibody screening test, 12 staff out of 310 screened (3.8%) had been exposed to the COVID-19 infection without being aware of it. This serology surveillance reflected the actual rate of asymptomatic and non-PUI infection among the SHC healthcare worker. Many of these infections were not detected earlier because the PUI criteria were not met. Some HCW who had close contact (low-medium risk)[31] with confirmed cases did not receive the PCR testing during the early days of pandemic. This is likely due to scarce resources leading to prioritization protocol as suggested by many sources.[18,32]

WHO estimated a 2%-3% of the world's population tested positive for antibody response towards COVID-19.[33] Applying this projected percentage to our total HCW in SHC (686 clinical staff), the estimated number of staff with IgG antibody would be 13.7. Our surveillance result showed a higher percentage of the previous

infection compared to this estimation (3.8% vs. 2%). However, this comparison is a lot lower compared to the findings of a multicentre RT-PCR surveillance study conducted on mildly symptomatic HCW in the Netherlands (COVID centres)[13],3.8% vs. 9.5%.

We postulated a few reasons for the discrepancy of our staff's infection rate with the WHO and European data. Comparing to the public population, HCW have a higher risk of being exposed to infection while delivering medical care in the frontline. While the public are expected to observe a more controlled social distancing manoeuvres during the public movement restriction orders, HCW are required to travel, and hence a higher potential risk of exposure to infection. Lower rate of infection compared to the Netherlands data may be explained by the work environment, where lower staff exposure is anticipated in a non-COVID medical facility. Shorter timing of exposure to COVID-19 patients may also explain the lower risk and rate of infection.[31,34] A lower prevalence of COVID-19 cases in Kuching-Samarahan in compared to Netherlands could also be the reason for less possibility of community-acquired infections.[7,35] Total HCW infection from China[12] or the Netherlands[13] may be higher than what were reported by the two countries if their positive PCR results had been combined with positive IgG tests in asymptomatic HCW.

Statistical analysis of our study showed a significant association of IgG status with the clinical symptoms, potential exposure at the cluster area, and place of work within the cardiology department. This finding agreed with the criteria used by WHO[36] and our Ministry of Health[28] to consider screening persons at higher risk when they developed respiratory symptoms or had close contact with to confirmed COVID patients or cluster areas. While testing capacity is generally not meeting the needs, this finding could guide the hospital occupational safety team to prioritize screening of HCW with higher risk in the future. Another interesting observation from our study is the significant number of staff, 7(2.7%), who tested positive with IgG but reported no symptoms at all. Asymptomatic cases remained a challenge to the COVID-19 management.[37] More work is needed to study other potential clinical or epidemiological factors to risk stratify this group of patient.[38]

Our study had two false-positive IgM results. This observation explained the importance of interpreting lateral flow immunochromatographic assay as positive, only when the result line is clearly demarcated. A false positive result can also occur due to the cross reactivity to the other coronavirus infection.[21] All 14 staff from our survey were quarantined until two sets of RT-PCR tests returned negative. These positive findings in our survey highlighted the need for post antibody serological testing plan if non-COVID medical facilities wishes to conduct an antibody serology survey. The capacity to carry out RT-PCR testing with support from the relevant authority such as the ID team, needs to be established for confirmation of viral status. It is necessary to adjust staff duty roster and pre-inform all sections of a possibility of staff shortage if quarantine orders are issued once antibody screening results are positive. Staff should also ensure that proper quarantine place is available before attempting the screening test.

Our centre's lower IgG prevalence during the peak of the pandemic in our country may be the result of effective in-hospital infection control measures. Our COVID-19 taskforce team produced a temporary infection control protocol to reduce staff's exposure to the infection within the hospital. Elective invasive cardiology procedures, i.e., diagnostic angiogram, transcatheter aortic valve replacement, and transoesophageal echocardiography, were postponed. Patients with clinic appointments were contacted via telephone and given options to either defer their clinic consultation with auto-renewal of prescriptions or to continue clinic consultation. To prepare for potential admission and emergency catheterization of cardiac diseases with concomitant COVID-19 infection, we redesigned ward and established a dedicated cardiac catheterization laboratory team. Medical personnel who attended to patients were directed to don level II personal protective equipment (PPE) and level III PPE, in normal wards and isolation rooms, respectively. If aerosol producing procedures were unavoidable, i.e., intubation, level III PPE were to be used. Screening of cardiac cases with respiratory symptoms were done in a temporary tent as the holding bay. Suspected PUI cases were not admitted but were referred to a COVID designated hospital. Cases expressing respiratory symptoms without epidemiological links were also discussed with infectious disease specialists to risk stratify them before admission into the wards. These patients who did not fulfill the PUI criteria but with respiratory symptoms

were admitted to the temporarily designated ward where level 2 PPE were imposed for every healthcare staff who manage the patients. Patients with respiratory symptoms who needed intensive coronary care were admitted to the coronary care unit's isolation room with negative pressure.

Lower IgG prevalence also reflects the limited potential immunity among SHC healthcare workers towards COVID-19. The in-hospital infection control measurements should be continued and constantly reviewed to suit the latest trend of pandemic control. It is still uncertain whether the presence of IgG antibodies confers long-term immunity to the individual. If so, it will have several implications such as the deployment of these "immune" staff to work in high risk areas, and the prioritization of staff for immunization[32] once a vaccine becomes available.

Limitation

Although this antibody test had provided useful information to our department, there are some limitations to our findings. HEALGEN COVID-19 quoted accuracy of more than 90% in diagnosing RT-PCR positive patients.[30] However, it is not authorized for emergency use by the United States Food and Drug Administration.[39] It is also not validated on mild to asymptomatic individuals. The serology antibody test is not suitable to detect acute infection due to the nature of the immune response. Thus, staff who were infected within a week may show false-negative results. It is also unknown to many regarding the duration of antibody present in the blood after previous exposure. A positive IgG test may not be protective for future infection and deployment of staff at high-risk area should still be done with the highest degree of infection control.[19]

Conclusion

COVID-19 antibody serology test helps to supplement the diagnosis of COVID-19 infection and assess the adaptive immunological response of healthcare workers to the infection. Although having a diagnostic test is prudent, our survey showed the utility of a proper history taking procedure as a first-line screening to risk stratify HCW for the serology tests, especially when resources are limited. The established relationship between clinical or epidemiological factors to the IgG status underlines the importance of HCW to observe the standard hygiene precaution and social distancing to avoid potential community or nosocomial transmission. Periodic antibody surveillance of HCW during or at the end of the pandemic with careful cost assessment may be beneficial.

Conflict of Interest

We report no conflict of interest.

Authors' Contribution

Hwei Sung Ling: Conceptualization (equal); Methodology (equal); Investigation (equal); writing – original draft (lead), formal analysis (lead); writing – review and editing (equal). **Ing Xiang Pang:**Methodology (equal); Investigation (equal). **Alan Yean Yip Fong:**Writing – review and editing (equal); supporting in other contributions. **Tiong Kiam Ong:** Conceptualization (equal); Funding acquisition (lead); writing – review and editing (equal). Other authors supported in entire study.

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Table 1. Staff demographics, clinical symptoms experienced, epidemiological factors and antibody serology test results	**Table 1.** Staff demographics, clinical symptoms experienced, epidemiological factors and antibody serology test results	**Table 1.** Staff demographics, clinical symptoms experienced, epidemiological factors and antibody serology test results
Subject Demographics	n (%) unless specified	p value˜ Positive likelihood ratio (CI 95%)
Age, years	Age, years	Age, years
Mean, SD	36, 7.7	
Female Gender	220 (71.0)	
Department/ Unit		
General Cardiology	17 (5.5)	
NICL	20 (6.5)	
ICL	21 (6.8)	
Cardiology Clinic	15 (4.8)	
Cardiology Wards	132 (42.6)	
Clinical Research Unit	6 (1.9)	
Radiology	26 (8.4)	
Emergency Unit	67 (21.6)	
Others	6 (1.9)	
Occupation/ Position		
Doctor	37 (11.9)	
Nurses	165 (53.2)	
Allied HCW	96 (31)	
Others	12 (3.9)	
Residential Area		
Kuching	107 (34.5)	
Kota Samarahan	162 (52.3)	
Others	41 (13.2)	
Reported Clinical Symptoms experienced within January – March 2020	Reported Clinical Symptoms experienced within January – March 2020	Reported Clinical Symptoms experienced within January – March 2020
At least one symptom experienced	46 (14.8)	
Fever	11 (3.5)	
Cough	32 (10.3)	
Shortness of Breath	3 (1.0)	
Sore Throat	31 (10)	
Runny Nose	22 (7.1)	
Others	1 (0.3)	

Table 1. Staff demographics, clinical symptoms experienced, epidemiological factors and antibody serology test results	**Table 1.** Staff demographics, clinical symptoms experienced, epidemiological factors and antibody serology test results	**Table 1.** Staff demographics, clinical symptoms experienced, epidemiological factors and antibody serology test results
Epidemiological linked to COVID-19 infection	Epidemiological linked to COVID-19 infection	Epidemiological linked to COVID-19 infection
Exposure to COVID-19 clusters area	24 (7.7)	
Close contact with confirmed COVID-19 patients	24 (7.7)	
Travelling history to foreign countries	4 (1.3)	
Antibody Serology Test Result	Antibody Serology Test Result	Antibody Serology Test Result
IgM antibody positive	2 (0.6)	
IgG antibody positive	12 (3.9)	
Mean Age	40 years old 35 years old	0.058
Positive		
Negative		
Gender	4 (4.4) 8 (3.6)	0.750
Male (positive)		
Female (Positive)		
Unit	4 (5.9) 8 (3.2)	0.298
Emergency unit (positive)		
Other Units (positive)		
Within Cardiology Units	1 (0.7) 6 (5.7)	0.046 1.9 (1.42-2.79)
Cardiology ward (positive)		
Other cardiology units (positive)		
Occupation	2 (5.4) 6 (4.2) 2 (2.0)	0.623
Doctor (positive)		
Nurse (positive)		
Allied HCW (positive)		
Residential Area	3 (2.8) 9 (5.5)	0.2
Kuching (positive)		
Kota Samarahan (positive)		
Clinical Factors	5 (10.9) 7 (2.7)	0.021* 3(1.4-6.27)
Staff with symptoms (positive)		
Staff without symptoms (positive)		
Epidemiological Factors	4 (16.7) 8 (2.8)	0.009* 4.97(2-12.28)
Staff with exposure to COVID-19 clusters area (positive)		
Staff with exposure to COVID-19 clusters area (negative)		

SD Standard deviation, HCW Healthcare Workers, IgM Immunoglobulin M, IgG Immunoglobulin G, CI Confidence Interval, ˜ p value for interaction: (IgG antibody status x staff demographic/ clinical symptoms/ epidemiological factors)

Figure Legends:

Figure 1. Enrolment flowchart of antibody surveillance test among healthcare workers in PJS

HCW Healthcare Worker, PUI Person under investigation, OHST Occupational Health and Safety Team, ID Infectious Diseases, RTK Rapid test kit

Figure 2. Flowchart on management of SHC HCW with positive antibody surveillance test

HCW Healthcare Worker, PUI Person under investigation, OHST Occupational Health and Safety Team, ID Infectious Diseases, RT-PCR Real time- Polymerase Chain Reaction, RTK Rapid test kit

Figure 3. Illustration on how to use and interpret the results of HEALGEN COVID-19 antibody rapid test kit.[30]

Figure 4. Illustration of serum separated from the whole blood (left).[40] An example of faintly positive IgM (middle) and clearly demarcated IgG line (right).

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`Figure 1 Enrolment flowchart of antibody surveillance test among healthcare workers in PJS.docx` available at https://authorea.com/users/322431/articles/451396-covid-19-antibody-surveillance-among-healthcare-workers-in-a-non-covid-designated-cardiology-centre

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`Figure 2 Flowchart on management of SHC HCW with positive antibody surveillance test.docx` available at https://authorea.com/users/322431/articles/451396-covid-19-antibody-surveillance-among-healthcare-workers-in-a-non-covid-designated-cardiology-centre